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3/29/91

Mr. Jackson Ransohoff
Neutron Products, Inc.
22301 Mt. Ephraim Road
P.O. Box 68
Dickerson, MD 20842

Information in this record was deleted in accordance with the Freedom of Information Act.
Exemptions [illegible]
FOIA/PA 2008-0145

Dear Mr. Ransohoff:

This letter is to notify you that I have sent copies of my March 28 report evaluating NPI radiation protection for the period April through December, 1990 and my March 29 report evaluating the 1990 NPI melts and cleanups to Mr. Arthur Fletcher, MDCRH, by Federal Express today. Outstanding items are a report on conditions in January, 1990, and my review of NPI reports on conditions in January and February, 1991. I need to be out of town the week of March 31, and am requesting that I might delay submitting those reports until April 12. Please call me if that is not workable.

Sincerely,

Thomas E. Potter

Thomas E. Potter

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APR 2 1991
RADIOLOGICAL HEALTH PROGRAM

6/14

RADIATION PROTECTION EVALUATION
OF NEUTRON PRODUCTS, INC.

MONTHLY REPORTS 12-20
4/90 THROUGH 12/90

3/28/91

by

Thomas E. Potter

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4231 Jenifer Street NW
Washington, DC 20015-1959

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RADIATION PROTECTION EVALUATION
OF NEUTRON PRODUCTS, INC.

MONTHLY REPORTS 12-20
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Introduction

This evaluation was undertaken in response to conditions added to Condition 13 of MDCRH license 31-025-01 added by Amendment 33. Section numbers and titles in this report are keyed to the above noted conditions. This report includes the twelfth through the twentieth monthly reports required by the amendment, and describes conditions in the period April through December, 1990. The format of these reports differs from the format of previously submitted reports. In previous reports all data were presented in the text of the report. In these reports, data are presented in tabular form for each month. The tables indicate departure from normal levels and results of investigative and corrective actions. This evaluation report here includes analysis only. The revised format should make reports easier to prepare and use.

C.1.a Contamination Control Procedures and Methods

Surface Contamination

In general, contamination levels throughout most of the LAA work zone (ante-room, machine shop, and manipulator side of the hot cell) departed only slightly from a pattern established in earlier periods. Summaries of these data are included in the monthly data summaries. In May through July, surface contamination levels in the contamination control zone behind the hot cell were substantially higher than in periods prior to February, when contamination levels were lowest. Levels through the remainder of the year were somewhat lower than the maximum levels observed in the summer. Summaries of these data are included in Appendix A of this report.

Elevated levels of contamination appear to be due to contamination spread during cleanups and transfers of equipment between the hot tool room and the cell. Frequency of decontamination was apparently reduced in May through July while alternate methods of managing contaminated liquid waste were being developed. Contamination levels remained acceptably low from the standpoint of worker internal exposure considerations (based on no detection of significant levels of internal contamination by the HECM), the elevated levels continued to indicate that control measures effective in similar operations in the past year were not implemented as effectively in this period. Isolation of contamination within the contamination control zone appeared to be reasonably effective, based on the low contamination levels observed outside the zone.

Smear data indicate that contamination levels in the courtyard remain low, but are not as reliable as smear data for smooth surfaces. Increases in radiation levels observed in the drypond, which catches runoff from the courtyard, may be due to flushing of material accumulated in previous years in drainage pipes, but contribution from operations during the period cannot be ruled out.

Work Area Air Sampling

Summaries of high-volume grab samples are included in the monthly data reports. These indicate that airborne cobalt-60 concentrations in the work area are almost always less than the unrestricted area maximum permissible concentration of 3×10^{-10} microCuries per cubic centimeter, and are always well below the restricted area maximum permissible concentration of 9×10^{-9} microCuries per cubic centimeter. These findings are consistent with results from annual whole body counting, approximately twice-daily personal contamination monitoring, which serves as a reasonably sensitive screening lung counter, and area contamination surveys. All of these measurements indicate that internal exposures are infrequent and insignificant from the internal dose standpoint.

Pool and Canal Water Contamination

Trends in pool and canal water contamination levels are included in the monthly data reports. North canal concentrations of cobalt-60 peaked in May and June, but a cleanup in the fall reduced concentrations to about 1×10^{-4} microCuries per cubic centimeter in the last quarter of the year. Concentrations in the main pool fluctuated between about 7×10^{-4} and 2×10^{-3} microCuries per cubic centimeter, well above normal, for most of the period. Levels were maintained in this range by periodic resin changes. The concentration increased markedly in December to a peak of 2×10^{-2} microCuries per cubic centimeter, but was reduced to 2×10^{-3} microCuries per cubic centimeter by the end of the month. A cleanup of the main pool and a change in the resin mix for the water purification was planned in the period. (Concentrations were effectively reduced to below the action level of 5×10^{-4} microCuries per cubic centimeter by the time this report was written.)

C.1.b Respiratory Protection Program

The implementation of the new respiratory protection program continued through the last period. Measurements continue to show that the performance of the respiratory protection program is generally adequate. Internal exposures associated with the use of respiratory protection equipment have been negligible, except for one case, in which a worker was exposed through the inhalation pathway during removal of respiratory protection equipment. This case, reported to MDCRH previously, involved a lapse in following the procedure for removal of respiratory protection equipment. Routine use of battery operated lapel samplers for coverage of work requiring respiratory protection was initiated during the period, but experience has not been sufficient to evaluate.

C.1.c Personnel Monitoring for Internal and External Radiation Exposure

Worker external radiation dosimetry

Use of extremity dosimetry was re-initiated in the cleanup following the January melt for the first time in many years. A single wrist dose exceeding extremity limits was measured in the cleanup following the June melt, but all other measured extremity doses during the two cleanups were below regulatory limits. These are discussed further in the report on melts. During this period, extremity monitoring was extended to other operations. No changes in dosimetry have been made in the last reporting period.

Measured whole body doses to the workers for the year 1990 are below regulatory limits and summarized in Appendix B. Approximately 50 people received doses exceeding 0.1 rem. The highest individual dose received was 8.8 rem. The aggregate dose to the worker population was about 115 person-rem, of which approximately 20 were accumulated in each of two melt cleanups. The aggregate dose in 1990 might be somewhat higher than normal because of the occurrence of two melt cleanups and canal and pool cleanups. On the other hand, NPI conducted two melts in three of the five years from 1984 through 1988.

About one-third of the aggregate dose (39 person-rem) was received by the five people who worked nearly every day in the

LAA through the year. The distribution of two-thirds of the dose to people who do not work every day in the area reflects the use of other NPI personnel, including top managers, in special work, such as hot cell cleanups, waste shipments, etc. The average dose to an individual in this group was approximately 7.8 rem.

About 60 percent of the total (72 person-rem) was received by the 11 people, including the five persons noted above, who received 4.9 rem or more in the year. These 11 people averaged about 6.5 rem in the year. About 20 percent of the total (24 person-rem) was received by the nine people who received more than 2.0 rem and less than 4.9 rem in the year.

Persons received more than 2.5 rem in a single quarter on five occasions. All but one of these involved persons who worked in the LAA nearly every day or a substantial fraction of the time. Persons received more than 2 rem in a single quarter on 17 occasions, including the five occasions noted above. All but four of these involved persons who worked in the LAA nearly every day or a substantial fraction of the time.

Two persons have lifetime doses of approximately 100 rem. One person's lifetime dose is approximately 50 rem. Seven persons have lifetime doses between 15 and 30 rem. Lifetime doses for all others are less than 15 rem. This summary excludes the lifetime dose of about 75 rem for one employee who received virtually all of that dose working as an x-ray technician for a previous employer. If lifetime dose is averaged over the years greater than age 18, three workers have working life average doses between 2.9 and 4.0 rem per year, three workers have working life average doses between 1.0 and 2.0 rem per year, and eight workers have working life average doses between 0.5 and 1.0 rem per year.

Worker internal radiation measurements

Routine whole body counting results are summarized in the monthly data report for October. Except for one case reported to MDCRH previously and discussed in Section C.1.b, all levels indicated less than 3 percent of the maximum permissible lung burden. The single exception possessed an initial lung burden on August 31 equal to approximately 61 percent of the ICRP 2 maximum permissible lung burden of 1,100 nanoCuries. This burden declined slowly over the following months, as tracked by counts on the personal contamination monitor, which also is sufficiently sensitive to cobalt-60 gamma radiation to serve as a screening lung counter for lung burdens above about 100 nanoCuries. The individual's lung burden had fallen below this threshold by the middle of March, 1991. A follow-up report on this case is in preparation.

C.1.d Radiological Effluent Monitoring and Control for Liquid and Gaseous Releases

Monitoring and Control of Gaseous Effluent

Data are summarized in the monthly reports. Concentrations are consistently less than 0.3 percent of the unrestricted area MPC of 3×10^{-10} microCuries per cubic centimeter.

Monitoring and Control of Liquid Effluent to WSSC

Liquid effluent sampling are summarized in the monthly data reports. These data indicate that releases to the Washington Sanitary Sewer Commission are low and controls are adequate. Concentrations were far lower than the 10 CFR Part 20 Appendix B Table 1 limit of 1×10^{-3} microCuries per cubic centimeter, and substantially below the more conservative license limit of 2×10^{-4} microCuries per cubic centimeter.

During this period, the collection sump for scrub water from the LAA intended for discharge to the sanitary sewer system was found to be leaking into soil beneath the building. The sump and virtually all of the contamination adsorbed on soils surrounding the sump (estimated to be no more than 200 milliCuries) were removed and packaged for disposal. A sump is no longer used to collect this water. As a part of the modification of the procedure for handling these wastes, a system to filter mop water was installed with the intent of reducing cobalt-60 in effluent water by collecting and solidifying the cobalt-rich sludge. The levels of cobalt-60 in water have been low, but limits will be reduced in the new 10 CFR Part 20.

Monitoring and Control of Waterborne Releases through the Drypond

This topic was addressed in detail in the second report. A plan for environmental monitoring and surveillance was submitted to CRH during third reporting period, and the plan addresses these releases. No other changes have occurred since the last report. Maximum radiation levels in the drypond have increased from about 0.1 millirem per hour to about 0.5 millirem per hour over the past 18 months. Penetrating radiation from cobalt-60 contamination released to unrestricted areas (the drypond area) exceed the license limit of 500 millirem per year, and are closely approaching the regulation limit, 100 millirem per week. Because members of the public are not usually present in those areas and because the peak dose rate measured is confined to a small area, it is not likely that any person would receive 500 millirem in a year.

The increase in activity indicates that the inventory in the drypond and the area beyond the drypond has increased. A more extensive survey of the area would be required to estimate the increase with confidence, but if the increase in peak levels are indicative of increases elsewhere, the increase in inventory may be from about 0.5 milliCuries to perhaps as much as about 3 milliCuries in a period of about 18 months. Increases may be due to flushing of material accumulated in previous years in drainage pipes, but contribution from operations during the period cannot be ruled out. In developing a plan to address this problem it would be desirable to include application for regulatory relief on at least a temporary basis (increasing the permissible dose rate), fencing the area, monitoring to better characterize contamination distribution in the area, and monitoring to better characterize the source of the contamination.

C.1.e Adequacy of Air Handling Systems in the Production Areas

There have been no changes to the air handling system since the last report. Concentrations of cobalt-60 in air in operating areas were far less than the maximum permissible concentration limit for restricted areas (see C.1.a).

C.1.f Control and Identification of Radiation and High Radiation Areas, and Contaminated Equipment and Facilities

High Radiation Areas, Major Gamma Radiation Sources and Control Measures

Major radiation sources and levels have not changed significantly in the reporting period. The only significant change in control measures has been modification of the design of the hot cell interlock system. This modification was initiated following a lapse in resetting the radiation level setpoint following interlock override to gain access to the cell for the post-melt cleanup in January. The modified system does not require setpoint modification for override, but does require RSO participation through a key switch mechanism. The maximum permissible setpoint is 750 mR/hr.

Work area direct radiation surveys

Routine radiation surveys continued to be performed as described in the first report.

Perimeter radiation surveys

Perimeter radiation survey results have been tabulated and submitted to MDCRH separately. There has been no substantial change in trends from previous reporting periods. Levels in some locations are very near and may slightly exceed license limits for radiation at the fence, 500 millirem per year.

Control and identification of contaminated equipment and facilities

These topics are discussed in Section C.1.a.

C.1.g Radiological Waste Handling, Processing, and Disposition (Storage and Shipment)

Waste shipments (volume and curie content) are listed in the monthly data reports. Waste shipment rates appear to be roughly matching waste generation rates. Inventory reduction, improved shielding in storage and handling, and improvements in materials handling (so that waste need not be handled twice--once in collection and storage, and once in preparation for shipment) would be desirable. Some combination of these may be necessary to meet current license radiation dose limits at the fence with a reasonably comfortable margin. Improved shielding will be essential in meeting new 10 CFR Part 20 limits and requirements for onsite storage of radioactive waste.

C.1.h Hot Cell Decontamination Methods and Procedures

No significant change in procedures has occurred in the last period. A separate report has been prepared on the radiation protection aspects of cobalt-60 melting.

C.1.i Personnel Training and Qualification

There was no participation by the CHP in training activities in this period. Although the formal general training program was not implemented in this period, general training was conducted in the implementation of revised RWPs and in respiratory protection. Some specialized training also took place. B. Boswell attended a two-day health physics training course at the National Institute of Standards and Technology (formerly NBS) in the fall. All three health physics techs ha completed this course in the last two years. Two health physi techs attended a half-day training session on the use, maintenance, and cleaning of respirators. This course was conducted on site by MSA and Chesapeake Optical Co.

C.1.j Management Oversight and Control of Radiological Activities

Events during the period indicate that continued improvement in management oversight, organization, and support of day-to-day operations is desirable. Certain kinds of minor citations for regulatory non-compliance (missed smears of seal sources, etc.) indicate that improvement in administrative oversight at the RSO level is desirable.

Complete implementation of the RSO report proposed by the CHP in early April, 1990, and resubmitted in a refined form in mid-May, 1990 would help document the history of operations so that developing trends could be detected early, would cause a more comprehensive and more consistent review of radiological protection data by the RSO, and would serve to communicate status of radiological conditions to top management in a more timely way. Recent adoption of the reduced form of that report that serves as the monthly data summaries in this package of reports is a good start in that direction.

Planning and scheduling become more important as regulator limits are approached to assure that material and human resources are used most efficiently and to assure the benefits of improvements in one area are not offset by aggravation of problems in other areas. Establishing a list of priorities an working on them from the top down incorporates an unexamined assumption that the available level of resources is sufficient and begs the question whether additional resources are needed t maintain a sufficiently high rate of improvement and to maintai improvements on a continuing basis. A living (ie., periodicall reviewed and updated) comprehensive plan and schedule, which shows, by task for each project, the work scope, personnel and financial resource allocation, and targeted milestone completi dates is desirable, and, in my view, necessary to answer this question prospectively. If such a plan is developed, it will b desirable, if not necessary, to coordinate the development of the plan and schedule with CRH to assure agreement on goals, priorities, and schedule, to give CRH early warning on the need for regulatory review, and to incorporate realistic schedules for regulatory review.

C.2 Portal Monitor Installation and Maintenance
C.3 Background at Portal Monitor
C.4 Portal Monitor Performance Report

Data and operating status are summarized in the monthly data reports. The personnel contamination monitor (PCM) operated continuously (during working hours) during the period. The portable contamination monitor with a 100 square centimeter gas proportional detector installed near the personnel contamination monitor for backup and complementary use continues to be operational. No significant changes in background or counting characteristics occurred in the period. The background radiation level in the personnel contamination monitor area remains at approximately 40 microRoentgen per hour.

In this reporting period, there were 20 personnel contamination events above the reporting level (22,000 dpm):

1. 4/23 33,000 dpm on back and arms
2. 5/14 181,000 dpm on back (CRH notified by phone)
3. 6/2 28,000 dpm on ear
4. 6/3 22,000 dpm on lower leg
5. 6/14 320,000 dpm on underwear (CRH notified by phone)
6. 6/16 23,000 dpm on hand
7. 6/22 22,000 dpm on back
8. 6/25 24,000 dpm on armpit
9. 7/6 22,000 dpm on thigh
10. 7/9 31,000 dpm on palm
11. 7/12 24,000 dpm on elbow
12. 7/24 27,000 dpm on hand
13. 7/25 133,000 dpm on shorts (CRH notified by phone)
14. 7/30 22,000 dpm on thigh
15. 7/30 31,000 dpm on thumb
16. 8/21 129,000 dpm on arm (CRH notified by phone)
17. 8/27 94,000 dpm on chest (CRH notified by phone)
18. 8/29 26,000 dpm on shoulder
19. 10/3 37,000 dpm on neck
20. 11/14 41,000 dpm on shoulder

In addition, there were 17 events of lesser contamination (between 10,000 and 22,000 dpm) requiring notification of the RSO. In all of these events the contamination was readily found and removed. None of these events resulted in doses to workers that represent significant fractions of regulatory limits, including the NRC enforcement policy statement regarding occupational doses from "hot particles" published in the Federal Register July 31, 1990. This NRC position in this policy statement is, in essence and effect, the same as that proposed to MDCRH by NPI in mid-1989. The causes of most of the events noted above are not known, but it is likely that the events in June and July were at least indirectly related to the post-melt cell cleanup or contamination associated with the cleanup. The current license requirements for reporting these events should be reviewed in light of the accumulated history and the modification of NRC position on the matter.

C.5 Courtyard Roof Design and Construction

There was no progress in this period.

C.6 Hot Cell Ventilation System

The hot cell ventilation system evaluation was submitted as a separate report dated May 17, 1989. Additional information requested in the CRH letter dated June 22, was included in Addendum 1 to the second report in this series. A supplementary report on the filtration efficiency during the cleanup after bare cobalt operations was submitted on August 24. The new backup electrical power generator for the hot cell ventilation fans continued to be operational.

The limited efficiency of the roughing filter results in transport of cobalt-60 into the ventilation ductwork. The exposure rate on the HEPA filter monitor after primary HEPA change is increasing at the rate of about 200 millirem per hour per year, and is currently about 1.8 R per hour, about twice as high as at the beginning of 1986. Although this observation may be misleading and may simply indicate changes in contamination minor conditions near the detector location, this could indicate that cobalt-60 contamination deposited within the ventilation system ductwork may be increasing slowly but perceptibly. The primary HEPA is changed about once per year on the average, and typically contains about 0.5 Curie of cobalt-60. The last HEPA filter change resulted in an aggregate dose of about 0.2 person-rem. A more complete set of surveys may be desirable to better assess the situation and to assist in determining the need for a corrective plan.

Conclusions

Most radiation protection problems at NPI have been sufficiently well controlled to meet the most basic regulatory requirements almost all of the time and other requirements most of the time. Workers receive doses exceeding current limits infrequently. Members of the public do not receive doses exceeding current limits. However, the slow accretion of a number of problems is reaching the point where regulatory compliance in a number of areas is becoming difficult to control using past approaches. Furthermore, anticipated changes in regulatory requirements will increase the difficulty of managing some of these problems. These problems are as follows:

1. Penetrating radiation doses for key LAA workers and some others regularly approach quarterly regulatory limits. Doses in these cases appear to be sufficiently controlled to keep overexposures unlikely under current regulations. Current regulatory limits are occasionally exceeded, roughly once every two or three years, but those overexposures are almost always associated with short-duration exposure in high dose rate work in which the anticipated dose is not accurately estimated or, more likely, in which a lapse in work procedure occurs. The margin for such lapses decreases with increasing dose rate. Reduction of the frequency of overexposures will require improved controls in high dose rate work and/or reduction of dose rates in that work. The removal of quarterly limits in the new 10 CFR Part 20, to be implemented in January, 1994, may reduce the increment of added restriction of lower annual dose limits from the standpoint of NPI overexposures, even if receipt of the annual dose in a single quarter is prohibited, as is likely. Compliance with the reduced annual dose limits in the new 10 CFR Part 20 will require dose rate reductions in general LAA work and in some specific tasks.

2. Penetrating radiation exposure rates in unrestricted areas from cobalt-60 within the restricted area (ie., inventory in waste storage rooms, etc.) regularly closely approach and may exceed license condition limits 500 millirem per year in several locations along the perimeter fence, assuming continuous occupation. However, because presence of members of the public in those areas is limited in time, doses to people are well below 500 millirem per year. In a few isolated areas in the unrestricted area (ie., parts of certain offices), levels closely approach or slightly exceed dose rate limits in regulations. Again, occupation times in those areas are limited and monitoring of those individuals shows that doses are more than a factor of three below the 500 millirem per year limit. Reduction will require reductions in inventory and/or additional shielding. Substantial reductions in dose rate will be required to meet the requirements of the new 10 CFR Part 20. Incorporation of reduced inventory, added shielding, and, at least on an

interim basis, a relaxation in the applicable regulatory limits would be desirable elements in the plan to be developed for corrective action.

3. Cobalt-60 contamination continues to be released to unrestricted areas through rain water runoff pathways. This material appears to be slowly accumulating in unrestricted areas within and beyond the drypond. Analyses showing that concentrations of cobalt-60 in rain water runoff are below maximum permissible concentrations are based on the assumption that a substantial fraction of the cobalt-60 released this way has been entirely collected in the area of measurable accumulation. While that assumption may be correct, confirmation would be desirable. The occasional discovery of microCurie spots of contamination offsite may or may not be associated with the milliCurie inventory in the drainage area. In developing a plan to address this problem it would be desirable to include application for regulatory relief on at least a temporary basis (increasing the permissible dose rate), fencing the area, monitoring to better characterize contamination distribution in the area, monitoring to better characterize the source of the contamination, and interim limits for radiation and contamination to guide remediation efforts until the situation is more fully understood.

4. Penetrating radiation from cobalt-60 contamination released to unrestricted areas (the drypond area) exceed the license limit of 500 millirem per year, and are closely approaching the regulation limit, 100 millirem per week. Because members of the public are not usually present in those areas and because the peak dose rate measured is confined to a small area, it is not likely that any person would receive 500 millirem in a year. Remediation of this problem as described in item 4 would be desirable.

5. Intakes of cobalt-60 on the order of a microCurie, resulting from short-duration exposures, typically less than one hour and often just minutes, occur at a frequency of about two per year. These have been perceived by NPI to be ingestion exposures based on the observed rapid clearance of most of the intake through the GI system, and on the highly localized nature of the contamination source. However, proving that the exposure is ingestion rather than inhalation is difficult because large fractions of inhaled material are also eliminated through the GI system in the

first few days following exposure. The uptake in the lung experienced in the exposure of one individual in 1990 is indication that the inhalation pathway exists even if it may not be the most likely.

If the intakes are indeed inhalations, they correspond to a significant fraction of the current maximum permissible quarterly inhalation of 5.7 microCuries (the intake equivalent to breathing air at restricted area MPC at 20 liters per minute for 40 hours per week for 13 weeks). If they are ingestions, the maximum permissible quarterly intakes should be about 71.5 microCuries (the intake equivalent to consuming 1,100 milliliters of water at restricted area MPC per work day for 5 days per week for 13 weeks) and the margin for compliance would be substantially greater.

Except for the single case identified above, the doses associated with these intakes are negligibly small, whether they are inhalations or ingestions. The small margin for regulatory compliance stems from conservatism in the current regulation. Margin for regulatory compliance will increase with the adoption of the new 10 CFR Part 20, due to a more realistic approach to regulation of internal exposures. Although this problem may not be serious from the health and safety standpoint, the regulatory agencies are particularly, perhaps overly, sensitive to it. The incorporation of half-face respirators for these situations could be a relatively easy way to accommodate their concerns and could provide insurance against less likely higher exposures.

6. Limitations in space, shielding, and remote-handling capabilities and accumulated backlogs of waste materials from past operations make radioactive waste handling, storage, and shipping facilities and procedures substantial contributors to several radiological problems. These include doses to operators, levels of radiation in unrestricted areas, and, probably, levels of contamination in unrestricted areas, the latter due to the fact that radioactive waste transfers between operating and storage areas, both of which are areas in which floor contamination levels are high, must pass through the open courtyard. Improvements in these facilities and procedures that properly integrate these considerations could improve the margin of regulatory compliance in a number of areas and

will probably be necessary to assure compliance with some of the new requirements. NPI is correct in placing a high priority on efforts along these lines and should continue those efforts.

7. NPI has no facility in which materials and equipment can be decontaminated in such a way that contamination containment and dose reduction features such as local shielding are available. The feasibility for and potential benefits from such a facility should be evaluated.

8. Limitations in facilities, equipment, and procedures used in the storage and transfer of contaminated equipment used in source fabrication frequently result in the spread of floor contamination in the CCZ on the order of 0.1 to 1 milliCurie each time the operation is performed. The feasibility for and potential benefits from improvements in these facilities and procedures should be evaluated.

9. Limited filtration efficiency at the point of entry to the hot cell exhaust ventilation system, when coupled with releases of cobalt-60 to the air in the cell, results in substantial transport of airborne cobalt-60 within the cell into the ventilation system, leading to high cobalt-60 inventories in the ventilation system and on the primary HEPA filter. The greatest increment occurred in 1986. Although increases in levels appear to have been relatively small since then, levels in the ventilation system remain high. This phenomenon contributes to a variety of problems:

   - High dose rates from cobalt-60 on the HEPA filter and in other ventilation system components contribute to high exposure rates in both restricted and unrestricted areas.

   - The HEPA filter change frequency is determined in part by anticipation of future accumulation of cobalt-60 on the filter, and is much higher than would be required if the change frequency were determined by particle loading. This increases costs and contributes to waste management problems.

   - High dose rates from material on the HEPA filter and in other ventilation components complicates the filter change operation and other operations in the area, such as efficiency testing of the final HEPA filter. Although reduction in dose rates would be desirable, that would not appear to be a major driving force for improved roughing filter efficiency in the near term. The primary HEPA filter change currently contributes about 0.2 person-rem per year to the aggregate dose, an insignificant part of the total aggregate dose in the operation.

10. Conductivity and concentrations of cobalt-60 in the main pool and in the canals were high in 1990 and were difficult to bring down. A substantial cleanup effort in the last half of 1990 reduced concentrations in the North Canal. (A similar effort for the main pool in early 1991 had reduced concentrations to levels below the action level.) Plans for future activities need to include provision for sustaining these gains. Long-term integrity of singly-encapsulated waste tubes with untested welds does not appear to be a contributor to pool contamination thusfar, but the potential for importance in the future should be analyzed.

These problems are manageable, but it is not clear that NPI has a workable way to manage them within the constraints of present and future regulatory requirements. A living (ie., periodically reviewed and updated) comprehensive plan and schedule, which shows, by task for each project, the work scope, personnel and financial resource allocation, and targeted milestone completion dates is desirable, and, in my view, necessary to answer this question prospectively. If such a plan is developed, it will be desirable, if not necessary, to coordinate the development of the plan and schedule with CRH to assure agreement on goals, priorities, and schedule, to give CRH early warning on the need for regulatory review, and to incorporate realistic schedules for regulatory review.

APPENDIX A

NEUTRON PRODUCTS, INC.
CCZ SMEAR SURVEY SUMMARIES

1/90-12/90

SMEAR SUMMARY
CONTAMINATION CONTROL ZONE
JANUARY, 1990

SMEAR ACTIVITY RANGE AND MEDIAN (DPM/100 SQ CM)

DAY	NUMBER OF SMEARS		-------RANGE-------		MEDIAN
1	0		HOLIDAY		
2	20		<1,000	23,000	2,500
3	20		<1,000	87,000	8,600
4	20		<1,000	37,000	2,900
5	20		<1,000	24,000	3,900
8	20		<1,000	67,000	8,100
9	20		1,200	23,000	5,700
10	20		<1,000	75,000	8,100
11	20		<1,000	98,000	6,400
12	20		1,100	73,000	6,500
15	15		<1,000	43,000	7,000
16	15		<1,000	28,000	6,500
17	0		MELT CLEANUP PREP		
18	20		MELT CLEANUP PREP		
19	20		MELT CLEANUP PREP		
22	0		MELT CLEANUP IN PROGRESS		
23	0		MELT CLEANUP IN PROGRESS		
24	0		MELT CLEANUP IN PROGRESS		
25	0		MELT CLEANUP IN PROGRESS		
26	0		MELT CLEANUP IN PROGRESS		
29	0		MELT CLEANUP IN PROGRESS		
30	5	PLASTIC	27,000	260,000	160,000
31	0		MELT CLEANUP IN PROGRESS		
				AVG MEDIAN	6,000

AVG EXCLUDES 1/30 SMEARS

SMEAR SUMMARY
CONTAMINATION CONTROL ZONE
FEBRUARY, 1990

SMEAR ACTIVITY RANGE AND MEDIAN (DPM/100 SQ CM)

DAY	NUMBER OF SMEARS	RANGE		MEDIAN
1	20	<1,000	179,000	25,000
2	20	<1,000	856,000	17,000
5	BARE CAMPAIGN CLEANUP UNDERWAY			
6	11	51,000	6,964,000	130,000
7	20	<1,000	292,000	13,000
8	20	<1,000	123,000	5,600
9	20	<1,000	137,000	19,000
12	20	<1,000	308,000	43,000
13	20	<1,000	95,000	8,700
14	BARE CAMPAIGN CLEANUP UNDERWAY			
15	BARE CAMPAIGN CLEANUP UNDERWAY			
16	20	<1,000	1,850,000	33,000
20	20	1,400	1,010,000	26,000
21	20	2,200	777,000	74,000
22	20	<1,000	1,023,000	16,000
23	20	<1,000	276,000	80,000
26	20	<1,000	302,000	60,000
27	20	1,200	297,000	15,000
28	20	<1,000	164,000	35,000
AVG			920,000	38,000

SMEAR SUMMARY
CONTAMINATION CONTROL ZONE
MARCH, 1990

SMEAR ACTIVITY RANGE AND MEDIAN (DPM/100 SQ CM)

DAY	NUMBER OF SMEARS	RANGE		MEDIAN
1	20	<1,000	180,000	16,000
2	20	<1,000	200,000	42,000
5	8	<1,000	67,000	10,000
6	20	<1,000	1,900,000	30,000
7	20	5,600	3,900,000	608,000
8	20	<1,000	1,200,000	5,800
9	20	<1,000	850,000	8,400
12	20	2,700	2,700,000	45,000
13	20	<1,000	660,000	3,100
14	20	1,700	720,000	19,000
15	20	<1,000	930,000	3,400
16	20	2,300	2,800,000	35,000
19	20	<1,000	780,000	8,600
20	20	2,000	89,000	10,000
21	20	<1,000	130,000	3,300
22	20	<1,000	74,000	7,700
23	20	<1,000	510,000	1,600
26	20	<1,000	210,000	6,600
27	20	<1,000	82,000	1,800
28	20	<1,000	610,000	6,600
29	20	<1,000	860,000	2,100
30	20	<1,000	730,000	7,400
AVG			917,000	40,100

Note: Average daily median is 12,400 excluding 3/7 value.

