UNITED STATES
NUCLEAR REGULATORY COMMISSION
REGION I
631 PARK AVENUE
KING OF PRUSSIA, PENNSYLVANIA 19406

May 6, 1986

Dal 5/29/86

MEMORANDUM FOR: Donald A. Nussbaumer, Assistant Director for State Agreements Program, OSP

FROM: John R. McGrath, Regional State Agreements Officer

SUBJECT: REPORT AND STAFF EVALUATION - NEW YORK STATE DEPARTMENT OF LABOR RADIATION CONTROL PROGRAM

Enclosed is the subject report and staff evaluation.

As noted in the report, the Department of Labor program is adequate to protect the public health and safety and compatible with the NRC's program.

The staff recommends that the next routine review meeting be scheduled in 18 months.

John R. McGrath
John R. McGrath
Regional State Agreements Officer

Enclosure:
As Stated

August 26, 1985

Lillian Roberts
Commissioner of Labor
New York State Department
of Labor
State Office Campus Building
Albany, New York 12240

Dear Commissioner Roberts:

During the week of July 22-26, 1985, we completed our review and evaluation of the Department's Radiation Control Program. The review covered the principal administrative and technical aspects of this program and included an examination of the program's legislation and regulations, organization, management and administration, personnel, licensing and compliance. Particular emphasis was placed on the significant problem areas noted during our previous review and the Department's comprehensive plan to address the problem areas.

We are pleased to report that the Department has made significant progress in addressing program deficiencies. The approval of two additional professional staff positions is an especially important step in achieving continued program strength. Additional improvements noted include the adoption in June 1985 of revised regulations, a reduction in the inspection backlog, and the drafting of administrative procedures for managing the licensing and inspection programs.

As a consequence of these improvements we are now able to offer a finding that the Department's program for regulating agreement materials is adequate to protect the public health and safety and compatible with the Commission's program for regulation of like materials.

Even though significant improvements in the Department's program were noted, there are areas where continued effort is needed. The inspection backlog, although reduced from the time of our last review, remains higher than it should be. In addition, our review of enforcement actions taken by the Department revealed a number of deficiencies regarding the appropriateness of certain citations. "Enforcement Procedures" is a Category I indicator in NRC's Guidance for NRC Review of Agreement State Radiation Control Programs. A description of the categories used by NRC and how they relate to our findings is contained in Enclosure 1. Additional details on these deficiencies are provided in Enclosure 2.

With respect to the licensing backlog, it is essentially unchanged from the time of our last review. This backlog problem could, at least in part, be ameliorated through the availability and utilization of automatic typing capability by the clerical staff. Dr. Bradley has requested appropriate equipment be obtained for use by the clerical staff. We feel that the availability of this equipment will be of significant assistance in reducing the licensing backlog and in keeping it at a manageable level.

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The additional staff is, however, the most important factor in reducing the licensing backlog and in this regard training for the new staff is an important consideration. The NRC has a number of training courses available for Agreement State personnel and we would be happy to assist the Department in providing training for its new staff whenever it is convenient. Also, Mr. Awai is the only member of the current staff who has not attended the NRC's industrial radiography course. We recommend that he attend this course the next time it is offered. We will forward an announcement to Dr. Bradley when the course is scheduled. "Training" is a Category II indicator in the NRC Guidelines.

Additional comments regarding the Department's program are provided in Enclosure 2. These comments were discussed with Dr. Bradley during our review. You may wish to have him address these comments.

In accordance with NRC practice, I am providing a second copy of this letter for placement in the State's Public Document Room or otherwise made available for public review.

The expeditious actions you and your staff have taken to address program deficiencies is commendable. We will assist you and your staff in any way we can to assure our mutual goal of protecting the public health and safety.

Sincerely,

Original signed by
Thomas E. Murley

Thomas E. Murley
Regional Administrator

Enclosures:
As Stated

cc: (w/Encls.)
D. Axelrod, NYSH
D. Sencer, NYCH
H. Williams, NYDEC
NRC Public Document Room
State Public Document Room
G. Wayne Kerr, OSP
F. Bradley, NYSDOL

Distribution:
TMurley
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McGrath by phone DW 8/12/85	8/12/85	8/1/85		8/23/85

COMMENTS AND RECOMMENDATIONS ON THE NEW YORK STATE DEPARTMENT OF LABOR RADIATION CONTROL PROGRAM

I. COMPLIANCE

1. Enforcement Procedures is a Category I indicator. The following comment is of major significance.

   Comment

   In reviewing a number of Notices of Violation issued by the Department, we found a number of cases where citations were inappropriate, i.e., no actual violation existed, the wrong section of the code was cited, or the citation addressed an area not under the Department's jurisdiction. For example, one licensee was cited for performing instrument calibration when not authorized to do so. The licensee responded pointing out that the Department had approved their procedures to do so. One licensee was cited against 38.22 radiation levels in uncontrolled areas when in fact the deficiency concerned inadequate records of surveys to determine radiation levels in unrestricted areas. As an example of the third type of inappropriate citation, a licensee was cited for performing radiography in Ohio. Such activity is clearly not under the jurisdiction of the Department and the licensee in his response pointed out that such work was done under reciprocity.

   Recommendation

   It is apparent that more careful preparation of Notices of Violation is required. We recommend that such notices be given careful scrutiny by program management and that this subject be discussed at the next staff meeting held for all inspectors. New staff members should be provided instruction on the proper preparation of citations for Notices of Violations.

2. Inspection Reports is a Category II indicator.

   Comment

   In a number of cases, inspection reports did not provide adequate justification or support for items of noncompliance. For example, one licensee was cited for exceeding water effluent limits, however, the calculation supporting this violation was unclear as to the quantity of material released and the volume of water discharged to determine whether the daily, monthly or yearly limit was being exceeded. Documented support for a citation should be in sufficient detail such that management, or any other party, reviewing the report would come to the same conclusion as the inspector with regard to the item cited. Adequate support is important from a number of perspective not the least of which is the possibility of future escalated enforcement action which may involve the presentation of inspection reports as evidence in hearings or trials.

Recommendation

We recommend that program management selectively review inspection reports to assure that they provide adequate support for enforcement actions. This should also be a subject of a staff meeting with the inspection staff. We also feel that this is an important area in which new staff should be properly instructed.

3. Investigation of Incidents is a Category I indicator. The following comment is, however, of minor significance.

Comment

The Department's investigation of the Auburn Steel incident has been essentially completed, however the Department's final report has not been completed.

Recommendation

We recommend that the Department's draft report be completed and a copy forwarded to NRC.

