70-820 UNC RECOVERY SYSTEMS #12

W/h

GENERAL INFORMATION AND PROCEDURES APPLICABLE TO THE HANDLING OF SPECIAL NUCLEAR MATERIAL

Rec'd w/ ltr dtd 10/31/68 AA-4

UNITED NUCLEAR CORPORATION

COMMERCIAL PRODUCTS DIVISION ROUTE 21A HEMATITE MISSOURI [illegible]

GENERAL INFORMATION AND PROCEDURES APPLICABLE TO THE HANDLING OF SPECIAL NUCLEAR MATERIAL

Applicable to

UNITED NUCLEAR CORP.

Commercial Products Division

Fuel Fabrication Operations
New Haven, Connecticut

Fuel Recovery Operations
Wood River Junction,
Rhode Island

Date issued October 31, 1968

SPECIAL NUCLEAR MATERIALS LICENSE 777

TABLE OF CONTENTS

LICENSE: SNM-777, Docket: 70-82

SECTION: 100 through 900

ISSUED: October 31, 1968

SUPERSEDES: New

UNITED NUCLEAR
CORPORATION

Approved:

SUBJECT: LICENSE SNM 777, DOCKET 70-820
SECTION 100: GENERAL INFORMATION

ISSUED October 31, 1968

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SUPERSEDES New

UNITED NUCLEAR CORPORATION

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SUBJECT: License: SNM-777, Docket 70-820
SECTION: 100 - GENERAL INFORMATION
Subsection: 101 - General

101. General

101.1 Introduction

This manual has been prepared to provide the information required by the Atomic Energy Commission regulations 10 CFR 20, 10 CFR 70, and 10 CFR 71 for renewal of special nuclear material license SNM-777. The manual outlines the United Nuclear Corp., Commercial Products Division practices, guides, proceedures and controls applied to insure the safe handling of special nuclear materials at its facilities at New Haven, Connecticut and Wood River Junction, Rhode Island.

101.2 Corporate Information

The United Nuclear Corporation, a Delaware corporation, maintains headquarter offices at Elmsford, New York. The corporation is in the business of mining and milling Uranium ores, processing of Uranium into fuel for nuclear power reactors, and developing improved reactor systems to utilize nuclear fuel.

The Commercial Products Division includes plants at Hematite, Missouri, Wood River Junction, Rhode Island, and Fuel Fabrication facilities in the New Haven, Connecticut Plant. Headquarters for this Division are located at the Hematite Plant.

A listing of the principal officers, major operating divisions and their locations may be found in the annual report. (A copy of the latest report is attached.)

There is no known ownership or control exercised upon United Nuclear Corporation by any alien, foreign corporation or foreign government.

102. Location and Facilities

1. Recovery Operation

The Recovery Operations Plant is located on a 1200 acre site in a sparsely populated area of Southwestern Rhode Island. The plant is approximately one mile southeast of Wood River Junction.

The general arrangement of the plant is shown on drawings A-601, A-602, A-603 and Y-601. The general facility arrangement is shown on Sketch 102-I.

The plant consists of a single principal building with office, locker-room, general utilities and maintenance facilities to the front (West End) and storage and processing facilities at the back (East End). A small laboratory is located at the second level above the locker-room area.

Two lagoons with waste discharge control facilities are located within the fenced area and just north of the building.

The building consists of the following areas (defined by bays):

Bays (For Bay designations, see Drawing Y-601)	Description of Operations
	Uranium Process Areas
VII, VIII	Shipping & Receiving Area
X, XIII, XIV, XVI, XVII, XIX	Head Ends Processing Area
XX (3 floors)	Purification Processing Area
XV, XVIII, XXI	End Product Processing Area
XII, XI	Product Storage Area
IV (Second Floor)	Control Laboratory
	Non-Uranium Storage Area
V, VI	Utility Area
I, II, III, IV (First Floor)	Main Entrance, General Plant Office, Lunch Room, Clothes-Change Locker - Change Room

Outside storage areas are the areas surrounding the plant within the fenced area. These areas are used for storage of uranium materials as received in protective spacing, birdcages and drums.

Empty shipping containers or other material containing unrecoverable amounts of uranium may be so identified and stored outside the security area prior to return to the owner.

102. Location and Facilities (continued)

2. Fuel Fabrication Operations

The Fuel Fabrications Operations are performed at the United Nuclear Corporation fabrication plant located in New Haven, Connecticut and the assembly plant located at Montville, Connecticut.

The Naval Products Division has control over Buildings 3H, 6H, 7H, 8H, 9H basement, 10H basement, 11H basement, 14H 41H and 24D of the New Haven Facilities and the Montville Assembly Plant. Commercial
* Products Division controls the first floor of building 9H, the first floor of building 10H except the chem sample storage area, the first floor of building 11H except the experimental welding area, the first floor of building 19H, the 19H basement waste disposal area and all of building 50H (except Navy*). The Naval Products Division and the Commercial Products Division are responsible for the nuclear criticality safety and health physics in their buildings.

2.1 New Haven Operations

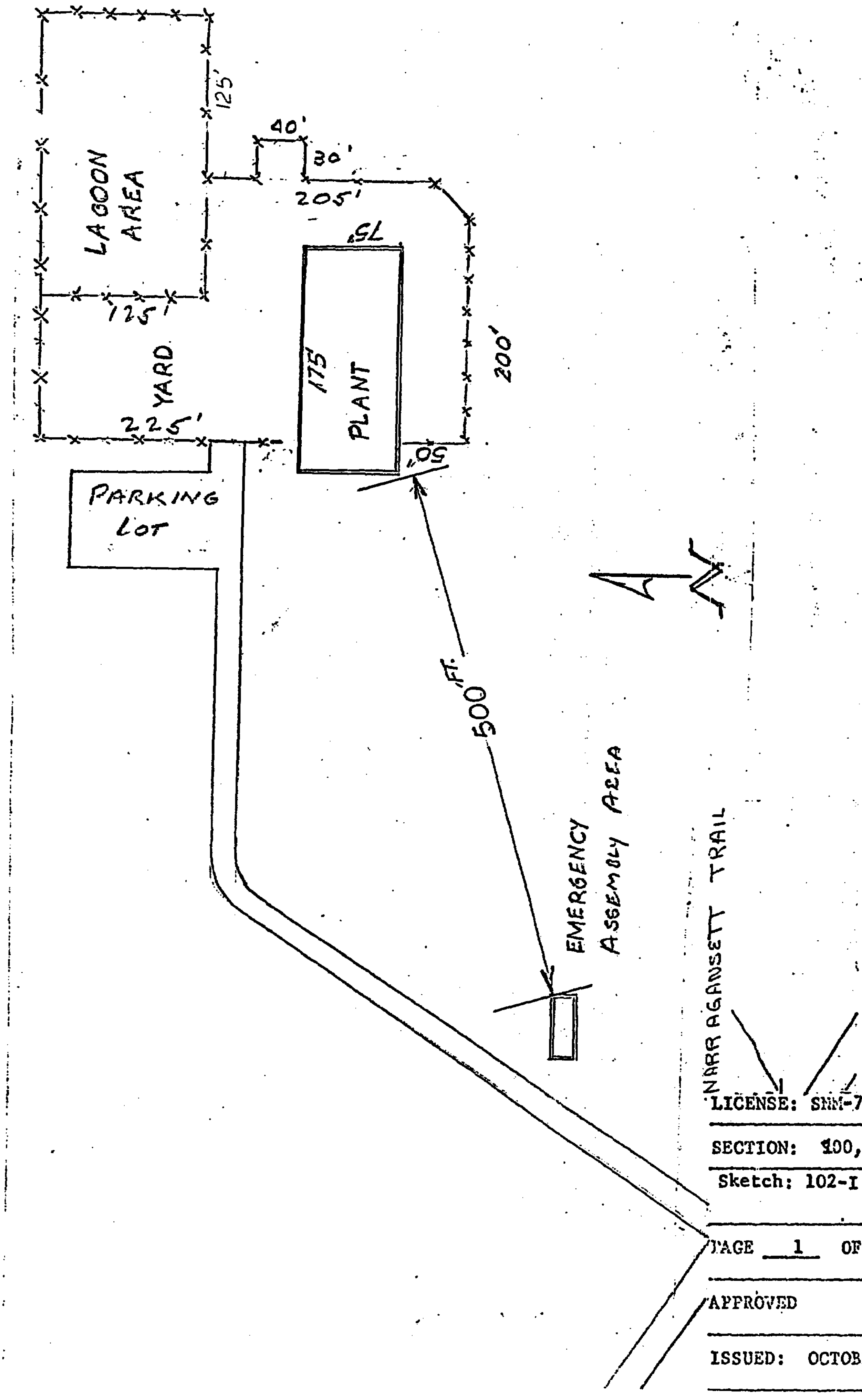
Figure 102-II is a map of the Corporation in New Haven. This property is located in the area generally bounded by Division Street on the north, Munson and Henry Streets on the east. The buildings indicated by the letter "H" on the map, are known as "D" Tract. The remaining buildings on the map marked as "E" Tracts (buildings 5E and 6E) do not comprise any manufacturing operations, but only office, administration, and engineering activities.