SMEAR SUMMARY
CONTAMINATION CONTROL ZONE
APRIL, 1990

SMEAR ACTIVITY RANGE AND MEDIAN (DPM/100 SQ CM)

DAY	NUMBER OF SMEARS	-------RANGE-------		MEDIAN
2	0	MINI-CLEANUP IN PROGRESS		
3	20	<1,000	37,000	11,800
4	20	<1,000	59,000	3,400
5	20	<1,000	83,000	14,700
6	20	<1,000	172,000	5,800
9	20	<1,000	69,000	8,700
10	20	<1,000	53,000	2,000
11	20	<1,000	81,000	14,000
12	20	<1,000	70,000	5,000
13	20	<1,000	74,000	7,600
16	20	<1,000	60,000	10,000
17	20	<1,000	280,000	7,900
18	20	<1,000	58,000	7,200
19	20	<1,000	142,000	5,900
20	20	1,600	58,000	8,400
23	20	<1,000	26,000	2,800
24	20	<1,000	548,000	8,400
25	20	<1,000	50,000	4,800
26	20	<1,000	27,000	4,300
27	20	<1,000	69,000	6,900
30	20	<1,000	79,000	3,200
			AVG MEDIAN	7,100

SMEAR SUMMARY
CONTAMINATION CONTROL ZONE
MAY, 1990

SMEAR ACTIVITY RANGE AND MEDIAN (DPM/100 SQ CM)

DAY	NUMBER OF SMEARS	--------RANGE-------		MEDIAN
1	20	1,000	74,000	8,000
2	20	<1,000	62,000	3,200
3	20	<1,000	57,000	8,200
4	20	<1,000	64,000	8,900
7	20	<1,000	3,300,000	24,600
8	20	<1,000	630,000	17,300
9	20	1,300	5,700,000	32,400
10	20	<1,000	4,200,000	12,600
11	20	<1,000	4,200,000	6,800
14	20	1,100	1,500,000	54,400
15	20	<1,000	46,000	34,500
16	20	<1,000	340,000	34,000
17	20	<1,000	200,000	11,300
18	20	1,300	520,000	15,200
21	20	<1,000	210,000	31,600
22	20	<1,000	250,000	16,500
23	20	<1,000	120,000	28,000
24	20	<1,000	71,000	27,000
25	20	<1,000	440,000	17,600
29	20	<1,000	250,000	19,400
30	20	<1,000	220,000	4,900
31	20	<1,000	160,000	34,800
			AVG MEDIAN	20,500

SMEAR SUMMARY
CONTAMINATION CONTROL ZONE
JUNE, 1990

SMEAR ACTIVITY RANGE AND MEDIAN (DPM/100 SQ CM)

DAY	NUMBER OF SMEARS		-------RANGE-------		MEDIAN
1	20		<1,000	70,000	3,900
4	20		<1,000	98,000	18,000
5	20		<1,000	110,000	6,100
6	20	PLASTIC	<1,000	71,000	2,500
7	20	PLASTIC	<1,000	17,000	900
8	20	PLASTIC	<1,000	170,000	4,100
11	0		MELT CLEANUP IN PROGRESS		
12	0		MELT CLEANUP IN PROGRESS		
13	0		MELT CLEANUP IN PROGRESS		
14	0		MELT CLEANUP IN PROGRESS		
15	0		MELT CLEANUP IN PROGRESS		
18	0		MELT CLEANUP IN PROGRESS		
19	20		<1,000	200,000	24,000
20	20		<1,000	900,000	55,000
21	20		MINI CLEANUP IN PROGRESS		
22	20		<1,000	420,000	48,000
25	20		<1,000	670,000	51,000
26	20		<1,000	210,000	44,000
27	20		<1,000	370,000	56,000
28	20		<1,000	85,000	3,000
29	20		<1,000	89,000	10,000
				AVG MEDIAN	23,300

SMEAR SUMMARY
CONTAMINATION CONTROL ZONE
JULY, 1990

SMEAR ACTIVITY RANGE AND MEDIAN (DPM/100 SQ CM)

DAY	NUMBER OF SMEARS	-------RANGE-------		MEDIAN
2	20	<1,000	540,000	30,000
3	20	<1,000	220,000	12,000
4	0	HOLIDAY		
5	20	<1,000	82,000	24,000
6	0	MINI CLEANUP IN PROGRESS		
9	20	<1,000	96,000	10,000
10	20	<1,000	790,000	41,000
11	20	<1,000	180,000	4,900
12	0	MINI CLEANUP IN PROGRESS		
13	20	<1,000	540,000	39,000
16	20	<1,000	690,000	34,000
17	20	<1,000	340,000	30,000
18	20	<1,000	480,000	22,000
19	20	<1,000	370,000	24,000
20	20	<1,000	140,000	19,000
23	20	<1,000	70,000	7,700
24	20	<1,000	360,000	20,000
25	20	<1,000	740,000	27,000
26	20	<1,000	580,000	19,000
27	20	<1,000	670,000	23,000
30	20	<1,000	1,300,000	58,000
31	20	<1,000	110,000	10,000
			AVG MEDIAN	23,900

SMEAR SUMMARY
CONTAMINATION CONTROL ZONE
AUGUST, 1990

SMEAR ACTIVITY RANGE AND MEDIAN (DPM/100 SQ CM)

DAY	NUMBER OF SMEARS	-------RANGE-------		MEDIAN
1	20	<1,000	97,000	9,800
2	20	<1,000	45,000	20,000
3	0	MINI CLEANUP IN PROGRESS		
6	0	MINI CLEANUP IN PROGRESS		
7	20	<1,000	190,000	8,600
8	20	<1,000	130,000	9,400
9	20	<1,000	41,000	14,000
10	20	<1,000	54,000	9,700
13	20	<1,000	230,000	16,000
14	20	<1,000	1,200,000	29,000
15	20	1,400	15,000	6,700
16	20	<1,000	37,000	4,400
17	20	<1,000	26,000	3,000
20	20	<1,000	49,000	5,900
21	20	<1,000	23,000	5,300
22	20	<1,000	66,000	6,300
23	20	<1,000	110,000	5,900
24	20	<1,000	24,000	4,100
27	20	<1,000	26,000	5,000
28	20	<1,000	94,000	5,800
29	0	MINI CLEANUP IN PROGRESS		
30	20	<1,000	78,000	9,900
31	20	<1,000	25,000	5,700
			AVG MEDIAN	9,200

SMEAR SUMMARY
CONTAMINATION CONTROL ZONE
SEPTEMBER, 1990

SMEAR ACTIVITY RANGE AND MEDIAN (DPM/100 SQ CM)

DAY	NUMBER OF SMEARS	-------RANGE-------		MEDIAN
3	0	HOLIDAY		
4	20	<1,000	3,000,000	25,000
5	20	1,100	410,000	45,000
6	20	<1,000	550,000	57,000
7	20	<1,000	38,000	5,800
10	20	<1,000	67,000	19,000
11	20	<1,000	400,000	37,000
12	20	<1,000	78,000	13,000
13	20	<1,000	75,000	2,000
14	20	1,100	100,000	6,400
17	20	<1,000	14,000	5,700
18	20	<1,000	81,000	5,100
19	20	<1,000	350,000	18,000
20	20	<1,000	180,000	7,400
21	20	<1,000	160,000	7,400
24	20	<1,000	63,000	15,000
25	20	<1,000	60,000	12,000
26	20	<1,000	90,000	13,000
27	20	<1,000	61,000	11,000
28	20	<1,000	67,000	7,100
			AVG MEDIAN	16,400

SMEAR SUMMARY
CONTAMINATION CONTROL ZONE
OCTOBER, 1990

SMEAR ACTIVITY RANGE AND MEDIAN (DPM/100 SQ CM)

DAY	NUMBER OF SMEARS	-------RANGE-------		MEDIAN
1	20	1,800	70,000	13,000
2	20	<1,000	27,000	4,400
3	20	<1,000	63,000	15,000
4	20	1,500	66,000	5,200
5	20	<1,000	30,000	7,200
8	20	<1,000	63,000	9,800
9	20	<1,000	75,000	11,000
10	0	MINI CLEANUP IN PROGRESS		
11	20	1,700	62,000	17,000
12	20	<1,000	160,000	3,400
15	20	<1,000	110,000	21,000
16	20	<1,000	100,000	20,000
17	20	<1,000	72,000	17,000
18	20	<1,000	23,000	8,200
19	20	<1,000	160,000	8,700
22	20	<1,000	44,000	16,000
23	20	<1,000	47,000	8,600
24	20	<1,000	47,000	14,000
25	20	<1,000	76,000	9,600
26	20	<1,000	42,000	9,600
29	20	<1,000	48,000	10,000
30	20	<1,000	140,000	12,000
31	20	<1,000	72,000	15,000
			AVG MEDIAN	11,600

SMEAR SUMMARY
CONTAMINATION CONTROL ZONE
NOVEMBER, 1990

SMEAR ACTIVITY RANGE AND MEDIAN (DPM/100 SQ CM)

DAY	NUMBER OF SMEARS	-------RANGE-------		MEDIAN
1	20	<1,000	61,000	22,000
2	20	<1,000	75,000	12,000
5	20	<1,000	51,000	12,000
6	20	<1,000	67,000	17,000
7	20	<1,000	28,000	21,000
8	20	<1,000	82,000	12,000
9	20	<1,000	96,000	7,000
12	20	<1,000	240,000	17,000
13	20	<1,000	240,000	16,000
14	20	<1,000	62,000	27,000
15	20	<1,000	160,000	20,000
16	20	<1,000	270,000	7,800
19	20	<1,000	160,000	14,000
20	20	<1,000	290,000	21,000
21	20	<1,000	230,000	13,000
22	0	HOLIDAY		
23	0	HOLIDAY		
26	20	<1,000	48,000	3,700
27	20	<1,000	58,000	18,000
28	20	<1,000	26,000	20,000
29	20	<1,000	61,000	1,600
30	20	<1,000	22,000	9,600
			AVG MEDIAN	14,600

SMEAR SUMMARY
CONTAMINATION CONTROL ZONE
DECEMBER, 1990

SMEAR ACTIVITY RANGE AND MEDIAN (DPM/100 SQ CM)

DAY	NUMBER OF SMEARS	-------RANGE-------		MEDIAN
3	20	<1,000	85,000	7,900
4	20	<1,000	93,000	6,800
5	20	<1,000	93,000	21,000
6	20	<1,000	82,000	12,000
7	20	<1,000	260,000	8,300
10	20	<1,000	29,000	7,600
11	20	<1,000	70,000	12,000
12	20	<1,000	200,000	24,000
13	20	<1,000	63,000	32,000
14	20	<1,000	66,000	27,000
17	20	<1,000	170,000	23,000
18	20	<1,000	160,000	29,000
19	20	<1,000	150,000	25,000
20	20	<1,000	150,000	22,000
21	20	<1,000	53,000	5,200
24	0	SMEAR SURVEY MISSED		
25	0	HOLIDAY		
26	20	<1,000	28,000	8,200
27	20	<1,000	31,000	14,000
28	20	<1,000	22,000	15,000
31	0	MINI CLEANUP IN PROGRESS		
			AVG MEDIAN	16,700

APPENDIX B

NEUTRON PRODUCTS, INC.
WHOLE BODY DOSE SUMMARY

1990

WBODDOS.WKS--NPI WHOLE BODY DOSE ANALYSIS
EXCLUDES PEOPLE WITH DOSES LESS THAN 0.1 REM/Y
EXCEPT FOR LEGUELLEC

BDGE	VENDOR BADGE NUMBER
NAME	WORKER'S LAST NAME
INIT	WORKER'S INITIALS
D90	1990 WHOLE BODY DOSE (REM)
DL1290	LIFETIME WHOLE BODY DOSE THROUGH 12/90 (REM)
PAD1290	PERMISSIBLE ACCUMULATED DOSE AS OF 12/90 (REM)
AV1290	DOSE AVERAGED OVER YEARS GREATER THAN 18 (REM/YEAR)
RTOTAL	RUNNING TOTAL 1990 WHOLE BODY DOSE (REM)

SORT BY DECREASING LIFETIME DOSE

BDGE	NAME	INIT	D90	DL1290	PAD1290	AV1290	RTOTAL
1			7.40	100.29	125	4.0	7.40
2			8.78	90.75	145	3.1	16.18
18			5.62	52.06	140	1.9	21.80
17			5.33	28.44	220	0.6	27.13
453			2.85	25.66	45	2.9	29.97
25			0.56	24.55	200	0.6	30.53
280			5.30	19.85	125	0.8	35.82
74			1.69	19.11	155	0.6	37.52
370			7.84	18.97	250	0.4	45.36
215			7.73	15.63	70	1.1	53.09
373			6.12	14.29	205	0.3	59.21
434			7.36	11.76	75	0.8	66.57
236			1.37	11.50	170	0.3	67.94
275			0.80	10.23	85	0.6	68.74
26			2.39	9.05	185	0.2	71.13
429			5.60	7.27	55	0.7	76.73
308			1.05	6.86	65	0.5	77.78
340			2.17	6.21	105	0.3	79.95
337			4.94	5.89	NBD	ERR	84.89
241			3.03	5.76	75	0.4	87.92
262			0.06	5.36	55	0.5	87.98
80			3.52	5.06	85	0.3	91.50
270			2.28	4.66	60	0.4	93.78
405			1.08	4.06	80	0.3	94.86
433			3.25	3.47	35	0.5	98.12
457			0.12	2.39	165	0.1	98.24
399			1.33	2.38	50	0.2	99.57
470			2.32	2.32	10	1.2	101.89
237			0.75	2.27	80	0.1	102.64
264			0.59	2.06	60	0.2	103.23
456			2.03	2.03	25	0.4	105.26
437			1.69	1.69	60	0.1	106.94
455			1.37	1.37	20	0.3	108.31
93			0.22	1.05	140	0.0	108.53
359			0.15	0.96	55	0.1	108.68
449			0.93	0.94	5	0.9	109.61
460			0.90	0.90	15	0.3	110.50
461			0.83	0.83	10	0.4	111.33
450			0.77	0.81	25	0.2	112.10
451			0.40	0.80	25	0.2	112.49
418			0.58	0.73	80	0.0	113.07
222			0.15	0.72	75	0.0	113.22
252			0.51	0.63	155	0.0	113.73
427			0.24	0.51	70	0.0	113.97
298			0.21	0.36	175	0.0	114.18
458			0.34	0.34	65	0.0	114.52
468			0.11	0.11	85	0.0	114.63
		SUM	114.63	532.91			

WBODDOS.WKS--NPI WHOLE BODY DOSE ANALYSIS
EXCLUDES PEOPLE WITH DOSES LESS THAN 0.1 REM/Y
EXCEPT FOR LEGUELLEC

BDGE	VENDOR BADGE NUMBER
NAME	WORKER'S LAST NAME
INIT	WORKER'S INITIALS
D90	1990 WHOLE BODY DOSE (REM)
DL1290	LIFETIME WHOLE BODY DOSE THROUGH 12/90 (REM)
PAD1290	PERMISSIBLE ACCUMULATED DOSE AS OF 12/90 (REM)
AV1290	DOSE AVERAGED OVER YEARS GREATER THAN 18 (REM/YEAR)
RTOTAL	RUNNING TOTAL 1990 WHOLE BODY DOSE (REM)

SORT BY DECREASING 1990 DOSE

BDGE	NAME	INIT	D90	DL1290	PAD1290	AV1290	RTOTAL
2			8.78	90.75	145	3.1	8.78
370			7.84	18.97	250	0.4	16.62
215			7.73	15.63	70	1.1	24.35
1			7.40	100.29	125	4.0	31.75
434			7.36	11.76	75	0.8	39.11
373			6.12	14.29	205	0.3	45.23
18			5.62	52.06	140	1.9	50.85
429			5.60	7.27	55	0.7	56.46
17			5.33	28.44	220	0.6	61.78
280			5.30	19.85	125	0.8	67.08
337			4.94	5.89	NBD	ERR	72.02
80			3.52	5.06	85	0.3	75.54
433			3.25	3.47	35	0.5	78.79
241			3.03	5.76	75	0.4	81.82
453			2.85	25.66	45	2.9	84.66
26			2.39	9.05	185	0.2	87.05
470			2.32	2.32	10	1.2	89.37
270			2.28	4.66	60	0.4	91.65
340			2.17	6.21	105	0.3	93.82
456			2.03	2.03	25	0.4	95.85
74			1.69	19.11	155	0.6	97.55
437			1.69	1.69	60	0.1	99.23
236			1.37	11.50	170	0.3	100.61
455			1.37	1.37	20	0.3	101.98
399			1.33	2.38	50	0.2	103.30
405			1.08	4.06	80	0.3	104.39
308			1.05	6.86	65	0.5	105.44
449			0.93	0.94	5	0.9	106.37
460			0.90	0.90	15	0.3	107.26
461			0.83	0.83	10	0.4	108.09
275			0.80	10.23	85	0.6	108.89
450			0.77	0.81	25	0.2	109.65
237			0.75	2.27	80	0.1	110.40
264			0.59	2.06	60	0.2	110.99
418			0.58	0.73	80	0.0	111.57
25			0.56	24.55	200	0.6	112.13
252			0.51	0.63	155	0.0	112.64
451			0.40	0.80	25	0.2	113.04
458			0.34	0.34	65	0.0	113.38
427			0.24	0.51	70	0.0	113.62
93			0.22	1.05	140	0.0	113.84
298			0.21	0.36	175	0.0	114.04
222			0.15	0.72	75	0.0	114.19
359			0.15	0.96	55	0.1	114.34
457			0.12	2.39	165	0.1	114.46
468			0.11	0.11	85	0.0	114.57
262			0.06	5.36	55	0.5	114.63
		SUM	114.63	532.91			

WBODDOS.WKS--NPI WHOLE BODY DOSE ANALYSIS
EXCLUDES PEOPLE WITH DOSES LESS THAN 0.1 REM/Y
EXCEPT FOR LEGUELLEC

BDGE	VENDOR BADGE NUMBER
NAME	WORKER'S LAST NAME
INIT	WORKER'S INITIALS
D90	1990 WHOLE BODY DOSE (REM)
DL1290	LIFETIME WHOLE BODY DOSE THROUGH 12/90 (REM)
PAD1290	PERMISSIBLE ACCUMULATED DOSE AS OF 12/90 (REM)
AV1290	DOSE AVERAGED OVER YEARS GREATER THAN 18 (REM/YEAR)
RTOTAL	RUNNING TOTAL 1990 WHOLE BODY DOSE (REM)

SORT BY DECREASING DOSE AVERAGED OVER YEARS GREATER THAN 18

BDGE	NAME	INIT	D90	DL1290	PAD1290	AV1290	RTOTAL
1			7.40	100.29	125	4.0	7.40
2			8.78	90.75	145	3.1	16.18
453			2.85	25.66	45	2.9	19.02
18			5.62	52.06	140	1.9	24.65
470			2.32	2.32	10	1.2	26.97
215			7.73	15.63	70	1.1	34.70
449			0.93	0.94	5	0.9	35.63
280			5.30	19.85	125	0.8	40.92
434			7.36	11.76	75	0.8	48.28
429			5.60	7.27	55	0.7	53.89
17			5.33	28.44	220	0.6	59.21
74			1.69	19.11	155	0.6	60.90
25			0.56	24.55	200	0.6	61.46
275			0.80	10.23	85	0.6	62.25
308			1.05	6.86	65	0.5	63.31
433			3.25	3.47	35	0.5	66.56
232			0.06	5.36	55	0.5	66.62
461			0.83	0.83	10	0.4	67.45
456			2.03	2.03	25	0.4	69.48
270			2.28	4.66	60	0.4	71.76
241			3.03	5.76	75	0.4	74.79
370			7.84	18.97	250	0.4	82.63
373			6.12	14.29	205	0.3	88.75
455			1.37	1.37	20	0.3	90.12
236			1.37	11.50	170	0.3	91.49
460			0.90	0.90	15	0.3	92.39
80			3.52	5.06	85	0.3	95.91
340			2.17	6.21	105	0.3	98.09
405			1.08	4.06	80	0.3	99.17
26			2.39	9.05	185	0.2	101.55
399			1.33	2.38	50	0.2	102.88
264			0.59	2.06	60	0.2	103.47
450			0.77	0.81	25	0.2	104.24
451			0.40	0.80	25	0.2	104.64
237			0.75	2.27	80	0.1	105.39
437			1.69	1.69	60	0.1	107.07
359			0.15	0.96	55	0.1	107.22
457			0.12	2.39	165	0.1	107.34
222			0.15	0.72	75	0.0	107.49
418			0.58	0.73	80	0.0	108.07
93			0.22	1.05	140	0.0	108.29
427			0.24	0.51	70	0.0	108.52
458			0.34	0.34	65	0.0	108.86
252			0.51	0.63	155	0.0	109.38
298			0.21	0.36	175	0.0	109.59
468			0.11	0.11	85	0.0	109.70
337			4.94	5.89	NBD	ERR	114.63
		SUM	114.63	532.91			

NEUTRON PRODUCTS, INC.
MONTHLY DATA SUMMARIES

4/90-12/90

NPI MONTHLY RSO REPORT
MONTH 4 YEAR 90

SEE NOTE 1 AT END FOR EXPLANATION OF STATUS NOTATION.

ITEM	STATUS	NORMAL	INVESTIGATION LEVEL	NOTE
HOT CELL VENTILATION SYSTEM				
VENTILATION SYSTEM OPERABILITY	0	0	NO	
PRIMARY HEPA DP (IN)	0.7	0.25-1.5	<0.25, >1.5	
SECONDARY HEPA DP (IN)	0.5	0.25-1.5	<0.25, >1.5	
OLD EFFLUENT SAMPLING SYSTEM OPERABILITY	0	0	NO	
NEW EFFLUENT SAMPLING SYSTEM OPERABILITY	0	0	NO	
MAX EFFLUENT CONCENTRATION (UCI/CC)				
OLD SYSTEM 0 DAILY SAMPLES	—	<1E-11	>3E-11	
NEW SYSTEM 0 DAILY SAMPLES	—	<1E-11	>3E-11	
OLD SYSTEM 4 WEEKLY SAMPLES	1.1E-13	<1E-12	>3E-11	
NEW SYSTEM 4 WEEKLY SAMPLES	< 8.0E-13	<1E-12	>3E-11	
FILTER RADIATION MONITOR (MR/HR)	2.5-4.0	<2000	<4000	
FILTER RADIATION MONITOR OPERABILITY	0	0	NO	
FILTER ROOM DOOR EXPOSURE RATE (MR/HR)	40	40-50	>60	
LAST PREFILTER CHANGE DATE	4/2/90			
LAST PRIMARY HEPA CHANGE DATE	12/21/89			
LAST SECONDARY HEPA CHANGE DATE	2/27/85			
HOT CELL INTERLOCK SYSTEM				
RADIATION MONITOR (CELL EMPTY) (MR/HR)	—	200-400	<100, >600	4
RADIATION MONITOR OPERABILITY	—	0	NO	4
RADIATION MONITOR INTERLOCK SETPOINT (MR/HR)	—	600-800	>800	4
INTERLOCK SYSTEM OPERABILITY	—	0	NO	4
MAIN POOL				
ACTIVITY (UCI/CC)	1.5E-3 ↑ 1.8E-3 ↓ 3E-4	<3E-4	>3E-4	2
CONDUCTIVITY (umho/cm)	150 ↓ 70	<100	>100	2
NORTH CANAL				
ACTIVITY (UCI/CC)	2.0E-4 → 1.5E-4	<3E-4	>3E-4	
CONDUCTIVITY (umho/cm)	10-30	<100	>100	
SOUTH CANAL				
ACTIVITY (UCI/CC)	1.0E-3 ↓ 1.0E-4	<3E-4	>3E-4	2
CONDUCTIVITY (umho/cm)	150 ↓ 70	<100	>100	2
WORKER EXTERNAL DOSIMETRY PROGRAM (MO:___, YR:___)				
NO OF PERSONS >0.5 REM/MO	—	0	>0	4
MAN-REM IN MONTH	—	<5	>5	4
WHOLE BODY COUNTING PROGRAM (MO: —, YR: —)				
NO PERSONS COUNTED	0			
NO PERSONS >5% MPLB	0	0	>0	
LAA AIR SAMPLES (EXCL SAMPLES FOR RESP PROT WORK)				
NO OF SAMPLES	25	20	<20	
NO OF SAMPLES FROM CELL OR CCZ	18	10	<10	
NO OF SAMPLES >3E-10 UCI/CC	2	0	>0	3
MAX SAMPLE (UCI/CC)	9.4E-10	<3E-10	>9E-10	

4/90

BARE COBALT CAMPAIGNS

DATES:______ TO ______ CURIES HANDLED:____________
DATES:______ TO ______ CURIES HANDLED:____________
DATES:______ TO ______ CURIES HANDLED:____________

MINI-CLEANUPS

DATES: 4/2 TO 4/2 MAN-REM: 1.1
DATES:______ TO ______ MAN-REM:__________
DATES:______ TO ______ MAN-REM:__________

MELT CAMPAIGNS

DATES: — TO — CURIES MELTED:____________ NUMBER OF MELTS:______

MELT CLEANUPS

DATES: — TO — MAN-REM:__________

OTHER OPERATIONS NOT NOTED ABOVE

EXPLANATORY NOTES

1. OPERABILITY STATUS "O" INDICATES ITEM WAS OPERABLE THROUGHOUT REPORTING PERIOD. "NO" INDICATES INOPERABLE FOR AT LEAST PART OF THE MONTH, AS EXPLAINED IN ACTION NOTE.

   CALIBRATION OR TEST STATUS "-" MEANS NO CALIBRATION OR TEST REQUIRED OR PERFORMED IN REPORTING PERIOD. A "C" OR "T" INDICATES CALIBRATION OR TEST PERFORMED SUCCESSFULLY DURING MONTH. AN "L" OR "F" INDICATES LATE OR FAILED CALIBRATION OR TEST, AS EXPLAINED IN ACTION NOTE.

   LEAKAGE STATUS "-" INDICATES NO LEAK TEST REQUIRED OR PERFORMED IN PERIOD. A "T" INDICATES LEAK TEST PASSED SUCCESSFULLY OR CONTINUOUS LEAK TEST DEVICE INDICATES ACCEPTABLY LOW LEAKAGE.

   INVESTIGATION LEVEL IS THE LEVEL AT WHICH ADDITIONAL MANAGEMENT ATTENTION MAY BE APPROPRIATE. THIS LEVEL IS IS SET AT A LEVEL TYPICALLY OUT OF THE ORDINARY RANGE, BUT WELL WITHIN THE RANGE PERMISSIBLE BY REGULATION, LICENSE CONDITION, ETC. THE INTENT IS TO DRAW MANAGEMENT ATTENTION TO CHANGES IN STATUS BEFORE REGULATORY LIMITS ARE EXCEEDED. THE INVESTIGATION LEVEL SHOULD NOT BE CONSIDERED A REGULATORY LIMIT.

2. Resin changed for MP/SC
3. Max 2% MPC
4. See CHP evaluation report
5. Drypond levels slowly increasing, exceed 500 mrem/y, approaching 100 mrem/wk
6. Not investigated

4/90

ITEM	STATUS LEVEL	NORMAL	INVESTIGATION	NOTE
PERSONAL CONTAMINATION MONITOR				
OPERABILITY	0	0	NO	
MAINTENANCE DURING MONTH	NONE	NONE	ANY	
BACKGROUND RADIATION LEVEL (UR/HR)	<40	<40	>50	
DETECTOR BACKGROUND RANGE (CPS)	37-91	35-95 ~~65-90~~	<30 ~~<50~~, >100	
BACKUP MONITOR OPERABILITY	0	0	NO	
NO OF PERSONAL CONTAMINATION EVENTS >50K DPM	0	0	>0	
NO OF PERSONAL CONTAMINATION EVENTS >22K <50K DPM	1	0	>0	4
NO OF PERSONAL CONTAMINATION EVENTS >10K <22K DPM	2	<3	>5	
NO OF PERSONAL CONTAMINATION EVENTS >5K <10K DPM	—	<10	>20	
LIQUID WASTE MANAGEMENT				
VOLUME TO WSSC (GAL)	24,000	10,000-40,000	<10,000	
CO-60 TO WSSC (CI)	0.003	<0.003	>0.005	
MAX CO-60 CONCENTRATION (UCI/CC)	5.8E-5	<1E-4	>1E-4	
AVG CO-60 CONC (UCI/CC)	3.6E-5	<6E-5	>6E-5	
CO-60 SOLID WASTE MANAGEMENT				
WASTE SHIPMENTS (CU FT)	—			
WASTE SHIPMENTS (CI)	—			
LAA CONTAMINATION LEVELS (SEE SUMMARY SHEETS)				
NO OF WORK ZONE SMEARS (DAILIES ONLY)	420	>400	<400	
% OF WORK ZONE SMEARS >1,000 DPM/100 SQ CM	14	<10	>15	
% OF WORK ZONE SMEARS >3,000 DPM/100 SQ CM	2	<1	>2	
NO OF CCZ (EXCL WASTE & HOT ROOMS) SMEARS		>400	<400	4
MAX OF CCZ DAILY SMEAR MEDIANS (DPM/100 SQ CM)		20,000-40,000	>50,000	4
AVG OF CCZ DAILY SMEAR MEDIANS (DPM/100 SQ CM)		5,000-10,000	>10,000	4
CLEAN ROOM CONTAMINATION LEVELS				
NO OF SMEARS	176	>100	<100	
NO >440 DPM/100 SQ CM	0	0	>0	
PERIMETER THERMOLUMINESCENT DOSIMETERS (MO:___, YR:___)				
MAX (NET MR/MO)		<40	>50	3
DRYPOND CONTAMINATION				
MAX EXPOSURE RATE (MR/HR)	0.3-1.0	<0.5	>0.5	5
ENVIRONMENTAL SURVEYS				
NO OF PROPERTIES SURVEYED		6	<4	3
NO OF PROPERTIES WITH SPOTS EXCEEDING CRITERIA		0	>0	3
PERSONNEL TRAINING				
NO OF SESSIONS		1	<1	3
SUBJECTS:				

NPI MONTHLY RSO REPORT
MONTH 5 YEAR 90

SEE NOTE 1 AT END FOR EXPLANATION OF STATUS NOTATION.