STATE OF NEW YORK

DEPARTMENT OF LABOR

STATE OFFICE BUILDING CAMPUS

ALBANY, N.Y. 12240-0002

LILLIAN ROBERTS
COMMISSIONER OF LABOR

September 30, 1985

Mr. Thomas E. Murley
Regional Administrator
United States Nuclear Regulatory
Commission -- Region 1
631 Park Avenue
King of Prussia, Pennsylvania 19406

Dear Mr. Murley:

I would like to thank you for your letter of August 26, 1985, indicating that the Department's Radiation Program is adequate and compatible with the Commission's criteria. The Department has invested considerable time and effort in assuring that the Radiological Health Unit has adequate staff and back-up assistance to meet its obligations. Your acknowledgment of this effort is appreciated. Many of the steps undertaken will take additional time to implement fully but I can assure you that the intiated steps will be followed through to completion.

Your offer of specialized training courses will be very helpful in initiating the new staff members into the Radiation Program.

Regarding your Enclosure #2 comments, Dr. Francis Bradley, the Department's Principal Radiophysicist, will reply directly to you and your staff. The report will be forwarded to you on or about October 15, 1985.

The efforts of you and your staff over the past 12 months in this audit and last year's audit are appreciated and I believe have resulted in a revitalized Radiation Program.

Sincerely,

Lillian Roberts

Lillian Roberts
Commissioner of Labor

~~8600070303~~

STATE OF NEW YORK
DEPARTMENT OF LABOR
Division of Safety and Health
TWO WORLD TRADE CENTER
NEW YORK, N.Y. 10047

Radiological Health Unit
Room 6989

(tel: 212 - 488-7790)

October 24, 1985

Mr. Thomas E. Murley
Regional Administrator
U.S. Nuclear Regulatory Commission
Region 1
631 Park Avenue
King of Prussia, Pennsylvania, 19406

Dear Mr. Murley:

I have reviewed with our staff the Comments and Recommendations resulting from your 1985 Program Audit. Specific actions and observations based on these recommendations are attached, and procedures are in place through training and new procedures to reduce the incidence of inappropriate citations. These measures together with our augmented staff should be sufficient to meet our commitments.

The Auburn Steel Report is also enclosed. In the training area, it would aid our program immeasureably if the two new radiophysicists could attend the next 5 week Health Physics Course in Oak Ridge.

I would like to thank you, Mr. Allen, J.Lubenau and J. McGrath for their fine efforts on our behalf. Their efforts have aided our program greatly.

Sincerely,

F. J. Bradley

Francis J. Bradley
Principal Radiophysicist

FJB:tp
Encls.

cc: J. McGrath
S. Schrank

~~8600070307~~

New York State Response to Nuclear Regulatory Commission Comments and Recommendations based on May 6 and 7 and July 22-26, 1985 Program Audit.

I. Compliance

1. Enforcement Procedures is a Category I indicator.

Action. Part of the problem resulted from the concerted Unit effort to reduce inspection backlog especially in the Buffalo Area. This involved considerable travel and inspection of licensees by all field staff in a short time frame. Sometimes when this is attempted the inspection results can be spotty, as your review noted. With two new radiophysicists now in training we will be able to get back to a normal scheduling and review cycle with more careful preparation and review of citations.

NOTE: Attendance by two new radiophysicists at the next 5 week Health Physics Course would help greatly in their training. Also, not all of the inspections upon which these observations were made had undergone our internal Unit review.

2. Inspection Reports is a Category II indicator.

Action. The effluent citation noted is an area where we have taken more stringent compliance action over the past year. An Internal Enforcement Memo was issued and is being enforced by our field staff. Additional instructions to staff and additional clarity in substantiating the citation are necessary. This will be on the agenda for our next Staff Meeting.

3. Investigation of Incidents is a Category I indicator.

Action. A copy of the Auburn Steel Report is attached in draft form for your staff's comment. We will issue a final report in about 4 weeks when we have received everyones comments.

DRAFT

Report on Auburn Steel Company Incident, February 21, 1983

Prepared by Staff of Radiological Health Unit, DOSH

I. INTRODUCTION

At About 6:00 P.M. on February 21, 1983 personnel of Auburn Steel Company located in Auburn, New York discovered that approximately 120 tons of steel were contaminated with radioactive material. The steel came from Heats #65 and #66 poured that day. Auburn Steel Company is a "minimill" processing only scrap metal into steel via an electric furnace. These "minimills" are only a recent phenomena (1) and may be contrasted with integrated mills which take iron ore to the finished product. "Minimills" depend on a steady, inexpensive supply of ferrous scrap metal. At this particular plant a scrap charge weights between 60-70 tons. Only scrap attracted to a magnet is added to the charge. The heating cycle lasts about 120 minutes during which the scrap is heated to 2000 °C. Slag with most of the non-ferrous contaminants floats on top of the molten steel. At the end of the heating cycle one ends up with molten steel 89-90% by weight of initial charge, slag 10-11% and particulates 1-1.5%

Dust is captured in a large air cleaning system with special filters located in so-called baghouses. After heating the molten steel is poured into a ladle which transfers the steel to a tundish which regulates flow of molten steel into a continuous casting machine. This vertical casting machine has three molds with three level gauges, each one with a 200 mCi, Cs-137 source. These gauges indicate the height of molten steel in the molds. On the day of the incident the plant was making steel bars cut into 4" X 4" X 12.5' long length called billets. The billets are cooled by a spray of water in the roll out area. To shape billets into finished products the second part of the mill comprises a reheat section and rolling mill section to reform the billets into the desired end shapes. To maintain quality of the product at least 4 samples are taken for elemental analysis at various stages in the steel making process. No testing for radioactivity is made.

The details of the discovery of activity, decontamination of plant and disposal of activity are summarized in the following Sections.

II. Chronology

At about noon on February 21, 1983 foundry Control Room personnel at Auburn Steel noticed a malfunction of the Kay Ray level gauges while pouring Heat #65 into the continuous casting machine. When the gauges malfunctioned, the casting system was run on manual through the billet stage. At the same time an electrician was called to check out the electrical system on the gauges but nothing was found wrong with it. As steel from Heat #65 was being formed into billets from noon to 2 P.M., the following Heat #66 was in the electric furnace and starting after 2:00 P.M., it was formed into billets. No further work was done after Heat #66 was formed into billets as the plant was scheduled for a routine shutdown till 10 P.M. At about 6 P.M. after the mold cover on the casting machine had cooled the Kay Ray gauges were to be checked. The standard procedure was for the electrician to carry a GM survey meter when checking the gauges themselves. As the electrician approached the gauge the GM survey meter went off scale and the electrician informed the foreman on the shift who immediately notified Mr. J. Dacey, the Company Radiation Safety Officer. When Mr. J. Dacey checked the gauges the survey meter also read off scale. The surrounding area was checked and it was determined that the billets were contaminated with radioactivity. Company management was alerted as well as N.Y.S. Department of Health and State Police. At about 11:00 P.M. the N.Y.S. Department of Health radiation specialist from Syracuse, N.Y. checked the plant and some of the workers. The workers were free of contamination and were permitted to go home. The plant operates 24 hours a day but all operations ceased at 6 P.M. until the extent of the contamination could be determined.

