



UNITED STATES  
**ATOMIC ENERGY COMMISSION**  
 DIRECTORATE OF REGULATORY OPERATIONS  
 REGION I  
 631 PARK AVENUE  
 KING OF PRUSSIA, PENNSYLVANIA 19406

MAY 21 1974

Nuclear Metals, Inc.  
 Attention: Mr. W. B. Tuffin  
 2229 Main Street  
 Concord, Massachusetts 01742

License No. SNM-65  
 Inspection No. 70-82/74-01

Gentlemen:

This letter refers to the special inspection conducted on February 20-22, 1974, of activities authorized by AEC License No. SNM-65 and to the discussion of our findings with Mr. Matthews and members of your staff on February 22, and to a subsequent telephone discussion between you and Mr. Kinney on March 20, 1974. This letter also refers to the management meetings on March 28 and April 30 held at your request in our Region I offices during which our findings were discussed at length with you, Mr. Gilman, and Mr. W. N. Harrell Smith, your attorney.

This special inspection was prompted by an occurrence involving fissile material of unknown uranium-235 (U-235) content being present in a container not-safe-due-to-geometry, which was reported to Region I on February 15, 1974. Analyses of samples of the contents of five 5-gallon pails indicated that one pail might contain from 1800 to 4000 grams of uranium. The uranium was possibly highly enriched in U-235 (93% U-235) since it was cleaned from a power hacksaw used with highly enriched uranium components. You formulated a plan to remove the criticality hazard. After receiving AEC review and concurrence with the plan, you implemented it on February 21 and 22 under the observation of a Region I inspector. The hazard was removed by placing the contents of the 5-gallon pails into safe-by-geometry containers.

During this inspection, it was found that certain of your activities appeared to be in violation of AEC requirements, and another activity appeared to raise a question concerning the safety of operations. The items and references to the pertinent requirements and to generally accepted guidance are listed in the enclosures to this letter.

After careful consideration of these violations and safety item, the fact that you no longer have sufficient special nuclear material to present

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OFFICE ▶	GRESS				
SURNAME ▶	<i>W. B. Tuffin</i> Kinney	<i>five</i> Crocker	<i>again</i> Martin	<i>0</i> O'Reilly	
DATE ▶	5-23-74	<i>5/21/74</i>	<i>5/22/74</i>	<i>5/24/74</i>	

a possible criticality hazard, and that you have requested that AEC License No. SNM-65 be terminated, you are not required to reply to these items.

In accordance with Section 2.790 of the AEC's "Rules of Practice", Part 2, Title 10, Code of Federal Regulations, a copy of this letter and the enclosed inspection report will be placed in the AEC's Public Document Room. If this report contains any information that you (or your contractor) believe to be proprietary, it is necessary that you make a written application within 20 days to this office to withhold such information from public disclosure. Any such application must include a full statement of the reasons on the basis of which it is claimed that the information is proprietary, and should be prepared so that proprietary information identified in the application is contained in a separate part of the document. If we do not hear from you in this regard within the specified period, the report will be placed in the Public Document Room.

Should you have any questions concerning this inspection, we will be pleased to discuss them with you.

Sincerely,

/s/

James P. O'Reilly  
Director

Enclosures:

1. Description of Violations
2. Description of Safety Item
3. RO Inspection Report No. 70-82/74-01

bcc (w/encls):

RO Chief, FS&EB (2)

RO:HQ (4)

L:D/D for Fuels and Mat's

PDR

NSIC

RO Files

DR Central Files

State of Massachusetts

ENCLOSURE I

DESCRIPTION OF VIOLATIONS

Nuclear Metals, Inc.  
2229 Main Street  
Concord, Massachusetts 01742  
License SNM-65  
Docket No. 70-82

Certain activities under your license appear to be in violation of Condition No. 8 of License No. SNM-65, which incorporates the "Application for Renewal of License to Process Special Nuclear Material" dated January 1, 1969, or other AEC Requirements. The apparent violations listed below are considered to be of Category II severity.

1. Accepted criticality control practices require that criticality safety be assured by: 1) the use of geometrically safe or "geometrically favorable" equipment; 2) the use of mass control; 3) the use of volume control. Administrative controls based on combinations of the above along with concentration control are also used to assure criticality safety. Section IV, Table I, Mass and Container Volume Limits for Individual Units of U-235, of your license application gives the volume limit of 3.6 liters for units with an H/X ratio above 20. Section IV.(b)2. of your application states that the minimum center-to-center spacing between units stored in the storage facility for special nuclear material is 20 inches. An array for storage of 5-gallon pails is also provided. Section IV(a)3(a)V. states that, "Preparations to be completed prior to any issue of material include the establishment of an exclusion area. Removal from the exclusion area of all other fissionable material. Thorough cleaning of equipment to be used on the SNM within the exclusion area".