Further details on the "H" Tract arrangement and building 9H, 10H, 11H, 19H and 50H are shown in following listed drawings:

B-304 238	Equipment layout 9H, 10H, 11H
B-304 236	Equipment layout 19H
B-304 237	Equipment layout 50H
B-304 23A	Change Room layout 19H
B-304 252	H Tract Building layout

*An area approximately 50 feet x 65 feet on the north side, approximately 100 feet from the entrance.

*Indicates Change



LICENSE: SNM-777; DOCKET: 70-8

SECTION: 100, SUBPART: 102

Sketch: 102-I

PAGE 1 OF 1

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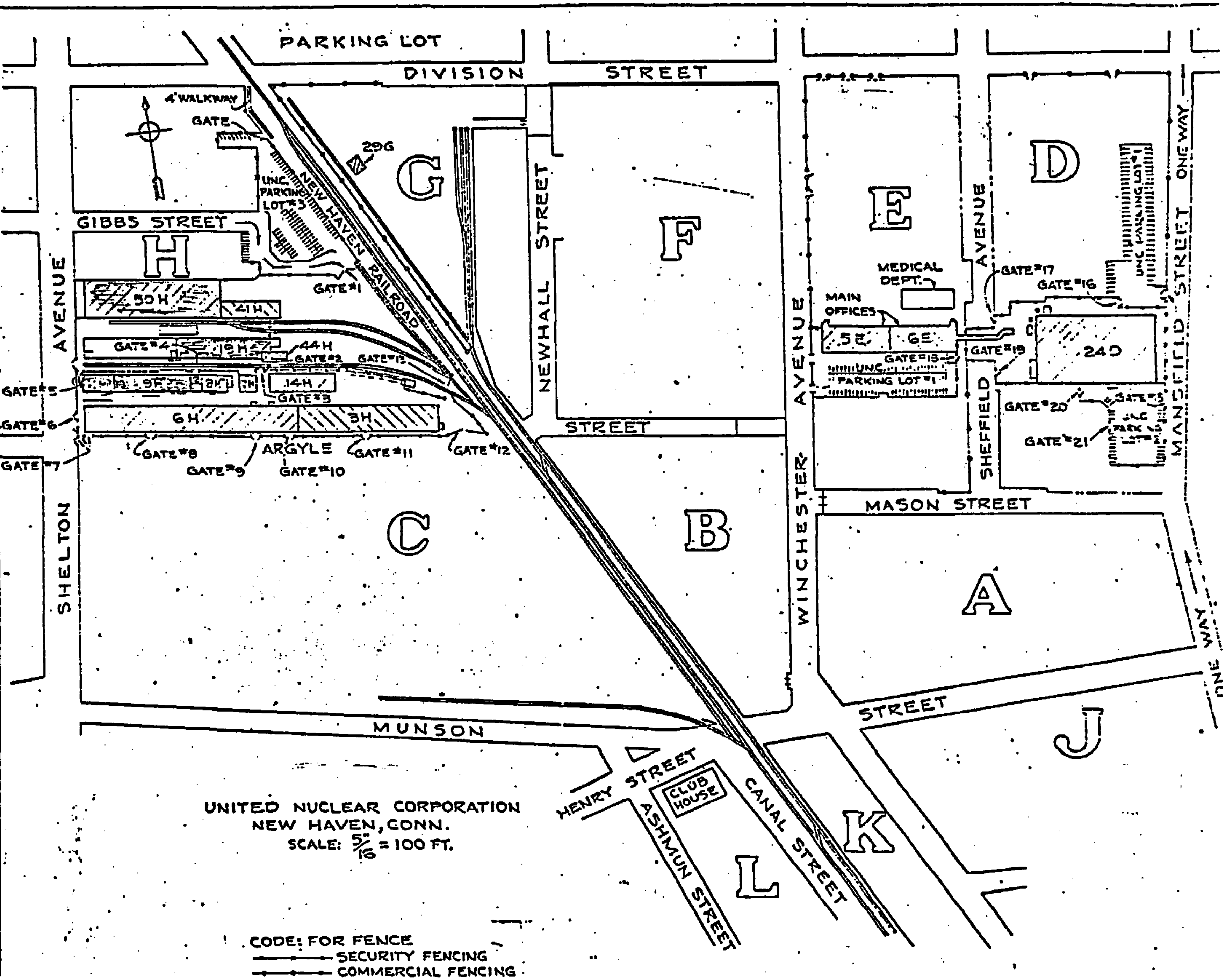
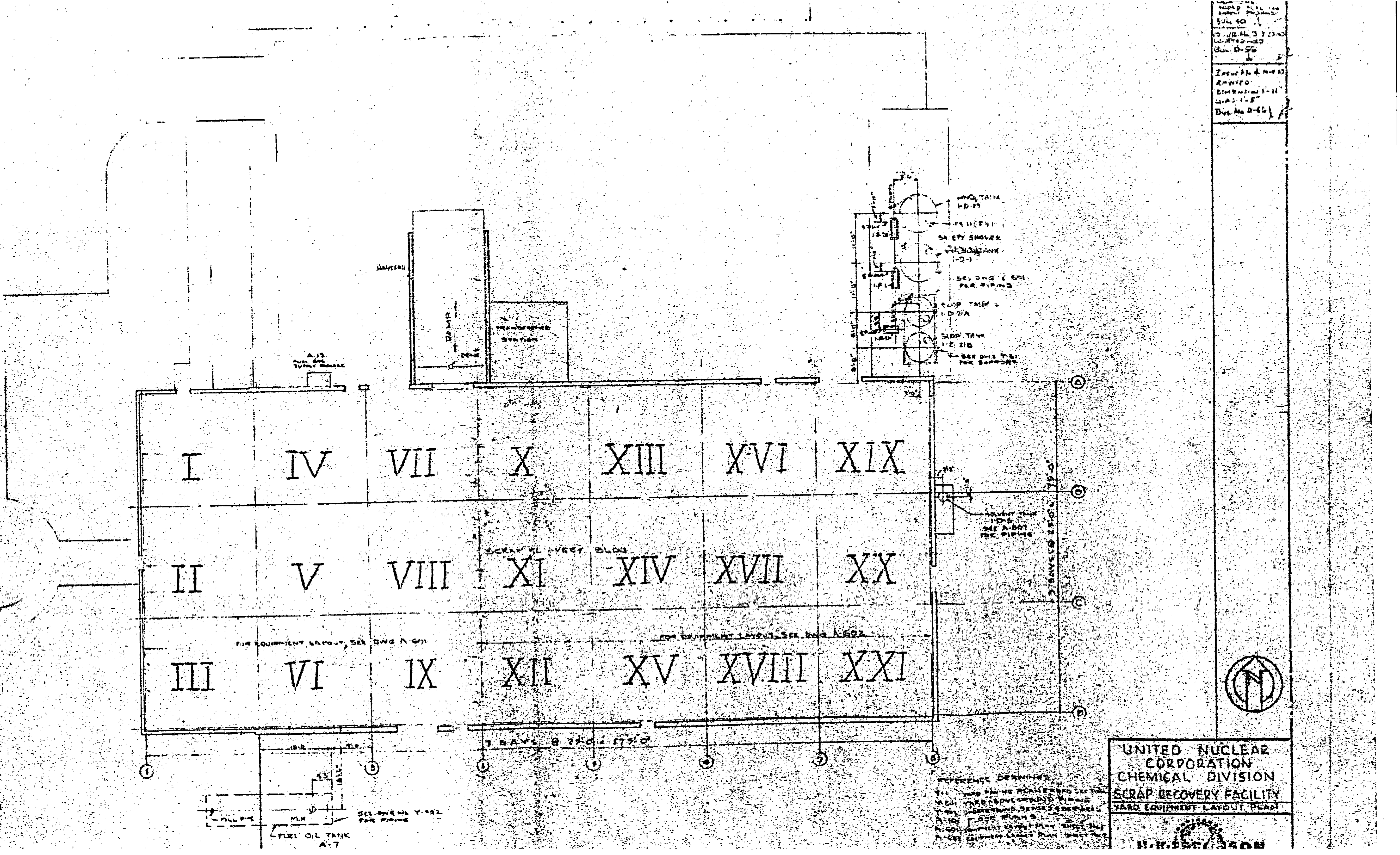
ISSUED: OCTOBER 31, 1968