The next day upon the advice of Dr. J. Myers of Syracuse University, London Nuclear Services, Inc. Niagara Falls, New York, was called in as consultants. At the same time NYS/DOL was notified as the licensing agency for the gauges. Two NYS/DOL radiophysicists, one from N.Y. City and one from Buffalo office were sent to the facility. Both arrived on February 23, 1983. On February 22, 1983 London Nuclear determined that about half the steel mill was contaminated and in some areas quite extensively. The contaminated areas included the electric furnace, continuous casting area, billet cutting area and the ventilation system. The outside of the building where the slag from Heat #65 and 66 was stored was also contaminated. Soil, air and water samples were taken and analyzed by Dr. J. Myers at Syracuse University. The contaminant was identified as Co-60. The extent of the contamination indicated that a multicurie source of Co-60 was involved. The activity as subsequently determined by 2 groups is summarized in Table #1.

On February 23, 1983 DOL radiophysicists surveyed the facility and confirmed that the contamination was confined to approximately half the plant; since the reheat section and continuous rolling mill section of the foundry were not used with the billets from Heats #65 or 66 those parts of the plant were not exposed to the Co-60 contamination. In addition it was found that the Co-60 was generally confined to the steel itself; scale from the surface of cooling steel billets was not heavily contaminated with Co-60. Apparently the alloying of cobalt into steel was quite complete.

In addition the ventilation system on the electric furnace was very efficient and little contaminated particulates had spread beyond the immediate vicinity of the melt house proper. This included the electric furnace, casting area and billet cutting area. On the other hand the ductwork and baghouses of the ventilation system were extensively contaminated.

Effective February 21, 1983 at 6:00 P.M., the steel production portion of the plant was shut down. The reheat and reshaping parts of the plant could operate but lacked steel.

Since the firm had existing orders it wanted to fill, management contracted with London Nuclear, Inc., to decontaminate the plant. London Nuclear subcontracted with Chem-Nuclear, Inc. to provide health physics services during the decontamination phase and to dispose of all contaminated materials and with Vikem, Inc. to do the actual decontamination work. Since Chem-Nuclear has a decontamination license issued by the State of Washington, decontamination was done under reciprocity under this license.

Industrial Code, Rule 38(2) clearly spells out decontamination limits and based on these limits a Decontamination Plan was developed and presented to the State on March 1, 1983. This plan was approved with some modification on March 2, 1983 and decontamination began immediately 24 hours a day, 7 days a week until the decontamination job was completed on March 21, 1983.

During April, 1983 the contaminated slag was packaged and stored in a secure area on-site. Shipments of contaminated waste started in June, 1983 to Barnwell, S.C. and were completed in December, 1983. Fixed residual activity on rotary air lock was checked in February, 1985 and found to be less than 0.25 mR/hr and consequently the entire plant was considered clear of contamination at that time.

III. Clean Up

A. Basic Plan

Based on initial surveys conducted by London Nuclear Corporation and DOL contamination was confined to 5 plant areas as follows: Melt Shop, approximately 11,000 square feet; Casting Area, approximately 8,000 square feet; Dust Collectors, approximately 1,000 square feet, Exhaust Ductwork and "Hackett" Slag Pit (see figure 1). At the end of the heating cycle slag is poured off the top of the molten steel onto the Melt Shop earthen floor. Later the slag is moved to the outdoor "Hackett" Slag Pit. When it cooled, slag has the consistency of porous rock and generally held Co-60 contaminant and did not contribute to widespread removable contamination. Each dust collector consisted of a baghouse w... 2 chambers-one chamber for the filtration bags and the ot... chamber called a hopper where the particulates accumulate. ... hoppers empty into a large bin which sits on ground and measures 8'x8'x30'. Not all dust collectors are in operation at the same time; the exhaust air stream is cleaned by 2 chambers at a time.

The basic decontamination plan called for isolating contaminated plant areas into 5 contamination zones as indicated above, decontaminating each zone using appropriate procedures including grinding, chipping, heating, vacuuming, sand blasting, scrubbing and washing. Each contamination zone varied in its decon requirements necessitating different personnel protective requirements for each zone. Each zone was entered using a work area permit (at least in theory) which specified the protective clothing, respirator, personnel monitoring device, decon technique and training required. Following decontamination each zone was checked for compliance with limits specified in Table 2 and a survey report was prepared by Chem-Nuclear and presented to the State for verification.

B. Decontamination Highlights

Standard decon procedures usually specify the initial clean-up of all loose and easily removable contamination utilizing vacuuming, washing and scrubbing techniques. Next follows the removal of fixed contamination. This is normally the more difficult step and the Auburn Steel decontamination proved no exception. In some cases, the use of chemicals or complete excision of the contaminated part proved relatively easy but these procedures were not always usable.

In decontaminating the electric furnace it was decided to replace all the fire brick lining the furnace rather than attempt to clean the brick. To extend the life of the electric furnace the sides of the furnace are lined with water jackets to moderate the temperature of the lining. Some of these water jackets had to be replaced, but due to a replacement cost of $40,000 per jacket they were placed in an outside storage shed for a later attempt at decontamination. After the area around the electric furnace was cleaned up and the brick lining replaced, it was discovered that the furnace top was still contaminated. In order to decontaminate the furnace top in the same area without recontamnating the area required the erection of a temporary tent structure next to furnace where the furnace top was decontaminated.

The casting area included a modern vertical 3 channel continuous casting machine out of which poured from each channel 4" X 4" square rods which were cut into 12.5' billets. For apportioning the steel the casting machine had a device called a tundish with three outlets from which poured molten steel into each channel. The tundish received molten steel from the transfer ladel and regulated the flow of steel into casting machine. Each casting channel had a Kay Ray level gauge which monitored the height of molten steel. Data from gauge was presumably fed back through the control system in order that the tundish provided a proper flow of molten steel. These gauges malfunctioned on February 21, 1983. The casting machine was housed in a structure three stories tall. External dose rates ranged from 60 to 1200 mR/hr. Following the casting machine was a billet cutting and roll-out area onto which the cut-up billets ended up to cool. In this area the billets are sprayed with water forming steam and scale on the billets-some of which flaked off and dropped below the rollers and contaminated the area. External dose rates in this area ranged from 3 to 500 mR/hr. The higher readings were on billet ends which collected here. Residual steel contamination in channels and on rollers ranged from 5-10 mR/hr. Removal of this contamination required chiseling, grinding and heating the contaminated steel. The water from the spraying operation drained to a sump in the area. All contaminated sand and scale was placed in 55 gal. drums or low specific activity wooden crates as appropriate for disposal.