ITEM	STATUS	NORMAL	INVESTIGATION LEVEL	NOTE
HOT CELL VENTILATION SYSTEM				
VENTILATION SYSTEM OPERABILITY	0	0	NO	
PRIMARY HEPA DP (IN)	0.7	0.25-1.5	<0.25, >1.5	
SECONDARY HEPA DP (IN)	0.5	0.25-1.5	<0.25, >1.5	
OLD EFFLUENT SAMPLING SYSTEM OPERABILITY	0	0	NO	
NEW EFFLUENT SAMPLING SYSTEM OPERABILITY	0	0	NO	
MAX EFFLUENT CONCENTRATION (UCI/CC)				
OLD SYSTEM 11 DAILY SAMPLES	<5.6E-12	<1E-11	>3E-11	
NEW SYSTEM 0 DAILY SAMPLES	–	<1E-11	>3E-11	
OLD SYSTEM 1 WEEKLY SAMPLES	8.0E-14	<1E-12	>3E-11	
NEW SYSTEM 4 WEEKLY SAMPLES	<8.0E-13	<1E-12	>3E-11	
FILTER RADIATION MONITOR (MR/HR)	>4	<2000	<4000	2
FILTER RADIATION MONITOR OPERABILITY	0?	0	NO	2
FILTER ROOM DOOR EXPOSURE RATE (MR/HR)	40	40-50	>60	
LAST PREFILTER CHANGE DATE	4/2/90			
LAST PRIMARY HEPA CHANGE DATE	12/21/89			
LAST SECONDARY HEPA CHANGE DATE	2/27/85			
HOT CELL INTERLOCK SYSTEM				
RADIATION MONITOR (CELL EMPTY) (MR/HR)	–	200-400	<100, >600	4
RADIATION MONITOR OPERABILITY	–	0	NO	4
RADIATION MONITOR INTERLOCK SETPOINT (MR/HR)	–	600-800	>800	4
INTERLOCK SYSTEM OPERABILITY	–	0	NO	4
MAIN POOL				
ACTIVITY (UCI/CC)	3E-4 ↑ 1.5E-3 ↓ 1.0E-3	<3E-4	>3E-4	5
CONDUCTIVITY (umho/cm)	70-100	<100	>100	
NORTH CANAL				
ACTIVITY (UCI/CC)	1.5E-4 ↑ 5.0E-3	<3E-4	>3E-4	5
CONDUCTIVITY (umho/cm)	10-30	<100	>100	
SOUTH CANAL				
ACTIVITY (UCI/CC)	1E-4 ↑ 1.5E-3 ↓ 5E-4	<3E-4	>3E-4	5
CONDUCTIVITY (umho/cm)	70-100	<100	>100	
WORKER EXTERNAL DOSIMETRY PROGRAM (MO:___, YR:___)				
NO OF PERSONS >0.5 REM/MO	–	0	>0	4
MAN-REM IN MONTH	–	<5	>5	4
WHOLE BODY COUNTING PROGRAM (MO: –, YR: –)				
NO PERSONS COUNTED	0			
NO PERSONS >5% MPLB	0	0	>0	
LAA AIR SAMPLES (EXCL SAMPLES FOR RESP PROT WORK)				
NO OF SAMPLES	16	20	<20	3
NO OF SAMPLES FROM CELL OR CCZ	1	10	<10	3
NO OF SAMPLES >3E-10 UCI/CC	0	0	>0	
MAX SAMPLE (UCI/CC)	1.2E-10	<3E-10	>9E-10	

5/90

ITEM	STATUS LEVEL	NORMAL	INVESTIGATION	NOTE
PERSONAL CONTAMINATION MONITOR				
OPERABILITY	0	0	NO	
MAINTENANCE DURING MONTH	NONE	NONE	ANY	
BACKGROUND RADIATION LEVEL (UR/HR)	<40	<40	>50	
DETECTOR BACKGROUND RANGE (CPS)	38-93	35-95 ~~65-90~~	<30 ~~50~~, >100	
BACKUP MONITOR OPERABILITY	0	0	NO	
NO OF PERSONAL CONTAMINATION EVENTS >50K DPM	1	0	>0	4
NO OF PERSONAL CONTAMINATION EVENTS >22K <50K DPM	0	0	>0	
NO OF PERSONAL CONTAMINATION EVENTS >10K <22K DPM	0	<3	>5	
NO OF PERSONAL CONTAMINATION EVENTS >5K <10K DPM	-	<10	>20	7
LIQUID WASTE MANAGEMENT				
VOLUME TO WSSC (GAL)	15,000	10,000-40,000	<10,000	
CO-60 TO WSSC (CI)	0.0015	<0.003	>0.005	
MAX CO-60 CONCENTRATION (UCI/CC)	3.0E-5	<1E-4	>1E-4	
AVG CO-60 CONC (UCI/CC)	2.6E-5	<6E-5	>6E-5	
CO-60 SOLID WASTE MANAGEMENT				
WASTE SHIPMENTS (CU FT)	63			
WASTE SHIPMENTS (CI)	100			
LAA CONTAMINATION LEVELS (SEE SUMMARY SHEETS)				
NO OF WORK ZONE SMEARS (DAILIES ONLY)	440	>400	<400	
% OF WORK ZONE SMEARS >1,000 DPM/100 SQ CM	17	<10	>15	8
% OF WORK ZONE SMEARS >3,000 DPM/100 SQ CM	4	<1	>2	8
NO OF CCZ (EXCL WASTE & HOT ROOMS) SMEARS		>400	<400	4
MAX OF CCZ DAILY SMEAR MEDIANS (DPM/100 SQ CM)		20,000-40,000	>50,000	4
AVG OF CCZ DAILY SMEAR MEDIANS (DPM/100 SQ CM)		5,000-10,000	>10,000	4
CLEAN ROOM CONTAMINATION LEVELS				
NO OF SMEARS	126	>100	<100	
NO >440 DPM/100 SQ CM	0	0	>0	
PERIMETER THERMOLUMINESCENT DOSIMETERS (MO:___, YR:___)				
MAX (NET MR/MO)		<40	>50	3
DRYPOND CONTAMINATION				
MAX EXPOSURE RATE (MR/HR)	0.5-0.6	<0.5	>0.5	6
ENVIRONMENTAL SURVEYS				
NO OF PROPERTIES SURVEYED		6	<4	3
NO OF PROPERTIES WITH SPOTS EXCEEDING CRITERIA		0	>0	3
PERSONNEL TRAINING				
NO OF SESSIONS		1	<1	3
SUBJECTS:______________________				

5/90

BARE COBALT CAMPAIGNS

DATES: — TO — CURIES HANDLED:______
DATES:______ TO ______ CURIES HANDLED:______
DATES:______ TO ______ CURIES HANDLED:______

MINI-CLEANUPS

DATES: — TO — MAN-REM:______
DATES:______ TO ______ MAN-REM:______
DATES:______ TO ______ MAN-REM:______

MELT CAMPAIGNS

DATES: 5/20 TO 5/31 CURIES MELTED:______ NUMBER OF MELTS:______

MELT CLEANUPS

DATES: — TO — MAN-REM: ~20

OTHER OPERATIONS NOT NOTED ABOVE

EXPLANATORY NOTES

1. OPERABILITY STATUS "O" INDICATES ITEM WAS OPERABLE THROUGHOUT REPORTING PERIOD. "NO" INDICATES INOPERABLE FOR AT LEAST PART OF THE MONTH, AS EXPLAINED IN ACTION NOTE.

   CALIBRATION OR TEST STATUS "-" MEANS NO CALIBRATION OR TEST REQUIRED OR PERFORMED IN REPORTING PERIOD. A "C" OR "T" INDICATES CALIBRATION OR TEST PERFORMED SUCCESSFULLY DURING MONTH. AN "L" OR "F" INDICATES LATE OR FAILED CALIBRATION OR TEST, AS EXPLAINED IN ACTION NOTE.

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   INVESTIGATION LEVEL IS THE LEVEL AT WHICH ADDITIONAL MANAGEMENT ATTENTION MAY BE APPROPRIATE. THIS LEVEL IS IS SET AT A LEVEL TYPICALLY OUT OF THE ORDINARY RANGE, BUT WELL WITHIN THE RANGE PERMISSIBLE BY REGULATION, LICENSE CONDITION, ETC. THE INTENT IS TO DRAW MANAGEMENT ATTENTION TO CHANGES IN STATUS BEFORE REGULATORY LIMITS ARE EXCEEDED. THE INVESTIGATION LEVEL SHOULD NOT BE CONSIDERED A REGULATORY LIMIT.

2. 4↑8R/h 5/1-5/14, >10 R/h 5/14-5/31, apparently calibration drift. Filter reads ~2R/h with portable instrument, levels normal at filter room door.
3. Melt in progress much of month
4. See CHP evaluation
5. Elevated levels attributed to transfer of melt waste to canals & pool
6. Continuation of increasing trend
7. Not investigated
8. Slight increase on last 3 days of month. No indication of major breakdown

6/90

ITEM	STATUS LEVEL	NORMAL	INVESTIGATION	NOTE
PERSONAL CONTAMINATION MONITOR				
OPERABILITY	0	0	NO	
MAINTENANCE DURING MONTH	NONE	NONE	ANY	
BACKGROUND RADIATION LEVEL (UR/HR)	<40	<40	>50	
DETECTOR BACKGROUND RANGE (CPS)	38-101	35-95 ~~65-90~~	<30 ~~<50~~, >100	8
BACKUP MONITOR OPERABILITY	0	0	NO	
NO OF PERSONAL CONTAMINATION EVENTS >50K DPM	1	0	>0	4
NO OF PERSONAL CONTAMINATION EVENTS >22K <50K DPM	5	0	>0	4
NO OF PERSONAL CONTAMINATION EVENTS >10K <22K DPM	2	<3	>5	
NO OF PERSONAL CONTAMINATION EVENTS >5K <10K DPM	—	<10	>20	7
LIQUID WASTE MANAGEMENT				
VOLUME TO WSSC (GAL)	18,000	10,000-40,000	<10,000	
CO-60 TO WSSC (CI)	0.0027	<0.003	>0.005	
MAX CO-60 CONCENTRATION (UCI/CC)	7.0E-5	<1E-4	>1E-4	
AVG CO-60 CONC (UCI/CC)	4.1E-5	<6E-5	>6E-5	
CO-60 SOLID WASTE MANAGEMENT				
WASTE SHIPMENTS (CU FT)	—			
WASTE SHIPMENTS (CI)	—			
LAA CONTAMINATION LEVELS (SEE SUMMARY SHEETS)				
NO OF WORK ZONE SMEARS (DAILIES ONLY)	420	>400	<400	
% OF WORK ZONE SMEARS >1,000 DPM/100 SQ CM	23	<10	>15	9
% OF WORK ZONE SMEARS >3,000 DPM/100 SQ CM	6	<1	>2	9
NO OF CCZ (EXCL WASTE & HOT ROOMS) SMEARS		>400	<400	4
MAX OF CCZ DAILY SMEAR MEDIANS (DPM/100 SQ CM)		20,000-40,000	>50,000	4
AVG OF CCZ DAILY SMEAR MEDIANS (DPM/100 SQ CM)		5,000-10,000	>10,000	4
CLEAN ROOM CONTAMINATION LEVELS				
NO OF SMEARS	120	>100	<100	
NO >440 DPM/100 SQ CM	0	0	>0	
PERIMETER THERMOLUMINESCENT DOSIMETERS (MO:___, YR:___)				
MAX (NET MR/MO)		<40	>50	3
DRYPOND CONTAMINATION				
MAX EXPOSURE RATE (MR/HR)	—	<0.5	>0.5	6
ENVIRONMENTAL SURVEYS				
NO OF PROPERTIES SURVEYED		6	<4	3
NO OF PROPERTIES WITH SPOTS EXCEEDING CRITERIA		0	>0	3
PERSONNEL TRAINING				
NO OF SESSIONS		1	<1	3
SUBJECTS:________________				

NPI MONTHLY RSO REPORT
MONTH 6 YEAR 90

SEE NOTE 1 AT END FOR EXPLANATION OF STATUS NOTATION.

ITEM	STATUS	NORMAL	INVESTIGATION LEVEL	NOTE
HOT CELL VENTILATION SYSTEM				
VENTILATION SYSTEM OPERABILITY	0	0	NO	
PRIMARY HEPA DP (IN)	0.7	0.25-1.5	<0.25, >1.5	
SECONDARY HEPA DP (IN)	0.5	0.25-1.5	<0.25, >1.5	
OLD EFFLUENT SAMPLING SYSTEM OPERABILITY	0	0	NO	
NEW EFFLUENT SAMPLING SYSTEM OPERABILITY	0	0	NO	
MAX EFFLUENT CONCENTRATION (UCI/CC)				
OLD SYSTEM 1 DAILY SAMPLES	8.0E-13	<1E-11	>3E-11	
NEW SYSTEM 0 DAILY SAMPLES	—	<1E-11	>3E-11	
OLD SYSTEM 5 WEEKLY SAMPLES	8.0E-13	<1E-12	>3E-11	
NEW SYSTEM 4 WEEKLY SAMPLES	9.0E-13	<1E-12	>3E-11	
FILTER RADIATION MONITOR (MR/HR)	>10	<2000	<4000	2
FILTER RADIATION MONITOR OPERABILITY	0?	0	NO	2
FILTER ROOM DOOR EXPOSURE RATE (MR/HR)	35-40	40-50	>60	
LAST PREFILTER CHANGE DATE	6/13/90			
LAST PRIMARY HEPA CHANGE DATE	12/21/89			
LAST SECONDARY HEPA CHANGE DATE	2/27/85			
HOT CELL INTERLOCK SYSTEM				
RADIATION MONITOR (CELL EMPTY) (MR/HR)	—	200-400	<100, >600	4
RADIATION MONITOR OPERABILITY	—	0	NO	4
RADIATION MONITOR INTERLOCK SETPOINT (MR/HR)	—	600-800	>800	4
INTERLOCK SYSTEM OPERABILITY	—	0	NO	4
MAIN POOL				
ACTIVITY (UCI/CC)	1E-3 ↓ 7E-4	<3E-4	>3E-4	5
CONDUCTIVITY (umho/cm)	80-100	<100	>100	
NORTH CANAL				
ACTIVITY (UCI/CC)	4E-3 to 5E-3	<3E-4	>3E-4	5
CONDUCTIVITY (umho/cm)	15 ↑ 30	<100	>100	
SOUTH CANAL				
ACTIVITY (UCI/CC)	5E-4	<3E-4	>3E-4	5
CONDUCTIVITY (umho/cm)	80-100	<100	>100	
WORKER EXTERNAL DOSIMETRY PROGRAM (MO:___, YR:___)				
NO OF PERSONS >0.5 REM/MO	—	0	>0	4
MAN-REM IN MONTH	—	<5	>5	4
WHOLE BODY COUNTING PROGRAM (MO: 6, YR: 0)				
NO PERSONS COUNTED	—			
NO PERSONS >5% MPLB	—	0	>0	
LAA AIR SAMPLES (EXCL SAMPLES FOR RESP PROT WORK)				
NO OF SAMPLES	20	20	<20	
NO OF SAMPLES FROM CELL OR CCZ	15	10	<10	
NO OF SAMPLES >3E-10 UCI/CC	2	0	>0	3
MAX SAMPLE (UCI/CC)	5.2E-10	<3E-10	>9E-10	

BARE COBALT CAMPAIGNS

DATES:_____ TO _____ CURIES HANDLED:________
DATES:_____ TO _____ CURIES HANDLED:________
DATES:_____ TO _____ CURIES HANDLED:________

MINI-CLEANUPS

DATES: — TO — MAN-REM:________
DATES:_____ TO _____ MAN-REM:________
DATES:_____ TO _____ MAN-REM:________

MELT CAMPAIGNS

DATES: — TO — CURIES MELTED:________ NUMBER OF MELTS:______

MELT CLEANUPS

DATES: 6/11 TO 6/21 MAN-REM: ~20

OTHER OPERATIONS NOT NOTED ABOVE

EXPLANATORY NOTES

1. OPERABILITY STATUS "O" INDICATES ITEM WAS OPERABLE THROUGHOUT REPORTING PERIOD. "NO" INDICATES INOPERABLE FOR AT LEAST PART OF THE MONTH, AS EXPLAINED IN ACTION NOTE.

CALIBRATION OR TEST STATUS "-" MEANS NO CALIBRATION OR TEST REQUIRED OR PERFORMED IN REPORTING PERIOD. A "C" OR "T" INDICATES CALIBRATION OR TEST PERFORMED SUCCESSFULLY DURING MONTH. AN "L" OR "F" INDICATES LATE OR FAILED CALIBRATION OR TEST, AS EXPLAINED IN ACTION NOTE.

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INVESTIGATION LEVEL IS THE LEVEL AT WHICH ADDITIONAL MANAGEMENT ATTENTION MAY BE APPROPRIATE. THIS LEVEL IS IS SET AT A LEVEL TYPICALLY OUT OF THE ORDINARY RANGE, BUT WELL WITHIN THE RANGE PERMISSIBLE BY REGULATION, LICENSE CONDITION, ETC. THE INTENT IS TO DRAW MANAGEMENT ATTENTION TO CHANGES IN STATUS BEFORE REGULATORY LIMITS ARE EXCEEDED. THE INVESTIGATION LEVEL SHOULD NOT BE CONSIDERED A REGULATORY LIMIT.

2. >10 R/h entire month, apparently cal. drift, portable instr reads 2 R/h, levels at door to filter room normal
3. Max < 6% MPC
4. See CHP evaluation
5. Elevated levels attributed to melt waste
6. Not measured
7. Not investigated
8. Contaminated detector, LLD remains < 5000 dpm
9. Slightly higher than normal contamination evenly distributed through month. 3 smears in month > 10,000 dpm/100 cm²; 15,000, 24,000, 109,000, the last 2 in widely distant locations on 6/4. The highest was in ante room near entry to CCZ.

NPI MONTHLY RSO REPORT
MONTH 7 YEAR 90

SEE NOTE 1 AT END FOR EXPLANATION OF STATUS NOTATION.

ITEM	STATUS	NORMAL	INVESTIGATION LEVEL	NOTE
HOT CELL VENTILATION SYSTEM				
VENTILATION SYSTEM OPERABILITY	0	0	NO	
PRIMARY HEPA DP (IN)	0.7	0.25-1.5	<0.25, >1.5	
SECONDARY HEPA DP (IN)	0.5	0.25-1.5	<0.25, >1.5	
OLD EFFLUENT SAMPLING SYSTEM OPERABILITY	0	0	NO	
NEW EFFLUENT SAMPLING SYSTEM OPERABILITY	NO	0	NO	10
MAX EFFLUENT CONCENTRATION (UCI/CC)				
OLD SYSTEM 2 DAILY SAMPLES	2.3E-13	<1E-11	>3E-11	
NEW SYSTEM 0 DAILY SAMPLES	–	<1E-11	>3E-11	
OLD SYSTEM 5 WEEKLY SAMPLES	2.2E-13	<1E-12	>3E-11	
NEW SYSTEM 3 WEEKLY SAMPLES	< 8.0E-13	<1E-12	>3E-11	
FILTER RADIATION MONITOR (MR/HR)	>10 ↓ 1.8	<2000	<4000	2
FILTER RADIATION MONITOR OPERABILITY	0? → 0	0	NO	2
FILTER ROOM DOOR EXPOSURE RATE (MR/HR)	35-45	40-50	>60	
LAST PREFILTER CHANGE DATE	7/12/90 ALSO 7/6			
LAST PRIMARY HEPA CHANGE DATE	7/18/90			
LAST SECONDARY HEPA CHANGE DATE	2/27/85			
HOT CELL INTERLOCK SYSTEM				
RADIATION MONITOR (CELL EMPTY) (MR/HR)	–	200-400	<100, >600	4
RADIATION MONITOR OPERABILITY	–	0	NO	4
RADIATION MONITOR INTERLOCK SETPOINT (MR/HR)	–	600-800	>800	4
INTERLOCK SYSTEM OPERABILITY	–	0	NO	4
MAIN POOL				
ACTIVITY (UCI/CC)	7E-4 ↑ 2E-3 ↓ 9E-4	<3E-4	>3E-4	5
CONDUCTIVITY (umho/cm)	100-130	<100	>100	6
NORTH CANAL				
ACTIVITY (UCI/CC)	5E-3 ↓ 1E-3 ↓ 5E-4	<3E-4	>3E-4	7
CONDUCTIVITY (umho/cm)	30 ↑ 70	<100	>100	
SOUTH CANAL				
ACTIVITY (UCI/CC)	5E-4 to 7E-4	<3E-4	>3E-4	
CONDUCTIVITY (umho/cm)	100-130	<100	>100	6
WORKER EXTERNAL DOSIMETRY PROGRAM (MO:___, YR:___)				
NO OF PERSONS >0.5 REM/MO	–	0	>0	4
MAN-REM IN MONTH	–	<5	>5	4
WHOLE BODY COUNTING PROGRAM (MO:___, YR: –)				
NO PERSONS COUNTED	0			
NO PERSONS >5% MPLB	0	0	>0	
LAA AIR SAMPLES (EXCL SAMPLES FOR RESP PROT WORK)				
NO OF SAMPLES	23	20	<20	
NO OF SAMPLES FROM CELL OR CCZ	15	10	<10	
NO OF SAMPLES >3E-10 UCI/CC	3	0	>0	3
MAX SAMPLE (UCI/CC)	3.8E-10	<3E-10	>9E-10	

7/90

BARE COBALT CAMPAIGNS

DATES:_______ TO _______ CURIES HANDLED:____________
DATES:_______ TO _______ CURIES HANDLED:____________
DATES:_______ TO _______ CURIES HANDLED:____________

MINI-CLEANUPS

DATES: 7/6 TO 7/6 MAN-REM: 0.8
DATES: 7/12 TO 7/12 MAN-REM: 0.9
DATES:_______ TO _______ MAN-REM:__________

MELT CAMPAIGNS

DATES: — TO — CURIES MELTED:____________ NUMBER OF MELTS:_______

MELT CLEANUPS

DATES: — TO — MAN-REM:__________

OTHER OPERATIONS NOT NOTED ABOVE

EXPLANATORY NOTES

1. OPERABILITY STATUS "O" INDICATES ITEM WAS OPERABLE THROUGHOUT REPORTING PERIOD. "NO" INDICATES INOPERABLE FOR AT LEAST PART OF THE MONTH, AS EXPLAINED IN ACTION NOTE.

   CALIBRATION OR TEST STATUS "-" MEANS NO CALIBRATION OR TEST REQUIRED OR PERFORMED IN REPORTING PERIOD. A "C" OR "T" INDICATES CALIBRATION OR TEST PERFORMED SUCCESSFULLY DURING MONTH. AN "L" OR "F" INDICATES LATE OR FAILED CALIBRATION OR TEST, AS EXPLAINED IN ACTION NOTE.

   LEAKAGE STATUS "-" INDICATES NO LEAK TEST REQUIRED OR PERFORMED IN PERIOD. A "T" INDICATES LEAK TEST PASSED SUCCESSFULLY OR CONTINUOUS LEAK TEST DEVICE INDICATES ACCEPTABLY LOW LEAKAGE.

   INVESTIGATION LEVEL IS THE LEVEL AT WHICH ADDITIONAL MANAGEMENT ATTENTION MAY BE APPROPRIATE. THIS LEVEL IS IS SET AT A LEVEL TYPICALLY OUT OF THE ORDINARY RANGE, BUT WELL WITHIN THE RANGE PERMISSIBLE BY REGULATION, LICENSE CONDITION, ETC. THE INTENT IS TO DRAW MANAGEMENT ATTENTION TO CHANGES IN STATUS BEFORE REGULATORY LIMITS ARE EXCEEDED. THE INVESTIGATION LEVEL SHOULD NOT BE CONSIDERED A REGULATORY LIMIT.

2. See 6/90 report, recal
3. Max 4% of MPC
4. See CHP evaluation
5. Short-duration spike
6. Evidence of resin deterioration
7. Resin changed
8. Continued increasing trend
9. Max < 12,000 dpm/100 cm²
10. Sampler out ~1 week due to breaker trip

8/90

ITEM	STATUS LEVEL	NORMAL	INVESTIGATION	NOTE
PERSONAL CONTAMINATION MONITOR				
OPERABILITY	0	0	NO	
MAINTENANCE DURING MONTH	NONE	NONE	ANY	
BACKGROUND RADIATION LEVEL (UR/HR)	<38	<40	>50	
DETECTOR BACKGROUND RANGE (CPS)	38-102	35-95 ~~65-90~~	<30 ~~<50~~, >100	6
BACKUP MONITOR OPERABILITY	0	0	NO	
NO OF PERSONAL CONTAMINATION EVENTS >50K DPM	2	0	>0	3
NO OF PERSONAL CONTAMINATION EVENTS >22K <50K DPM	1	0	>0	3
NO OF PERSONAL CONTAMINATION EVENTS >10K <22K DPM	1	<3	>5	
NO OF PERSONAL CONTAMINATION EVENTS >5K <10K DPM		<10	>20	
LIQUID WASTE MANAGEMENT				
VOLUME TO WSSC (GAL)	9,000	10,000-40,000	<10,000	5
CO-60 TO WSSC (CI)	0.0017	<0.003	>0.005	
MAX CO-60 CONCENTRATION (UCI/CC)	6.3E-5	<1E-4	>1E-4	
AVG CO-60 CONC (UCI/CC)	4.8E-5	<6E-5	>6E-5	
CO-60 SOLID WASTE MANAGEMENT				
WASTE SHIPMENTS (CU FT)	—			
WASTE SHIPMENTS (CI)	—			
LAA CONTAMINATION LEVELS (SEE SUMMARY SHEETS)				
NO OF WORK ZONE SMEARS (DAILIES ONLY)	452	>400	<400	
% OF WORK ZONE SMEARS >1,000 DPM/100 SQ CM	20	<10	>15	7
% OF WORK ZONE SMEARS >3,000 DPM/100 SQ CM	4	<1	>2	7
NO OF CCZ (EXCL WASTE & HOT ROOMS) SMEARS		>400	<400	3
MAX OF CCZ DAILY SMEAR MEDIANS (DPM/100 SQ CM)		20,000-40,000	>50,000	3
AVG OF CCZ DAILY SMEAR MEDIANS (DPM/100 SQ CM)		5,000-10,000	>10,000	3
CLEAN ROOM CONTAMINATION LEVELS				
NO OF SMEARS	138	>100	<100	
NO >440 DPM/100 SQ CM	0	0	>0	
PERIMETER THERMOLUMINESCENT DOSIMETERS (MO:___, YR:___)				
MAX (NET MR/MO)		<40	>50	3
DRYPOND CONTAMINATION				
MAX EXPOSURE RATE (MR/HR)	0.5-0.6	<0.5	>0.5	4
ENVIRONMENTAL SURVEYS				
NO OF PROPERTIES SURVEYED		6	<4	3
NO OF PROPERTIES WITH SPOTS EXCEEDING CRITERIA		0	>0	3
PERSONNEL TRAINING				
NO OF SESSIONS		1	<1	3
SUBJECTS: ____________________				

7/90

ITEM	STATUS LEVEL	NORMAL	INVESTIGATION	NOTE
PERSONAL CONTAMINATION MONITOR				
OPERABILITY	0	0	NO	
MAINTENANCE DURING MONTH	NONE	NONE	ANY	
BACKGROUND RADIATION LEVEL (UR/HR)	<40	<40	>50	
DETECTOR BACKGROUND RANGE (CPS)	40-97	35-95 ~~65-90~~	<30 ~~<60~~, >100	
BACKUP MONITOR OPERABILITY	0	0	NO	
NO OF PERSONAL CONTAMINATION EVENTS >50K DPM	1	0	>0	4
NO OF PERSONAL CONTAMINATION EVENTS >22K <50K DPM	6	0	>0	4
NO OF PERSONAL CONTAMINATION EVENTS >10K <22K DPM	7	<3	>5	4
NO OF PERSONAL CONTAMINATION EVENTS >5K <10K DPM		<10	>20	
LIQUID WASTE MANAGEMENT				
VOLUME TO WSSC (GAL)	15,000	10,000-40,000	<10,000	
CO-60 TO WSSC (CI)	0.0022	<0.003	>0.005	
MAX CO-60 CONCENTRATION (UCI/CC)	6.4E-5	<1E-4	>1E-4	
AVG CO-60 CONC (UCI/CC)	4.0E-5	<6E-5	>6E-5	
CO-60 SOLID WASTE MANAGEMENT				
WASTE SHIPMENTS (CU FT)	—			
WASTE SHIPMENTS (CI)	—			
LAA CONTAMINATION LEVELS (SEE SUMMARY SHEETS)				
NO OF WORK ZONE SMEARS (DAILIES ONLY)	426	>400	<400	
% OF WORK ZONE SMEARS >1,000 DPM/100 SQ CM	21	<10	>15	9
% OF WORK ZONE SMEARS >3,000 DPM/100 SQ CM	3.3	<1	>2	9
NO OF CCZ (EXCL WASTE & HOT ROOMS) SMEARS		>400	<400	4
MAX OF CCZ DAILY SMEAR MEDIANS (DPM/100 SQ CM)		20,000-40,000	>50,000	4
AVG OF CCZ DAILY SMEAR MEDIANS (DPM/100 SQ CM)		5,000-10,000	>10,000	4
CLEAN ROOM CONTAMINATION LEVELS				
NO OF SMEARS	170	>100	<100	
NO >440 DPM/100 SQ CM	0	0	>0	
PERIMETER THERMOLUMINESCENT DOSIMETERS (MO:___, YR:___)				
MAX (NET MR/MO)		<40	>50	3
DRYPOND CONTAMINATION				
MAX EXPOSURE RATE (MR/HR)	0.5-0.7	<0.5	>0.5	8
ENVIRONMENTAL SURVEYS				
NO OF PROPERTIES SURVEYED		6	<4	3
NO OF PROPERTIES WITH SPOTS EXCEEDING CRITERIA		0	>0	3
PERSONNEL TRAINING				
NO OF SESSIONS		1	<1	3
SUBJECTS:______________________________				

NPI MONTHLY RSO REPORT
MONTH 8 YEAR 90

SEE NOTE 1 AT END FOR EXPLANATION OF STATUS NOTATION.

ITEM	STATUS	NORMAL	INVESTIGATION LEVEL	NOTE
HOT CELL VENTILATION SYSTEM				
VENTILATION SYSTEM OPERABILITY	0	0	NO	
PRIMARY HEPA DP (IN)	0.7	0.25-1.5	<0.25, >1.5	
SECONDARY HEPA DP (IN)	0.5	0.25-1.5	<0.25, >1.5	
OLD EFFLUENT SAMPLING SYSTEM OPERABILITY	0	0	NO	
NEW EFFLUENT SAMPLING SYSTEM OPERABILITY	0	0	NO	
MAX EFFLUENT CONCENTRATION (UCI/CC)				
OLD SYSTEM 3 DAILY SAMPLES	3.7E-13	<1E-11	>3E-11	
NEW SYSTEM 0 DAILY SAMPLES	–	<1E-11	>3E-11	
OLD SYSTEM 4 WEEKLY SAMPLES	1.5E-13	<1E-12	>3E-11	
NEW SYSTEM 5 WEEKLY SAMPLES	<8.0E-13	<1E-12	>3E-11	
FILTER RADIATION MONITOR (MR/HR)	1.8-2.5	<2000	<4000	
FILTER RADIATION MONITOR OPERABILITY	0	0	NO	
FILTER ROOM DOOR EXPOSURE RATE (MR/HR)	35	40-50	>60	
LAST PREFILTER CHANGE DATE	8/29/90 Also 8/3			
LAST PRIMARY HEPA CHANGE DATE	7/18/90			
LAST SECONDARY HEPA CHANGE DATE	2/27/85			
HOT CELL INTERLOCK SYSTEM				
RADIATION MONITOR (CELL EMPTY) (MR/HR)	–	200-400	<100, >600	3
RADIATION MONITOR OPERABILITY	–	0	NO	3
RADIATION MONITOR INTERLOCK SETPOINT (MR/HR)	–	600-800	>800	3
INTERLOCK SYSTEM OPERABILITY	–	0	NO	3
MAIN POOL				
ACTIVITY (UCI/CC)	8E-4 to 1E-3	<3E-4	>3E-4	4
CONDUCTIVITY (umho/cm)	130	<100	>100	4
NORTH CANAL				
ACTIVITY (UCI/CC)	2E-4 & 7E-5	<3E-4	>3E-4	
CONDUCTIVITY (umho/cm)	10	<100	>100	
SOUTH CANAL				
ACTIVITY (UCI/CC)	5E-4	<3E-4	>3E-4	4
CONDUCTIVITY (umho/cm)	130	<100	>100	4
WORKER EXTERNAL DOSIMETRY PROGRAM (MO:___, YR:___)				
NO OF PERSONS >0.5 REM/MO	–	0	>0	3
MAN-REM IN MONTH	–	<5	>5	3
WHOLE BODY COUNTING PROGRAM (MO: –, YR: –)				
NO PERSONS COUNTED	0			
NO PERSONS >5% MPLB	0	0	>0	
LAA AIR SAMPLES (EXCL SAMPLES FOR RESP PROT WORK)				
NO OF SAMPLES	22	20	<20	
NO OF SAMPLES FROM CELL OR CCZ	12	10	<10	
NO OF SAMPLES >3E-10 UCI/CC	8	0	>0	2
MAX SAMPLE (UCI/CC)	6.8E-10	<3E-10	>9E-10	

8/90

BARE COBALT CAMPAIGNS

DATES:______ TO ______ CURIES HANDLED:__________
DATES:______ TO ______ CURIES HANDLED:__________
DATES:______ TO ______ CURIES HANDLED:__________

MINI-CLEANUPS

DATES: 8/3 TO 8/6 MAN-REM: 0.9 (2-days)
DATES: 8/29 TO 8/29 MAN-REM: 1.0
DATES:______ TO ______ MAN-REM:______

MELT CAMPAIGNS

DATES: — TO — CURIES MELTED:__________ NUMBER OF MELTS:______

MELT CLEANUPS

DATES: — TO — MAN-REM:______

OTHER OPERATIONS NOT NOTED ABOVE

EXPLANATORY NOTES

1. OPERABILITY STATUS "O" INDICATES ITEM WAS OPERABLE THROUGHOUT REPORTING PERIOD. "NO" INDICATES INOPERABLE FOR AT LEAST PART OF THE MONTH, AS EXPLAINED IN ACTION NOTE.

   CALIBRATION OR TEST STATUS "-" MEANS NO CALIBRATION OR TEST REQUIRED OR PERFORMED IN REPORTING PERIOD. A "C" OR "T" INDICATES CALIBRATION OR TEST PERFORMED SUCCESSFULLY DURING MONTH. AN "L" OR "F" INDICATES LATE OR FAILED CALIBRATION OR TEST, AS EXPLAINED IN ACTION NOTE.

   LEAKAGE STATUS "-" INDICATES NO LEAK TEST REQUIRED OR PERFORMED IN PERIOD. A "T" INDICATES LEAK TEST PASSED SUCCESSFULLY OR CONTINUOUS LEAK TEST DEVICE INDICATES ACCEPTABLY LOW LEAKAGE.