Contrary to these requirements, special nuclear material with unknown U-235 contents with H/X ratios above 20 was placed in 5-gallon (20.5 liter) containers in late November, 1973. The five 5-gallon pails were stored in the storage facility and the pails, which were each an individual unit of special nuclear material, were not placed in the array which was provided to assure that 5-gallon pails containing special nuclear material were adequately spaced.

The reason you gave for your failure to meet the first two license conditions cited was that you applied a different license condition based on mass control. Section IV.(b)2. of the license application states that a mass of 200 grams U-235 may be stored as a single unit or subdivided and stored at several storage locations.

You demonstrated that you did not exercise the mass control required by this license condition. You sampled and analyzed the involved material after you had placed it in the 5-gallon pails rather than prior to placing it in the pails. You assumed that all the uranium in the pails was 93 percent U-235, and you did not analyze the material for U-235 content. These analyses showed that one 5-gallon pail contained between 1800 and 4000 grams of U-235. Until you analyzed the material for U-235 content in March, you actually did not know that the mass of U-235 in the pail was less than 200 grams.

You used your nuclear material accounting system to determine the amount of U-235 left in the hacksaw material balance area during the last processing run, 150 grams. The reason the use of this data was not valid to establish the total amount of U-235 present in the area was that U-235 present in the sump of the saw at the start of the processing run was not accounted for. The sump of the saw was not cleaned of all the U-235 before the hacksaw exclusion area was established. This is contrary to the license requirement to clean the equipment before establishing it in an exclusion area.

2. Section I(f)3. states that, "Containers used for storage or for carrying SNM are marked in a distinctive manner to readily distinguish them from containers used throughout the plant for source or other materials". It also states that identification tags (control cards) must be present with all SNM.

Contrary to these requirements, the five 5-gallon pails were not marked in a distinctive manner to readily distinguish them as containing SNM. Identification tags (control cards) giving the amount of U-235 present in the pails were not present with the pails.

ENCLOSURE 2

DESCRIPTION OF SAFETY ITEM

Nuclear Metals, Inc.  
2229 Main Street  
Concord, Massachusetts 01742  
License No. SNM-65  
Docket No. 70-82

One activity under your license appears to raise questions concerning the safety of operations as identified below:

Prudent criticality prevention practice in a situation involving a fissile system near criticality dictates that unnecessary reflection of neutrons to the fissile system be avoided.

Contrary to this practice, when the evidence indicated that a fissile system near criticality might exist, three persons simultaneously approached the 5-gallon containers thereby providing unnecessary neutron reflection. This neutron reflection decreased the margin of safety of the unknown fissile system.

U. S. ATOMIC ENERGY COMMISSION  
DIRECTORATE OF REGULATORY OPERATIONS  
REGION I

RO Inspection Report No: 70-82/74-01

Docket No: 70-82

Licensee: Nuclear Metals, Incorporated

License No: SNM-65

2229 Main Street

Priority: 1

Category: A(1)

Location: Concord, Massachusetts

Type of Licensee: Fuel Fabricator

Type of Inspection: Special

Dates of Inspection: February 20-22, 1974

Dates of Previous Inspection: January 8-9, 1974

Reporting Inspector: W. W. Kinney  
W. W. Kinney, Fuel Facilities Inspector

3/22/74  
Date

Accompanying Inspectors: \_\_\_\_\_

\_\_\_\_\_ Date

\_\_\_\_\_

\_\_\_\_\_ Date

\_\_\_\_\_

\_\_\_\_\_ Date

\_\_\_\_\_

\_\_\_\_\_ Date

Other Accompanying Personnel: \_\_\_\_\_

\_\_\_\_\_ Date

Reviewed By: H. W. Crocker  
H. W. Crocker, Senior Inspector, Projects and Technical  
Support Section, Materials and Plant  
Protection Branch