The Exhaust Ductwork and Dust Collectors presented the biggest decontamination challenge during the entire project. Some parts were difficult to reach, other parts could not be decontaminated to Table 2 limits. Decontamination of the system started immediately and extended over the entire 3 week period. The Exhaust Ductwork includes 9' diameter ducts connected to an extensive dust collection system. The ducts were sand blasted to remove contamination coating the inside duct walls. All contaminated sand from sand blasting was placed in drums for disposal.

The dust collection system consisted of 18 cells; each cell contains two bag chambers each measuring 12.5' high X 8' wide X 10.6' deep and consisting of 144 cloth filter bags. A hopper in which dust particulates accumulated tapers down 4' under each cell. The dust is transferred to 8' X 8' X 13' bins below the hoppers. The chamber with cloth filters read 20-60 mR/hr and the dust bins at ground level read 350 and 380 mR/hr, maximum on their surface. Despite much effort certain parts in this system could not be decontaminated to 0.25 mR/hr limit. One part in this category was the rotary air lock on the bottom of the hoppers. Apparently the contamination was imbedded in the metal, since extensive sand blasting failed to reduce external dose level to 0.25 mR/hr. Replacement of the airlocks would have been both expensive and time consuming. It was estimated that it would take a minimum of 6-8 weeks to obtain and install replacement airlocks. Further the area was normally not occupied and maximum residual activity was estimated to be <1 mCi. Posting the area would reduce the probability of anyone staying in the area. It was assumed that abrasion would reduce the activity level. This occurred since the area was checked and read 0.15 mR/hr when last checked in February, 1985.

On March 21, 1983, Chem-Nuclear Corporation provided the State with their final survey specifying that all areas were cleaned to Table 2 limits except for the air locks as noted above and the outside Hackett Slag Site which was to be cleaned up within 30 days as weather permitted. Since plant management wanted to start the plant as quickly as possible after submittal of their final survey, the State verification survey extended over a 16 hour period on March 20 and 21, 1983 involving 3 radiophysicists. The DOL declared the plant itself clean with the exceptions noted above, on March 21, 1983. Table 3 summarizes the results of the final decontamination surveys conducted by Chem-Nuclear Corporation. Again the practicality of the limits listed in Table 2 are evident. The decontamination crews knew in advance the limits that they had to meet and the average and maximum removable limits gave some flexibility to the process.

The contaminated slag in the Hackett Slag Pit was removed and placed in drums for shipment over the next 30 days. All of the contamination was now out of the main plant and stored in a secure and posted area behind the plant. During decontamination certain items were replaced and the contaminated item placed in a storage shed. Due to their expense a protocol was submitted proposing further decontamination. This involved building a temporary plastic shed with an exhaust through high efficiency filters in the storage shed. These additional efforts led to the decontamination of two tundishes and a water jacket.

In summary despite extensive initial contamination by approximately 30 Ci, Co-60 concerted efforts by a trained work force with proper supervision expediously decontaminated a steel mill with a 15,360 man-hour effort. As in many decon jobs the most difficult part involved removing fixed contamination. The steel mill was back in operation on March 22, 1983, during the 3 week period while the Melt Shop was not operational, steel was brought from as far away as Florida to continue operating the reheat and reshaping portion of the mill.

C. Incident

During the Decontamination phase DOL physicists monitored the operation to ensure that all the procedures spelled out in the Decontamination Plan were followed. Since the plan required 24 hour/day operations, this meant that DOL inspections and surveillance work took place on a round the clock basis. One incident occurred during the clean-up involving an apparently dissatisfied worker who on Saturday night March 5, 1983 at about 10:30 P.M. phoned the NRC with his complaints. The NRC phoned the NYS 24 hour radiation emergency number which is manned by

N.Y. State Police who in turn checked out the individual. The complainant had not given his name to NRC but he did give his motel and room number. The individual denied having called anyone but later admitted calling NRC. A DOL physicist interviewed the individual who at first denied calling NRC but then stated he did and gave the following complaints. One involved working in excessively dusty areas and the second involved the lack of supervision at check-out points to ensure that workers were properly surveyed as they left the control area. All decontamination work ceased until the complaints were resolved. The Company RSO and a DOL physicist checked the area where the dusty operation was said to have taken place. It was determined that the operation was not as dusty as was made out and that procedures were being followed. The check-out survey procedures were being followed at check-out points so decon operations resumed. DOL later did cite Chem-Nuclear for not having a health physicist present at check-out points to ensure that each worker frisked himself thoroughly before he left the controlled area.

IV. Dosimetry

Cleaning up a contaminated steel mill requires a large number of persons including many persons with special skills. In this incident one firm, Chem-Nuclear Corporation, was responsible for managing all persons who entered the contaminated areas to ensure that they received minimal internal and external doses consistent with standards and the clean up program. As detailed in Section III this program involved partitioning the contaminated portions of the mill into 5 zones. Each zone had its distinct requirements for decontamination, protective clothing, dosimeters and respiratory protection as specified in the Radiation Work Permit (PWP). As each zone was cleaned up it was sealed off from the contaminated portions of the mill. Since the hot billets with major amount of activity were secured in a remote on-site storage location during the first week of incident, a major source of external radiation was removed.

The need for respirators was determined by Chem-Nuclear Corporation based on the decon procedures and the air contamination level as determined by air monitoring. Some operations required continuous air monitoring because the air contamination varied during job.

Each person who entered a controlled area was issued a pocket dosimeter and in most cases a thermoluminescent (TLD) dosimeter badge as well. Dosimeter results for the month of March, 1983 during which the bulk of the work was done are summarized in Table 4. The listing is by firm which performed the diversified tasks needed to complete the decontamination project. Chem-Nuclear Corporation provided health physics services; Trimbec, Inc. personnel did the actual clean-up work; Auburn Steel Company personnel did specialized jobs such as replacement of bags in Baghouse; Diversified Nuclear Company provided the nuclear counting capability; Vikem Industries Company provided oversight of the Trimbec workers; London Nuclear Company provided overall management of decon project and Wiltsie Construction Company personnel provided sand blasting capability needed in the ventilation system clean-up. Table 4 indicates a total collective dose equivalent of 5.1 man-rems as determined by TLD for 130 persons and 6.9 man-rems as determined by the pocket dosimeter for 192 persons. Considering that each person that entered a controlled area was a radiation worker and that the values listed are for the 3 week decontamination period the maximum permitted collective dose would be (0.3 rem) X (192-man) = 57.6 man-rem. Since the observed collective dose was 12% of this value, this must be considered a well controlled decontamination job considering the always present uncertainties in any decontamination job. The 6.9 man-rem is the best estimate of the collective dose.