LICENSE: SNM-368, Docket: 70-371
SNM-777, Docket: 70-820
SECTION: 100, Subsection: 102
Figure 102- II
Issued: October 31, 1968



I
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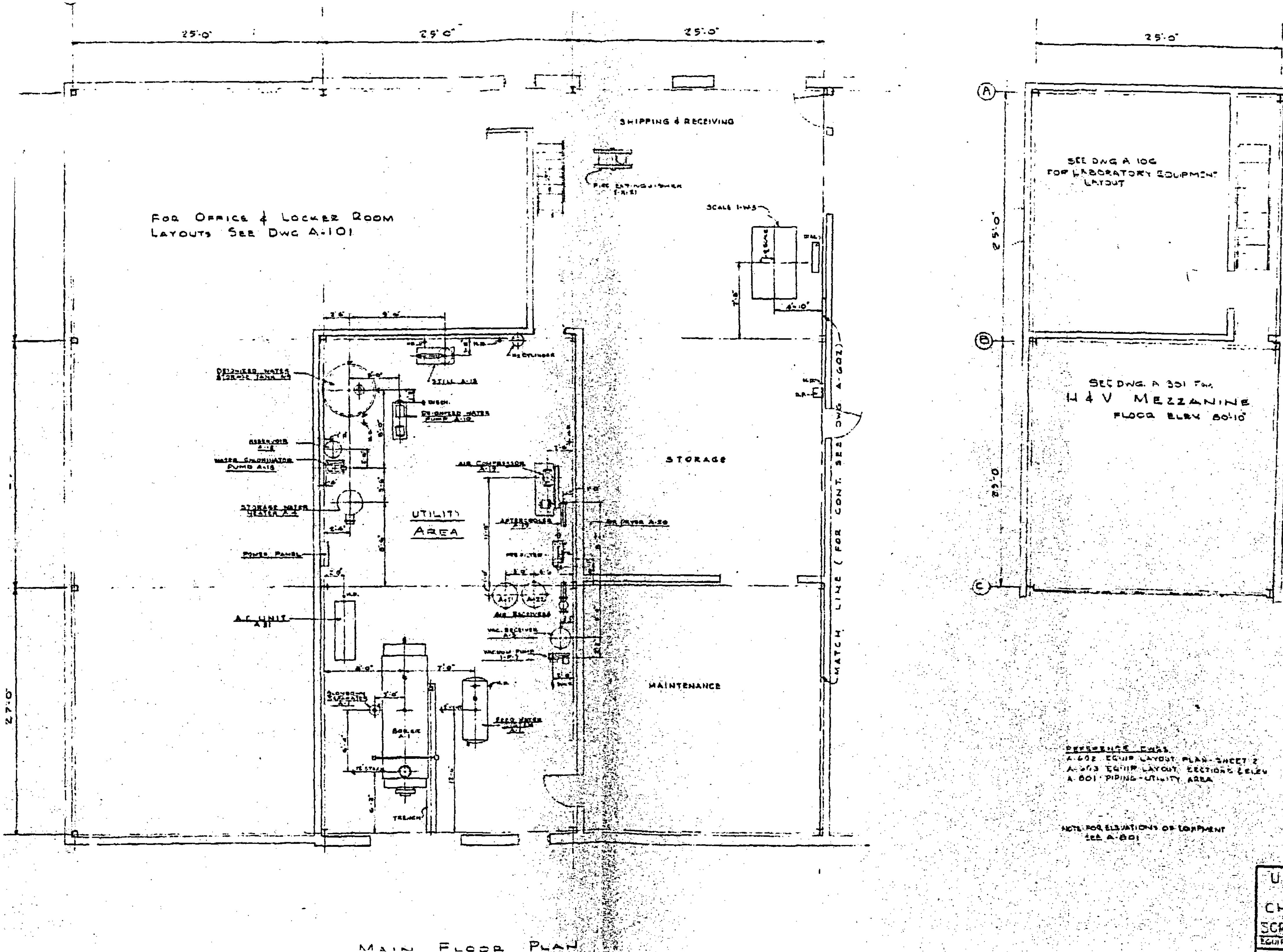
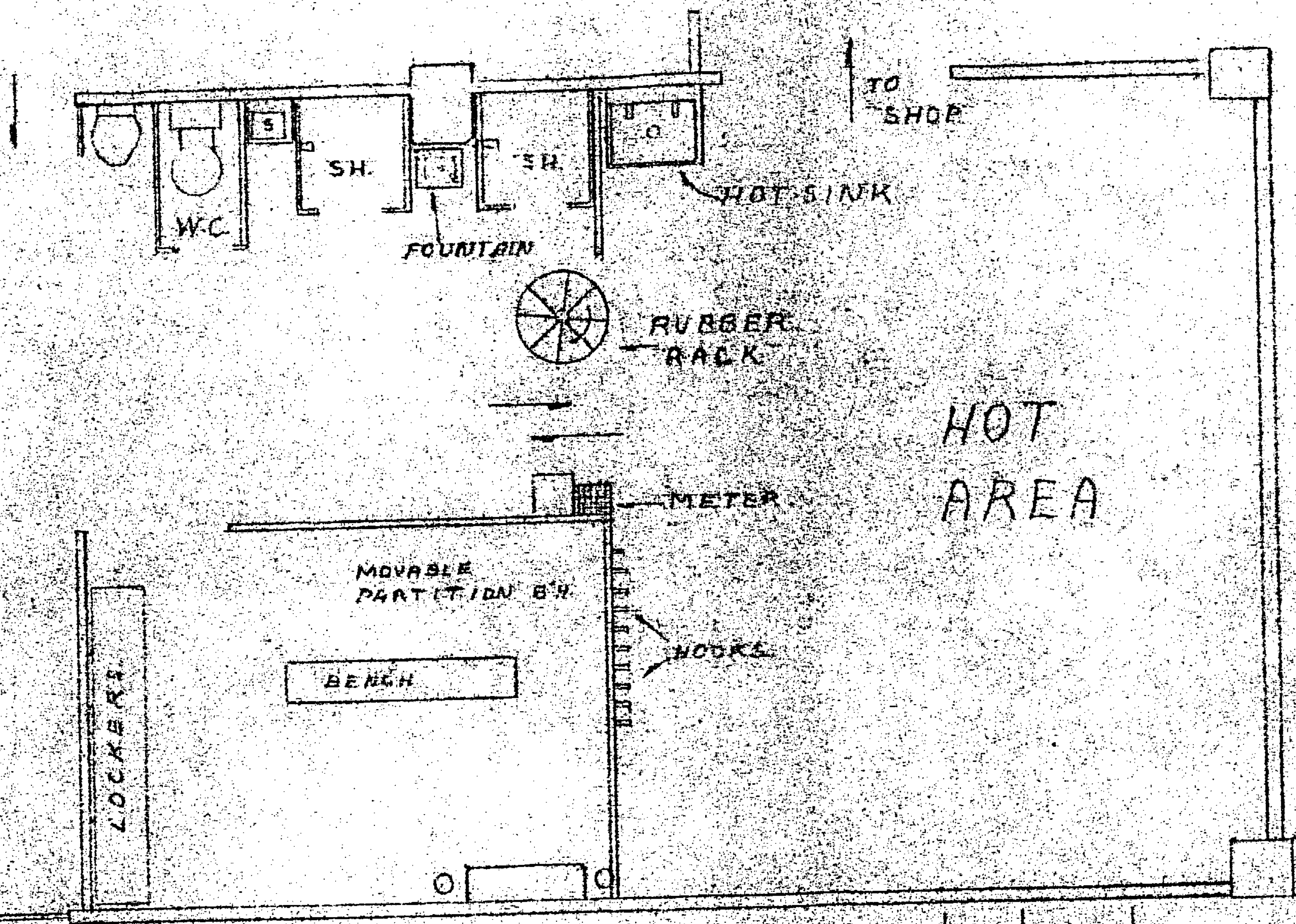
XXI
TRANSFORMER STATION
SLOP TANK
SAFETY SHOWER
FUEL OIL TANK
A-7
UNITED NUCLEAR CORPORATION
CHEMICAL DIVISION
SCRAP RECOVERY FACILITY
YARD EQUIPMENT LAYOUT PLAN
REFERENCE DRAWINGS