   INVESTIGATION LEVEL IS THE LEVEL AT WHICH ADDITIONAL MANAGEMENT ATTENTION MAY BE APPROPRIATE. THIS LEVEL IS IS SET AT A LEVEL TYPICALLY OUT OF THE ORDINARY RANGE, BUT WELL WITHIN THE RANGE PERMISSIBLE BY REGULATION, LICENSE CONDITION, ETC. THE INTENT IS TO DRAW MANAGEMENT ATTENTION TO CHANGES IN STATUS BEFORE REGULATORY LIMITS ARE EXCEEDED. THE INVESTIGATION LEVEL SHOULD NOT BE CONSIDERED A REGULATORY LIMIT.

2. Max < 7% of MPC
3. See CHP evaluation
4. Continuation of conditions from 7/90
5. Low staffing, low water use
6. Minor detector contamination, LLD < 5,000 cpm
7. Max isolated smears 41,000 and 31,000 dpm/100 cm². All others <15,000.

NPI MONTHLY RSO REPORT
MONTH 9 YEAR 90

SEE NOTE 1 AT END FOR EXPLANATION OF STATUS NOTATION.

ITEM	STATUS	NORMAL	INVESTIGATION LEVEL	NOTE
HOT CELL VENTILATION SYSTEM				
VENTILATION SYSTEM OPERABILITY	0	0	NO	
PRIMARY HEPA DP (IN)	0.7	0.25-1.5	<0.25, >1.5	
SECONDARY HEPA DP (IN)	0.5	0.25-1.5	<0.25, >1.5	
OLD EFFLUENT SAMPLING SYSTEM OPERABILITY	0	0	NO	
NEW EFFLUENT SAMPLING SYSTEM OPERABILITY	0	0	NO	
MAX EFFLUENT CONCENTRATION (UCI/CC)				
OLD SYSTEM 0 DAILY SAMPLES	–	<1E-11	>3E-11	
NEW SYSTEM 0 DAILY SAMPLES	–	<1E-11	>3E-11	
OLD SYSTEM 3 WEEKLY SAMPLES	7.2E-14	<1E-12	>3E-11	
NEW SYSTEM 3 WEEKLY SAMPLES	<8.0E-13	<1E-12	>3E-11	
FILTER RADIATION MONITOR (MR/HR)	3→2	<2000	<4000	
FILTER RADIATION MONITOR OPERABILITY	0	0	NO	
FILTER ROOM DOOR EXPOSURE RATE (MR/HR)	35	40-50	>60	
LAST PREFILTER CHANGE DATE	8/29/90			
LAST PRIMARY HEPA CHANGE DATE	7/12/90			
LAST SECONDARY HEPA CHANGE DATE	2/27/85			
HOT CELL INTERLOCK SYSTEM				
RADIATION MONITOR (CELL EMPTY) (MR/HR)	–	200-400	<100, >600	3
RADIATION MONITOR OPERABILITY	–	0	NO	3
RADIATION MONITOR INTERLOCK SETPOINT (MR/HR)	–	600-800	>800	3
INTERLOCK SYSTEM OPERABILITY	–	0	NO	3
MAIN POOL				
ACTIVITY (UCI/CC)	1.0E-3 ↑ 1.7E-3 ↓ 1E-3	<3E-4	>3E-4	4
CONDUCTIVITY (umho/cm)	130 ↓ 80	<100	>100	4
NORTH CANAL				
ACTIVITY (UCI/CC)	7E-5 ↓ 2E-5	<3E-4	>3E-4	
CONDUCTIVITY (umho/cm)	10	<100	>100	
SOUTH CANAL				
ACTIVITY (UCI/CC)	5E-4 ↑ 3E-2 ↓ 1E-3	<3E-4	>3E-4	4
CONDUCTIVITY (umho/cm)	130 ↓ 80	<100	>100	4
WORKER EXTERNAL DOSIMETRY PROGRAM (MO:___, YR:___)				
NO OF PERSONS >0.5 REM/MO	–	0	>0	3
MAN-REM IN MONTH	–	<5	>5	3
WHOLE BODY COUNTING PROGRAM (MO: –, YR: –)				
NO PERSONS COUNTED	0			
NO PERSONS >5% MPLB	0	0	>0	
LAA AIR SAMPLES (EXCL SAMPLES FOR RESP PROT WORK)				
NO OF SAMPLES	22	20	<20	
NO OF SAMPLES FROM CELL OR CCZ	14	10	<10	
NO OF SAMPLES >3E-10 UCI/CC	7	0	>0	2
MAX SAMPLE (UCI/CC)	6.9E-10	<3E-10	>9E-10	

9/90

ITEM	STATUS LEVEL	NORMAL	INVESTIGATION	NOTE
PERSONAL CONTAMINATION MONITOR				
OPERABILITY	0	0	NO	
MAINTENANCE DURING MONTH	0	NONE	ANY	
BACKGROUND RADIATION LEVEL (UR/HR)	<40	<40	>50	
DETECTOR BACKGROUND RANGE (CPS)	38-94	35-95 ~~65-90~~	<30 ~~<50,~~ >100	
BACKUP MONITOR OPERABILITY	0	0	NO	
NO OF PERSONAL CONTAMINATION EVENTS >50K DPM	0	0	>0	
NO OF PERSONAL CONTAMINATION EVENTS >22K <50K DPM	0	0	>0	
NO OF PERSONAL CONTAMINATION EVENTS >10K <22K DPM	0	<3	>5	
NO OF PERSONAL CONTAMINATION EVENTS >5K <10K DPM	—	<10	>20	6
LIQUID WASTE MANAGEMENT				
VOLUME TO WSSC (GAL)	18,000	10,000-40,000	<10,000	
CO-60 TO WSSC (CI)	0.0055	<0.003	>0.005	8
MAX CO-60 CONCENTRATION (UCI/CC)	1.9E-4	<1E-4	>1E-4	8
AVG CO-60 CONC (UCI/CC)	8.3E-5	<6E-5	>6E-5	8
CO-60 SOLID WASTE MANAGEMENT				
WASTE SHIPMENTS (CU FT)	—			
WASTE SHIPMENTS (CI)	—			
LAA CONTAMINATION LEVELS (SEE SUMMARY SHEETS)				
NO OF WORK ZONE SMEARS (DAILIES ONLY)	380	>400	<400	7
% OF WORK ZONE SMEARS >1,000 DPM/100 SQ CM	27	<10	>15	7
% OF WORK ZONE SMEARS >3,000 DPM/100 SQ CM	7	<1	>2	7
NO OF CCZ (EXCL WASTE & HOT ROOMS) SMEARS		>400	<400	3
MAX OF CCZ DAILY SMEAR MEDIANS (DPM/100 SQ CM)		20,000-40,000	>50,000	3
AVG OF CCZ DAILY SMEAR MEDIANS (DPM/100 SQ CM)		5,000-10,000	>10,000	3
CLEAN ROOM CONTAMINATION LEVELS				
NO OF SMEARS	114	>100	<100	
NO >440 DPM/100 SQ CM	0	0	>0	
PERIMETER THERMOLUMINESCENT DOSIMETERS (MO:___, YR:___)				
MAX (NET MR/MO)		<40	>50	3
DRYPOND CONTAMINATION				
MAX EXPOSURE RATE (MR/HR)	0.3-0.6	<0.5	>0.5	5
ENVIRONMENTAL SURVEYS				
NO OF PROPERTIES SURVEYED		6	<4	3
NO OF PROPERTIES WITH SPOTS EXCEEDING CRITERIA		0	>0	3
PERSONNEL TRAINING				
NO OF SESSIONS		1	<1	3
SUBJECTS:______				

9/90

BARE COBALT CAMPAIGNS

DATES:______ TO ______ CURIES HANDLED:__________
DATES:______ TO ______ CURIES HANDLED:__________
DATES:______ TO ______ CURIES HANDLED:__________

MINI-CLEANUPS

DATES: — TO — MAN-REM:________
DATES:______ TO ______ MAN-REM:________
DATES:______ TO ______ MAN-REM:________

MELT CAMPAIGNS

DATES: — TO — CURIES MELTED:__________ NUMBER OF MELTS:______

MELT CLEANUPS

DATES: — TO — MAN-REM:________

OTHER OPERATIONS NOT NOTED ABOVE

EXPLANATORY NOTES

1. OPERABILITY STATUS "O" INDICATES ITEM WAS OPERABLE THROUGHOUT REPORTING PERIOD. "NO" INDICATES INOPERABLE FOR AT LEAST PART OF THE MONTH, AS EXPLAINED IN ACTION NOTE.

   CALIBRATION OR TEST STATUS "-" MEANS NO CALIBRATION OR TEST REQUIRED OR PERFORMED IN REPORTING PERIOD. A "C" OR "T" INDICATES CALIBRATION OR TEST PERFORMED SUCCESSFULLY DURING MONTH. AN "L" OR "F" INDICATES LATE OR FAILED CALIBRATION OR TEST, AS EXPLAINED IN ACTION NOTE.

   LEAKAGE STATUS "-" INDICATES NO LEAK TEST REQUIRED OR PERFORMED IN PERIOD. A "T" INDICATES LEAK TEST PASSED SUCCESSFULLY OR CONTINUOUS LEAK TEST DEVICE INDICATES ACCEPTABLY LOW LEAKAGE.

   INVESTIGATION LEVEL IS THE LEVEL AT WHICH ADDITIONAL MANAGEMENT ATTENTION MAY BE APPROPRIATE. THIS LEVEL IS IS SET AT A LEVEL TYPICALLY OUT OF THE ORDINARY RANGE, BUT WELL WITHIN THE RANGE PERMISSIBLE BY REGULATION, LICENSE CONDITION, ETC. THE INTENT IS TO DRAW MANAGEMENT ATTENTION TO CHANGES IN STATUS BEFORE REGULATORY LIMITS ARE EXCEEDED. THE INVESTIGATION LEVEL SHOULD NOT BE CONSIDERED A REGULATORY LIMIT.

2. Max < 8% MPC
3. See CHP evaluation
4. Apparent introduction from cell, reason for conductivity decline not known
5. Continued trend
6. Not investigated
7. Smears taken every work day (short month). 60% of 15 smears > 6,000 found on 9/24-9/26. No RSO review date noted on 9/25, 9/26 sheets. Max levels were 3 smears 126,000, 53,000, 23,000 dpm/100 cm² in same area (near operating side of cell) on 3 successive days. All other smears <16,00
8. Higher than normal but below license limit.

10/90

ITEM	STATUS LEVEL	NORMAL	INVESTIGATION	NOTE
PERSONAL CONTAMINATION MONITOR				
OPERABILITY	0	0	NO	
MAINTENANCE DURING MONTH	NONE	NONE	ANY	
BACKGROUND RADIATION LEVEL (UR/HR)	<40	<40	>50	
DETECTOR BACKGROUND RANGE (CPS)	41-91	55-95 ~~65-90~~	<30 ~~<50~~, >100	
BACKUP MONITOR OPERABILITY	0	0	NO	
NO OF PERSONAL CONTAMINATION EVENTS >50K DPM	0	0	>0	
NO OF PERSONAL CONTAMINATION EVENTS >22K <50K DPM	1	0	>0	4
NO OF PERSONAL CONTAMINATION EVENTS >10K <22K DPM	0	<3	>5	
NO OF PERSONAL CONTAMINATION EVENTS >5K <10K DPM	0	<10	>20	
LIQUID WASTE MANAGEMENT				
VOLUME TO WSSC (GAL)	24,000	10,000-40,000	<10,000	
CO-60 TO WSSC (CI)	0.002	<0.003	>0.005	
MAX CO-60 CONCENTRATION (UCI/CC)	9.9E-5	<1E-4	>1E-4	
AVG CO-60 CONC (UCI/CC)	2.2E-5	<6E-5	>6E-5	
CO-60 SOLID WASTE MANAGEMENT				
WASTE SHIPMENTS (CU FT)	200			
WASTE SHIPMENTS (CI)	0.7			
LAA CONTAMINATION LEVELS (SEE SUMMARY SHEETS)				
NO OF WORK ZONE SMEARS (DAILIES ONLY)	460	>400	<400	
% OF WORK ZONE SMEARS >1,000 DPM/100 SQ CM	14	<10	>15	
% OF WORK ZONE SMEARS >3,000 DPM/100 SQ CM	<1	<1	>2	
NO OF CCZ (EXCL WASTE & HOT ROOMS) SMEARS		>400	<400	4
MAX OF CCZ DAILY SMEAR MEDIANS (DPM/100 SQ CM)		20,000-40,000	>50,000	4
AVG OF CCZ DAILY SMEAR MEDIANS (DPM/100 SQ CM)		5,000-10,000	>10,000	4
CLEAN ROOM CONTAMINATION LEVELS				
NO OF SMEARS	138	>100	<100	
NO >440 DPM/100 SQ CM	0	0	>0	
PERIMETER THERMOLUMINESCENT DOSIMETERS (MO:___, YR:___)				
MAX (NET MR/MO)		<40	>50	3
DRYPOND CONTAMINATION				
MAX EXPOSURE RATE (MR/HR)	0.4-0.5	<0.5	>0.5	5
ENVIRONMENTAL SURVEYS				
NO OF PROPERTIES SURVEYED		6	<4	3
NO OF PROPERTIES WITH SPOTS EXCEEDING CRITERIA		0	>0	3
PERSONNEL TRAINING				
NO OF SESSIONS		1	<1	3
SUBJECTS:____________				

NPI MONTHLY RSO REPORT
MONTH 10 YEAR 90

SEE NOTE 1 AT END FOR EXPLANATION OF STATUS NOTATION.

ITEM	STATUS	NORMAL	INVESTIGATION LEVEL	NOTE
HOT CELL VENTILATION SYSTEM				
VENTILATION SYSTEM OPERABILITY	0	0	NO	
PRIMARY HEPA DP (IN)	0.7	0.25-1.5	<0.25, >1.5	
SECONDARY HEPA DP (IN)	0.5	0.25-1.5	<0.25, >1.5	
OLD EFFLUENT SAMPLING SYSTEM OPERABILITY	0	0	NO	
NEW EFFLUENT SAMPLING SYSTEM OPERABILITY	0	0	NO	
MAX EFFLUENT CONCENTRATION (UCI/CC)				
OLD SYSTEM – DAILY SAMPLES	–	<1E-11	>3E-11	
NEW SYSTEM – DAILY SAMPLES	–	<1E-11	>3E-11	
OLD SYSTEM 4 WEEKLY SAMPLES	1.6E-13 to 5E-13	<1E-12	>3E-11	
NEW SYSTEM 4 WEEKLY SAMPLES	<8E-13	<1E-12	>3E-11	
FILTER RADIATION MONITOR (MR/HR)	2.0-2.5	<2000	<4000	
FILTER RADIATION MONITOR OPERABILITY	0	0	NO	
FILTER ROOM DOOR EXPOSURE RATE (MR/HR)	35	40-50	>60	
LAST PREFILTER CHANGE DATE	10/30/90 ALSO 10/10			
LAST PRIMARY HEPA CHANGE DATE	7/19/90			
LAST SECONDARY HEPA CHANGE DATE	2/27/85			
HOT CELL INTERLOCK SYSTEM				
RADIATION MONITOR (CELL EMPTY) (MR/HR)	–	200-400	<100, >600	4
RADIATION MONITOR OPERABILITY	–	0	NO	4
RADIATION MONITOR INTERLOCK SETPOINT (MR/HR)	–	600-800	>800	4
INTERLOCK SYSTEM OPERABILITY	–	0	NO	4
MAIN POOL				
ACTIVITY (UCI/CC)	~1.2E-3	<3E-4	>3E-4	5
CONDUCTIVITY (umho/cm)	90	<100	>100	
NORTH CANAL				
ACTIVITY (UCI/CC)	3E-5 ↑ 1E-4	<3E-4	>3E-4	
CONDUCTIVITY (umho/cm)	10	<100	>100	
SOUTH CANAL				
ACTIVITY (UCI/CC)	7E-4 ↓ 5E-4	<3E-4	>3E-4	5
CONDUCTIVITY (umho/cm)	90	<100	>100	
WORKER EXTERNAL DOSIMETRY PROGRAM (MO:___, YR:___)				
NO OF PERSONS >0.5 REM/MO	–	0	>0	4
MAN-REM IN MONTH	–	<5	>5	4
WHOLE BODY COUNTING PROGRAM (MO: 8,9, YR: 90)				
NO PERSONS COUNTED	23			
NO PERSONS >5% MPLB	1	0	>0	2
LAA AIR SAMPLES (EXCL SAMPLES FOR RESP PROT WORK)				
NO OF SAMPLES	29	20	<20	
NO OF SAMPLES FROM CELL OR CCZ	16	10	<10	
NO OF SAMPLES >3E-10 UCI/CC	1	0	>0	3
MAX SAMPLE (UCI/CC)	4.2E-10	<3E-10	>9E-10	

BARE COBALT CAMPAIGNS

DATES:______ TO ______ CURIES HANDLED:__________
DATES:______ TO ______ CURIES HANDLED:__________
DATES:______ TO ______ CURIES HANDLED:__________

MINI-CLEANUPS

DATES: 10/10 TO 10/10 MAN-REM: 0.5
DATES:______ TO ______ MAN-REM:______
DATES:______ TO ______ MAN-REM:______

MELT CAMPAIGNS

DATES: — TO — CURIES MELTED:__________ NUMBER OF MELTS:______

MELT CLEANUPS

DATES: — TO — MAN-REM:______

OTHER OPERATIONS NOT NOTED ABOVE

EXPLANATORY NOTES

1. OPERABILITY STATUS "O" INDICATES ITEM WAS OPERABLE THROUGHOUT REPORTING PERIOD. "NO" INDICATES INOPERABLE FOR AT LEAST PART OF THE MONTH, AS EXPLAINED IN ACTION NOTE.

   CALIBRATION OR TEST STATUS "-" MEANS NO CALIBRATION OR TEST REQUIRED OR PERFORMED IN REPORTING PERIOD. A "C" OR "T" INDICATES CALIBRATION OR TEST PERFORMED SUCCESSFULLY DURING MONTH. AN "L" OR "F" INDICATES LATE OR FAILED CALIBRATION OR TEST, AS EXPLAINED IN ACTION NOTE.

   LEAKAGE STATUS "-" INDICATES NO LEAK TEST REQUIRED OR PERFORMED IN PERIOD. A "T" INDICATES LEAK TEST PASSED SUCCESSFULLY OR CONTINUOUS LEAK TEST DEVICE INDICATES ACCEPTABLY LOW LEAKAGE.

   INVESTIGATION LEVEL IS THE LEVEL AT WHICH ADDITIONAL MANAGEMENT ATTENTION MAY BE APPROPRIATE. THIS LEVEL IS IS SET AT A LEVEL TYPICALLY OUT OF THE ORDINARY RANGE, BUT WELL WITHIN THE RANGE PERMISSIBLE BY REGULATION, LICENSE CONDITION, ETC. THE INTENT IS TO DRAW MANAGEMENT ATTENTION TO CHANGES IN STATUS BEFORE REGULATORY LIMITS ARE EXCEEDED. THE INVESTIGATION LEVEL SHOULD NOT BE CONSIDERED A REGULATORY LIMIT.

2. 1 individual 0.7 µCi, reported to CRH previously. All others < 3% MPLB
3. Max < 5% MPC
4. See CHP evaluation
5. Continuation of trend from 9/90

11/90

ITEM	STATUS LEVEL	NORMAL	INVESTIGATION	NOTE
PERSONAL CONTAMINATION MONITOR				
OPERABILITY	0	0	NO	
MAINTENANCE DURING MONTH	NONE	NONE	ANY	
BACKGROUND RADIATION LEVEL (UR/HR)	<40	<40	>50	
DETECTOR BACKGROUND RANGE (CPS)	39-93	35-95 ~~65-90~~	<30 ~~<50~~, >100	
BACKUP MONITOR OPERABILITY	0	0	NO	
NO OF PERSONAL CONTAMINATION EVENTS >50K DPM	0	0	>0	
NO OF PERSONAL CONTAMINATION EVENTS >22K <50K DPM	1	0	>0	3
NO OF PERSONAL CONTAMINATION EVENTS >10K <22K DPM	4	<3	>5	3
NO OF PERSONAL CONTAMINATION EVENTS >5K <10K DPM	0	<10	>20	
LIQUID WASTE MANAGEMENT				
VOLUME TO WSSC (GAL)	18,000	10,000-40,000	<10,000	
CO-60 TO WSSC (CI)	0.0027	<0.003	>0.005	
MAX CO-60 CONCENTRATION (UCI/CC)	3.7E-5	<1E-4	>1E-4	
AVG CO-60 CONC (UCI/CC)	4.0E-5	<6E-5	>6E-5	
CO-60 SOLID WASTE MANAGEMENT				
WASTE SHIPMENTS (CU FT)	—			
WASTE SHIPMENTS (CI)	—			
LAA CONTAMINATION LEVELS (SEE SUMMARY SHEETS)				
NO OF WORK ZONE SMEARS (DAILIES ONLY)	400	>400	<400	
% OF WORK ZONE SMEARS >1,000 DPM/100 SQ CM	23	<10	>15	6
% OF WORK ZONE SMEARS >3,000 DPM/100 SQ CM	2.5	<1	>2	6
NO OF CCZ (EXCL WASTE & HOT ROOMS) SMEARS		>400	<400	3
MAX OF CCZ DAILY SMEAR MEDIANS (DPM/100 SQ CM)		20,000-40,000	>50,000	3
AVG OF CCZ DAILY SMEAR MEDIANS (DPM/100 SQ CM)		5,000-10,000	>10,000	3
CLEAN ROOM CONTAMINATION LEVELS				
NO OF SMEARS	170	>100	<100	
NO >440 DPM/100 SQ CM	0	0	>0	
PERIMETER THERMOLUMINESCENT DOSIMETERS (MO:___, YR:___)				
MAX (NET MR/MO)		<40	>50	3
DRYPOND CONTAMINATION				
MAX EXPOSURE RATE (MR/HR)	—	<0.5	>0.5	5
ENVIRONMENTAL SURVEYS				
NO OF PROPERTIES SURVEYED		6	<4	3
NO OF PROPERTIES WITH SPOTS EXCEEDING CRITERIA		0	>0	3
PERSONNEL TRAINING				
NO OF SESSIONS		1	<1	3
SUBJECTS:____________________				

NPI MONTHLY RSO REPORT
MONTH 11 YEAR 90

SEE NOTE 1 AT END FOR EXPLANATION OF STATUS NOTATION.

ITEM	STATUS	NORMAL	INVESTIGATION LEVEL	NOTE
HOT CELL VENTILATION SYSTEM				
VENTILATION SYSTEM OPERABILITY	0	0	NO	
PRIMARY HEPA DP (IN)	0.7	0.25-1.5	<0.25, >1.5	
SECONDARY HEPA DP (IN)	0.5	0.25-1.5	<0.25, >1.5	
OLD EFFLUENT SAMPLING SYSTEM OPERABILITY	0	0	NO	
NEW EFFLUENT SAMPLING SYSTEM OPERABILITY	0	0	NO	
MAX EFFLUENT CONCENTRATION (UCI/CC)				
OLD SYSTEM 0 DAILY SAMPLES	—	<1E-11	>3E-11	
NEW SYSTEM 0 DAILY SAMPLES	—	<1E-11	>3E-11	
OLD SYSTEM 7 WEEKLY SAMPLES	1.2E-13 to 2.4E-13	<1E-12	>3E-11	
NEW SYSTEM 4 WEEKLY SAMPLES	<8E-13	<1E-12	>3E-11	
FILTER RADIATION MONITOR (MR/HR)	2.0 + 2.5 ↑ 4.0	<2000	<4000	
FILTER RADIATION MONITOR OPERABILITY	0	0	NO	
FILTER ROOM DOOR EXPOSURE RATE (MR/HR)	35-40	40-50	>60	
LAST PREFILTER CHANGE DATE	11/21/90			
LAST PRIMARY HEPA CHANGE DATE	7/18/90			
LAST SECONDARY HEPA CHANGE DATE	2/27/85			
HOT CELL INTERLOCK SYSTEM				
RADIATION MONITOR (CELL EMPTY) (MR/HR)	—	200-400	<100, >600	3
RADIATION MONITOR OPERABILITY	—	0	NO	3
RADIATION MONITOR INTERLOCK SETPOINT (MR/HR)	—	600-800	>800	3
INTERLOCK SYSTEM OPERABILITY	—	0	NO	3
MAIN POOL				
ACTIVITY (UCI/CC)	9E-4 ↑ 4E-3	<3E-4	>3E-4	4
CONDUCTIVITY (umho/cm)	90-110	<100	>100	
NORTH CANAL				
ACTIVITY (UCI/CC)	~1E-4	<3E-4	>3E-4	
CONDUCTIVITY (umho/cm)	10	<100	>100	
SOUTH CANAL				
ACTIVITY (UCI/CC)	5E-4 ↑ 3E-3	<3E-4	>3E-4	4
CONDUCTIVITY (umho/cm)	90-110	<100	>100	
WORKER EXTERNAL DOSIMETRY PROGRAM (MO:___, YR:___)				
NO OF PERSONS >0.5 REM/MO	—	0	>0	3
MAN-REM IN MONTH	—	<5	>5	3
WHOLE BODY COUNTING PROGRAM (MO: —, YR: —)				
NO PERSONS COUNTED	0			
NO PERSONS >5% MPLB	0	0	>0	
LAA AIR SAMPLES (EXCL SAMPLES FOR RESP PROT WORK)				
NO OF SAMPLES	19	20	<20	2
NO OF SAMPLES FROM CELL OR CCZ	11	10	<10	
NO OF SAMPLES >3E-10 UCI/CC	4	0	>0	2
MAX SAMPLE (UCI/CC)	1.2E-9	<3E-10	>9E-10	

11/90

BARE COBALT CAMPAIGNS

DATES:_______ TO _______ CURIES HANDLED:____________
DATES:_______ TO _______ CURIES HANDLED:____________
DATES:_______ TO _______ CURIES HANDLED:____________

MINI-CLEANUPS

DATES: 11/21 TO 11/21 MAN-REM: 0.1
DATES:_______ TO _______ MAN-REM:__________
DATES:_______ TO _______ MAN-REM:__________

MELT CAMPAIGNS

DATES: — TO — CURIES MELTED:____________ NUMBER OF MELTS:_______

MELT CLEANUPS

DATES: — TO — MAN-REM:__________

OTHER OPERATIONS NOT NOTED ABOVE

EXPLANATORY NOTES

1. OPERABILITY STATUS "O" INDICATES ITEM WAS OPERABLE THROUGHOUT REPORTING PERIOD. "NO" INDICATES INOPERABLE FOR AT LEAST PART OF THE MONTH, AS EXPLAINED IN ACTION NOTE.

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2. Target no missed by only one, not symptomatic of decline in program. Elevated samples from cell, max 13% of MPC
3. See CHP evaluation
4. Apparent intro from cell + loss of DF
5. Not measured
6. All smears >6,000 found near ante-room entry to CCZ. Max 19,000

NPI MONTHLY RSO REPORT
MONTH 12 YEAR 90

SEE NOTE 1 AT END FOR EXPLANATION OF STATUS NOTATION.

ITEM	STATUS	NORMAL	INVESTIGATION LEVEL	NOTE
HOT CELL VENTILATION SYSTEM				
VENTILATION SYSTEM OPERABILITY	0	0	NO	
PRIMARY HEPA DP (IN)	0.7	0.25-1.5	<0.25, >1.5	
SECONDARY HEPA DP (IN)	0.5	0.25-1.5	<0.25, >1.5	
OLD EFFLUENT SAMPLING SYSTEM OPERABILITY	0	0	NO	
NEW EFFLUENT SAMPLING SYSTEM OPERABILITY	0	0	NO	
MAX EFFLUENT CONCENTRATION (UCI/CC)				
OLD SYSTEM 0 DAILY SAMPLES	—	<1E-11	>3E-11	
NEW SYSTEM 2 DAILY SAMPLES	<5E-12	<1E-11	>3E-11	
OLD SYSTEM 4 WEEKLY SAMPLES	1.5E-14 to 1.4E-13	<1E-12	>3E-11	
NEW SYSTEM 4 WEEKLY SAMPLES	<8E-13	<1E-12	>3E-11	
FILTER RADIATION MONITOR (MR/HR)	2.5-4.0	<2000	<4000	
FILTER RADIATION MONITOR OPERABILITY	0	0	NO	
FILTER ROOM DOOR EXPOSURE RATE (MR/HR)	35-40	40-50	>60	
LAST PREFILTER CHANGE DATE	12/31/90 Also 12/7			
LAST PRIMARY HEPA CHANGE DATE	7/18/90			
LAST SECONDARY HEPA CHANGE DATE	2/27/85			
HOT CELL INTERLOCK SYSTEM				
RADIATION MONITOR (CELL EMPTY) (MR/HR)	—	200-400	<100, >600	3
RADIATION MONITOR OPERABILITY	—	0	NO	3
RADIATION MONITOR INTERLOCK SETPOINT (MR/HR)	—	600-800	>800	3
INTERLOCK SYSTEM OPERABILITY	—	0	NO	3
MAIN POOL				
ACTIVITY (UCI/CC)	4.0E-3 ↑ 2.3E-2 ↓ 1.5E-3	<3E-4	>3E-4	4
CONDUCTIVITY (umho/cm)	110 ↑ 200 ↓ 70	<100	>100	4
NORTH CANAL				
ACTIVITY (UCI/CC)	~1E-4	<3E-4	>3E-4	
CONDUCTIVITY (umho/cm)	10	<100	>100	
SOUTH CANAL				
ACTIVITY (UCI/CC)	3E-3 ↑ 2.5E-2 ↓ 8E-4	<3E-4	>3E-4	4
CONDUCTIVITY (umho/cm)	110 ↑ 200 ↓ 70	<100	>100	4
WORKER EXTERNAL DOSIMETRY PROGRAM (MO:___, YR:___)				
NO OF PERSONS >0.5 REM/MO	—	0	>0	3
MAN-REM IN MONTH	—	<5	>5	3
WHOLE BODY COUNTING PROGRAM (MO: —, YR: —)				
NO PERSONS COUNTED	0			
NO PERSONS >5% MPLB	0	0	>0	
LAA AIR SAMPLES (EXCL SAMPLES FOR RESP PROT WORK)				
NO OF SAMPLES	23	20	<20	
NO OF SAMPLES FROM CELL OR CCZ	13	10	<10	
NO OF SAMPLES >3E-10 UCI/CC	2	0	>0	2
MAX SAMPLE (UCI/CC)	5.1E-10	<3E-10	>9E-10	

12/90

ITEM	STATUS LEVEL	NORMAL	INVESTIGATION	NOTE
PERSONAL CONTAMINATION MONITOR				
OPERABILITY	0	0	NO	
MAINTENANCE DURING MONTH	NONE	NONE	ANY	
BACKGROUND RADIATION LEVEL (UR/HR)	<40	<40	>50	
DETECTOR BACKGROUND RANGE (CPS)	40-92	35-95 ~~65-90~~	<30 ~~<50~~, >100	
BACKUP MONITOR OPERABILITY	0	0	NO	
NO OF PERSONAL CONTAMINATION EVENTS >50K DPM	0	0	>0	
NO OF PERSONAL CONTAMINATION EVENTS >22K <50K DPM	0	0	>0	
NO OF PERSONAL CONTAMINATION EVENTS >10K <22K DPM	1	<3	>5	
NO OF PERSONAL CONTAMINATION EVENTS >5K <10K DPM	0	<10	>20	
LIQUID WASTE MANAGEMENT				
VOLUME TO WSSC (GAL)	12,000	10,000-40,000	<10,000	
CO-60 TO WSSC (CI)	0.001	<0.003	>0.005	
MAX CO-60 CONCENTRATION (UCI/CC)	2.8E-5	<1E-4	>1E-4	
AVG CO-60 CONC (UCI/CC)	2.2E-5	<6E-5	>6E-5	
CO-60 SOLID WASTE MANAGEMENT				
WASTE SHIPMENTS (CU FT)	600	80	(2 shipments)	
WASTE SHIPMENTS (CI)	0.1	68		
LAA CONTAMINATION LEVELS (SEE SUMMARY SHEETS)				
NO OF WORK ZONE SMEARS (DAILIES ONLY)	400	>400	<400	
% OF WORK ZONE SMEARS >1,000 DPM/100 SQ CM	20	<10	>15	5
% OF WORK ZONE SMEARS >3,000 DPM/100 SQ CM	0.25	<1	>2	
NO OF CCZ (EXCL WASTE & HOT ROOMS) SMEARS		>400	<400	3
MAX OF CCZ DAILY SMEAR MEDIANS (DPM/100 SQ CM)		20,000-40,000	>50,000	3
AVG OF CCZ DAILY SMEAR MEDIANS (DPM/100 SQ CM)		5,000-10,000	>10,000	3
CLEAN ROOM CONTAMINATION LEVELS				
NO OF SMEARS	120	>100	<100	
NO >440 DPM/100 SQ CM	0	0	>0	
PERIMETER THERMOLUMINESCENT DOSIMETERS (MO:___, YR:___)				
MAX (NET MR/MO)		<40	>50	3
DRYPOND CONTAMINATION				
MAX EXPOSURE RATE (MR/HR)	0.4-0.5	<0.5	>0.5	
ENVIRONMENTAL SURVEYS				
NO OF PROPERTIES SURVEYED		6	<4	3
NO OF PROPERTIES WITH SPOTS EXCEEDING CRITERIA		0	>0	3
PERSONNEL TRAINING				
NO OF SESSIONS		1	<1	3
SUBJECTS:___				

12/90

BARE COBALT CAMPAIGNS

DATES:_______ TO _______ CURIES HANDLED:____________
DATES:_______ TO _______ CURIES HANDLED:____________
DATES:_______ TO _______ CURIES HANDLED:____________

MINI-CLEANUPS

DATES: 12/7 TO 12/7 MAN-REM: 0.2
DATES: 12/31 TO 12/31 MAN-REM: 0.2
DATES:_______ TO _______ MAN-REM:________

MELT CAMPAIGNS

DATES: — TO — CURIES MELTED:____________ NUMBER OF MELTS:_______

MELT CLEANUPS

DATES: — TO — MAN-REM:________

OTHER OPERATIONS NOT NOTED ABOVE

EXPLANATORY NOTES

1. OPERABILITY STATUS "O" INDICATES ITEM WAS OPERABLE THROUGHOUT REPORTING PERIOD. "NO" INDICATES INOPERABLE FOR AT LEAST PART OF THE MONTH, AS EXPLAINED IN ACTION NOTE.