In the case of the Trimbec Company employees a comparison between the TLD and pocket dosimeter results can be made. This firm had the largest number of employees -74 -who wore both dosimeters. For these workers the mean and standard deviation of the TLD dose estimate was 0.049 ± 0.004 rem and the mean and standard deviation of the pocket dosimeter dose estimate 0.044 ± 0.004 rem. The correlation coefficient between TLD and pocket dosimeter values was 0.8 indicating a high degree of correlation between the two dosimetry methods. One reason for the high correlation was the hard gamma emitted by Co-60 making the 2 dosimeters less sensitive to orientation and exposure location on the body.

Internal contamination of workers was not a problem. Initial smear surveys indicated that loose contamination was not extensively spread throughout the plant. In one area where smears were taken on February 23, 1983 before decon started the average smear value of 22 smears was 125 pCi/100cm^2. Assuming a resuspension factor of 10^{-6} (Brodsky, 2) this gives an anticipated air contamination value of 1.3×10^{-6} pCi/cm^3. This is a factor of 9×10^3 lower than the MPC for Co-60 for occupational exposures. Whole body counts and urine results confirmed low internal contamination. Procedures called for respirators in all areas exceeding 3×10^{-4} pCi/cm^3. Certain procedures such as sand blasting generated airborne activity and respirators were always required.

Pre-exposure urines were collected on March 1, 1984 and at the end of the decontamination on March 21, 1984. Most urines gave background results; the highest urine activity observed was 1×10^4 pCi/l.

On February 21, 1983 three instrument engineers were working in the Steel Mill while Heats #65 and 66 were run through the Melt Shop. In a recapitulation of where they were on the afternoon of February 21, 1983 the 3 individuals spent about one hour on the foundry floor approximately 25' from the electric furnace while Heat #66 was being poured into casting machine. Heat #66 was the less heavily contaminated of the two Heats. These engineers had whole body counts taken and no internal contamination was detected. This was an additional check on the efficiency of the ventilation system and the generally fixed nature of the contamination.

V. Disposal

The packaging and disposal of Co-60 contaminated debris and steel from a minifoundry presented some unique problems. The sheer volume and weight of the waste required a staggered approach to be accepted for burial. All of the radioactive waste was buried in Barnwell, South Carolina which has a monthly allocation system for use of the burial site. Consequently the use of the site on any given month was dependent on getting the necessary approvals. Starting in June, 1983 and extending over a seven month period, a total of 52 ram waste shipments were made to South Carolina. The volume and activity shipped each month are summarized in Table 5. The total volume shipped was 27,336 $feet^3$. This represented 32% of the total non-reactor low-level radioactive waste disposed of from N.Y.S. during 1983. The total activity shipped was 15.3 Ci, Co-60. This varied from estimates of the total activity as given in Table 1 of Section 11. Part of the discrepancy can be explained by the difficulty in estimating activity in crates of varying geometry and drums of varying weight.

Since the Barnwell Disposal Site has restriction on burial of drums with free standing water, elaborate precautions were taken to ensure that this did not occur. Any damp item that might release water when sealed in a shipping drum, such as, sludge, soil, slag or rags was solidified in the 17H drum using approved media. The drum was left to stand uncovered for 48 hours. If water appeared, additional solidifying agent was added and the drum sealed, inverted and allowed to stand 48 hours. After reinverting and opening if water appeared drum was cut up and placed in a 55 gallon drum overpack.

The billets from Heats #65 and 66 were placed in custom-built steel crates. These crates were welded together on site and met the DOT criteria for a well constructed container (see Figure 2).

Another contaminated item requiring special custom built container was the steel scull which measured about 5 foot in diameter, 4' in depth and 3" thick with shape of a paraboloid. A wooden crate was fabricated on site to enclose this item. The void spaces in some of the odd shaped shipping containers were loaded with contaminated scale and slag to better utilize all the container volume.

All shipments were made without transportation incident or citation at the burial site.

The U.S. Department of Transportation shipping classification that was used for most containers other than billets was "Radioactive - LSA". The low specific activity designation was based on the fact that the activity was an integral part of the slag, scale and steel. Many decon jobs in fact end up generating large quanities of LSA waste.

VI. Cost

Auburn Steel estimated (4) that the cost of decontaminating the plant and disposing of the radioactive waste was in excess of 2,200,000\$. This is a cost of 88,000\$ per curie of contamination (assuming 25 Ci, Co-60). While the contamination was contained relatively well in the steel, cleaning a steel plant is an expensive undertaking. In addition this figure only includes actual costs and not the cost arising from lost steel production.

VII Preventing a Reoccurrence

One can not correct a system until one learns where the Co-60 source came from. There are two prime candidates for the missing Co-60. One is a industrial radiography source and the other is a very old teletheraphy source. These are the prime candidate sources but they are not the only ones. The source could have been from a gauge using such a size source. There are very few Co-60 sources in the size range in question in gauges. It is possible that a one-of-a- kind source in use by universities, government or industry could have been lost, misplaced or stolen or surplussed. If one adds to this list the possibility that the source could have been imported one can appreciate the complexity of locating the source's former owner.

While one can not correct a situation until one learns where the source came from, one can reduce the public health and worker exposures of future occurrences by certain measures. One of the prime targets for control measures is the scrap dealer and foundry owner transactions. It would appear to be relatively simple to stop any sale of contaminated scrap or scrap containing ram sources by making the scrap dealer liable for cost of clean-up. In the past the federal government was the prime source of such items through its surplus disposal sales but presumably most of these sales involved small sources (but in some cases could involve large numbers) and slightly contaminated scrap. In any case scrap dealers would be the first line of defense in restricting the flow of such items in commerce. The scrap dealer could screen each item with a sensitive radiation detector. Certain nuclides could still get through such a screening procedure such as H-3 and C-14 or shielded gamma sources. But a large shielded hard gamma source would be simple to detect by this procedure.

At the foundry the incoming scrap could be screened or the melt itself could be checked. Making an existing nuclear gauge's mal-function an indication of the potential presence of contaminated steel is another approach as in Auburn Steel Incident but it has its drawbacks. Part of the foundry is already contaminated and, of course, nuclear gauges malfunction for a variety of reasons not just the presence of contamination. The technique, while valuable from a public health standpoint, does not restrict the flow of contaminated scrap. Neither of the above -measures on scrap dealer or on foundry operator are easily susceptable to regulation. But they could come in play because of economic reasons such as insurance charges.

For the owner of licensed sources the person is obligated pursuant to present regulation to dispoce of the source only to another licensed person. So the present rules cover the unauthorized distribution to a scrap dealer. Whether the present rules on importation, especially scrap, are sufficient should be investigated.

Granting the owners of large sources have primary responsibility for the handling the sources in accord with regulation, it is possible that inspection of such sources should be reviewed or tightened up to insure the return of large sources to licensed persons.