UNITED NUCLEAR CORPORATION
CHEMICAL DIVISION
SCRAP RECOVERY FACILITY
EQUIPMENT LAYOUT-PLAN-SHEET 1



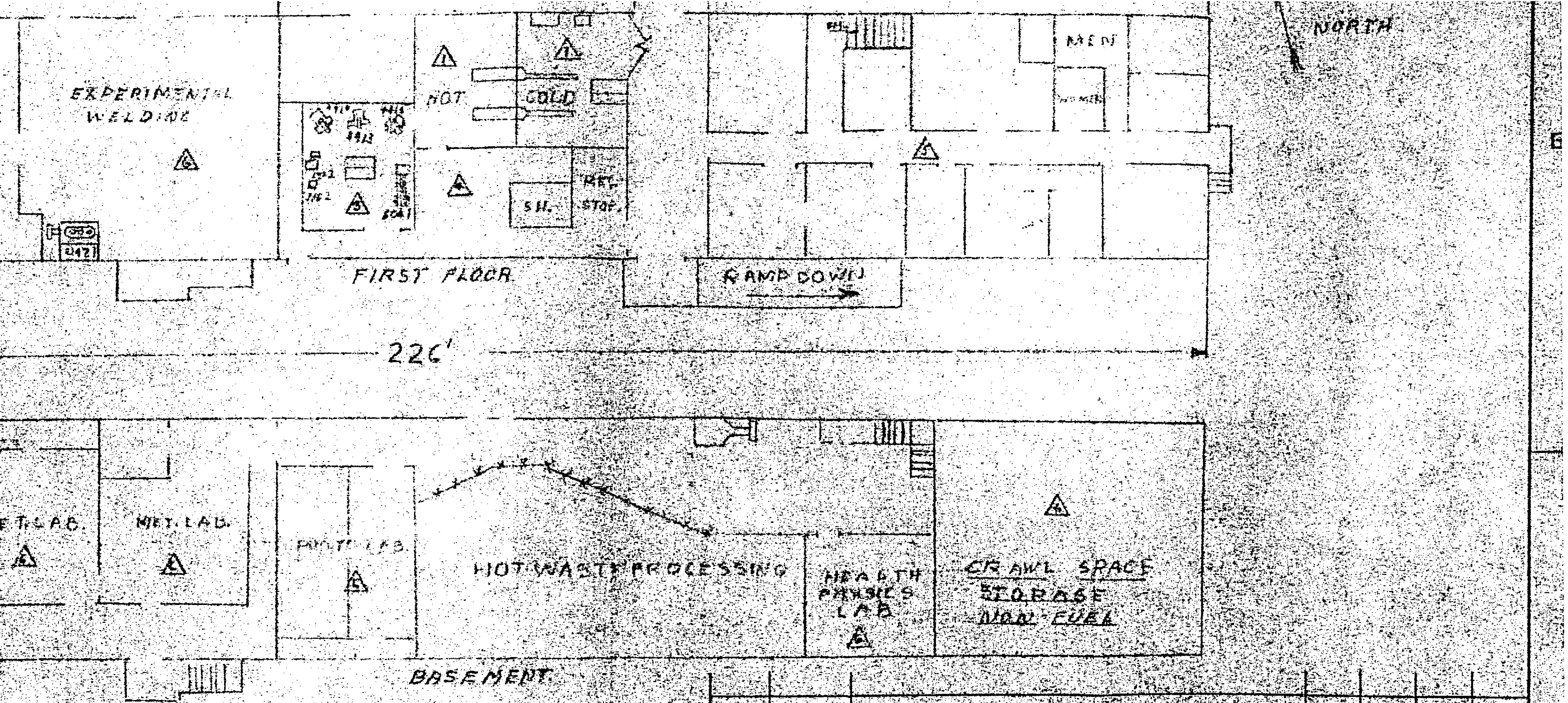
REV.	DATE	REVISION	BY	DATE	APP'D	DATE

GEOMETRIC SYMBOLS MIL-STD-8
- FLATNESS
- STRAIGHTNESS
- ANGULARITY
- PERPENDICULARITY
- PARALLELISM

TOLERANCES UNLESS OTHERWISE SPECIFIED
FRACTIONAL ±
DECIMAL
X.XX ±
X.XXX ±
ANGULAR ±
SURFACE FINISH
SCALE 1/4" = 1'