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2. Max < 6% MPC
3. See CWP evaluation
4. Loss of dP. Resin changed 12/11 and 12/21
5. Contamination levels low, frequency uniform through month

THOMAS E. POTTER
4231 JENIFER STREET NW
WASHINGTON, DC 20015-1959

202-363-4727

3/29/91

Mr. Jackson Ransohoff
Neutron Products, Inc.
22301 Mt. Ephraim Road
P.O. Box 68
Dickerson, MD 20842

Dear Mr. Ransohoff:

Enclosed is a report describing my evaluation of the radiological safety aspects of the two melt campaigns and cleanups conducted in 1990. These reports are intended to fulfill reporting requirements in Condition 13 of MDCRH license 31-025-01. Please call if you have any questions.

Sincerely,

Thomas E. Potter

Thomas E. Potter

RADIATION PROTECTION EVALUATION
OF NEUTRON PRODUCTS, INC.

1990 COBALT-60 MELT AND CLEANUPS

3/29/91

by

Thomas E. Potter

Thomas E. Potter

Thomas E. Potter
4231 Jenifer Street NW
Washington, DC 20015-1959

202-363-4727

INTRODUCTION AND SUMMARY

This report documents the evaluation of the radiological safety aspects of the two NPI cobalt-60 melt and cleanup conducted in January and June, 1990. An evaluation of available data from these melts and from other melts in the recent past indicates with reasonable assurance that the most basic regulatory requirements are usually being met in the melt/cleanup processes themselves, although margins are smaller than might be desired. These data indicate that workers are not being exposed at levels exceeding limits frequently, and when they are, the margins appear to be small. Increased margin is required to reduce the frequency of overexposures. Members of the public are not being exposed to radiation levels exceeding regulatory limits.

An evaluation of expanded scope, which takes into account potential effects of limitations in available data, the effects of melt/cleanup processes on ancillary operations, and anticipated changes in regulatory requirements, suggests that improvements are needed:

- Simple, but significant, changes to the melt/cleanup process are highly desirable in the near term to continue melting operations while maintaining an adequate margin of compliance with current regulatory requirements.

- Fundamental re-evaluations of and changes in the melt/cleanup process will be necessary in the longer term (over the next several years) to continue melting while maintaining an adequate level of compliance with new regulatory requirements.

- From the regulatory standpoint, the most important adverse impacts of melting may well be those affecting current radiological problems that are closely linked to, but not considered part of, the melt/cleanup process (ie., radioactive waste management, pool water quality maintenance, etc.). It is my opinion that melting operations will have to be conducted within the framework of a well-designed management plan to adequately limit those impacts if the overall level of regulatory compliance is to be maintained at an adequate level over the next several years, while making a successful transition to more restrictive new requirements.

These conclusions are based on several considerations:

- Limitations in currently available data need to be accommodated in planning future melt/cleanup activities. More thorough monitoring of extremity exposure in the 1990 cleanups has confirmed that extremity doses are in the range expected (not much higher than whole body doses) in most cases. But the improved monitoring has also shown that extremity doses are somewhat higher than previously thought in rare instances. For planning purposes, it would be reasonable to expect that future planned improvements in extremity and whole body dose monitoring will indicate that doses may be somewhat higher than currently thought and exposures in excess of limits may be more likely than thought based on data available to date. Additional exposure controls should be imposed in future melt/cleanups to allow for this expectation.

- Pending changes in regulatory requirements (10 CFR Part 20, on-site waste storage requirements, etc.), which take effect in the next few years, will reduce dose limits substantially and will complicate waste management operations so that current margins in compliance with regulatory requirements will either be reduced or eliminated unless melt/cleanup operations, waste management operations, and other operations are changed in fundamental ways.

- Basic radiological requirements are usually satisfied in the melt/cleanup process itself, but the process is contributing to the accretion of a number of radiological problems, some of which involve reduction or loss of margin in compliance with license or regulatory limits. Although any one of these problems in isolation would seem to be be reasonably easily managed, each is more challenging when faced as part of a larger complex of problems.

NPI has had success at various times over the last two years in at least temporarily addressing some of these problems, and in recent months has had some success in addressing several of these problems simultaneously, but resource limitations and changing priorities appear to make it difficult to sustain these improvements while adequately addressing the entire complex of problems.

Planning and scheduling become more important as regulatory limits are approached to assure that material and human resources are used most efficiently and to assure the benefits of improvements in one area are not offset by aggravation of problems in other areas. Establishing a list of priorities and working on them from the top down incorporates an unexamined assumption that the available level of resources is sufficient and begs the question whether additional resources are needed to maintain a sufficiently high rate of improvement and to maintain improvements on a continuing basis. A living (ie., periodically reviewed and updated) comprehensive plan and schedule, which shows, by task for each project, the work scope, personnel and financial resource allocation, and targeted milestone completion dates is desirable, and probably necessary to answer this question prospectively. It will be desirable, if not necessary, to coordinate the development of the plan and schedule with CRH to assure agreement on goals, priorities, and schedule.

)LOGICAL SAFETY ASPECTS OF THE MELT/CLEANUP PROCESS

Process and Distribution of Activity

A cobalt-60 melting campaign typically consists of multiple of cobalt-60 in the form of cobalt metal at a specific ity of (b)(4) per gram or more in batches of about (b)(4) each. Melting is conducted remotely in apparatus set up in the NPI hot cell. The total quantity of cobalt melted in an entire campaign is typically about (b)(4) The fraction retained in the product slug is probably variable and is difficult to quantify accurately, but measurements in melt waste indicate that about 99.9 percent of the cobalt melted is retained.

Almost all of the cobalt-60 not retained in the product slug, on the order of several hundred Curies, is retained within the melt apparatus itself and deposits on crucible surfaces, internal parts of the melt furnace and in the furnace evacuation line filter. Only a fraction of this inventory is readily dispersible. Most of these items are encapsulated in stainless steel remotely (ie., using manipulators) and transferred to the pool remotely, where they are stored as radioactive waste. However, some of these parts which may contain substantial cobalt-60 inventories (b)(4) or more) are transferred through the pool or through the wall of the hot cell to a shielded dry well for storage or to shielded drums in the operating area, which are then added to the radioactive waste inventory awaiting shipment to a licensed disposal facility. (Material for storage in the drywell is sealed in plastic tubes before removal from the hot cell.) Contamination on materials transferred from the cell to the pool following melting operation contributes to an unknown but probably significant extent to contamination in the pool.

Deposition on furnace internals and the vacuum line filter is the only available mechanism for local confinement or capture of cobalt-60 near the point of release. Although a large fraction of the cobalt released does appear to be captured on furnace internals, quantities of cobalt-60 are dispersed within the cell when the furnace is disassembled and when crucibles are broken from the cobalt product slugs. Material dispersed in this way is completely confined within the hot cell and its ventilation system, as described below, but the material constitutes a substantial radiation problem in cleanup of the cell. Much of this material is cleaned up remotely, and some of the materials are transferred to the shielded dry well or shielded drums as described above. However, some highly contaminated equipment and materials must be removed from the cell manually. Something on the order of (b)(4) remain deposited on cell internal surfaces and equipment surfaces at the end of remote decontamination following a melt. Dose rates for the first cleanup entry are usually in the range of 10 to 20 R/hour.

Cobalt-60 that is not captured on melt apparatus is completely confined within the hot cell and its filtered-exhaust ventilation system. There is no release from the ventilation system of hot cell air containing more than an insignificant fraction of the maximum permissible concentration of cobalt-60 for unrestricted areas. This conclusion is based on analysis of continuous samples of air released from the ventilation system. Concentrations of cobalt-60 in air in work areas around the cell are also very low during melting, and except for the access area immediately behind the cell, during cleanup. This conclusion is supported by air sample data and confirmed by annual whole body counting measurements on workers, approximately twice-daily personal contamination monitoring (which serves as a reasonably sensitive screening lung counter), and area contamination survey data.

Curie quantities of cobalt-60 in particulate aerosol form are transported to the ventilation system. The key components of the system include the roughing filter at the ventilation exit port in the cell, and two HEPA filters in series located approximately 15-20 feet downstream from the roughing filter. The ventilation duct runs through the wall and roof of the hot cell. Collection of as much as 0.5 Curie on the primary HEPA filter during a single melt is not unusual. Although precise measurement is difficult, accumulated cobalt-60 inventory on the secondary filter is much lower.

The quantity of cobalt-60 collected on the roughing filter is not easily measured without significantly increasing the radiation dose of the worker handling the filter. The filter efficiency of the filter material, widely used in many industrial applications, is certainly not high, but it is likely that Curie quantities are collected on the roughing filter as well.

Quantities of cobalt-60 accumulated between the roughing filter and the primary HEPA filter over the entire history of cobalt operations cannot be accurately measured or estimated, but certainly exceed one Curie. Radiation levels in the filter monitor after a change of the primary HEPA filter are currently about 1.8 rem per hour, and have been increasing at a rate of about 0.2 rem per hour each year since 1986. This measurement may only be indicative of the change in the local distribution of cobalt-60 contamination in the ductwork near the detector location, but it may indicate increasing inventories in the ductwork generally.

Cell Decontamination

The NPI hot cell is used for operations that differ considerably in their tolerance for contamination levels in the cell. Primary encapsulation of sources, secondary encapsulation of sources, and transfers to and from shipping containers each require progressively lower levels of contamination in the cell. This means that the extent of cleanup after each melt is probably higher than would be required if the cell were used only for melting. Although most of the cobalt-60 deposited within the cell is packaged and removed from the cell remotely, a substantial quantity (including that deposited on the roughing filter during melting) cannot be fully recovered, packaged, and removed from the cell using existing remote-handling capabilities. Completion of decontamination requires manual removal or cleanup (some by hand-scrubbing) of quantities of cobalt-60 on the order of b4 In practice, this is typically conducted without the benefit of dose-reduction aids, such as long-handled tools, apparently because such devices have been tried in the past and found ineffective.

Cleanup External Exposure

Because of the large cobalt-60 inventory, exposure rates in the cleanup environment are high, usually in the range of 10 R/hour for the first several entries. These dose rates pose the potential for exceeding regulatory dose limits in short exposure times, and, in fact, the few overexposures that have occurred in recent times have occurred in high dose rate operations.

Personnel whole body exposures to penetrating radiation during cleanup are typically in the range of 20 man-rem per melt cleanup (excluding waste handling doses). The two melts in 1990 were typical in this regard. The aggregate dose from the two cleanups amounted to about 35 percent of the total aggregate dose to workers receiving more than 0.1 rem.

Lifetime doses of three NPI workers exceed 75 rem as of the end of 1990. One of them received virtually all of his dose previous employment as an x-ray technician. The other two have lifetime doses of approximately 90 and 100 rem, and are special skills workers that do not participate in melt cleanups except in a low-dose support role.

Workers that spend much of their time in the LAA (a group that currently numbers about six people) are typically used only in support roles in melt cleanups so that the cleanup dose can be distributed over several dozen people from the much larger portion of the NPI work force that typically receives only small or negligible doses from routine operations. Nonetheless, the aggregate dose is averaged over a relatively small pool of perhaps several dozen workers so that a number of individuals receive doses exceeding 1 rem per melt.

Workers typically do not receive whole body doses much above 1.5 rem in a single entry. Doses are controlled by using multiple sets of self-reading dosimeters (SRD) worn on the chest. Both high and low range dosimeters are included. Extremity TLD badges, worn on both wrists and both ankles, were used for the first time in many years in the two 1990 cleanups. Summaries of these data are included in Appendix A for the cleanup in January, 1990, and in Appendix B for the cleanup in June, 1990. These data indicate that whole body dose rates typically range from about 6 rem per hour down, but that higher rates can occur, usually during the removal of high-activity hot spots after general radiation levels have been reduced in the early entries. (It should be noted that these rates are time averaged and include some time spent outside the cell. Exposure rates in the work area are somewhat higher than indicated by these data.)

Extremity badges indicated that whole body dose is almost always limiting relative to wrist dose. Except for two instances, one in each cleanup, the ratio of the maximum wrist dose to the measured whole body dose was less than 4. The ratio would have to exceed 6 to make wrist dose controlling. Plots of frequency distributions of maximum wrist dose clearly show that these two cases are outliers. In one of these instances, a wrist badge revealed a slight overexposure, reported to CRH previously.

It is possible that these exposures resulted from unlikely deposition of hot particles near the wrist badge, in which case the badge reading would be a conservative estimate of the dose to other parts of the hand. On the other hand, it is possible that the source of radiation was near the finger tip, which would make the wrist badge reading an underestimate of dose to other parts of the hand. Such a scenario might occur during decontamination of a hot spot. If such a scenario occurred calculation of the dose at the base of the finger from the dose measured at the wrist, assuming a point source and separation distances of 3 inches to the base of the finger and 6 inches to the wrist, would indicate that both of the outlier instances would be overexposures. Other exposures would remain below permissible limits.

Improved monitoring is needed and is planned in future melts to better characterize the exposure conditions. Finger badges will be used in the future, and remote monitoring will be used to better characterize the activity of hot spots prior to manual decontamination. This will permit the establishment of special exposure controls in these cases in anticipation that extremity doses may be higher than expected based on wrist dose measurements.

The problem of monitoring and controlling dose to parts of the hand is best illustrated in Figure 1, which shows the gamma dose rate versus distance from one Curie of cobalt-60 in a variety of geometries. The wrist badge would typically be about 6 inches of about 15 centimeters from the fingertips of the extended hand. A finger badge at the base of the finger would be about 3 inches or about 7 centimeters from the fingertips of the extended hand. A source at the fingertips of the extended hand could deliver a dose to tissue at one centimeter ranging from 10 to perhaps as high as 200 times the dose measured at the wrist and from 3 to 50 times the dose measured at the base of the finger, depending on the geometry of the source, or, equivalently, the pattern of motion of the hand over a source fixed in place. Such high variability means that measurement of extremity dose at the wrist or finger base alone may not be very meaningful in estimating actual dose in such an exposure situation. The planned monitoring for the characterization of hot spots will provide essential supplemental information for accurate determination of actual extremity dose. Decontamination tools providing separation distances of as little as 6 inches would also be very helpful in controlling doses in such situations, and would, of course, be the preferred method of managing this problem.

The non-uniformity in dose indicated by extremity badge results also suggest that placement (normally on the chest) of badges used to determine whole body dose may not be optimum in some cases. Ankle badge results indicate that dose to the upper legs, counted as whole body dose, may be somewhat higher than indicated by chest dosimeters in cases in which workers are kneeling on the floor. Use of multiple badges including badges on the leg above the knee, would be desirable in these cases. If possible, kneeling on the floor should be avoided. If kneeling on the floor is necessary, the controlling dose based on the chest SRD, should be reduced somewhat to allow for potentially higher doses measured on the leg.

Cleanup Internal Exposure

Airborne concentrations of cobalt-60 are typically many hundreds of times higher than the maximum permissible concentration, which poses the potential for exceeding regulatory exposure limits in short times, and which dictate the use of protective clothing and respiratory protection equipment and an elaborate program to control the use of such equipment. Data on worker internal exposure show that this program is functionally successful. These data are summarized in Appendix A for the cleanup in January, 1990, and in Appendix B for the cleanup in June, 1990.

Data from high volume air samples from inside the cell and from the room immediately behind the cell are usually collected. These data indicate that general concentrations in the cell are usually in the range of 10 to 50 times the maximum permissible concentration for restricted areas (9×10^{-9} microCuries per cubic centimeter) and are usually much higher than concentrations outside the cell. In perhaps as many as one-quarter of the entries, concentrations outside the cell approach concentrations inside the cell.

Early entries make use of forced-air respiratory protection equipment. Later entries, when air concentrations are typically lower, make use of full-face respirators. Filter cartridges used in these entries are counted and provide some indication of air concentration to the extent that they are not contaminated by direct contact with contaminated objects. Data from respirator cartridges, if they represent local air concentrations accurately, indicate concentrations in the breathing zone on the order of 100 to 1,000 times the maximum permissible concentration for restricted areas. It should be noted that these estimates may be erroneous, and if they are, they are most certainly erroneous on the high side. Furthermore, it should be noted that exposure durations in these cases are short, always less than one hour, and the people exposed seldom receive any other exposure in any calendar quarter. So the potential for internal exposure from inhalation of aerosol during cell work is much less than might be indicated by the conservatively estimated concentration alone.

The greatest potential for internal exposure is probably related to inhalation of very highly localized, high-concentration aerosol generated during removal of contaminated clothing. Such an occurrence in late 1990 resulted from a procedural lapse in which a worker contacted his contaminated hand to his mouth during removal of contaminated clothing and respirator following a lower-level cleanup. The uptake resulted in an initial lung burden equivalent to about 61 percent of the ICRP 2 maximum permissible lung burden, almost all of which had cleared as of this writing. An assisting technician received a negligibly small exposure. (This occurrence was reported to CRH previously.) Such an occurrence shows that the hazard of inhalation exposure during clothing removal is present and warrants continued careful control and continued efforts to minimize contamination levels in the cell through process design and remote cleanup.) Except for the isolated case mentioned above, data from nasal smears, twice-daily personal contamination monitoring (which is sensitive to lung depositions of about 100 nanoCuries or more) and annual whole body counting are consistent in indicating that internal exposures associated with melt cleanups are and have been negligibly small.

Radioactive Waste Generation

Significant quantities (both volumes and activities) of radioactive wastes are produced in the cleanup and present handling, storage, and disposal problems. The small volume of very high activity waste that is encapsulated remotely in stored in the pool presents no significant direct radiation exposure or waste management problem in the near term, and should be relatively easily managed, from the radiation exposure standpoint, in the long term. However, something on the order of 50 Curies of cobalt-60 waste in two or three shielded drums are produced in a single cleanup. A substantial volume of lower-level contaminated plastic sheet, paper, disposable clothing, and cleaning materials is also produced, and is added to the radioactive waste inventory in storage awaiting disposal.

Residual Cell Contamination

Residual radiation left in the cell after the melt cleanup contributes significantly to worker doses. The exposure rate after cleanup is usually in the range of 300-500 mR/hour. Residual contamination left in the cell after the melt cleanup (in the range of 10 microCuries/100 square centimeters), complicates subsequent source encapsulation and packaging operations and contamination tracked from the cell is probably a major contributor to surface contamination in work areas.

RE-EVALUATION OF THE MELT PROCESS

The melt and cleanup process developed described above has been conducted many times NPI. The level of success has been generally good. Occasional problems have occurred, but NPI has been generally successful in responding to them and in making incremental improvements to the process. However, periodic reexamination of fundamental assumptions is often helpful in responding to changing conditions. The new 10 CFR Part 20 codifies a requirement that doses be kept ALARA, and it can be expected that requirements for formal ALARA programs will be added to licenses. This will replace current regulatory language that strongly urges that doses be kept ALARA, but does not require it. Since implementation of such a program will require a complete re-evaluation of the melt and cleanup process design, and a comparative evaluation of likely candidates for alternative approaches, it would be desirable to get an early start on that effort so that it can be completed in time to permit orderly transition to operations under the new 10 CFR Part 20. Because the relative safety of alternative approaches would be an important consideration in an ALARA analysis, I would recommend developing an updated safety analysis for the melt/cleanup process in coordination with the ALARA effort. I believe that three evaluations conducted over the next several years would be highly desirable:

- The necessity for and benefit from melting cobalt, as opposed to fabricating sources from forms not requiring melting (including both mini-pellets and larger forms shaped prior to irradiation) should be evaluated in a comprehensive and systematic way. Such an evaluation should document the benefits and costs of the various alternative approaches to source fabrication and would be important in determining the need for the melt/cleanup process.

- Considerable thought has apparently been given to redesign of the melt/cleanup processes, and significant improvements have been made in the melt process and in the cleanup process. Most of these improvements have been focused on remote cleanup. These efforts should be continued. However, there has been no documented systematic effort to redesign the melt process itself to minimize doses by reducing the dispersion of contamination. For example there has been no systematic attempt to develop a system to confine and capture locally material released to the cell during the melting process thereby reducing the quantities of cobalt that must be recovered manually in the cleanup. Of course, design of such a system would not be a simple task (and may not be feasible), because the system would have to allow for space limitations, requirements for and limitations in manipulator maneuverability, the requirement to retain access to the canals, the capability for minimizing doses during removal of cobalt-60 captured in such a system, etc. That is why a systematic effort is warranted. Such an evaluation should include examination of a reasonable sample of likely candidates for improving the process.

- The melt process has the potential for accidental releases of quantities of cobalt to the cell greater than that typically observed. Past experience (no such release in a very large number of melts) is strong indication that the probability of such an event is low, and the capabilities of the ventilation system are certainly sufficient to limit consequences offsite. Nonetheless, the degree to which control of this hazard is optimized in the existing melt process and in potential ALARA alternatives may warrant re-examination. Such an analysis would probably confirm that the probability is sufficiently low, but it could identify reasonably achievable modifications to further reduce the probability. Such a study might also show that the consequences of such an event and the recoverability from such an event could be significantly improved by some reasonably achievable means, such as increasing the filtration efficiency at the present roughing filter location.

INDIRECT IMPACTS OF MELT/CLEANUP PROCESS

Complete evaluation of the melting and cleanup operations must consider the extent to which these operations contribute to the magnitude of general radiation protection problems existing at NPI. These have been discussed in detail in my report dated March 28, 1990, and will only be summarized here. The general problems upon which the melt and cleanup operations bear in important ways are as follows:

1. Penetrating radiation doses for key LAA workers and some others regularly approach quarterly regulatory limits. Doses in these cases appear to be sufficiently controlled to keep overexposures unlikely under current regulations. Current regulatory limits are occasionally exceeded, roughly once every two or three years, but those overexposures are almost always associated with short-duration exposure in high dose rate work in which the anticipated dose is not accurately estimated or, more likely, in which a lapse in work procedure occurs. The margin for such lapses decreases with increasing dose rate. Reduction of the frequency of overexposures will require improved controls in high dose rate work and/or reduction of dose rates in that work. The removal of quarterly limits in the new 10 CFR Part 20, to be implemented in January, 1994, may reduce the increment of added restriction of lower annual dose limits from the standpoint of NPI overexposures, even if receipt of the annual dose in a single quarter is prohibited, as is likely. Compliance with the reduced annual dose limits in the new 10 CFR Part 20 will require dose rate reductions in general LAA work and in some specific tasks.

   Total exposure in 1990 was about 120 man-rem, about 40 of which resulted directly from melt cleanups. A significant part of the remainder resulted from handling waste associated with melt-cleanups. The single overexposure to penetrating radiation in 1990 occurred during a melt cleanup

2. Penetrating radiation exposure rates in unrestricted areas from cobalt-60 within the restricted area (ie., inventory in waste storage rooms, etc.) regularly closely approach and may exceed license condition limits 500 millirem per year in several locations along the perimeter fence, assuming continuous occupation. However, because presence of members of the public in those areas is limited in time, doses to people are well below 500 millirem per year. In a few isolated areas in the unrestricted area (ie., parts of certain offices), levels closely approach or slightly exceed dose rate limits in regulations. Again, occupation times in those areas are limited and monitoring of those individuals shows that doses are more than a factor of three below the 500 millirem per year limit. Reduction will require reductions in inventory and/or additional shielding. Substantial reductions in dose rate will be required to meet the requirements of the new 10 CFR Part 20. Incorporation of reduced inventory, added shielding, and, at least on an interim basis, a relaxation in the applicable regulatory limits would be desirable elements in the plan to be developed for corrective action.

   The major sources of this radiation is waste inventory, the bulk of which appears to stem from melt cleanup, and radiation from cobalt-60 in the ventilation system, most of which is due to melting.

3. Cobalt-60 contamination continues to be released to unrestricted areas through rain water runoff pathways. This material appears to be slowly accumulating in unrestricted areas within and beyond the drypond. Analyses showing that concentrations of cobalt-60 in rain water runoff are below maximum permissible concentrations are based on the assumption that a substantial fraction of the cobalt-60 released this way has been entirely collected in the area of measurable accumulation. While that assumption may be correct, confirmation would be desirable. The occasional discovery of microCurie spots of contamination offsite may or may not be associated with the milliCurie inventory in the drainage area. In developing a plan to address this problem it would be desirable to include application for regulatory relief on at least a temporary basis (increasing the permissible dose rate), fencing the area, monitoring to better characterize contamination distribution in the area, monitoring to better characterize the source of the

contamination, and interim limits for radiation and contamination to guide remediation efforts until the situation is more fully understood.

Because the courtyard is not enclosed waste is transported through the courtyard during transfer to the waste storage room and is handled in the courtyard during preparation for shipment. Contribution of present operations to this problem cannot be reliably estimated, but increases in levels in the drypond indicate that present operations may be contributing significantly. To the extent that contributions from present operations may be significant, wastes from melt operations are a substantial component.

4. Penetrating radiation from cobalt-60 contamination released to unrestricted areas (the drypond area) exceed the license limit of 500 millirem per year, and are closely approaching the regulation limit, 100 millirem per week. Because members of the public are not usually present in those areas and because the peak dose rate measured is confined to a small area, it is not likely that any person would receive 500 millirem in a year. Remediation of this problem as described in item 3 would be desirable.

   See comment under item 3.

5. Intakes of cobalt-60 on the order of a microCurie, resulting from short-duration exposures, typically less than one hour and often just minutes, occur at a frequency of about two per year. Except for the single case identified above, the doses associated with these intakes are negligibly small, whether they are inhalations or ingestions. The small margin for regulatory compliance stems from conservatism in the current regulation. Margin for regulatory compliance will increase with the adoption of the new 10 CFR Part 20, due to a more realistic approach to regulation of internal exposures. Although this problem may not be serious from the health and safety standpoint, the regulatory agencies are particularly, perhaps overly, sensitive to it. The incorporation of half-face respirators for these situations could be a relatively easy way to accommodate their concerns and could provide insurance against less likely higher exposures.

   Handling of wastes, much from melting, and residual cell contamination are important contributors to this problem.

6. Limitations in space, shielding, and remote-handling capabilities and accumulated backlogs of waste materials from past operations make radioactive waste handling, storage, and shipping facilities and procedures substantial contributors to several radiological problems. These include doses to operators, levels of radiation in unrestricted areas, and, probably, levels of contamination in unrestricted areas, the latter due to the fact that radioactive waste transfers between operating and storage areas, both of which are areas in which floor contamination levels are high, must pass through the open courtyard. Improvements in these facilities and procedures that properly integrate these considerations could improve the margin of regulatory compliance in a number of areas and will probably be necessary to assure compliance with some of the new requirements. NPI is correct in placing a high priority on efforts along these lines and should continue those efforts.

   Melt cleanup waste is a substantial component of cobalt-60 waste inventory and a major contributor to the problems identified. Although a number of waste shipments have been made over the last year, the cobalt-60 inventory has apparently not been reduced appreciably.

7. NPI has no facility in which materials and equipment can be decontaminated in such a way that contamination containment and dose reduction features such as local shielding are available. The feasibility for and potential benefits from such a facility should be evaluated.

   Some contaminated melt equipment is saved for use in later melts. This equipment is stored in the Hot Tool Storage Room where it constitutes a radiation source. Transfer of the equipment between the cell and the room is also a significant contamination source.

8. Limitations in facilities, equipment, and procedures used in the storage and transfer of contaminated equipment used in source fabrication frequently result in the spread of floor contamination in the CCZ on the order of 0.1 to 1 milliCurie each time the operation is performed. The feasibility for and potential benefits from improvements in these facilities and procedures should be evaluated.

   See comment under item 7.

9. Limited filtration efficiency at the point of entry to the hot cell exhaust ventilation system, when coupled with releases of cobalt-60 to the air in the cell, results in substantial transport of airborne cobalt-60 within the cell into the ventilation system, leading to high cobalt-60 inventories in the ventilation system and on the primary HEPA filter. The greatest increment occurred in 1986. Although increases in levels appear to have been relatively small since then, levels in the ventilation system remain high. This phenomenon contributes to a variety of problems:

   - High dose rates from cobalt-60 on the HEPA filter and in other ventilation system components contribute to high exposure rates in both restricted and unrestricted areas.

   - The HEPA filter change frequency is determined in part by anticipation of future accumulation of cobalt-60 on the filter, and is much higher than would be required if the change frequency were determined by particle loading. This increases costs and contributes to waste management problems.

   - High dose rates from material on the HEPA filter and in other ventilation components complicates the filter change operation and other operations in the area, such as efficiency testing of the final HEPA filter. Although reduction in dose rates would be desirable, that would not appear to be a major driving force for improved roughing filter efficiency in the near term. The primary HEPA filter change currently contributes about 0.2 person-rem per year to the aggregate dose, an insignificant part of the total aggregate dose in the operation.

   Melting is the major source of this problem.

10. Conductivity and concentrations of cobalt-60 in the main pool and in the canals were high in 1990 and were difficult to bring down. A substantial cleanup effort in the last half of 1990 reduced concentrations in the North Canal. (A similar effort for the main pool in early 1991 had reduced concentrations to levels below the action level.) Plans for future activities need to include provision for sustaining these gains. Long-term integrity of singly-encapsulated waste tubes with untested welds does not appear to be a contributor to pool contamination thusfar, but the potential for importance in the future should be analyzed.

Transfer of contaminated items from the cell to the pool after melts is prabably a major source of contamination in the pool.

Even though basic radiological requirements are usually satisfied in the melt/cleanup process itself, the process is contributing in a major way to the accretion of all of the most challenging radiological problems faced by NPI. It is clear that elimination of melting would greatly reduce the magnitude of these problems. It is also apparent that good progress in managing this complex of problems will be essential to be able to continue melting cobalt-60 within the constraints of existing and anticipated regulatory requirements.

Although any one of these problems in isolation would seem to be be reasonably easily managed, each is much more challenging when faced as part of a larger complex of problems. NPI has had success at various times over the last two years in at least temporarily addressing some of these problems, and in recent months has had some success in addressing several of these problems simultaneously, but resource limitations and changing priorities appear to make it difficult to sustain these improvements while adequately addressing the entire complex of problems.