Another regulatory area that potentially could be a source of a problem in the future are generally licensed devices. At 50 tons of steel per melt a one curie Co-60, Cs-137 or Sr-90 source would not pose an unacceptable risk at specific activities of 22 nanocuries per gram (nCi/g) but at 30 Ci the specific activities of 660 nanocuries per gram could be a problem. Specific activity of the steel in Heat #65 at Auburn Steel was estimated at 330 nCi/g and 538 nCi/g (Table 1). Limiting sources in generally licensed devices to less than 1 curie would seem to be sensible based upon this experience.

Ancillary to main concern of preventing a reoccurrence there are several observations one can make and may be useful in future. In licensing a facility competent and knowledgeable individuals certainly helps even for modest size licensed sources in limiting the spread of activity in an incident. In this case the instrument technicians in using a GM survey meter to check for the closed shutters on the gauges and the radiation safety officer in recommending the shut down of the plant after assessing the problem and alerting government authorities were fortunate and wise decisions. The clean-up itself was greatly aided by the build-up of expertise and personnel in the private sector in decontamination work. This is obviously a result of the nuclear power industry where such work is an everyday occurrence now as opposed to such work being a unique occurrence 20 years ago. This permitted the rapid decontamination of the major part of the plant in just 3 weeks time. The availability of decontamination limits in the regulations also helped since it immediately focussed all resources on meeting these limits and not in establishing limits on an ad hoc basis.

In the light of what recently happened in an almost identical setting to the Auburn Steel Company incident in Mexico (3) additional precautions are certainly warranted on the part of all segments of the steel business --scrap dealers and steel mill operators and on the part of owners and regulators of large ram sources.

Finally, one can never rule out malicious activity for whatever reason might be involved in such an incident.

VIII References

(1) Miller. J.R., 1984, "Steel Minimills", Scientific American 250, pg. 33-39.

(2) Industrial Code, Rule 38 (12 NYCRR 38) 1978, "Ionizing Radiation Protection", Table 5, pg. 43.

(3) Brodsky.

(4) Dacey, J., 1983, personal communication, Auburn Steel Co.

(5) Staff of U.S. NRC, "Contaminated Mexican Steel Incident" 1985, NUREG 1103, U.S. Nuclear Regulatory Commission, Washington, D.C.

Table 1 - Activity Determinations

Lab	Item	Mass	Volume	Specific Activity	Total Activity
		kg	m^3	$\frac{uCi}{kg}$	Ci
Galson	steel billet (H.#65)	5.748×10^4 (63.2t)	7.465	538	30.5
	slag (H.#65)	7.272×10^3 (8t)			
	dust (H.#65)	9.55×10^2 (1.05t)		4.096	0.0039
	steel billet (H.#66)	4.792×10^4 (52.7t)	6.305	3.542	0.17
	slag (H.#66)	5.909×10^3 (6.5t)			
	dust (H.#66)	7.63×10^2 (0.8t)		5.072	0.0039
					30.7Ci
nemNuclear	steel billet (H.#65)	5.236×10^4 57.6t)		330	17.28Ci
	steel billet (H.#66)	5.236×10^4 (57.6t)		3.3	0.173Ci
					17.453Ci

TABLE 2
Decontamination Limits
(from Table 5, 12 NYCRR 38)

Surface Contamination

Removable	$100 \frac{pCi}{100 \, cm^2}$	; average over any one surface
	$500 \frac{pCi}{100 \, cm^2}$	; maximum
Total (fixed)	$0.25 \frac{mrem}{hr}$ @ 1 cm. from surface	

Concentration in soil and other materials except water

$500 \frac{pCi}{g}$

TABLE 3

Summary of Final Survey by Chem Nuclear

Area	Smear Results Range (pCi/100 cm^2) Average (pCi/100 cm^2)	Ext. Dose Rate (mR/hr)
ydraulic Pump Area	BG - 55	BG - 0.05
elt Shop	BG - 52	BG - 2
ide Area Bet. Baghouse & Main Bldg.	BG - 67	none recorded
aboratory	BG - 69	.04 - 0.14
/Mill Floor	BG - 54	BG - .08
adle Crane & Access Ladder	BG -	0.05 - 0.1
urnace Shell	BG - 143 37 Avg.	.05 - 5
ffice/Area -	BG - 36	.02 - 0.23
aster Area 1st Deck	BG - 36	BG - 0.1
aster Area 2nd Deck	BG - 72	BG - .06
aster Area 3rd Deck	BG - 43 13	.03 - .06
undish Area	BG	BG - 0.07
adleman's Area	BG - 32 6	BG - 0.08

Area	Smear Results Range $\left(\frac{pCi}{100cm^2}\right)$ Average $\left(\frac{pCi}{100cm^2}\right)$	Ext. Dose Rate $\left(\frac{mR}{hr}\right)$
Ladle Laydown Area	BG	BG - 0.2
Melt Shop East End	BG	BG - 0.1
Furnace Laydown Area	BG - 56 11.4	BG - .07
Slag Area East End of Bldg.1	BG - 57 3	BG - 0.25
Slag Area East End of Bldg.2	BG - 52 5	none recorded
Work Shop-by Furnace	BG - 23 6	BG - .05
Furnace Area	BG - 85 13	BG - .2
Furnace Transformer Rm.	BG - 38 11	BG - .02
East Slag Area	BG - 23 6	BG - 0.2
Torch Pit	BG - 83 11	BG - 0.2
Roller Area Stairs to Caster Area	BG - 44 6	BG - 1.5
Caster Roll out Area	BG - 114 8	0.2
Spray Room -1st Level	BG	0.2
Furnace Support Head	BG - 140 26	BG - 0.15

Area	Smear Results Range (pCi/100 cm^2) Average (pCi/100 cm^2)	Ext. Dose Rate (mR/hr)
Furnace Deck	BG - 27 1	.05 - 0.1
Cooling Pit	BG - 45 3	0.05 - 0.15
Vent Ducting Top of Bldg.	BG - 143 31	0.1
Vent on Top of Bldg.	BG - 101 12	0.1
Furnace Vent	BG - 64 14	0.05 - 0.15
Spark Anestor	BG - 103 15	0.05 - 0.18
Scale Pit Area	BG - 47 4	
Scale Pit Sump	BG - 65 16	
Scale Pit	BG - 34 1	BG - 0.07
North Side Lower Level Bagh.	BG - 119 26	0.03
Hopper #1	BG - 137 61	
Hopper #2	BG - 139 60	
Hopper #3	BG - 123 63	
Hopper ~~#5~~	28 - 364 93	0.5 - 0.7
per #6	29 - 90 63	0.5 - 0.8