UNITED NUCLEAR
CORPORATION
COMMERCIAL PRODUCTS DIVISION

Change Room Layout 19H



AREA
RAGE AREA
HING AREA

ROD. DIV. OFFICE AREA
DIV. AREA

REV.	DATE	REVISION	BY	DATE	APP'D	DATE

GEOMETRIC SYMBOLS MIL-STD-8

- FLATNESS
- STRAIGHTNESS
- ANGULARITY
- PERPENDICULARITY
- PARALLELISM
- INLINE
- CONCENTRICITY

TOLERANCES UNLESS OTHERWISE SPECIFIED

FRACTIONAL ±
DECIMAL
X.XX ±
X.XXX ±
ANGULAR ±
SURFACE FINISH √

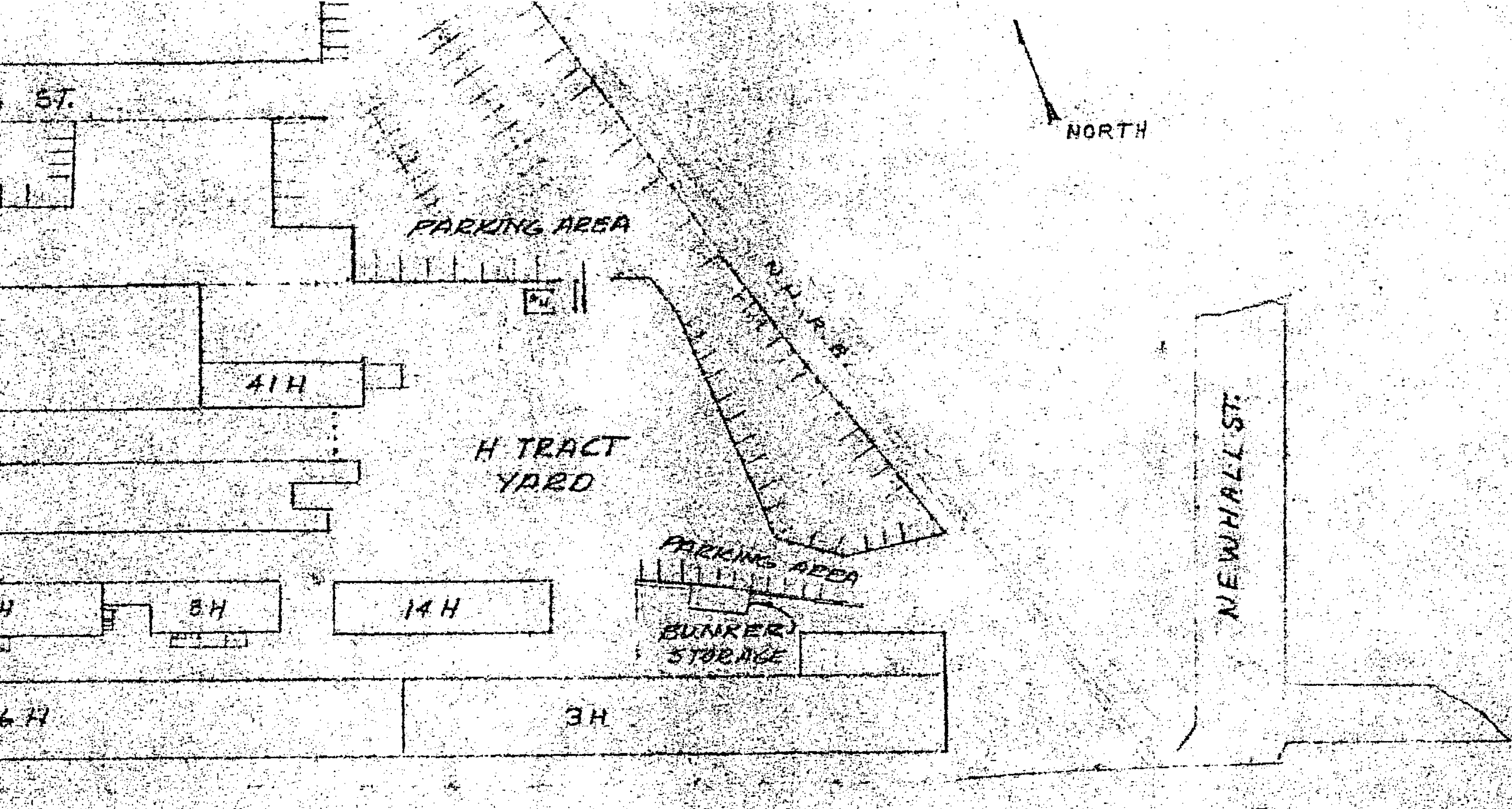
SCALE

DRAWN BY W. DeLEAN DATE

UNITED NUCLEAR CORPORATION
COMMERCIAL PRODUCTS DIVISION

EQUIPMENT LAYOUT
9H, 10H, 11H

REV.



B

A

REV.	DATE	REVISION	BY	DATE	APP'D	DATE

GEOMETRIC SYMBOLS MIL-STD-8
- FLATNESS
- STRAIGHTNESS
- ANGULARITY
- PERPENDICULARITY
- PARALLELISM
- INLINE

TOLERANCES
UNLESS OTHERWISE SPECIFIED
FRACTIONAL ±
DECIMAL
X.XX ±
X.XXX ±
ANGULAR ±
SURFACE FINISH
SCALE

UNC
UNITED NUCLEAR
CORPORATION
COMMERCIAL PRODUCTS DIVISION

H-TRACT-BUILDING
LAYOUT

4 oversized drawings
w/h Ex. 4

103. Summary of Activities

SNM bearing materials are received, handled, stored, processed and shipped in accordance with Regulations of the Atomic Energy Commission or as provided by this license.

The maximum quantity of slightly irradiated material+ at any one time will be less than 2% of the total allowable SNM. The maximum radiation levels acceptable will be 10 mr/hr at one foot.

1. Recovery Operations

   These materials may be in the form of uranium metal or its alloys, compounds and solutions. This includes those materials in fabricated reactor component shapes. The U-235 isotopic content of the uranium will be up to and including full enrichment.

2. Fuel Fabrication Operations

   Operations under this license are primarily the fabrication of uranium bearing materials into specified shapes, cladding these with corrosion resistant materials such as: zirconium, stainless steel or aluminum, and assembling these into larger components or into cores for reactors.