3/22/74  
Date

## SUMMARY OF FINDINGS

### Enforcement Action

#### A. Violations

1. The licensee used mass control for criticality prevention when cleaning a power hacksaw. The licensee actually did not know the mass of U-235, as demonstrated by the licensee's announcement on February 15, 1974, of the existence of a possible criticality hazard due to an excessive amount of U-235 in a five-gallon pail. The following violations caused or resulted from the misuse of mass control for criticality prevention.
  - a. Failure to thoroughly clean power hacksaw of all fissionable material when its exclusion area was established for the manufacture of CP-5 fuel tubes. This violation caused the lack of mass control. (Details, Paragraph 5.c.)
  - b. Failure to use geometrically favorable or controlled volume containers to hold sludge from the sump of the power hacksaw. This violation resulted from lack of mass control. (Details, Paragraphs 2.a. and 5.a.)
  - c. Failure to assure spacing of units stored in the storage facility by using the storage array provided to assure proper spacing. This violation resulted from lack of mass control. (Details, Paragraphs 2.b. and 5.b.)
2. Failure to distinctively mark the containers to show that they contained U-235 and to label the containers with the amount of U-235 present in the kind of waste present. (Details, Paragraph 6.)

#### B. Safety Item

Three individuals simultaneously approached the five-gallon containers thereby providing unnecessary neutron reflection. This neutron reflection decreased the margin of safety of the unknown fissile system. (Details, Paragraph 2.e.)

#### Licensee Action on Previously Identified Enforcement Items

Not Inspected

#### Design Changes

Not Inspected

#### Unusual Occurrence

On February 15, 1974, Nuclear Metals, Inc. learned from analysis of a sample of liquid sludge waste that one of five 5-gallon pails might contain from 1800 to 4000 grams of uranium. The uranium was considered to be highly enriched in U-235, since the waste was cleaned from a power

hacksaw which was used in the manufacture of fuel tubes fabricated from an alloy of uranium metal enriched to 93 percent U-235. On the basis of the above information, a fissile system which might be close to criticality was thought to be present. The licensee informed Region I of the situation by telephone on February 15, 1974.

The licensee formulated a plan to remove the criticality hazard and telegraphed the plans to Regulatory Operations on February 20. After receiving AEC review and concurrence on February 21, Nuclear Metals implemented the plan on February 21 and 22 under the observation of a Region I inspector. The hazard was removed by placing the contents of the 5 gallon pail into safe-by-geometry containers. (Details, Paragraphs 2, 3, and 4)

Other Significant Findings

A. Current Findings

Not Inspected

B. Status of Previously Reported Unresolved Items

Not Inspected

Management Interview

At the conclusion of the inspection, a management discussion meeting was held at 11:00 AM on February 22, 1974. Those present were:

Nuclear Metals

- G. J. Matthews, Senior Partner, Matthews Management Group
- R. A. Robie, Director of Administration
- A. R. Gilman, Director of Industrial and Radiation Safety and  
Criticality Officer
- R. C. Franks, Safety Engineer

AEC

- W. W. Kinney, Fuel Facilities Inspector

The scope of the inspection was presented. The violation l.b. previously documented was discussed. The fact that the occurrence would be thoroughly reviewed by the inspector and further findings might result was pointed out during the discussion. The violations and safety items were discussed by telephone by Mr. Tuffin and Mr. Kinney on March 20, 1974 and at length in management meetings held at the licensee's request at Region I offices on March 28 and April 30, 1974.

## DETAILS

### 1. Persons Contacted

G. J. Matthews, Senior Partner, Matthews Management Group  
A. R. Gilman, Director of Industrial and Radiation Safety and  
Criticality Officer  
R. A. Robie, Director of Administration  
L. Clark, Consultant, Nuclear Physics  
S. Levin, Consultant, Radiation Safety  
R. C. Franks, Safety Engineer  
R. F. Huber, Process Engineer  
E. J. Martin, Senior Foreman  
R. Saintangelo, Foreman  
P. J. Zagarella, Nuclear Safety Technician

### 2. Description of Occurrence

The details of the description of this occurrence were gathered by interviewing concerned individuals, visually observing the material presenting the hazard from a distance, and examining the involved equipment and process.

#### a. Filling of 5-gallon Containers with Scrap

Nuclear Metals, Inc. has completed fabricating CP-5 fuel tubes and is cleaning the process equipment and operating areas of the uranium enriched to 93 percent U-235. According to the licensee, they filled five 5-gallon pails each about three-fourths full with liquid type scrap from the cleaning of a power hacksaw. The scrap was the sludge and lubricant taken from the sump of the hacksaw, dirty organic solvent used in cleaning the saw, and dirty water used in cleaning.

The use of a 5-gallon pail to hold the material from the sump of the hacksaw was not safe since the mass of U-235 in the sludge in the sump was not known.