Area	Smear Results Range (pCi/100 cm^2) Average (pCi/100 cm^2)	Ext. Dose Rate (mR/hr)
Bag House "11"	BG - 89 14	.22 - 0.28
Plenum	BG - 224 87	0.1 - 0.25
Plenum Outlets	BG - 2[illegible]9 51	0.1 - 0.25
[illegible]th Fan Housing Shaft House	BG - [illegible] 64	0.1
South Fan Housing	30 - 88 59	0.2
Hopper 4	BG - 46 18	
South Fan Housing	BG - 80 29	0.2
South Side Lower Level Baghouse	BG - 449 92	.25 - 5
Baghouse Top Level Center (catwalk)		.05 - 0.1
North Walkway		0.1 - 0.9
Upper Level Catwalks Baghouse		0.08 - 0.15
Baghouse - Ground Level		0.15 - 0.2

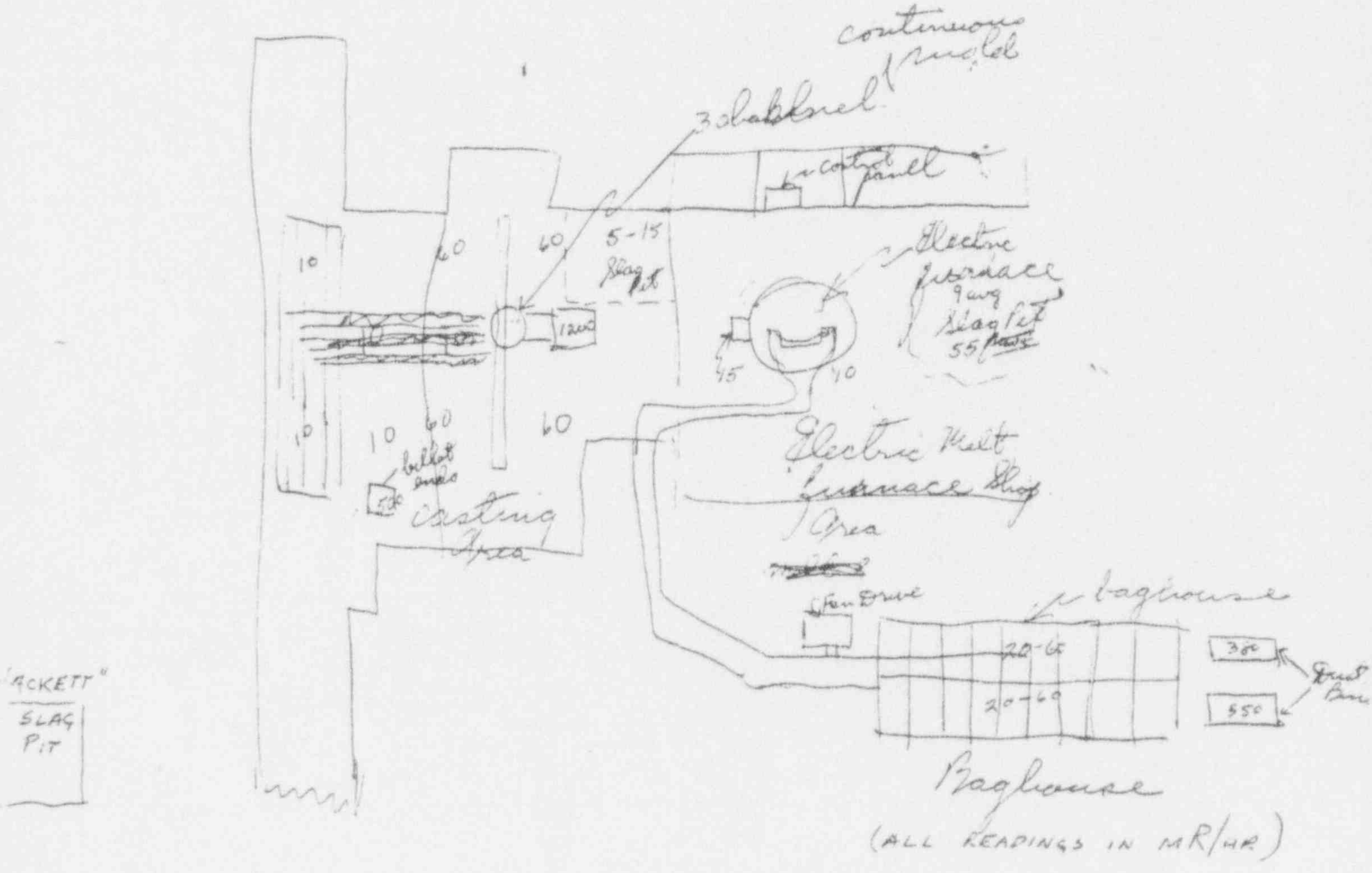
Area	Smear Results Range (pCi/100 cm^2) Average (pCi/100 cm^2)	Ext. Dose Rate (mR/hr)
Bag House "C"	BG - 40 4	.06 - .10
Bag House "D"	BG - 67 17	.03 - .10
Bag House "E"	BG - 188 74	.08 - .12
Bag House "F"	BG - 91 36	.08 - .14
ag House "G"	BG - 90 32	0.16 - 0.36
Bag House "1"	BG - 113 41	.08 - .22
Bag House "2"	BG - 89 34	.08 - .14
Bag House "3"	BG - 60 22	.14 - .22
Bag House "4"	BG - 98 32	.12 - .20
Bag House "6"	BG - 125 27	.18 - .24
Bag House "7"	BG - 111 40	.16 - .36
Bag House "8"	BG - 68 24	.14 - .20
House "9"	BG - 89 17	.24 - .42
Bag House "10"	BG - 159 25	.09 - .18

Area	Smear Results Range (pCi/100 cm^2) Average (pCi/100 cm^2)	Ext. Dose Rate (mR/hr)
Hopper #7	BG - 99.2 45	
Hopper #8	54 - 185 103.	
Hopper #9	34 - 318 144	
Hopper #9 (redone)	BG - 166 12	0.4 - 1.2
Hopper #10	BG - 226 81	
Hopper #11	BG - 159 51	
Hopper "A"	BG - 158 58	
Hopper "B"	BG - 98 36	
Hopper "C"	BG - 83 30	0.7 - 1.5
Hopper "D"	BG - 123 30	
Hopper "E"	BG - 85 14	
Hopper "F"	30 -145 67	
Hopper "G"	BG - 111 48	0.4 - 0.9
g House A	BG - 130 64	.06- 0.9
Bag House B	BG - 144 66	.06- .13