These problems are manageable, but it is not clear that NPI has a workable way to manage them within the constraints of present and future regulatory requirements. A living (ie., periodically reviewed and updated) comprehensive plan and schedule, which shows, by task for each project, the work scope, personnel and financial resource allocation, and targeted milestone completion dates is desirable, and, in my view, necessary to answer this question prospectively. If such a plan is developed, it will be desirable, if not necessary, to coordinate the development of the plan and schedule with CRH to assure agreement on goals, priorities, and schedule, to give CRH early warning on the need for regulatory review, and to incorporate realistic schedules for regulatory review.

RECOMMENDATIONS

1. Develop a living (ie., periodically reviewed and updated) comprehensive plan and schedule, which shows for each project by task, the work scope, personnel and financial resource allocation, and targeted milestone completion dates. Such a plan is needed to determine the level of resources required and to best allocate resources in

managing the entire complex of radiation problems adequately on a continuing basis. Coordination and cooperation between NPI and CRH will be necessary in the development and implementation of this plan.

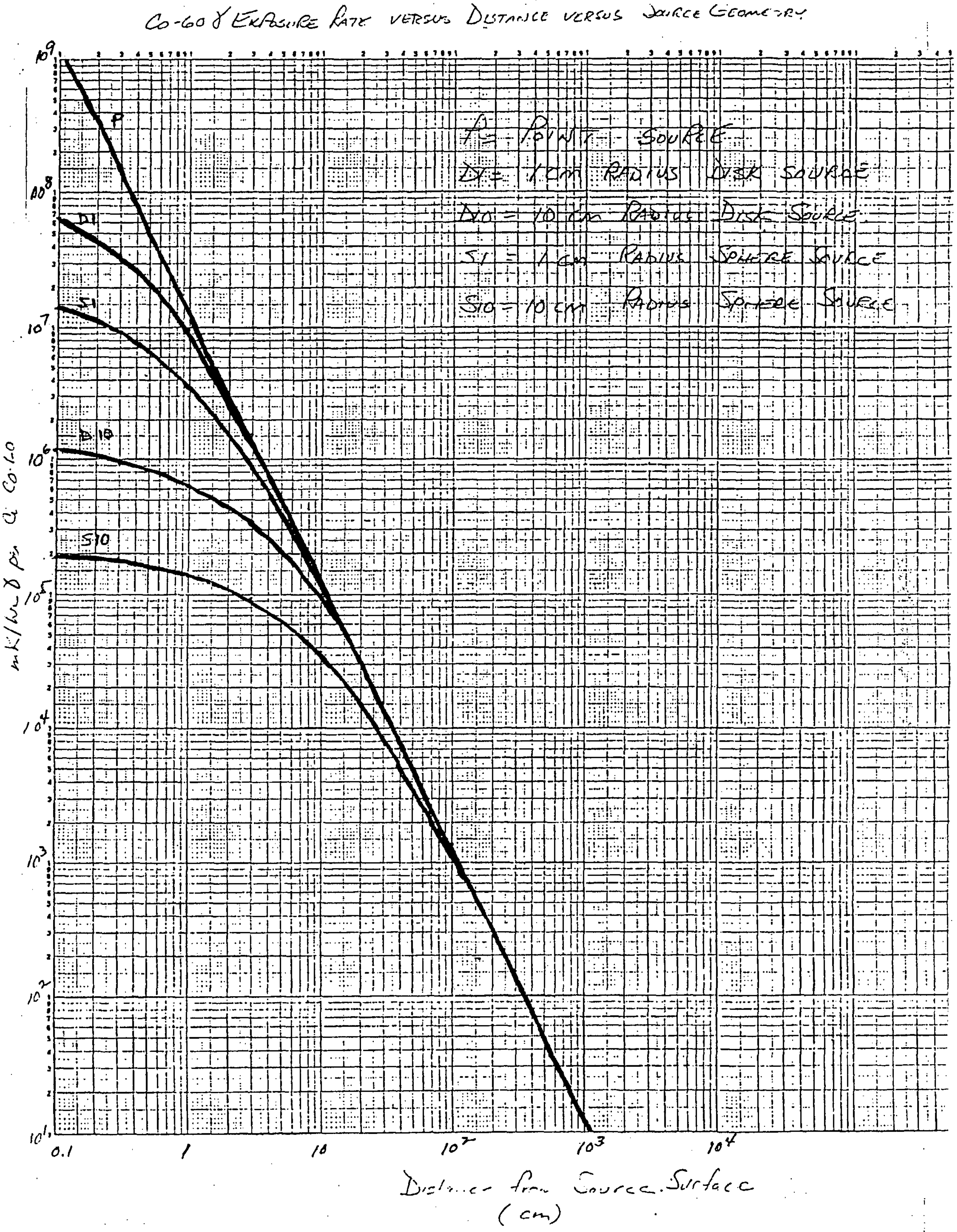
2. Institute improved penetrating dose monitoring (whole body and extremity dose) and controls (lower dose limits and characterization of hot spots) in future cleanups.

3. Continue incremental improvements in contamination confinement during melt (one-piece table) and remote decon (refine vacuum cleaning to improve coverage and efficiency) in all future cleanups.

4. Evaluate in a comprehensive and systematic way the necessity for and benefit from melting cobalt, as opposed to fabricating sources from forms not requiring melting. The primary objective should be to provide information supporting ALARA analyses described in item 6. The schedule should be designed to enable, to the extent practical, incorporation and testing of any selected process modifications by January, 1993 to assure fully operational status by January, 1994.

5. Evaluate in a systematic way the optimization of control of the potential for and consequences of accidental releases of higher than normal quantities of cobalt to the cell during the melt process. A major objective should be to provide information supporting ALARA analyses described in item 6, and work should be coordinated with that effort. The schedule should be designed to have any fixes necessary in place and tested by January, 1993 to assure fully operational status by January, 1994.

6. Institute a systematic effort to redesign the melt process itself to minimize doses during cleanup. This effort should include continued efforts toward improvements in remote cleanup capability and should specifically include development and examination of candidate designs of systems to confine and capture locally material released to the cell during the melting process thereby reducing the quantities of cobalt that must be recovered manually in the cleanup. The objective should be to have modifications in place and tested by January, 1993 to assure fully operational status by January, 1994, when changes to 10 CFR Part 20 become effective for agreement state licensees.

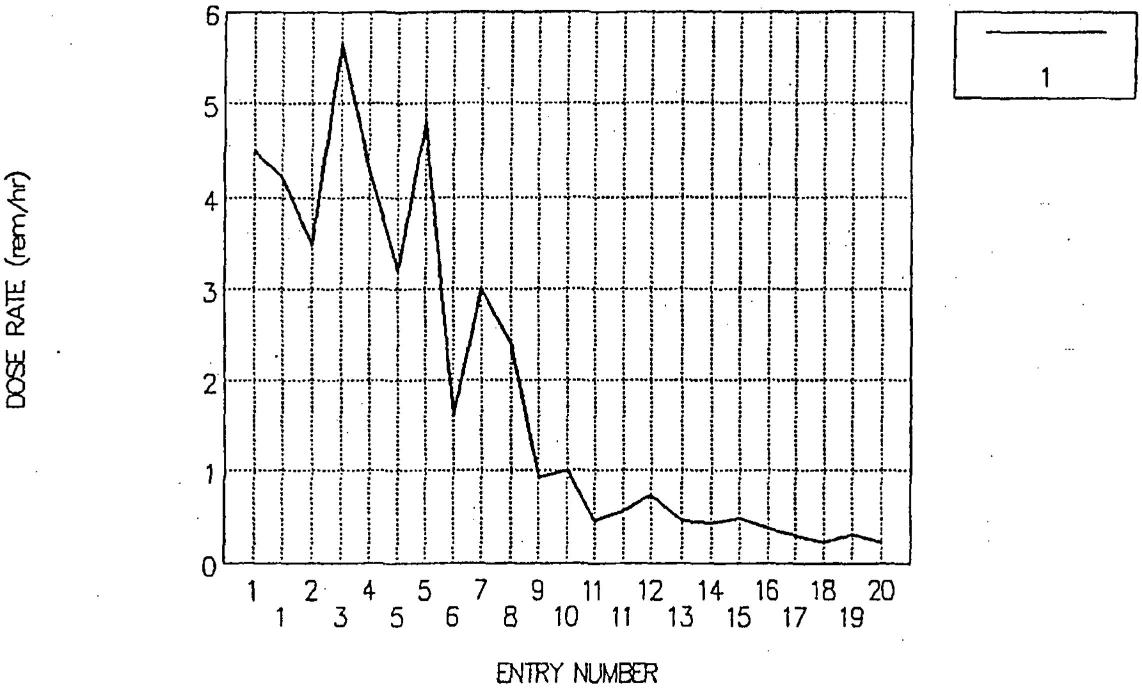

Co-60 γ Exposure Rate versus Distance versus Source Geometry
P = Point Source
D1 = 1 cm Radius Disk Source
D10 = 10 cm Radius Disk Source
S1 = 1 cm Radius Sphere Source
S10 = 10 cm Radius Sphere Source
P
D1
S1
D10
S10
mR/hr γ per Ci Co-60
Distance from Source Surface (cm)
0.1
1
10
10^2
10^3
10^4
10^1
10^2
10^3
10^4
10^5
10^6
10^7
10^8
10^9

APPENDIX A

NEUTRON PRODUCTS, INC.
JANUARY, 1990 MELT CLEANUP
DATA SUMMARY

AVERAGE DOSE RATE VERSUS ENTRY

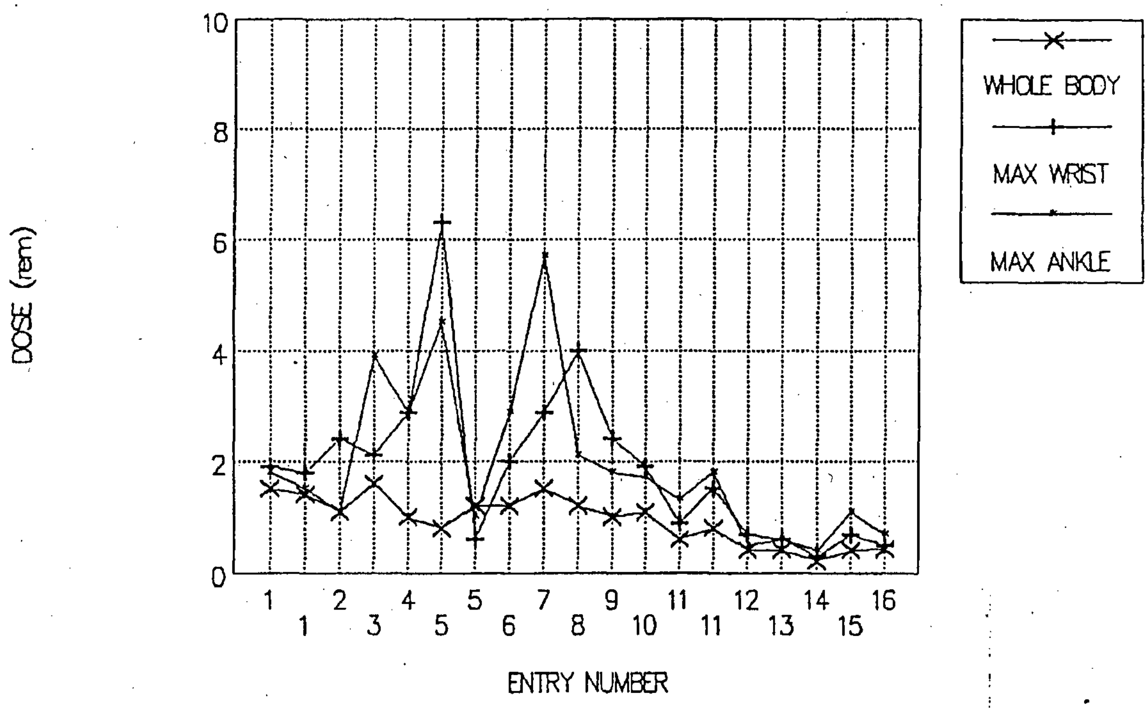
1/90 MELT CLEANUP



Dose rate = SRD total / Entry Duration

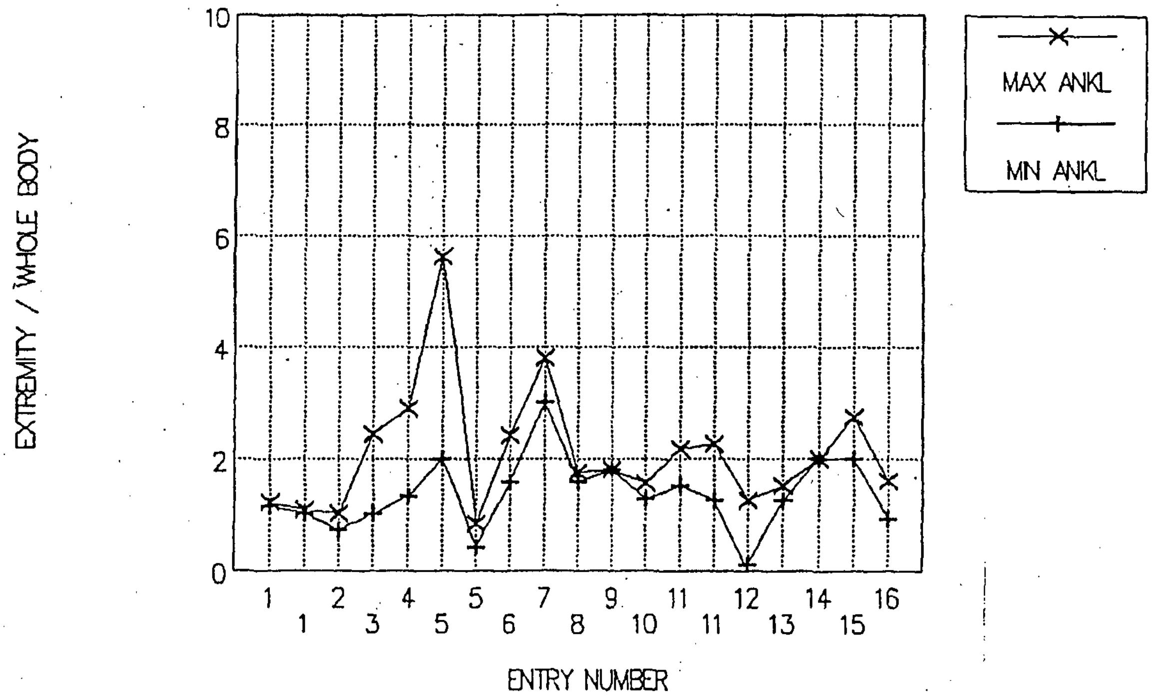
EXTREMITY DOSE AND WHOLE BODY DOSE

1/90 MELT CLEANUP



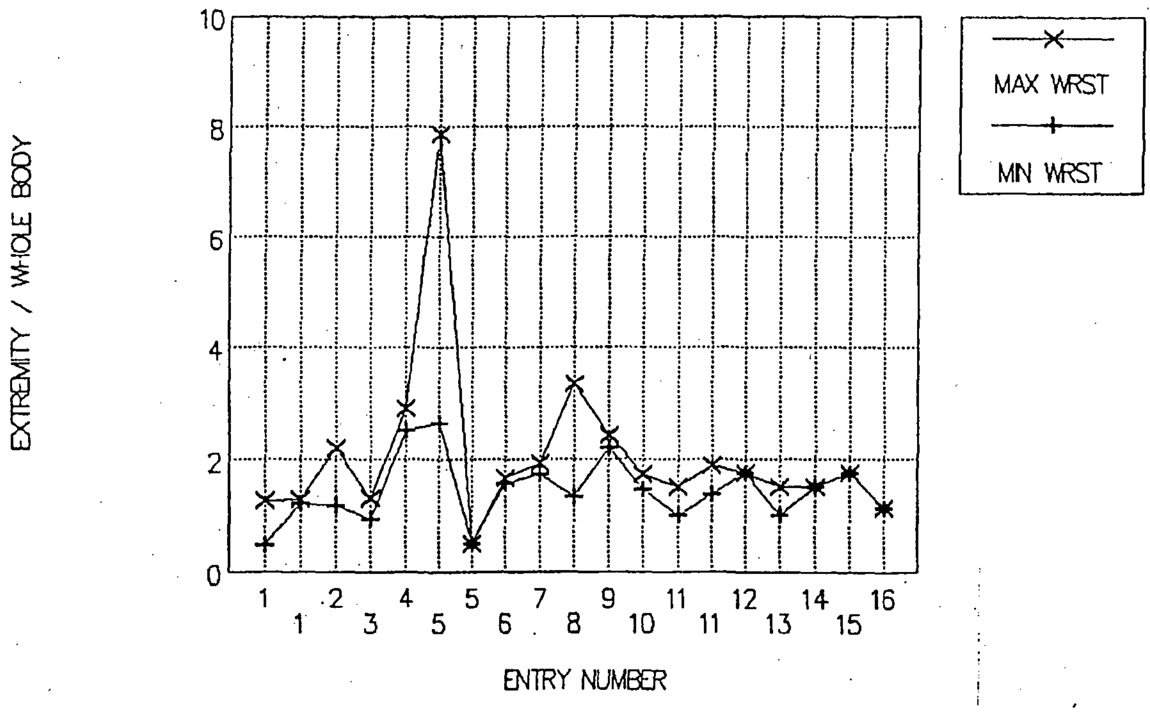
EXTREMITY DOSE/WHOLE BODY DOSE

1/90 MELT CLEANUP



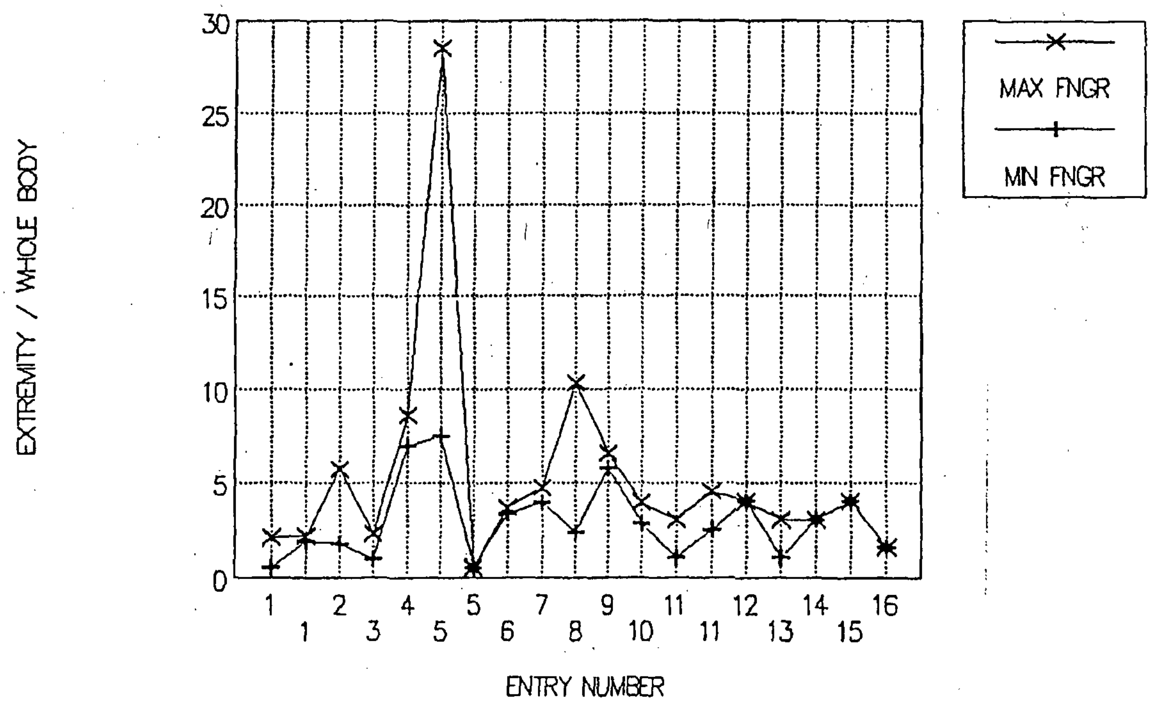
EXTREMITY DOSE/WHOLE BODY DOSE

1/90 MELT CLEANUP



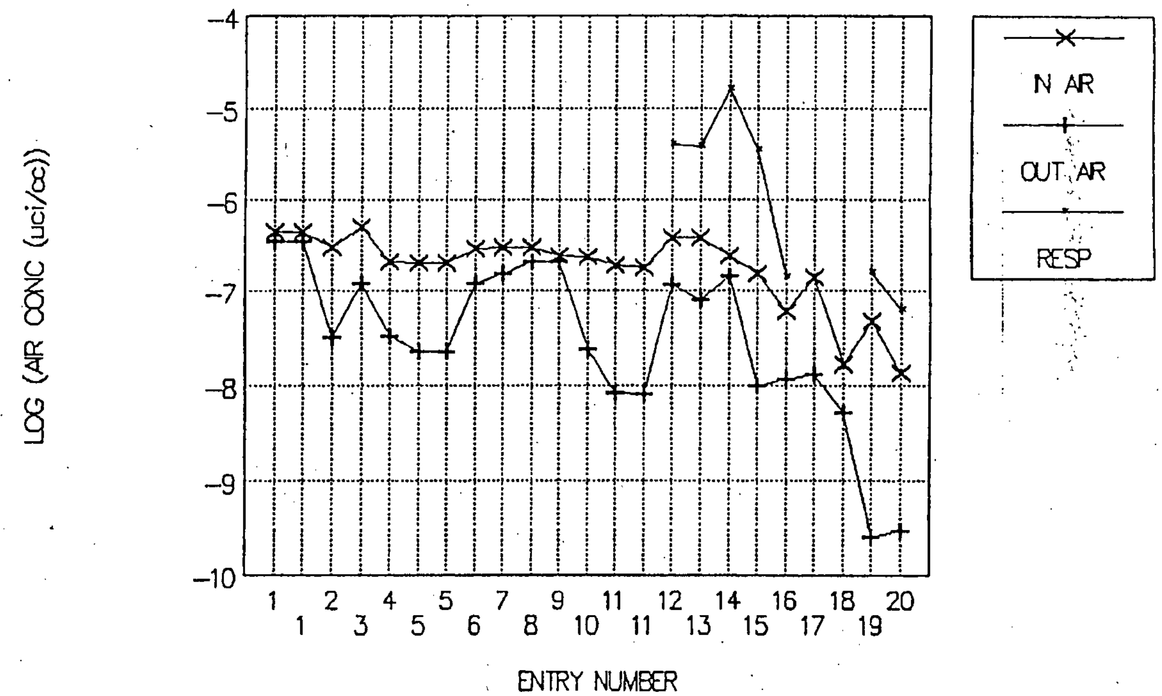
EXTREMITY DOSE/WHOLE BODY DOSE

1/90 MELT CLEANUP

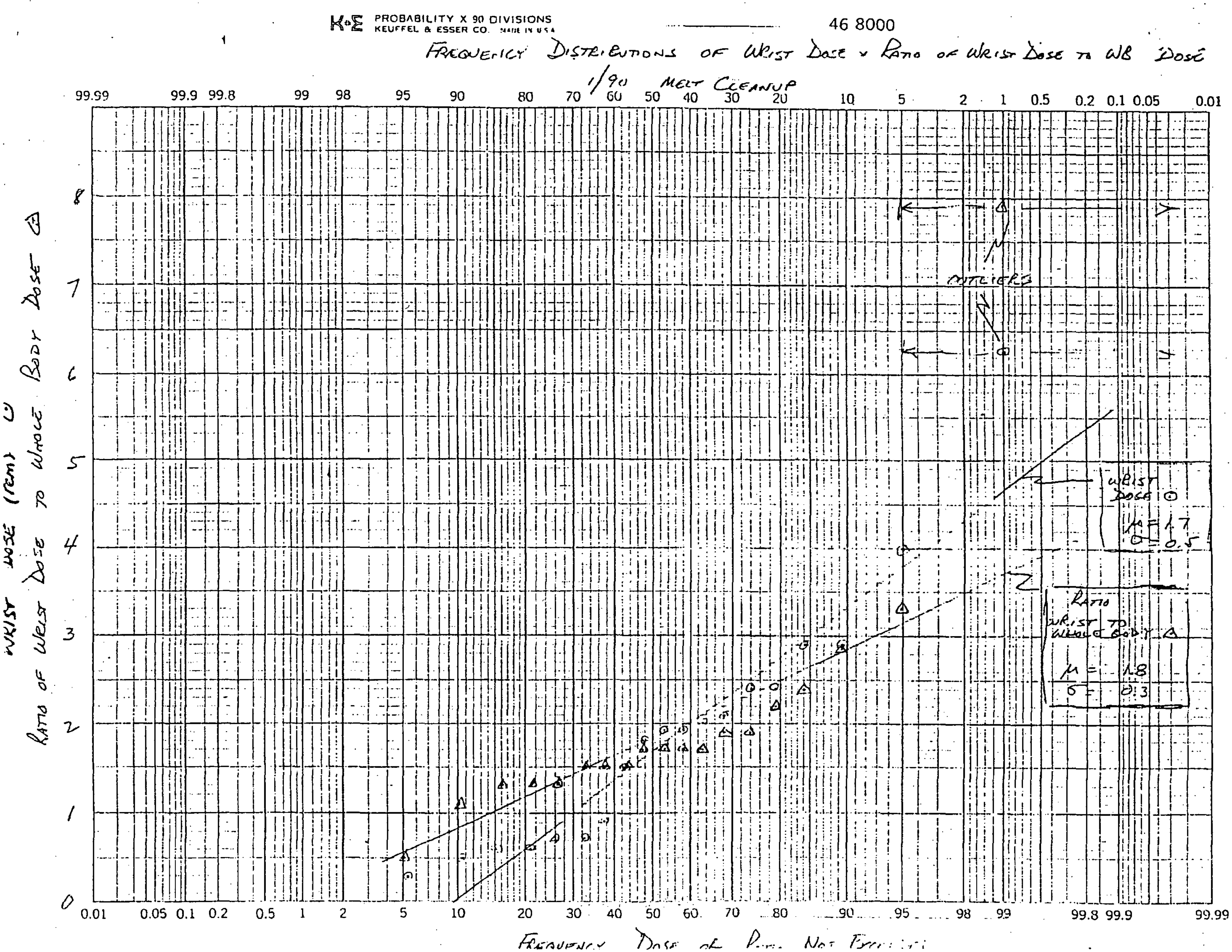


AIR CONC VERSUS ENTRY

1/90 MELT CLEANUP



Time-weighted average over entry duration



K+E PROBABILITY X 90 DIVISIONS
KEUFFEL & ESSER CO. MADE IN U.S.A.
46 8000
FREQUENCY DISTRIBUTIONS OF WRIST DOSE + RATIO OF WRIST DOSE TO WB DOSE
1/90 MELT CLEANUP
WRIST DOSE (rem) ⊙
RATIO OF WRIST DOSE TO WHOLE BODY DOSE △
OUTLIERS
WRIST DOSE ⊙
μ = 1.7
σ = 0.5
RATIO WRIST TO WHOLE BODY △
μ = 1.8
σ = 0.3
FREQUENCY DOSE OR RATIO NOT EXCEEDED

1/22/90-1/31/90 CLEANUP

MO DA	ET min	IN uci/cc	FRAC MPC	OUT uci/cc	FRAC MPC	RESP dpm	RESP uci/cc	FRAC MPC

(b)(6)

1.5 (SR)

MO DA	ET min	IN uci/cc	FRAC MPC	OUT uci/cc	FRAC MPC	RESP dpm	RESP uci/cc	FRAC MPC
1 22	15	4.4E-07	48.89	4.1E-07	45.56			
	5	4.5E-07	50.00	1.9E-07	21.11			
	0	0.0E+00	0.00	0.0E+00	0.00			
	0	0.0E+00	0.00	0.0E+00	0.00			
AVG	20	4.4E-07	49.17	3.5E-07	39.44	FA	0.0E+00	0.00

INHALATION EXPOSURE ACCOUNTING FOR RESPIRATORY PROTECTION
PROTECTION FACTOR: 2000
MPC-HR SAMPLE: 0.01 RESP CRT: 0.00

(b)(6)

MO DA	ET min	IN uci/cc	FRAC MPC	OUT uci/cc	FRAC MPC	RESP dpm	RESP uci/cc	FRAC MPC
1 22	15	4.4E-07	48.89	4.1E-07	45.56			
	5	4.5E-07	50.00	1.9E-07	21.11			
	0	0.0E+00	0.00	0.0E+00	0.00			
	0	0.0E+00	0.00	0.0E+00	0.00			
AVG	20	4.4E-07	49.17	3.5E-07	39.44	FA	0.0E+00	0.00

INHALATION EXPOSURE ACCOUNTING FOR RESPIRATORY PROTECTION
PROTECTION FACTOR: 2000
MPC-HR SAMPLE: 0.01 RESP CRT: 0.00

(b)(6)

MO DA	ET min	IN uci/cc	FRAC MPC	OUT uci/cc	FRAC MPC	RESP dpm	RESP uci/cc	FRAC MPC
		3.0E-07	33.33	3.2E-08	3.56			
	0	0.0E+00	0.00	0.0E+00	0.00			
	0	0.0E+00	0.00	0.0E+00	0.00			
	0	0.0E+00	0.00	0.0E+00	0.00			
AVG	19	3.0E-07	33.33	3.2E-08	3.56	FA	0.0E+00	0.00

INHALATION EXPOSURE ACCOUNTING FOR RESPIRATORY PROTECTION
PROTECTION FACTOR: 2000
MPC-HR SAMPLE: 0.01 RESP CRT: 0.00

1/22/90-1/31/90 CLEANUP

MO DA	ET min	IN uci/cc	FRAC MPC	OUT uci/cc	FRAC MPC	RESP dpm	RESP uci/cc	FRAC MPC

(b)(6)

3
1.6

MO DA	ET	IN	FRAC	OUT	FRAC	RESP	RESP	FRAC
1 22	17	5.0E-07	55.56	1.2E-07	13.33	IN SAMPLE LOST, ESTIMATED FROM FIRST		
	0	0.0E+00	0.00	0.0E+00	0.00			
	0	0.0E+00	0.00	0.0E+00	0.00			
	0	0.0E+00	0.00	0.0E+00	0.00			
AVG	17	5.0E-07	55.56	1.2E-07	13.33	FA	0.0E+00	0.00

INHALATION EXPOSURE ACCOUNTING FOR RESPIRATORY PROTECTION
PROTECTION FACTOR: 2000
MPC-HR SAMPLE: 0.01 RESP CRT: 0.00

(b)(6)

4
1

MO DA	ET	IN	FRAC	OUT	FRAC	RESP	RESP	FRAC
1 23	14	2.1E-07	23.33	3.3E-08	3.67			
	0	0.0E+00	0.00	0.0E+00	0.00			
	0	0.0E+00	0.00	0.0E+00	0.00			
	0	0.0E+00	0.00	0.0E+00	0.00			
AVG	14	2.1E-07	23.33	3.3E-08	3.67	FA	0.0E+00	0.00

INHALATION EXPOSURE ACCOUNTING FOR RESPIRATORY PROTECTION
PROTECTION FACTOR: 2000
MPC-HR SAMPLE: 0.00 RESP CRT: 0.00

(b)(6)

5
0.o

MO DA	ET	IN	FRAC	OUT	FRAC	RESP	RESP	FRAC
1 23	15	2.0E-07	22.22	2.3E-08	2.56			
	0	0.0E+00	0.00	0.0E+00	0.00			
	0	0.0E+00	0.00	0.0E+00	0.00			
	0	0.0E+00	0.00	0.0E+00	0.00			
AVG	15	2.0E-07	22.22	2.3E-08	2.56	FA	0.0E+00	0.00

INHALATION EXPOSURE ACCOUNTING FOR RESPIRATORY PROTECTION
PROTECTION FACTOR: 2000
MPC-HR SAMPLE: 0.00 RESP CRT: 0.00

1/22/90-1/31/90 CLEANUP

MO DA	ET min	IN uci/cc	FRAC MPC	OUT uci/cc	FRAC MPC	RESP dpm	RESP uci/cc	FRAC MPC