#### b. Storage of the 5-gallon Containers

The five 5-gallon pails were stored in the storage facility for special nuclear material, which is a Butler Building

separate from the main facility. The pails were stored adjacent to each other in two rows. An array for storage of 5-gallon pails providing a minimum 22 inch center-to-center spacing was available in the storage facility, and it was not used.

c. Sampling of 5-gallon Containers

The licensee related that they wanted to better assess the quantity of uranium in the containers for SNM accounting purposes. The contents of the five 5-gallon containers were stirred and sampled on December 18, 1973, according to the licensee. The samples were sent to Le Doux and Company on December 18, 1973. Uranium concentration analyses were requested. The percentage of U-235 analyses were not requested.

d. Analytical Results

On February 15, 1974, Le Doux reported the following uranium contents in weight percent:

<u>Sample No.</u>	<u>U Content Wt. %</u>
1	0.055
2	0.090
3	0.032
4	8.94 - 24.74
5	0.15

Le Doux and Company reported to Nuclear Metals, Inc. that they had trouble in analyzing sample No. 4 because the uranium content was greater than expected. They needed additional sample to arrive at a more accurate value for the uranium content. They felt the uranium value was between the two values given, 8.94 and 24.74 percent. They did not have any portions of the samples left to determine the percentage of U-235 in the uranium.

e. Approach of Personnel to Containers

Upon receiving the analytical results on February 15, three Nuclear Metals employees approached the containers and took radiation readings. They found that one of the pails did give readings above background but less than 0.5 mr/hr. The simultaneous approach of three individuals to the containers was

contrary to prudent criticality prevention practice. When the evidence indicated that a fissile system near criticality might exist, the presence of 3 bodies close to the 5-gallon containers provided unnecessary neutron reflection. This neutron reflection decreased the margin of safety of the unknown fissile system.

3. Licensee Immediate Action

On February 15, the licensee took the following action:

- a. The licensee made sure the security fence and the doors to the storage facility for special nuclear material were locked to prevent unauthorized approach to the material. The keys to the locks were held in the possession of the Director of Industrial and Radiation Safety.
- b. The licensee posted a "keepout" sign on the large double door to the facility. However, the licensee did not rope off the north side of the facility to prevent personnel from unknowingly approaching the material from the outside of the storage facility.
- c. The licensee notified Region I of the situation by telephone on the afternoon of February 15. They stated that they planned to take no further action until the situation was thoroughly assessed by their nuclear physics consultant.
- d. The licensee agreed that they would formulate a written plan to safely remove the hazard.
- e. The licensee agreed that they would transmit this written plan to Regulatory Operations for review prior to their implementation of the plan.
- f. The licensee agreed to perform the planned operation under the observation of a Regulatory Operations inspector.

4. Remedial Action

a. Provision of Undisturbed Storage

On February 15, 1974, Region I confirmed by mailgram that Nuclear Metals was to take positive measures to assure that

the material in the 5-gallon pails was to be maintained undisturbed in storage until a plan to cope with the possible hazard had been transmitted to Regulatory Operations, and Regulatory Operations had responded to the plan. Undisturbed storage was defined as no movement of personnel, equipment or material within 20 feet of this special nuclear material. Nuclear Metals did not take complete positive measures to prevent personnel or equipment from approaching within 20 feet of the special nuclear material. Personnel could unknowingly approach within 20 feet of the material from outside of the facility on the north side. The area was roped off on February 20, when this fact was pointed out to the licensee by the AEC inspector.

b. Plan

The plan to remove the hazard by transferring the contents of the 5-gallon pails to safe-by-geometry containers was conceived as follows after Nuclear Metals submitted the plan to Regulatory Operations for review on February 20 and Regulatory provided its review and concurrence on February 21, 1974.

- (1) Take a sample of remaining residue in the hacksaw sump and analyze for percentage U-235 of the uranium. This data will be evaluated prior to proceeding further with the plan.
- (2) Upon decision to proceed, separate pails 1, 2, 3, and 5 from pail 4. One pail will be moved at a time. The contents of the pail will be transferred to the two liter bottles before moving the next pail.
- (3) One person approach the array and remove any pail other than pail 4 from the array. During movement, the pail is to be kept in the same plane as the array as much as possible. Care is to be exercised to avoid disturbing the contents of the pail.
- (4) Place the pail at a location more than twelve feet from the array. Only one person is to be at the pail location.
- (5) Pump the contents of the pail into the two liter bottles. The pump is to be located more than twelve feet from both the pail being pumped and the pail array.