TABLE 4
Dosimeter Results
March 1983

COLLECTIVE DOSE

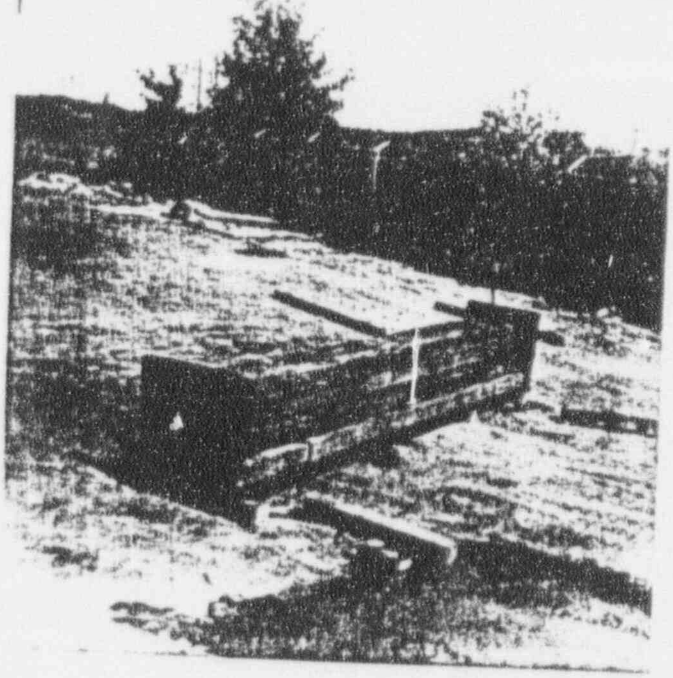
Firm	No. of Persons	TLD	No. of Pers.	pd
Chem Nuclear	7	0,223 man-rem	8	0.548 man-re
Trimbec	74	3.619	76	3.270
Auburn Steel	31	0.586	62	0.655
Diversified Nuclear	5	0.085	5	0.168
Vikem Industries	11	0.594	15	1.669
London Nuclear	2	0.0	5	0.005
Wiltsie	-	-	21	0.585
	130	5.107 man-rem	192	6.9 man-rem



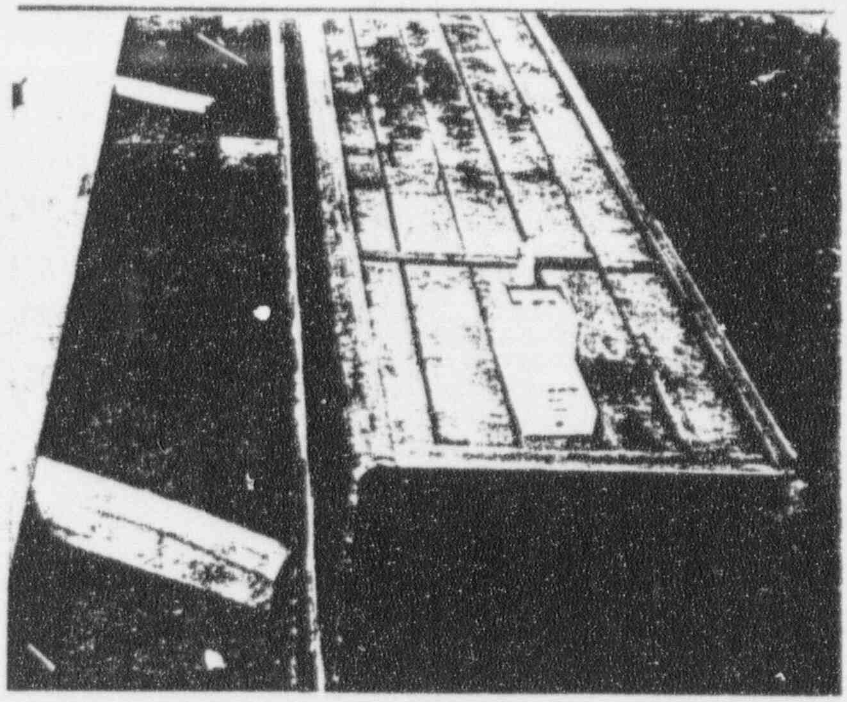
Mini-Foundry

Figure 1

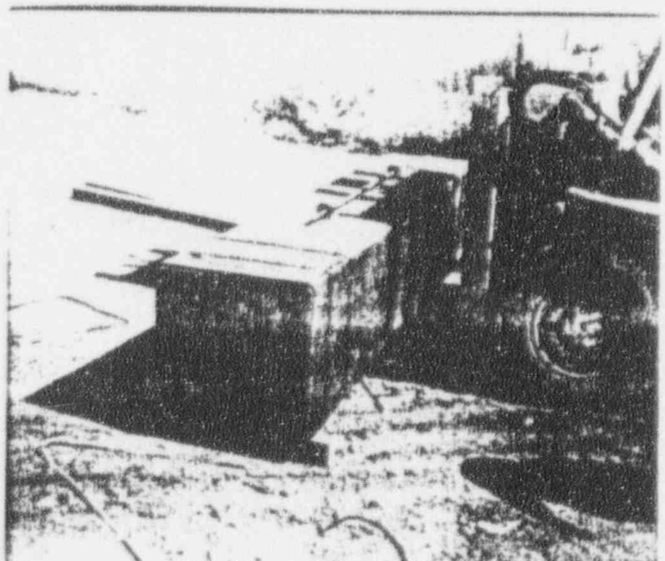
readings made on 7-7-84



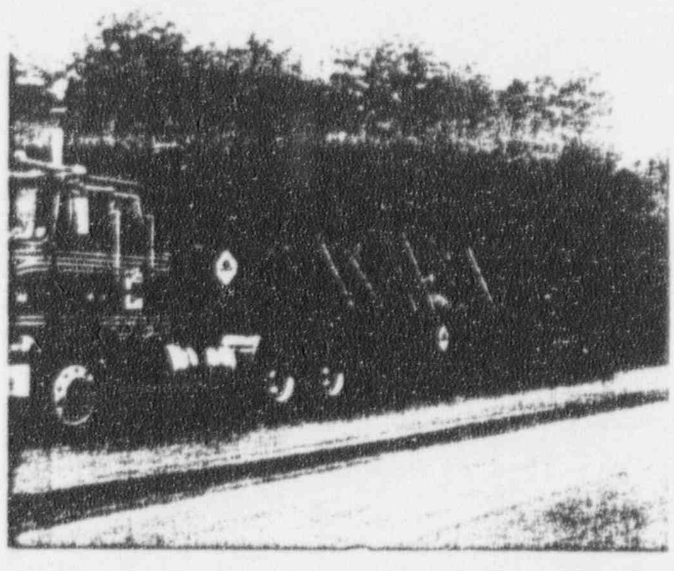
STEEL BILLETS
PARTIALLY COMPLETED CONTAINER
FIG 2a



STEEL BILLET CONTAINER
EXTERNAL DOSE MEASUREMENTS
FIG 2b



STEEL BILLET CONTAINER
READY FOR SHIPMENT
FIG 2C



RAM WASTE SHIPMENT
FROM AUBURN STEEL COMPAN
FIG 2d