(b)(6)

1 23	15	2.0E-07	22.22	2.3E-08	2.56			
	0	0.0E+00	0.00	0.0E+00	0.00			
	0	0.0E+00	0.00	0.0E+00	0.00			
	0	0.0E+00	0.00	0.0E+00	0.00			
AVG	15	2.0E-07	22.22	2.3E-08	2.56	FA	0.0E+00	0.00

INHALATION EXPOSURE ACCOUNTING FOR RESPIRATORY PROTECTION
PROTECTION FACTOR: 2000
MPC-HR SAMPLE: 0.00 RESP CRT: 0.00

(b)(6)

1 23	15	1.5E-07	16.67	8.0E-08	8.89			
	30	3.7E-07	41.11	1.4E-07	15.56			
	0	0.0E+00	0.00	0.0E+00	0.00			
	0	0.0E+00	0.00	0.0E+00	0.00			
AVG	45	3.0E-07	32.96	1.2E-07	13.33	FA	0.0E+00	0.00

INHALATION EXPOSURE ACCOUNTING FOR RESPIRATORY PROTECTION
PROTECTION FACTOR: 2000
MPC-HR SAMPLE: 0.01 RESP CRT: 0.00

(b)(6)

1 23	15	3.1E-07	34.44	1.2E-07	13.33			
	15	2.9E-07	32.22	1.9E-07	21.11			
	0	0.0E+00	0.00	0.0E+00	0.00			
	0	0.0E+00	0.00	0.0E+00	0.00			
AVG	30	3.0E-07	33.33	1.6E-07	17.22	FA	0.0E+00	0.00

INHALATION EXPOSURE ACCOUNTING FOR RESPIRATORY PROTECTION
PROTECTION FACTOR: 2000
MPC-HR SAMPLE: 0.01 RESP CRT: 0.00

1/22/90-1/31/90 CLEANUP

MO DA	ET min	IN uci/cc	FRAC MPC	OUT uci/cc	FRAC MPC	RESP dpm	RESP uci/cc	FRAC MPC

(b)(6)

1 23	15	2.0E-07	22.22	2.3E-08	2.56			
	0	0.0E+00	0.00	0.0E+00	0.00			
	0	0.0E+00	0.00	0.0E+00	0.00			
	0	0.0E+00	0.00	0.0E+00	0.00			
AVG	15	2.0E-07	22.22	2.3E-08	2.56	FA	0.0E+00	0.00

INHALATION EXPOSURE ACCOUNTING FOR RESPIRATORY PROTECTION
PROTECTION FACTOR: 2000
MPC-HR SAMPLE: 0.00 RESP CRT: 0.00

(b)(6)

1 23	15	1.5E-07	16.67	8.0E-08	8.89			
	30	3.7E-07	41.11	1.4E-07	15.56			
	0	0.0E+00	0.00	0.0E+00	0.00			
	0	0.0E+00	0.00	0.0E+00	0.00			
AVG	45	3.0E-07	32.96	1.2E-07	13.33	FA	0.0E+00	0.00

INHALATION EXPOSURE ACCOUNTING FOR RESPIRATORY PROTECTION
PROTECTION FACTOR: 2000
MPC-HR SAMPLE: 0.01 RESP CRT: 0.00

(b)(6)

1 23	15	3.1E-07	34.44	1.2E-07	13.33			
	15	2.9E-07	32.22	1.9E-07	21.11			
	0	0.0E+00	0.00	0.0E+00	0.00			
	0	0.0E+00	0.00	0.0E+00	0.00			
AVG	30	3.0E-07	33.33	1.6E-07	17.22	FA	0.0E+00	0.00

INHALATION EXPOSURE ACCOUNTING FOR RESPIRATORY PROTECTION
PROTECTION FACTOR: 2000
MPC-HR SAMPLE: 0.01 RESP CRT: 0.00

Ex 6

(b)(6)

			FRAC MPC	OUT uci/cc	FRAC MPC	RESP dpm	RESP uci/cc	FRAC MPC
1 24	30	3.0E-07	33.33	2.1E-07	23.33			
	0	0.0E+00	0.00	0.0E+00	0.00			
	0	0.0E+00	0.00	0.0E+00	0.00			
	0	0.0E+00	0.00	0.0E+00	0.00			
AVG	30	3.0E-07	33.33	2.1E-07	23.33	FA	0.0E+00	0.00

INHALATION EXPOSURE ACCOUNTING FOR RESPIRATORY PROTECTION
PROTECTION FACTOR: 2000
MPC-HR SAMPLE: 0.01 RESP CRT: 0.00

(b)(6)

1 24	15	9.6E-08	10.67	2.2E-08	2.44			
	15	8.9E-08	9.89	1.4E-07	15.56			
	35	3.7E-07	41.11	3.2E-07	35.56			
	0	0.0E+00	0.00	0.0E+00	0.00			
AVG	65	2.4E-07	26.38	2.1E-07	23.30	FA	0.0E+00	0.00

INHALATION EXPOSURE ACCOUNTING FOR RESPIRATORY PROTECTION
PROTECTION FACTOR: 2000
MPC-HR SAMPLE: 0.01 RESP CRT: 0.00

(b)(6)

1 25	15	1.4E-07	15.56	6.1E-09	0.68			
	15	4.5E-07	50.00	8.8E-08	9.78			
	15	3.4E-07	37.78	6.2E-09	0.69			
	21	8.2E-08	9.11	4.0E-09	0.44			
AVG	66	2.4E-07	26.38	2.4E-08	2.67	FA	0.0E+00	0.00

INHALATION EXPOSURE ACCOUNTING FOR RESPIRATORY PROTECTION
PROTECTION FACTOR: 2000
MPC-HR SAMPLE: 0.01 RESP CRT: 0.00

1/22/90-1/31/90 CLEANUP

MO DA	ET min	IN uci/cc	FRAC MPC	OUT uci/cc	FRAC MPC	RESP dpm	RESP uci/cc	FRAC MPC
(b)(6)								
1 26	15	4.2E-07	46.67	2.6E-07	28.89			
	15	2.9E-07	32.22	6.1E-09	0.68			
	23	4.1E-07	45.56	6.1E-09	0.68			
	0	0.0E+00	0.00	0.0E+00	0.00			
	0	0.0E+00	0.00	0.0E+00	0.00			
	53	3.8E-07	42.10	7.8E-08	8.66	8.9E+06	3.8E-06	424.05

TION EXPOSURE ACCOUNTING FOR RESPIRATORY PROTECTION
TION FACTOR: 50
SAMPLE: 0.74 RESP CRT: 7.49

MO DA	ET min	IN uci/cc	FRAC MPC	OUT uci/cc	FRAC MPC	RESP dpm	RESP uci/cc	FRAC MPC
(b)(6)								
1 26	15	2.6E-07	28.89	2.5E-07	27.78			
	13	2.3E-07	25.56	2.4E-08	2.67			
	0	0.0E+00	0.00	0.0E+00	0.00			
	0	0.0E+00	0.00	0.0E+00	0.00			
	0	0.0E+00	0.00	0.0E+00	0.00			
AVG	28	2.5E-07	27.34	1.5E-07	16.12	2.0E+07	1.6E-05	1803.75

INHALATION EXPOSURE ACCOUNTING FOR RESPIRATORY PROTECTION
PROTECTION FACTOR: 50
MPC-HR SAMPLE: 0.26 RESP CRT: 16.84

MO DA	ET min	IN uci/cc	FRAC MPC	OUT uci/cc	FRAC MPC	RESP dpm	RESP uci/cc	FRAC MPC
(b)(6)								
1 29	15	2.0E-07	22.22	1.6E-09	0.18			
	15	2.0E-07	22.22	1.7E-08	1.89			
	20	9.0E-08	10.00	1.1E-08	1.22			
	0	0.0E+00	0.00	0.0E+00	0.00			
	0	0.0E+00	0.00	0.0E+00	0.00			
AVG	50	1.6E-07	17.33	1.0E-08	1.11	7.5E+06	3.4E-06	378.79

INHALATION EXPOSURE ACCOUNTING FOR RESPIRATORY PROTECTION
PROTECTION FACTOR: 50
MPC-HR SAMPLE: 0.29 RESP CRT: 6.31

1/22/90-1/31/90 CLEANUP

```
MO DA      ET      IN      FRAC     OUT      FRAC    RESP     RESP      FRAC
           min   uci/cc    MPC    uci/cc     MPC     dpm     uci/cc     MPC
```

(b)(6)

```
 1 25      15   8.5E-08    9.44   3.5E-09    0.39
           15   2.3E-07   25.56   8.4E-09    0.93
           15   4.2E-07   46.67   1.9E-08    2.11
           15   2.7E-07   30.00   4.2E-09    0.47
           19   7.5E-09    0.83   6.9E-09    0.77

AVG        79   1.9E-07   21.40   8.3E-09    0.92      FA   0.0E+00    0.00
```

INHALATION EXPOSURE ACCOUNTING FOR RESPIRATORY PROTECTION

```
PROTECTION FACTOR:           2000
MPC-HR          SAMPLE:      0.01          RESP CRT:     0.00
```

(b)(6)

```
 1 25      15   8.5E-08    9.44   3.5E-09    0.39
           15   2.3E-07   25.56   8.4E-09    0.93
           15   4.2E-07   46.67   1.9E-08    2.11
           15   2.7E-07   30.00   4.2E-09    0.47
           26   7.5E-09    0.83   6.9E-09    0.77

AVG        86   1.8E-07   19.73   8.2E-09    0.91      FA   0.0E+00    0.00
```

INHALATION EXPOSURE ACCOUNTING FOR RESPIRATORY PROTECTION

```
PROTECTION FACTOR:           2000
MPC-HR          SAMPLE:      0.01          RESP CRT:     0.00
```

(b)(6)

```
 1 26      15   3.3E-07   36.67   4.1E-08    4.56
           18   4.4E-07   48.89   1.8E-07   20.00
            0   0.0E+00    0.00   0.0E+00    0.00
            0   0.0E+00    0.00   0.0E+00    0.00
            0   0.0E+00    0.00   0.0E+00    0.00

AVG        33   3.9E-07   43.33   1.2E-07   12.98   5.8E+06  4.0E-06  443.83
```

INHALATION EXPOSURE ACCOUNTING FOR RESPIRATORY PROTECTION

```
PROTECTION FACTOR:             50
MPC-HR          SAMPLE:      0.48          RESP CRT:     4.88
```

1/22/90-1/31/90 CLEANUP

(b)(6)

MO DA	ET min	IN uci/cc	FRAC MPC	OUT uci/cc	FRAC MPC	RESP dpm	RESP uci/cc	FRAC MPC
	15	6.7E-09	0.74	2.0E-10	0.02			
	15	1.3E-07	14.44	3.0E-10	0.03			
	20	1.4E-08	1.56	2.5E-10	0.03			
	0	0.0E+00	0.00	0.0E+00	0.00			
	0	0.0E+00	0.00	0.0E+00	0.00			
	50	4.7E-08	5.18	2.5E-10	0.03	3.5E+05	1.6E-07	17.68

TION EXPOSURE ACCOUNTING FOR RESPIRATORY PROTECTION
TION FACTOR: 50
SAMPLE: 0.09 RESP CRT: 0.29

(b)(6)

MO DA	ET min	IN uci/cc	FRAC MPC	OUT uci/cc	FRAC MPC	RESP dpm	RESP uci/cc	FRAC MPC
1 31	15	4.3E-09	0.48	6.6E-11	0.01			
	15	2.8E-09	0.31	2.7E-10	0.03			
	25	2.6E-08	2.89	4.5E-10	0.05			
	0	0.0E+00	0.00	0.0E+00	0.00			
	0	0.0E+00	0.00	0.0E+00	0.00			
AVG	55	1.4E-08	1.53	3.0E-10	0.03	1.5E+05	6.2E-08	6.89

INHALATION EXPOSURE ACCOUNTING FOR RESPIRATORY PROTECTION
PROTECTION FACTOR: 50
MPC-HR SAMPLE: 0.03 RESP CRT: 0.13

1/22/90-1/31/90 CLEANUP

(b)(6)

MO DA	ET min	IN uci/cc	FRAC MPC	OUT uci/cc	FRAC MPC	RESP dpm	RESP uci/cc	FRAC MPC
1 30	15	1.5E-07	16.67	3.3E-08	3.67			
	15	2.8E-08	3.11	5.4E-09	0.60			
	40	4.0E-08	4.44	5.8E-09	0.64			
	0	0.0E+00	0.00	0.0E+00	0.00			
	0	0.0E+00	0.00	0.0E+00	0.00			
AVG	70	6.1E-08	6.78	1.2E-08	1.28	4.4E+05	1.4E-07	15.87

INHALATION EXPOSURE ACCOUNTING FOR RESPIRATORY PROTECTION
PROTECTION FACTOR: 50
MPC-HR SAMPLE: 0.16 RESP CRT: 0.37

(b)(6)

MO DA	ET min	IN uci/cc	FRAC MPC	OUT uci/cc	FRAC MPC	RESP dpm	RESP uci/cc	FRAC MPC
1 31	15	2.4E-07	26.67	4.4E-08	4.89			
	15	2.2E-07	24.44	7.5E-09	0.83			
	15	1.4E-07	15.56	1.2E-09	0.13			
	35	6.8E-08	7.56	7.7E-09	0.86			
	0	0.0E+00	0.00	0.0E+00	0.00			
AVG	80	1.4E-07	15.81	1.3E-08	1.47	FA	0.0E+00	0.00

INHALATION EXPOSURE ACCOUNTING FOR RESPIRATORY PROTECTION
PROTECTION FACTOR: 50
MPC-HR SAMPLE: 0.42 RESP CRT: 0.00

(b)(6)

0.1

MO DA	ET min	IN uci/cc	FRAC MPC	OUT uci/cc	FRAC MPC	RESP dpm	RESP uci/cc	FRAC MPC
1 31	15	9.1E-09	1.01	1.2E-08	1.33			
	20	2.3E-08	2.56	0.0E+00	0.00 OUT SAMPLE LOST			
	0	0.0E+00	0.00	0.0E+00	0.00			
	0	0.0E+00	0.00	0.0E+00	0.00			
	0	0.0E+00	0.00	0.0E+00	0.00			
AVG	35	1.7E-08	1.89	5.1E-09	0.57	FA	0.0E+00	0.00

INHALATION EXPOSURE ACCOUNTING FOR RESPIRATORY PROTECTION
PROTECTION FACTOR: 2000
MPC-HR SAMPLE: 0.00 RESP CRT: 0.00

WHOLE BODY VS EXTREMITY DOSE

ENTRY	WB DOSE	MAX WRIST	MIN WRIST	MAX ANKLE	MIN ANKLE	MAX FINGER	MIN FINGER
	rem	rem	rem	rem	rem	rem	rem
1	1.5	1.9	0.7	1.8	1.7	3.1	0.7
1 A	1.4	1.8	1.7	1.5	1.4	3.0	2.6
2	1.1	2.4	1.3	1.1	0.8	6.3	1.9
3	1.6	2.1	1.5	3.9	1.6	3.6	1.5
4	1.0	2.9	2.5	2.9	1.3	8.6	7.0
5	0.8	6.3	2.1	4.5	1.6	22.8	6.0
5 A	1.2	0.6	0.6	1.0	0.5	0.6	0.6
6	1.2	2.0	1.9	2.9	1.9	4.4	4.0
7	1.5	2.9	2.6	5.7	4.5	7.1	5.9
8	1.2	4.0	1.6	2.1	1.9	12.4	2.8
9	1.0	2.4	2.2	1.8	1.8	6.6	5.8
10	1.1	1.9	1.6	1.7	1.4	4.3	3.1
11	0.6	0.9	0.6	1.3	0.9	1.8	0.6
11 A	0.8	1.5	1.1	1.8	1.0	3.6	2.0
12	0.4	0.7	0.7	0.5	0.0	1.6	1.6
13	0.4	0.6	0.4	0.6	0.5	1.2	0.4
14	0.2	0.3	0.3	0.4	0.4	0.6	0.6
15	0.4	0.7	0.7	1.1	0.8	1.6	1.6
16	0.4	0.5	0.5	0.7	0.4	0.7	0.7

ONE ANKLE BADGE LOST ON ENTRY 12

NO WRIST BADGES WORN ENTRIES 17-20

MAX FINGER = (MAX HAND - MIN(MAX HAND, WB))*4 + MIN(MAX HAND, WB)
CORRECTS EXTREMITY DOSE FROM 6 INCHES TO 3 INCHES, ASSUMING PT SOURCE

SUMMARY

ENTRY	TIME	DOSE	RATE	IN AIR	OUT AIR	RESP	LOG IN AIR	LOG OUT AIR	LOG RESP
	min	rem	rem/hr	uci/cc	uci/cc	uci/cc			
1	20	1.5	4.5	4.4E-07	3.5E-07	0.0E+00	-6.35	-6.45	
1 A	20	1.4	4.2	4.4E-07	3.5E-07	0.0E+00	-6.35	-6.45	
2	19	1.1	3.5	3.0E-07	3.2E-08	0.0E+00	-6.52	-7.49	
3	17	1.6	5.6	5.0E-07	1.2E-07	0.0E+00	-6.30	-6.92	
4	14	1.0	4.3	2.1E-07	3.3E-08	0.0E+00	-6.68	-7.48	
5	15	0.8	3.2	2.0E-07	2.3E-08	0.0E+00	-6.70	-7.64	
5 A	15	1.2	4.8	2.0E-07	2.3E-08	0.0E+00	-6.70	-7.64	
6	45	1.2	1.6	3.0E-07	1.2E-07	0.0E+00	-6.53	-6.92	
7	30	1.5	3.0	3.0E-07	1.6E-07	0.0E+00	-6.52	-6.81	
8	30	1.2	2.4	3.0E-07	2.1E-07	0.0E+00	-6.52	-6.68	
9	65	1.0	0.9	2.4E-07	2.1E-07	0.0E+00	-6.62	-6.68	
10	66	1.1	1.0	2.4E-07	2.4E-08	0.0E+00	-6.62	-7.62	
11	79	0.6	0.5	1.9E-07	8.3E-09	0.0E+00	-6.72	-8.08	
11 A	86	0.8	0.6	1.8E-07	8.2E-09	0.0E+00	-6.75	-8.09	
12	33	0.4	0.7	3.9E-07	1.2E-07	4.0E-06	-6.41	-6.93	-5.40
13	53	0.4	0.5	3.8E-07	7.8E-08	3.8E-06	-6.42	-7.11	-5.42
14	28	0.2	0.4	2.5E-07	1.5E-07	1.6E-05	-6.61	-6.84	-4.79
15	50	0.4	0.5	1.6E-07	1.0E-08	3.4E-06	-6.81	-8.00	-5.47
16	70	0.4	0.4	6.1E-08	1.2E-08	1.4E-07	-7.21	-7.94	-6.85
17	80	0.4	0.3	1.4E-07	1.3E-08	0.0E+00	-6.85	-7.88	
18	35	0.1	0.2	1.7E-08	5.1E-09	0.0E+00	-7.77	-8.29	
19	50	0.3	0.3	4.7E-08	2.5E-10	1.6E-07	-7.33	-9.60	-6.80
20	55	0.2	0.2	1.4E-08	3.0E-10	6.2E-08	-7.86	-9.53	-7.21
TOTAL	975	18.83							

TOTAL TIME (man-hr) 16.3
AVG DOSE RATE (rem/hr) 1.2

WHOLE BODY VS EXTREMITY DOSE

ENTRY	MAX HAND/WB	MIN HAND/WB	MAX ANK/WB	MIN ANK/WB	MAX FING/WB	MIN FING/WB
1	1.3	0.5	1.2	1.1	2.1	0.5
1 A	1.3	1.2	1.1	1.0	2.1	1.9
2	2.2	1.2	1.0	0.7	5.7	1.7
3	1.3	0.9	2.4	1.0	2.3	0.9
4	2.9	2.5	2.9	1.3	8.6	7.0
5	7.9	2.6	5.6	2.0	28.5	7.5
5 A	0.5	0.5	0.8	0.4	0.5	0.5
6	1.7	1.6	2.4	1.6	3.7	3.3
7	1.9	1.7	3.8	3.0	4.7	3.9
8	3.3	1.3	1.8	1.6	10.3	2.3
9	2.4	2.2	1.8	1.8	6.6	5.8
10	1.7	1.5	1.5	1.3	3.9	2.8
11	1.5	1.0	2.2	1.5	3.0	1.0
11 A	1.9	1.4	2.3	1.3	4.5	2.5
12	1.7	1.7	1.3	0.0	4.0	4.0
13	1.5	1.0	1.5	1.3	3.0	1.0
14	1.5	1.5	2.0	2.0	3.0	3.0
15	1.7	1.7	2.8	2.0	4.0	4.0
16	1.1	1.1	1.6	0.9	1.5	1.5

ENTRY	MAX WRIST	MAX HAND/WB		
	rem			
5 A	0.6	0.5	1	0.0526
16	0.5	1.1	2	0.1053
1	1.9	1.3	3	0.1579
1 A	1.8	1.3	4	0.2105
3	2.1	1.3	5	0.2632
13	0.6	1.5	6	0.3158
14	0.3	1.5	7	0.3684
11	0.9	1.5	8	0.4211
6	2.0	1.7	9	0.4737
10	1.9	1.7	10	0.5263
12	0.7	1.7	11	0.5789
15	0.7	1.7	12	0.6316
11 A	1.5	1.9	13	0.6842
7	2.9	1.9	14	0.7368
2	2.4	2.2	15	0.7895
9	2.4	2.4	16	0.8421
4	2.9	2.9	17	0.8947
8	4.0	3.3	18	0.9474
5	6.3	7.9	19	1.0000

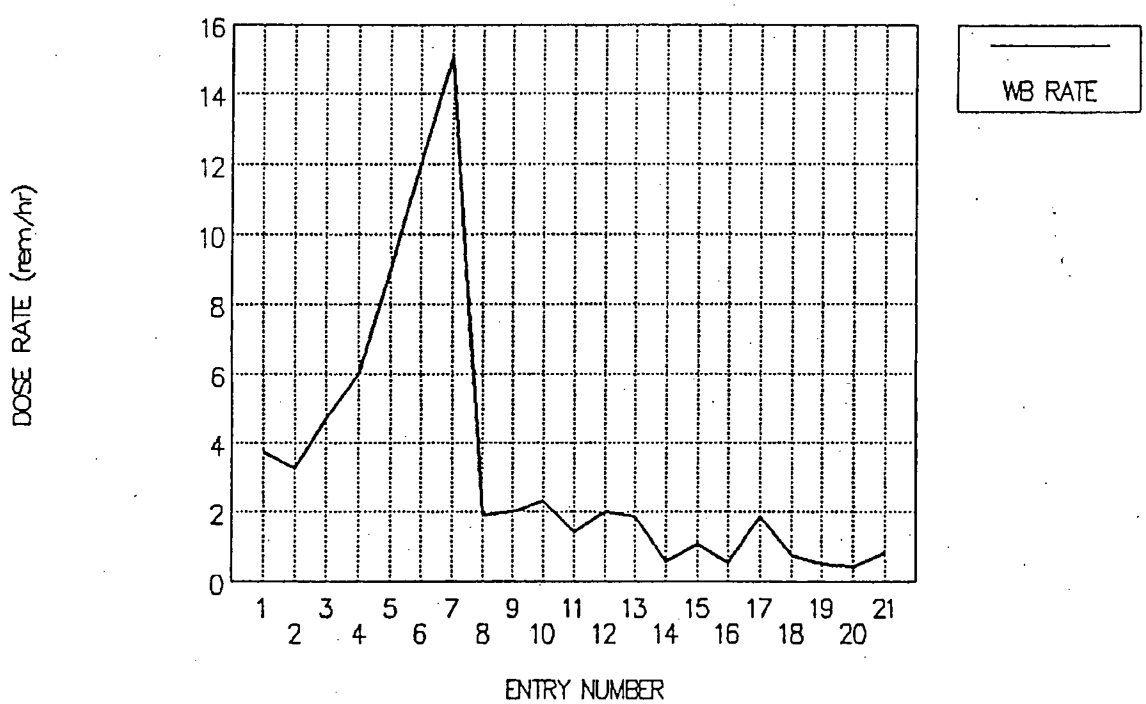
APPENDIX B

NEUTRON PRODUCTS, INC.
JUNE, 1990 MELT CLEANUP
DATA SUMMARY

ENTRY	MAX WRIST	MAX HAND/WB		
	rem			
14	0.3	1.5	1	0.0526
16	0.5	1.1	2	0.1053
5 A	0.6	0.5	3	0.1579
13	0.6	1.5	4	0.2105
12	0.7	1.7	5	0.2632
15	0.7	1.7	6	0.3158
11	0.9	1.5	7	0.3684
11 A	1.5	1.9	8	0.4211
1 A	1.8	1.3	9	0.4737
10	1.9	1.7	10	0.5263
1	1.9	1.3	11	0.5789
6	2.0	1.7	12	0.6316
3	2.1	1.3	13	0.6842
2	2.4	2.2	14	0.7368
9	2.4	2.4	15	0.7895
4	2.9	2.9	16	0.8421
7	2.9	1.9	17	0.8947
8	4.0	3.3	18	0.9474
5	6.3	7.9	19	1.0000

AVERAGE WB DOSE RATE VERSUS ENTRY

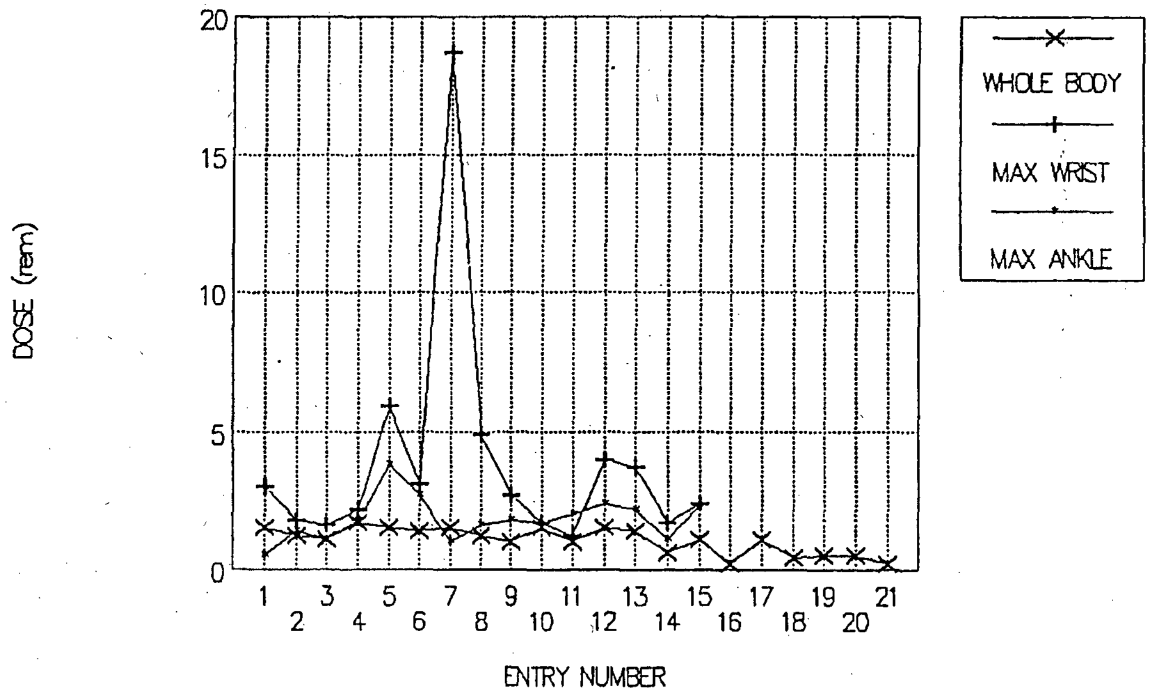
6/90 MELT CLEANUP

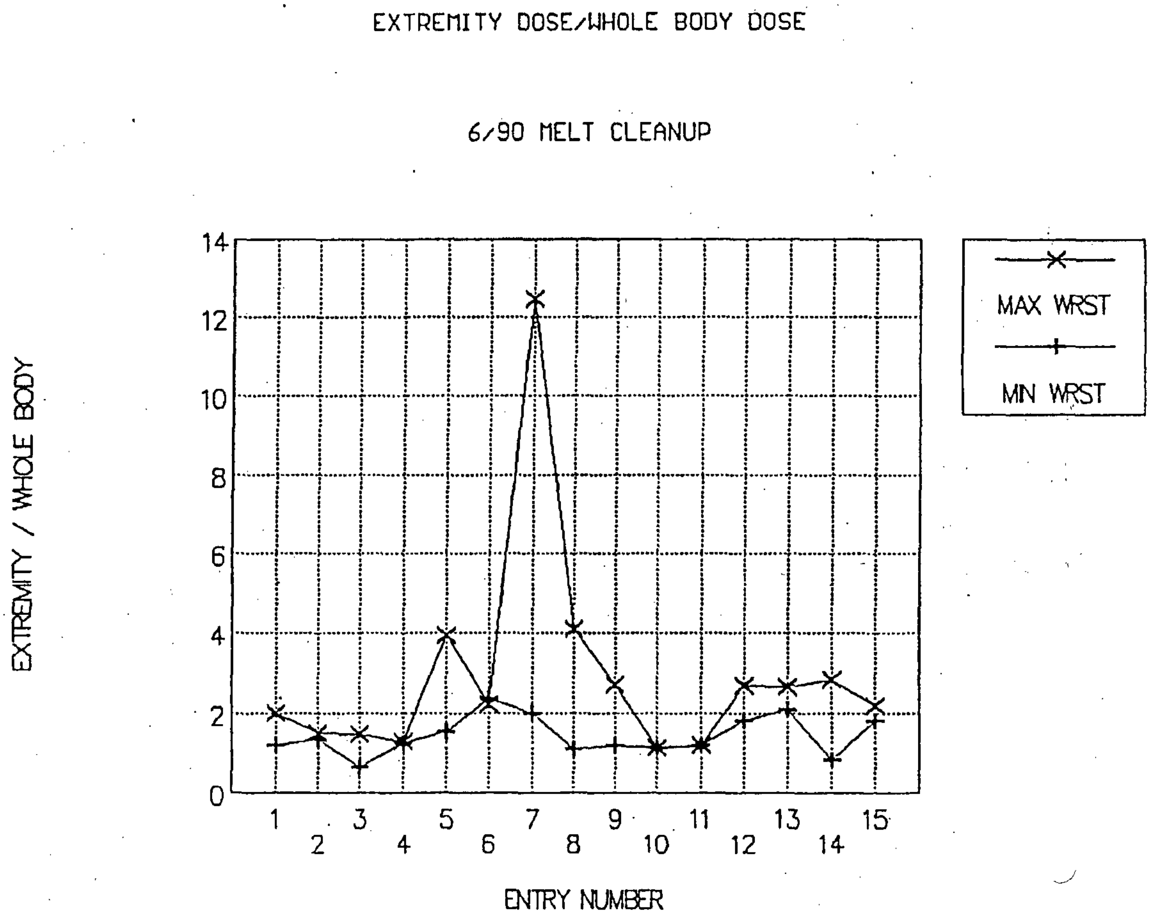


Dose rate = SRD total / Entry Duration

EXTREMITY DOSE AND WHOLE BODY DOSE

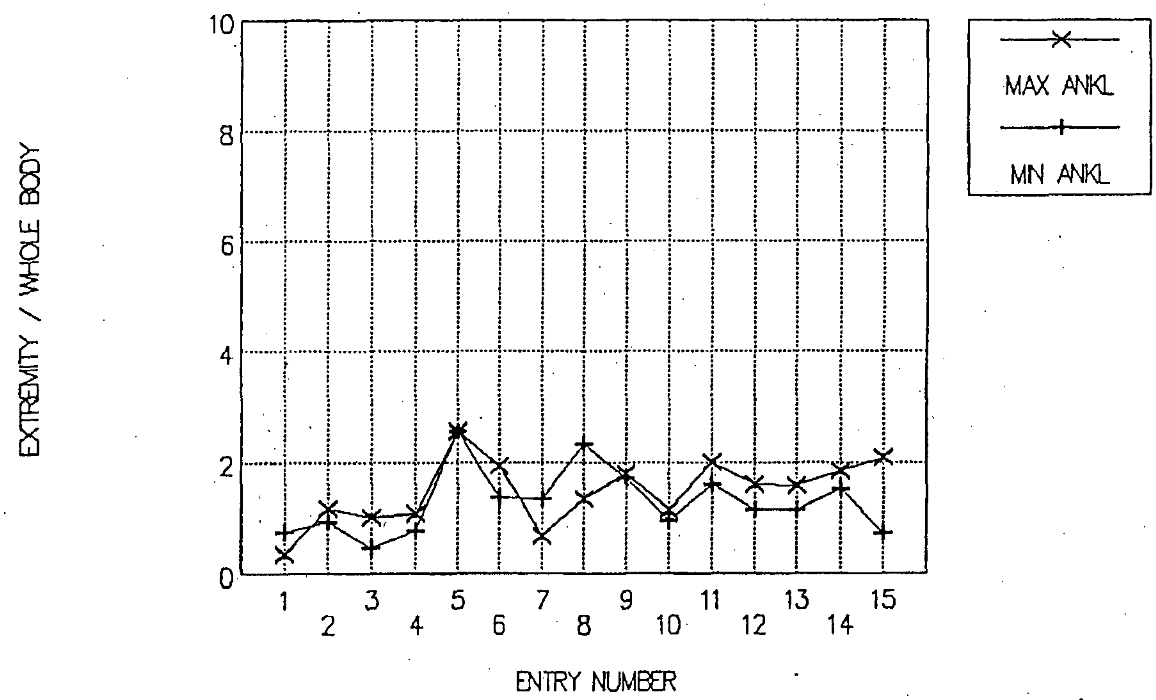
6/90 MELT CLEANUP




EXTREMITY DOSE/WHOLE BODY DOSE
6/90 MELT CLEANUP
EXTREMITY / WHOLE BODY
0
2
4
6
8
10
12
14
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
ENTRY NUMBER
MAX WRST
MIN WRST