* These materials may be in the form of uranium metal or its alloys, compounds and solutions and plutonium oxide-uranium oxide mixtures. The U-235 isotopic content of the uranium will be up to and including full enrichment. Plutonium oxide-uranium oxide mixtures will be in the form of sintered pellets in sealed rods.

+10CFR 50.2.3.ii ----- the material to be processed contains not more than 10^{-6} grams of plutonium per gram of U-235 and has fission product activity not in excess of 0.25 millicuries of fission products per gram of U-235. This material is in the form of fuel rods and assemblies and is only non-destructively modified and inspected.

*Indicates Change

UNITED NUCLEAR
CORPORATION

LICENSE:	SNM-777, Docket 70-820
SECTION:	100 - GENERAL INFORMATION
Subsection:	104 - Special Nuclear Material Possession Limits

Issued 2/6/70
Supersedes 10/31/68
Approved
Amendment No.

* 104. Source and Special Nuclear Materials Possession Limits

1. Recovery Operations

* The maximum quantity on hand at any one time is limited to 4000 kgs of contained U-235.

2. Fuel Fabrication Operations

* At any one time, the maximum quantity expected to be on hand is limited to 4000 kgs of contained U-235 and 10 kgs contained Plutonium.

*Indicates Change

SECTION 200

UNITED NUCLEAR CORPORATION

	NO.
	PAGE 1 OF 1
	Approved:
SUBJECT: License: SNM-777, Docket: 70-820 SECTION 200: ORGANIZATION, PERSONNEL AND ADMINISTRATION	ISSUED October 31, 1968
TABLE OF CONTENTS	SUPERSEDES New

LICENSE: SNM-777, Docket: 70-820

Approved

SECTION: 200 - ORGANIZATION, PERSONNEL AND ADMINISTRATION

ISSUED October 31, 1968

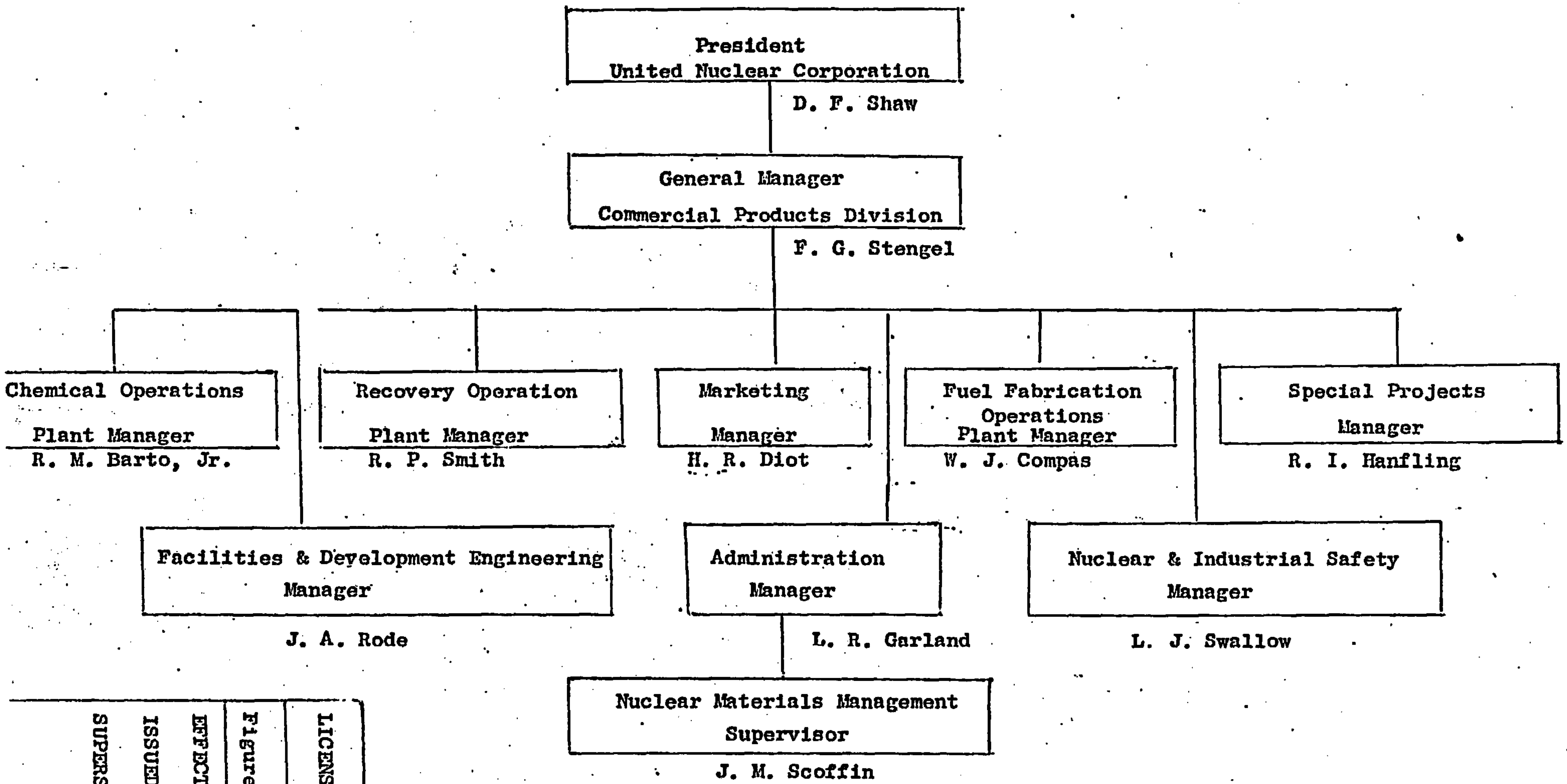
Subsection: 201 - Division Ogranization

SUPERSEDES New

201. Division Organization

The Commercial Products Division is organized for efficient management and administration of three independent operations located in three separate plants. The General Manager, Commercial Products Division reports to the President of United Nuclear Corporation and has the overall responsibility for operation of the Division Facilities.

The organization of the Division provides for administration, production, technical support, and nuclear industrial safety functions, and nuclear materials management on a Division wide basis. This is shown on the Division Organization Chart, Figure 201-I.



LICENSE: SNM-777, Docket: 70-820

Figure 201-I

EFFECTIVE:

ISSUED: October 31, 1968

SUPERSEDES: New

COMMERCIAL PRODUCTS DIVISION

ORGANIZATION

SUBJECT: License SNM 777, Docket 70-820
SECTION: 200 - ORGANIZATION, PERSONNEL AND ADMINISTRATION
Subsection: 202 - Nuclear and Industrial Safety Department

202. Nuclear and Industrial Safety Department

1. Organization

The Nuclear and Industrial Safety Department (NIS) is organized to provide nuclear criticality safety, health physics, industrial safety and fire prevention, and medical services for the Division. The Nuclear and Industrial Safety Manager reports to the General Manager, Commercial Products Division, and is responsible for all activities of the Department. The Department activities include:

1.1 Establishment of Division nuclear and industrial safety policy.

1.2 Preparation of Regulatory Agency licenses.

1.3 On site nuclear criticality safety and health physics control functions independent of, but parallel to the functions of operating personnel.