- (6) If contents must be ladled from the pails, ladle sludge carefully with minimal disturbance of the sludge in the pails.
- (7) As each liter bottle is filled, place it in the storage array with 22 inch center-to-center spacing.
- (8) After the contents of the four pails have been transferred to two liter bottles and the bottles have been properly stored, move the pump and lines so the contents of pail 4 can be pumped out without moving pail 4. Only one person is to approach within twelve feet of the pail.
- (9) Carefully remove the lid from the pail and insert the copper tubing just below the surface of the liquid.
- (10) Pump the contents from the pail into two liter bottles. If contents must be ladled from the pail, ladle sludge carefully with minimal disturbance of the sludge in the pail.
- (11) Store the bottles in the 22 inch center-to-center storage array as each bottle is filled.
- (12) Sample the bottles and analyze for uranium and U-235 percentage in the uranium.

c. Implementation of the Plan

Residual material in the sump of the power hacksaw was sampled on February 20, and the sample was sent to Massachusetts Institute of Technology for analysis of U-235 percentage in the uranium. MIT reported the uranium in the sample was 3.7 percent U-235.

On February 21, at 4:30 PM, the licensee initiated the plan to transfer the material to safe-by-geometry containers. The work was performed by the Director of Industrial and Radiation Safety and the Safety Engineer with guidance from the Nuclear Physics Consultant. The work was observed by an AEC Inspector.

The contents of the four pails were removed by pumping them into two liter bottles. The bottles were stored in the 22 inch center-to-center storage array as each bottle was filled.

The pump had to be replaced during the pumping of the contents of the fourth pail processed because of plugging of a small opening. The replacement pump operated quite satisfactorily.

Only about two liters could be pumped from the problem pail, pail 4, into 2 one-liter bottles.

The rest of the material, about 14 liters, had to be removed by ladling. Before proceeding with the ladling operation, the safety considerations were discussed. The material was carefully ladled into 15 one liter bottles. The material at the bottom of the pail was quite dry and would not flow to assume the shape of the bottles.

Adequate radiation protection and contamination control was exercised during the operation. Frequent personnel surveys were performed. Free access to exits was always maintained.

The operation was completed and the material properly stored in the 22 inch center-to-center array at 1:10 A.M. on February 22.

Three of the one-liter bottles from pail 4 were sampled by the licensee on February 26, 1974. The uranium assays were reported on March 4, 1974, to be 10.8, 9.4, and 15.5 (average 11.9) weight per cent uranium. The uranium-235 contents were reported to be 2.3, 4.5, and 3.7 (average 3.5) per cent of the uranium on March 6, 1974. According to the licensee, these values and the weight of material showed the pail contained about 2000 grams of uranium of which about 70 grams was U-235.

## 5. Cause of the Occurrence

### a. Misuse of Mass Limits for Criticality Safety

The licensee used a mass limit of 200 grams U-235 for criticality control as provided in his license when he actually did not know the mass of U-235 in the system. The licensee mistakenly assumed that the sump of the power hacksaw contained no U-235 when the power hacksaw exclusion area was established in early 1972. On the basis of the nuclear material accountability system, the licensee determined a 150 gram U-235 MUF, material unaccounted for, for the CP-5 fuel tube run just completed. They then mistakenly assumed only this uranium was present in the sump. It was demonstrated that the licensee did not know the amount of uranium or U-235 in the sludge taken from the sump. The sump contained uranium left from other previous processing runs. The licensee should have used geometrically favorable containers to contain the sludge from the sump to assure criticality safety.

b. Violation of Spacing Requirement

In order to provide nuclear criticality safety, the licensee established spacing limits for the storage of units of U-235 in the storage facility for special nuclear material. An array for storage of 5-gallon pails is provided. This spacing array was not used when the five 5-gallon pails were placed side by side in two rows.

c. Failure to Thoroughly Clean Equipment

The analysis of the material in the sump of the hacksaw showed the uranium was about 3.7 percent U-235. The uranium in the components sawed during the last establishment of the power hacksaw exclusion area was 93 percent U-235. Either natural or depleted uranium was present in the sump of this hacksaw when it was used on the uranium enriched to 93 percent U-235. Equipment is supposed to be thoroughly cleaned of all fissile material before it is placed in an exclusion area.

6. Failure to Identify Container Contents and Mark Containers

The contents of the 5-gallon pails were not identified in any manner. The source of the material, the uranium content, and the U-235 percentage or content were not listed on the containers. The 5-gallon pails were not marked in any way to show that they contained SNM.