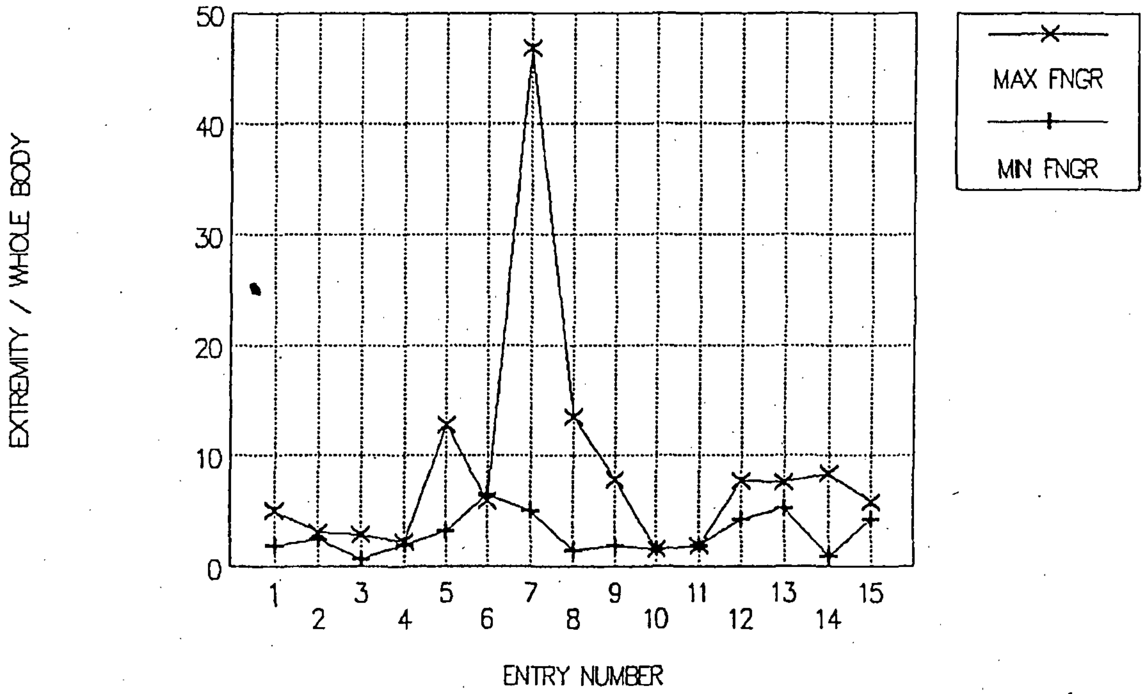
EXTREMITY DOSE/WHOLE BODY DOSE

6/90 MELT CLEANUP



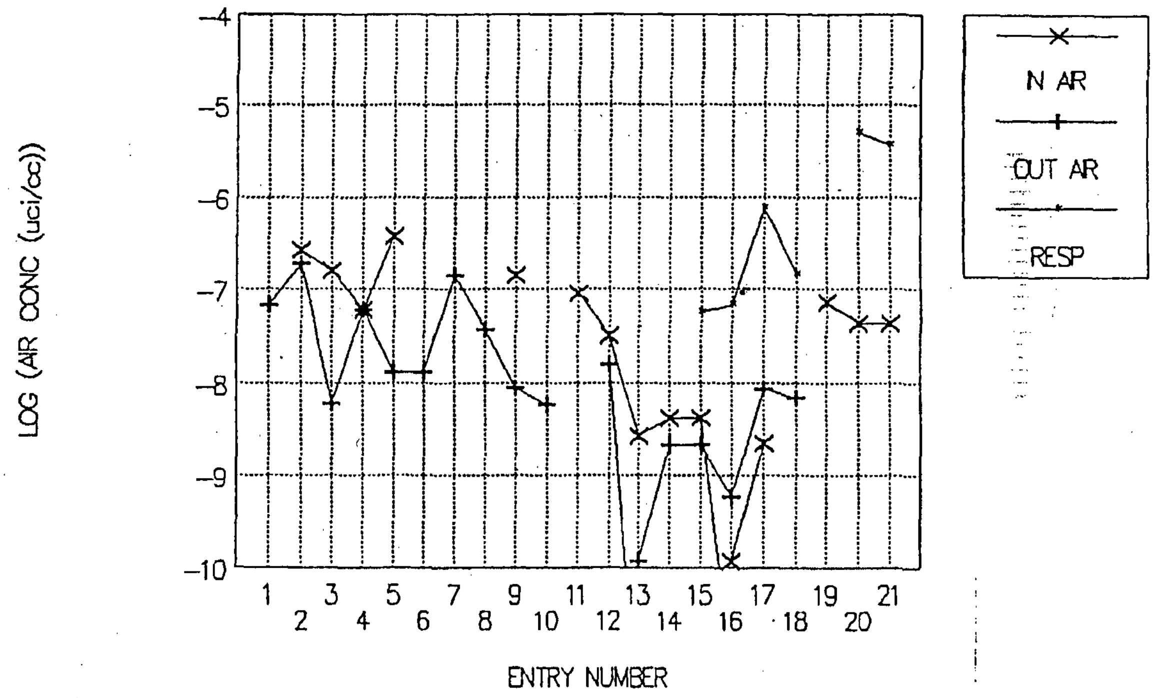
EXTREMITY DOSE/WHOLE BODY DOSE

6/90 MELT CLEANUP



AIR CONC VERSUS ENTRY

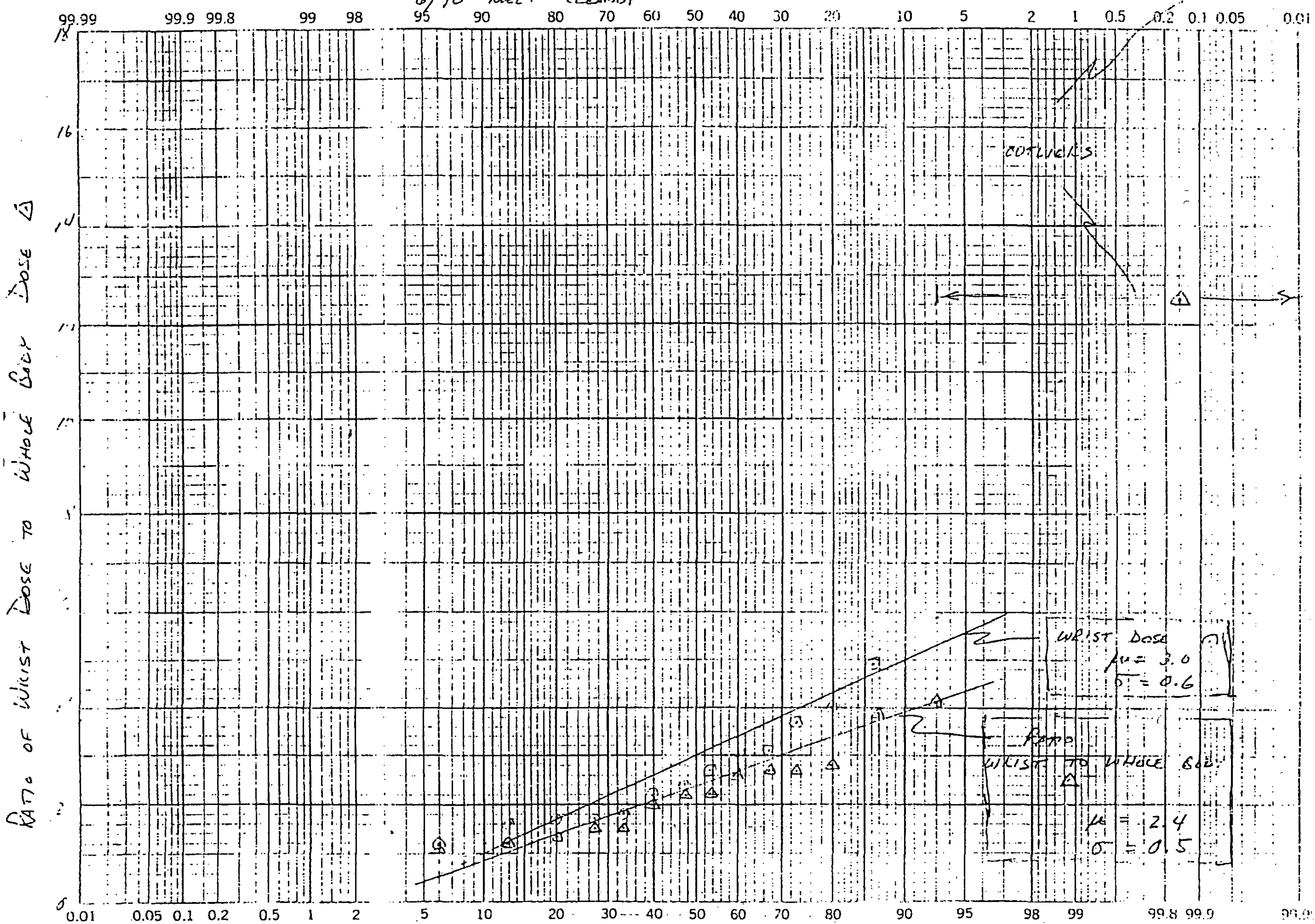
6/90 MELT CLEANUP



Time-weighted average over entry duration

FREQUENCY DISTRIBUTIONS OF WRIST DOSE & RATIO OF WRIST TO WB DOSE

6/90 MELT CLEANUP



6/11/90-6/21/90 CLEANUP

MO DA	ET min	IN uci/cc	FRAC MPC	OUT uci/cc	FRAC MPC	RESP dpm	RESP uci/cc	FRAC MPC
(b)(6)								
6 11	24	1.0E-15	0.00	6.8E-08	7.56			
	0	0.0E+00	0.00	0.0E+00	0.00			
	0	0.0E+00	0.00	0.0E+00	0.00			
	0	0.0E+00	0.00	0.0E+00	0.00			
AVG	24	1.0E-15	0.00	6.8E-08	7.56	FA	0.0E+00	0.00

INHALATION EXPOSURE ACCOUNTING FOR RESPIRATORY PROTECTION
PROTECTION FACTOR: 2000
MPC-HR SAMPLE: 0.00 RESP CRT: 0.00

(b)(6)								
	22	2.7E-07	30.00	1.9E-07	21.11			
	0	0.0E+00	0.00	0.0E+00	0.00			
	0	0.0E+00	0.00	0.0E+00	0.00			
	0	0.0E+00	0.00	0.0E+00	0.00			
	22	2.7E-07	30.00	1.9E-07	21.11	FA	0.0E+00	0.00

TION EXPOSURE ACCOUNTING FOR RESPIRATORY PROTECTION
PROTECTION FACTOR: 2000
MPC-HR SAMPLE: 0.01 RESP CRT: 0.00

(b)(6)								
1.1								
6 12	14	1.6E-07	17.78	5.9E-09	0.66			
	0	0.0E+00	0.00	0.0E+00	0.00			
	0	0.0E+00	0.00	0.0E+00	0.00			
	0	0.0E+00	0.00	0.0E+00	0.00			
AVG	14	1.6E-07	17.78	5.9E-09	0.66	FA	0.0E+00	0.00

INHALATION EXPOSURE ACCOUNTING FOR RESPIRATORY PROTECTION
PROTECTION FACTOR: 2000
MPC-HR SAMPLE: 0.00 RESP CRT: 0.00

6/11/90-6/21/90 CLEANUP

(b)(6)

MO DA	ET min	IN uci/cc	FRAC MPC	OUT uci/cc	FRAC MPC	RESP dpm	RESP uci/cc	FRAC MPC
6 12	6	1.0E-15	0.00	1.4E-07	15.56			
	0	0.0E+00	0.00	0.0E+00	0.00			
	0	0.0E+00	0.00	0.0E+00	0.00			
	0	0.0E+00	0.00	0.0E+00	0.00			
AVG	6	1.0E-15	0.00	1.4E-07	15.56	FA	0.0E+00	0.00

INHALATION EXPOSURE ACCOUNTING FOR RESPIRATORY PROTECTION
PROTECTION FACTOR: 2000
MPC-HR SAMPLE: 0.00 RESP CRT: 0.00

(b)(6)

MO DA	ET min	IN uci/cc	FRAC MPC	OUT uci/cc	FRAC MPC	RESP dpm	RESP uci/cc	FRAC MPC
6 13	38	1.0E-15	0.00	3.7E-08	4.11			
	0	0.0E+00	0.00	0.0E+00	0.00			
	0	0.0E+00	0.00	0.0E+00	0.00			
	0	0.0E+00	0.00	0.0E+00	0.00			
	38	1.0E-15	0.00	3.7E-08	4.11	FA	0.0E+00	0.00

ON EXPOSURE ACCOUNTING FOR RESPIRATORY PROTECTION
ON FACTOR: 2000
SAMPLE: 0.00 RESP CRT: 0.00

(b)(6)

MO DA	ET min	IN uci/cc	FRAC MPC	OUT uci/cc	FRAC MPC	RESP dpm	RESP uci/cc	FRAC MPC
6 13	30	1.4E-07	15.56	8.8E-09	0.98			
	0	0.0E+00	0.00	0.0E+00	0.00			
	0	0.0E+00	0.00	0.0E+00	0.00			
	0	0.0E+00	0.00	0.0E+00	0.00			
AVG	30	1.4E-07	15.56	8.8E-09	0.98	FA	0.0E+00	0.00

INHALATION EXPOSURE ACCOUNTING FOR RESPIRATORY PROTECTION
PROTECTION FACTOR: 2000
MPC-HR SAMPLE: 0.00 RESP CRT: 0.00

6/11/90-6/21/90 CLEANUP

(b)(6)

MO DA	ET min	IN uci/cc	FRAC MPC	OUT uci/cc	FRAC MPC	RESP dpm	RESP uci/cc	FRAC MPC
6 12	17	6.0E-08	6.67	6.1E-08	6.78	IN SAMPLE LOST, ESTIMATED F		
	0	0.0E+00	0.00	0.0E+00	0.00			
	0	0.0E+00	0.00	0.0E+00	0.00			
	0	0.0E+00	0.00	0.0E+00	0.00			
AVG	17	6.0E-08	6.67	6.1E-08	6.78	FA	0.0E+00	0.00

INHALATION EXPOSURE ACCOUNTING FOR RESPIRATORY PROTECTION
PROTECTION FACTOR: 2000
MPC-HR SAMPLE: 0.00 RESP CRT: 0.00

(b)(6)

MO DA	ET min	IN uci/cc	FRAC MPC	OUT uci/cc	FRAC MPC	RESP dpm	RESP uci/cc	FRAC MPC
6 12	10	3.7E-07	41.11	1.3E-08	1.44			
	0	0.0E+00	0.00	0.0E+00	0.00			
	0	0.0E+00	0.00	0.0E+00	0.00			
	0	0.0E+00	0.00	0.0E+00	0.00			
AVG	10	3.7E-07	41.11	1.3E-08	1.44	FA	0.0E+00	0.00

INHALATION EXPOSURE ACCOUNTING FOR RESPIRATORY PROTECTION
PROTECTION FACTOR: 2000
MPC-HR SAMPLE: 0.00 RESP CRT: 0.00

(b)(6)

MO DA	ET min	IN uci/cc	FRAC MPC	OUT uci/cc	FRAC MPC	RESP dpm	RESP uci/cc	FRAC MPC
6 12	7	1.0E-15	0.00	1.3E-08	1.44			
	0	0.0E+00	0.00	0.0E+00	0.00			
	0	0.0E+00	0.00	0.0E+00	0.00			
	0	0.0E+00	0.00	0.0E+00	0.00			
AVG	7	1.0E-15	0.00	1.3E-08	1.44	FA	0.0E+00	0.00

INHALATION EXPOSURE ACCOUNTING FOR RESPIRATORY PROTECTION
PROTECTION FACTOR: 2000
MPC-HR SAMPLE: 0.00 RESP CRT: 0.00

6/11/90-6/21/90 CLEANUP

MO DA	ET min	IN uci/cc	FRAC MPC	OUT uci/cc	FRAC MPC	RESP dpm	RESP uci/cc	FRAC MPC
(b)(6)								
6 13	39	1.0E-15	0.00	5.8E-09	0.64			
	0	0.0E+00	0.00	0.0E+00	0.00			
	0	0.0E+00	0.00	0.0E+00	0.00			
	0	0.0E+00	0.00	0.0E+00	0.00			
	39	1.0E-15	0.00	5.8E-09	0.64	FA	0.0E+00	0.00

ION EXPOSURE ACCOUNTING FOR RESPIRATORY PROTECTION
ION FACTOR: 2000
SAMPLE: 0.00 RESP CRT: 0.00

(b)(6)

6 13	43	9.0E-08	10.00	1.0E-15	0.00			
	0	0.0E+00	0.00	0.0E+00	0.00			
	0	0.0E+00	0.00	0.0E+00	0.00			
	0	0.0E+00	0.00	0.0E+00	0.00			
AVG	43	9.0E-08	10.00	1.0E-15	0.00	FA	0.0E+00	0.00

INHALATION EXPOSURE ACCOUNTING FOR RESPIRATORY PROTECTION
PROTECTION FACTOR: 2000
MPC-HR SAMPLE: 0.00 RESP CRT: 0.00

(b)(6)

6 13	45	3.2E-08	3.56	1.6E-08	1.78			
	0	0.0E+00	0.00	0.0E+00	0.00			
	0	0.0E+00	0.00	0.0E+00	0.00			
	0	0.0E+00	0.00	0.0E+00	0.00			
AVG	45	3.2E-08	3.56	1.6E-08	1.78	FA	0.0E+00	0.00

INHALATION EXPOSURE ACCOUNTING FOR RESPIRATORY PROTECTION
PROTECTION FACTOR: 2000
MPC-HR SAMPLE: 0.00 RESP CRT: 0.00

6/11/90-6/21/90 CLEANUP

(b)(6)

MO DA	ET min	IN uci/cc	FRAC MPC	OUT uci/cc	FRAC MPC	RESP dpm	RESP uci/cc	FRAC MPC
6 14	45	2.6E-09	0.29	2.3E-12	0.00			
	0	0.0E+00	0.00	0.0E+00	0.00			
	0	0.0E+00	0.00	0.0E+00	0.00			
	0	0.0E+00	0.00	0.0E+00	0.00			
	0	0.0E+00	0.00	0.0E+00	0.00			
AVG	45	2.6E-09	0.29	2.3E-12	0.00	5.5E+04	2.8E-08	3.09

INHALATION EXPOSURE ACCOUNTING FOR RESPIRATORY PROTECTION
PROTECTION FACTOR: 50
MPC-HR SAMPLE: 0.00 RESP CRT: 0.05

(b)(6)

MO DA	ET min	IN uci/cc	FRAC MPC	OUT uci/cc	FRAC MPC	RESP dpm	RESP uci/cc	FRAC MPC
6 14	64	4.1E-09	0.46	2.1E-09	0.23			
	0	0.0E+00	0.00	0.0E+00	0.00			
	0	0.0E+00	0.00	0.0E+00	0.00			
	0	0.0E+00	0.00	0.0E+00	0.00			
	0	0.0E+00	0.00	0.0E+00	0.00			
AVG	64	4.1E-09	0.46	2.1E-09	0.23	FA	0.0E+00	0.00

INHALATION EXPOSURE ACCOUNTING FOR RESPIRATORY PROTECTION
PROTECTION FACTOR: 2000
MPC-HR SAMPLE: 0.00 RESP CRT: 0.00

(b)(6)

MO DA	ET min	IN uci/cc	FRAC MPC	OUT uci/cc	FRAC MPC	RESP dpm	RESP uci/cc	FRAC MPC
6 14	64	4.1E-09	0.46	2.1E-09	0.23			
	0	0.0E+00	0.00	0.0E+00	0.00			
	0	0.0E+00	0.00	0.0E+00	0.00			
	0	0.0E+00	0.00	0.0E+00	0.00			
	0	0.0E+00	0.00	0.0E+00	0.00			
AVG	64	4.1E-09	0.46	2.1E-09	0.23	1.6E+05	5.7E-08	6.31

INHALATION EXPOSURE ACCOUNTING FOR RESPIRATORY PROTECTION
PROTECTION FACTOR: 50
MPC-HR SAMPLE: 0.01 RESP CRT: 0.13

6/11/90-6/21/90 CLEANUP

(b)(6)

MO DA	ET min	IN uci/cc	FRAC MPC	OUT uci/cc	FRAC MPC	RESP dpm	RESP uci/cc	FRAC MPC
6 18	62	7.2E-08	8.00	1.0E-15	0.00			
	0	0.0E+00	0.00	0.0E+00	0.00			
	0	0.0E+00	0.00	0.0E+00	0.00			
	0	0.0E+00	0.00	0.0E+00	0.00			
	0	0.0E+00	0.00	0.0E+00	0.00			
	62	7.2E-08	8.00	1.0E-15	0.00	FA	0.0E+00	0.00

Ex. 6

ON EXPOSURE ACCOUNTING FOR RESPIRATORY PROTECTION
ON FACTOR: 2000
SAMPLE: 0.00 RESP CRT: 0.00

(b)(6)

MO DA	ET min	IN uci/cc	FRAC MPC	OUT uci/cc	FRAC MPC	RESP dpm	RESP uci/cc	FRAC MPC
6 21	73	4.3E-08	4.78	1.0E-15	0.00			
	0	0.0E+00	0.00	0.0E+00	0.00			
	0	0.0E+00	0.00	0.0E+00	0.00			
	0	0.0E+00	0.00	0.0E+00	0.00			
	0	0.0E+00	0.00	0.0E+00	0.00			
AVG	73	4.3E-08	4.78	1.0E-15	0.00	1.6E+07	5.0E-06	553.48

INHALATION EXPOSURE ACCOUNTING FOR RESPIRATORY PROTECTION
PROTECTION FACTOR: 50
MPC-HR SAMPLE: 0.12 RESP CRT: 13.47

(b)(6)

MO DA	ET min	IN uci/cc	FRAC MPC	OUT uci/cc	FRAC MPC	RESP dpm	RESP uci/cc	FRAC MPC
6 21	15	4.3E-08	4.78	1.0E-15	0.00			
	0	0.0E+00	0.00	0.0E+00	0.00			
	0	0.0E+00	0.00	0.0E+00	0.00			
	0	0.0E+00	0.00	0.0E+00	0.00			
	0	0.0E+00	0.00	0.0E+00	0.00			
AVG	15	4.3E-08	4.78	1.0E-15	0.00	2.4E+06	3.6E-06	404.04

INHALATION EXPOSURE ACCOUNTING FOR RESPIRATORY PROTECTION
PROTECTION FACTOR: 50
MPC-HR SAMPLE: 0.02 RESP CRT: 2.02

6/11/90-6/21/90 CLEANUP

(b)(6)

MO DA	ET min	IN uci/cc	FRAC MPC	OUT uci/cc	FRAC MPC	RESP dpm	RESP uci/cc	FRAC MPC
6 15	23	6.5E-12	0.00	5.7E-10	0.06			
	0	0.0E+00	0.00	0.0E+00	0.00			
	0	0.0E+00	0.00	0.0E+00	0.00			
	0	0.0E+00	0.00	0.0E+00	0.00			
	0	0.0E+00	0.00	0.0E+00	0.00			
AVG	23	6.5E-12	0.00	5.7E-10	0.06	6.8E+04	6.7E-08	7.47

INHALATION EXPOSURE ACCOUNTING FOR RESPIRATORY PROTECTION
PROTECTION FACTOR: 50
MPC-HR SAMPLE: 0.00 RESP CRT: 0.06

(b)(6)

1.1

MO DA	ET min	IN uci/cc	FRAC MPC	OUT uci/cc	FRAC MPC	RESP dpm	RESP uci/cc	FRAC MPC
6 15	36	2.2E-09	0.24	8.5E-09	0.94			
	0	0.0E+00	0.00	0.0E+00	0.00			
	0	0.0E+00	0.00	0.0E+00	0.00			
	0	0.0E+00	0.00	0.0E+00	0.00			
	0	0.0E+00	0.00	0.0E+00	0.00			
AVG	36	2.2E-09	0.24	8.5E-09	0.94	1.2E+06	7.6E-07	84.18

INHALATION EXPOSURE ACCOUNTING FOR RESPIRATORY PROTECTION
PROTECTION FACTOR: 50
MPC-HR SAMPLE: 0.00 RESP CRT: 1.01

(b)(6)

MO DA	ET min	IN uci/cc	FRAC MPC	OUT uci/cc	FRAC MPC	RESP dpm	RESP uci/cc	FRAC MPC
6 15	33	1.0E-15	0.00	6.9E-09	0.77			
	0	0.0E+00	0.00	0.0E+00	0.00			
	0	0.0E+00	0.00	0.0E+00	0.00			
	0	0.0E+00	0.00	0.0E+00	0.00			
	0	0.0E+00	0.00	0.0E+00	0.00			
AVG	33	1.0E-15	0.00	6.9E-09	0.77	2.1E+05	1.4E-07	16.07

INHALATION EXPOSURE ACCOUNTING FOR RESPIRATORY PROTECTION
PROTECTION FACTOR: 50
MPC-HR SAMPLE: 0.00 RESP CRT: 0.18

6/11/90-6/21/90 CLEANUP

SUMMARY

ENTRY	TIME	DOSE	RATE	IN AIR	OUT AIR	RESP	LOG IN AIR	LOG OUT AIR	LOG RESP
	min	rem	rem/hr	uci/cc	uci/cc	uci/cc			
1	24	1.5	3.8	1.0E-15	6.8E-08	0.0E+00		-7.17	
2	22	1.2	3.3	2.7E-07	1.9E-07	0.0E+00	-6.57	-6.72	
3	14	1.1	4.7	1.6E-07	5.9E-09	0.0E+00	-6.80	-8.23	
4	17	1.7	6.0	6.0E-08	6.1E-08	0.0E+00	-7.22	-7.21	
5	10	1.5	9.0	3.7E-07	1.3E-08	0.0E+00	-6.43	-7.89	
6	7	1.4	12.0	1.0E-15	1.3E-08	0.0E+00		-7.89	
7	6	1.5	15.0	1.0E-15	1.4E-07	0.0E+00		-6.85	
8	38	1.2	1.9	1.0E-15	3.7E-08	0.0E+00		-7.43	
9	30	1.0	2.0	1.4E-07	8.8E-09	0.0E+00	-6.85	-8.06	
10	39	1.5	2.3	1.0E-15	5.8E-09	0.0E+00		-8.24	
11	43	1.0	1.4	9.0E-08	1.0E-15	0.0E+00	-7.05		
12	45	1.5	2.0	3.2E-08	1.6E-08	0.0E+00	-7.49	-7.80	
13	45	1.4	1.9	2.6E-09	2.3E-12	2.8E-08	-8.59	-11.64	
14	64	0.6	0.6	4.1E-09	2.1E-09	0.0E+00	-8.39	-8.68	
15	64	1.1	1.0	4.1E-09	2.1E-09	5.7E-08	-8.39	-8.68	-7.25
16	23	0.2	0.5	6.5E-12	5.7E-10	6.7E-08	-11.19	-9.24	-7.17
17	36	1.1	1.8	2.2E-09	8.5E-09	7.6E-07	-8.66	-8.07	-6.12
18	33	0.4	0.7	1.0E-15	6.9E-09	1.4E-07		-8.16	-6.84
19	62	0.5	0.5	7.2E-08	1.0E-15	0.0E+00	-7.14		
20	73	0.5	0.4	4.3E-08	1.0E-15	5.0E-06	-7.37		-5.30
21	15	0.2	0.8	4.3E-08	1.0E-15	3.6E-06	-7.37		-5.44
22	0	0.0	ERR	ERR	ERR	ERR	ERR	ERR	ERR
23	0	0.0	ERR	ERR	ERR	ERR	ERR	ERR	ERR
TOTAL	710	22.1							

TOTAL TIME (man-hr) 11.8

AVG DOSE RATE (rem/hr) 1.9

6/11/90-6/21/90 CLEANUP

WHOLE BODY VS EXTREMITY DOSE

ENTRY	WB DOSE	MAX WRIST	MIN WRIST	MAX ANKLE	MIN ANKLE	MAX FINGER	MIN FINGER
	rem	rem	rem	rem	rem	rem	rem
1	1.5	3.0	1.8	0.5	1.1	7.5	2.7
2	1.2	1.8	1.6	1.4	1.1	3.6	2.8
3	1.1	1.6	0.7	1.1	0.5	3.1	0.7
4	1.7	2.2	2.1	1.8	1.3	3.7	3.3
5	1.5	5.9	2.3	3.8	3.8	19.1	4.7
6	1.4	3.1	3.3	2.7	1.9	8.2	9.0
7	1.5	18.7	3.0	1.0	2.0	70.3	7.5
8	1.2	4.9	1.3	1.6	2.8	16.0	1.6
9	1.0	2.7	1.2	1.8	1.7	7.8	1.8
10	1.5	1.7	1.7	1.7	1.4	2.3	2.3
11	1.0	1.2	1.2	2.0	1.6	1.8	1.8
12	1.5	4.0	2.7	2.4	1.7	11.5	6.3
13	1.4	3.7	2.9	2.2	1.6	10.6	7.4
14	0.6	1.7	0.5	1.1	0.9	5.0	0.5
15	1.1	2.4	2.0	2.3	0.8	6.3	4.7
16	0.2	0.0	0.0	0.0	0.0	0.0	0.0
17	1.1	0.0	0.0	0.0	0.0	0.0	0.0
18	0.4	0.0	0.0	0.0	0.0	0.0	0.0
19	0.5	0.0	0.0	0.0	0.0	0.0	0.0
20	0.5	0.0	0.0	0.0	0.0	0.0	0.0
21	0.2	0.0	0.0	0.0	0.0	0.0	0.0
22	0.0	0.0	0.0	0.0	0.0	0.0	0.0
23	0.0	0.0	0.0	0.0	0.0	0.0	0.0

MAX FINGER = (MAX HAND - MIN(MAX HAND, WB))*4 + MIN(MAX HAND, WB)

CORRECTS EXTREMITY DOSE FROM 6 INCHES TO 3 INCHES, ASSUMING PT SOURCE