1.4 Technical support services, as related to nuclear criticality safety and health physics for review of proposed additions to or modifications of process equipment.

1.5 Systematic auditing of plant operations.

The Department organization is shown on Figure 202-I.

2. Basic Responsibilities

2.1 Nuclear and Industrial Safety Department Manager

The NIS Department Manager is responsible to ensure effective and timely administration of the nuclear and industrial safety control and audit function of the Division. He assists the Division in establishing sound programs in compliance with Division Policy and appropriate Federal and State Regulations and ensures continued compliance of these official programs through regular audits and follow-up with responsible Division management. He must provide competent techincal support services to the Division from either in-house specialists or from specialists outside of the Division on a consulting basis.

2.2 Nuclear and Industrial Safety Representative

The Nuclear and Industrial Safety Representative is responsible for daily surveillance of nuclear criticality/industrial safety and health physics at his assigned plant. He initiates NIS Department Nuclear criticality safety and health physics evaluations of proposed midifications to processes and equipment. He may perform preliminary nuclear criticality safety evaluations of these proposed changes. He performs inspections of operating

202. Nuclear and Industrial Safety Department (continued)

procedures and general plant conditions for the benefit of both the Nuclear and Industrial Safety Department and Operating Personnel. These audits may serve as a management tool for joint action to correct any deficiencies noted.

2.3 Nuclear Safety Specialist

The Nuclear Safety Specialist assists the Department Manager in providing a sound program in compliance with Division Policy, Federal and State regulations. He performs Nuclear Criticality Safety evaluations of processes and equipment, plant inspections and follow up with responsible operating management. He also provides competent technical support to other Divisions on a consulting basis.

2.4 Health Physics Specialist

The Health Physics Specialist assists the Department Manager in providing a sound program in compliance with Division Policy, Federal and State regulations. He performs evaluations of radiological safety and plant inspections, and follows up with responsible operating management. He also provides competent technical support to other Divisions on a consulting basis.

2.5 Consultants

Consultants to the Nuclear and Industrial Safety Department, assist the Department Manager through reviews, technical evaluations, etc., within the area of their specialty. Such assistance is at the request of the Department Manager.

* 3. Personnel Qualifications

The Nuclear and Industrial Safety Department Manager shall hold a degree in science or engineering and have at least ten years experience in a responsible position in the nuclear industry at least three years of which have been in an activity in which he has performed nuclear criticality safety assessments and has developed an understanding of health physics and industrial safety problems and controls.

Nuclear and Industrial Safety Department Specialist shall have a B.S. Degree in Science or Engineering and not less than three years experience in a responsible nuclear engineering or physics position and not less than one year of experience in the area of their speciality. In addition, the Nuclear Safety Specialist will be required to have at least one year experience in performing nuclear safety assessments.

Nuclear and Industrial Safety Department Representatives shall have a high school diploma and not less than three years experience in the

*Indicates Change

202. Nuclear and Industrial Safety Department (continued)

nuclear industry including specific training in nuclear criticality safety, health physics, and industrial safety, and fire prevention.

Nuclear and Industrial Safety Department Consultants shall meet the same requirements as listed for the Specialist.

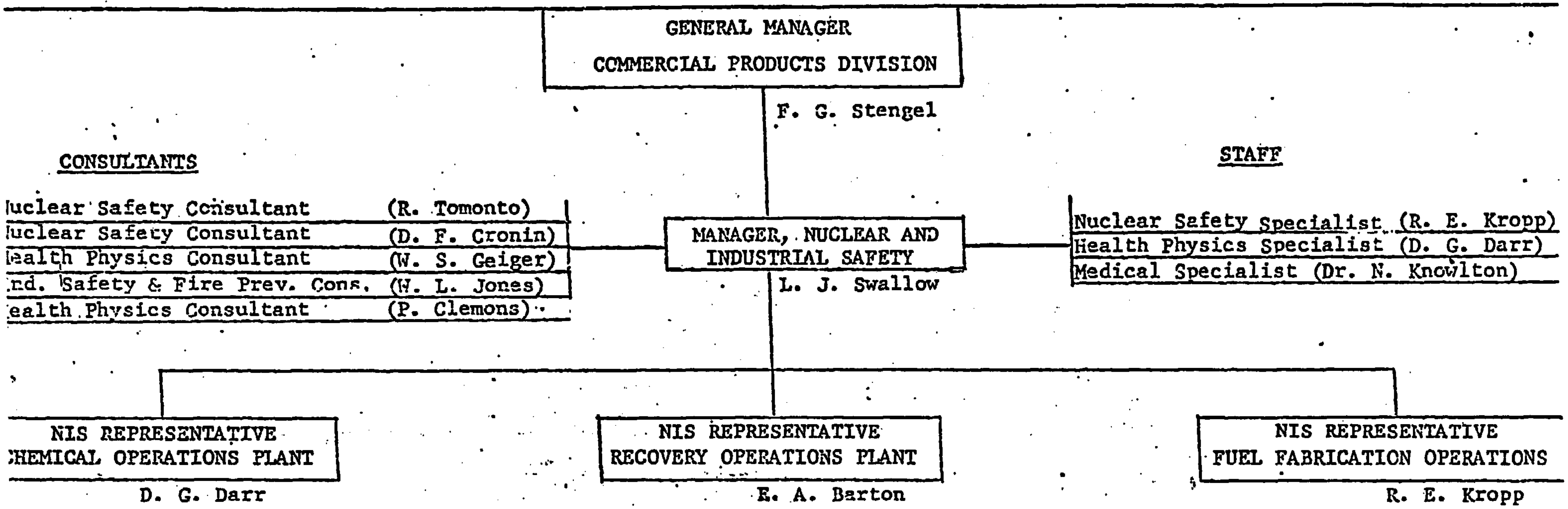
Resumes of the qualifications of the personnel performing these functions are included as back up information.

4. Combined Activities

* Routine health physics control services for the Commercial Products Division Fuel Fabrication Operations at New Haven will be contracted from Naval Products Division NIS personnel. These services include contamination control monitoring, sampling of ariborne effluents, monitoring and handling of liquid radioactive effluents, and health physics daily checks, etc. This service includes the evaluation of the data taken during the performance of these tasks. Results of these services, including the evaluations, will be furnished to the Commercial Products NIS Representative for record and follow-up action if required.

However, Naval Products NIS personnel have the authority to suspend unsafe operations in the Commercial Products activities.

*Indicates Change



COMMERCIAL PRODUCTS DIVISION

NUCLEAR AND INDUSTRIAL SAFETY DEPARTMENT ORGANIZATION

LICENSE: SNM-777, Docket: 70-82

Figure 202-I

NO.

EFFECTIVE:

ISSUED: October 31, 1968

SUPERSEDES: New

SUBJECT: License: SNM-777, Docket: 70-820
SECTION: 200 - ORGANIZATION, PERSONNEL AND ADMINISTRATION
Subsection: 203 - Nuclear Materials Management

203. Nuclear Materials Management

The Nuclear Materials Management responsibilities are a function of the Administration Department. The Nuclear Materials Management Section is headed by the Supervisor of Nuclear Materials Management. Each Operation has an SS Materials Control Representative. The SS Materials Control Representative and his delegates are responsible for accounting for all SS Materials, and overall administration of the Nuclear Materials Management Office. He maintains the accounting records of receipts, shipments, inventories, and losses of SS Materials. Details of the Nuclear Materials Management program are set forth in Section 500.

204. Production Organization

1. General Description

1.1 United Nuclear Corporation's Commercial Products Division is organized for the specific purpose of chemical and ceramic processing SNM for further fabrication of fuel elements, actual fabrication of fuel elements and the recovery of the SNM from unirradiated scrap material. The Organization chart, Figure 201-I shows how this organization is set up to carry out and control the various functions essential for this type of manufacturing operating. The General Manager of the Commercial Products Division reports directly to the President of the Corporation.

* 1.2 Each department is headed by a Department Manager who has full responsibility and authority to carry out the functions of that department in conjunction with contributions of other departments to achieve the overall objectives of the Commercial Products Division. Each Department Manager is directly responsible to the Division General Manager for the conduct of his departmental affairs including implementation of disciplinary action against personnel failing to follow instructions. Further, each Department Manager has line responsibility to the members of his department.

2. Manufacturing Departments

* 2.1 The manufacturing covered by this license will be carried out under the direct responsibility of the respective Manufacturing Department Manager or Superintendent. These departments have the responsibility for manufacture, engineering and shipment applicable to the production of products described in this application.

2.2 Specific procedures are set up to insure that the proper quantities of uranium are present in the various products produced. Processing procedures are set up within the responsible department.

Management channels are established as the need for delegation of work arises. Changes at levels below the first line management level reporting to the head of a department are a management prerogative, and therefore, a detailed listing of the present supervisory levels is not provided except for the Nuclear and Industrial Safety Department which is described in a separate subsection.

*Indicates Change

204. Production Organization (continued)

3. Recovery Operations

3.1 Organization

The Fuels Recovery Plant is organized for the specific purpose of conversion of scrap materials containing uranium into a high-purity compound for sale or re-use. The Organization Chart, Figure 204-I shows how this organization is set up to carry out and control the various functions essential for this operation.

3.2 Basic Responsibilities

3.2.1 Plant Manager

The Plant Manager is responsible for the safe efficient operation and maintenance of the plant in conformance with established policies and procedures for required administrative and process development work.

3.2.2 First Line Management

First Line Management reporting to the Plant Manager are responsible for the safe efficient operation of their assigned portions of the facilities. This includes the supervision of any activities assigned to them.

3.3 Personnel Qualifications

The minimum qualifications of the Plant Manager, and first line management shall be a B. S. degree in a technical field with two years experience in Nuclear plants and laboratories, or high school with ten years nuclear industry experience.

Resumes of the qualifications of the personnel performing these functions are included as back up information.

4. Fuel Fabrication Operations

4.1 Organization

The Fuel Fabrication Operation is organized for the purpose of fabricating SNM bearing components for test and power reactors. Figure 204-II shows the organization established to perform these functions.

LICENSE: SNM-777, Docket: 70-820
SECTION: 200 - ORGANIZATION, PERSONNEL AND ADMINISTRATION.
Subsection: 204 - Production Organization

Approved

ISSUED October 31, 1968

SUPERSEDES New

204. Production Organization (continued)

4.2 Basic Responsibilities

4.2.1 Plant Manager

The Plant Manager has the overall responsibility for the design, development and operations of the facilities. As is standard practice, he also is responsible to insure that all operations are performed safely.

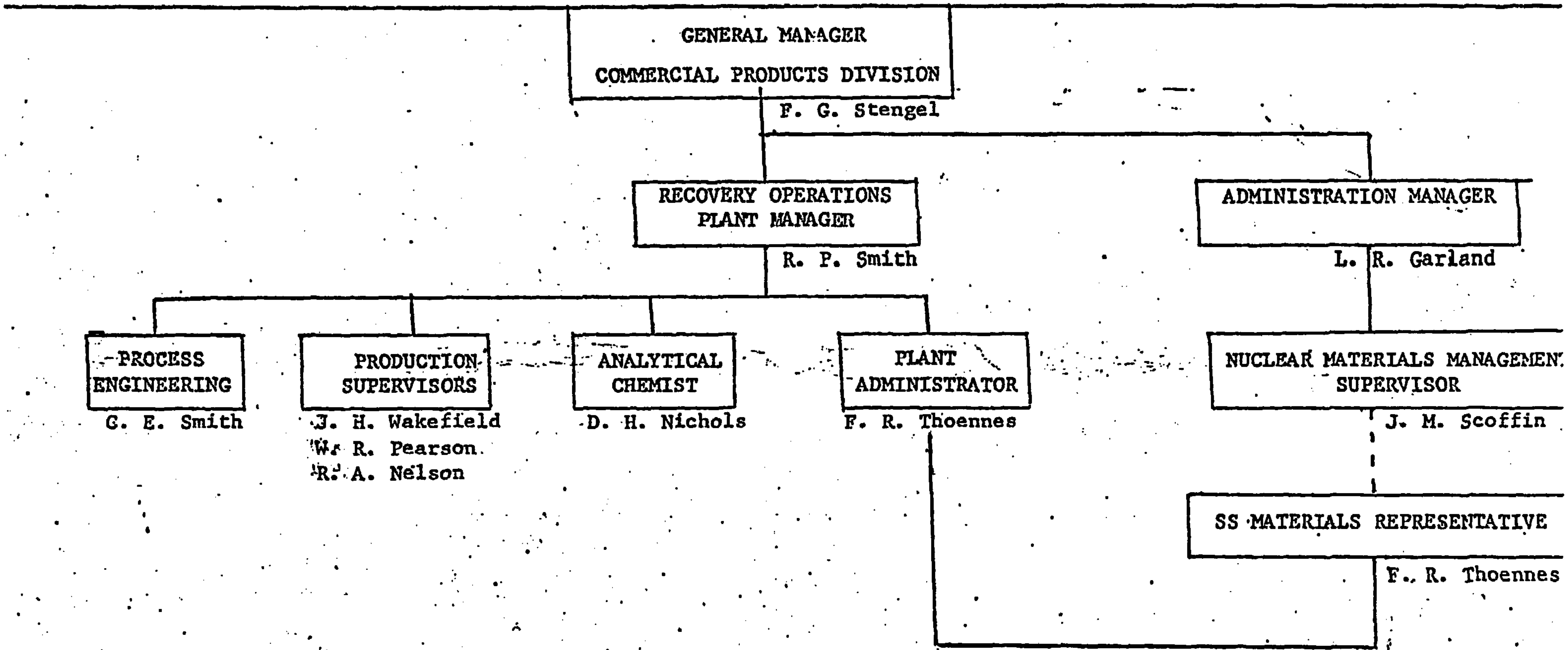
4.2.2 Managers

Managers reporting to the Plant Manager are responsible for the safe efficient operation of their assigned portions of the facilities. This includes the supervision of any activities assigned to them.

4.3 Personnel Qualifications

The minimum qualifications for Plant Manager or Manager shall be a B. S. degrees in a technical field with two years experience in the nuclear industry, or, high school with ten years industry experience.

Resumes of the qualifications of the personnel performing these functions are included as back up information.



COMMERCIAL PRODUCTS DIVISION

RECOVERY OPERATION ORGANIZATION

LICENSE: SNM-777, Docket:70-82

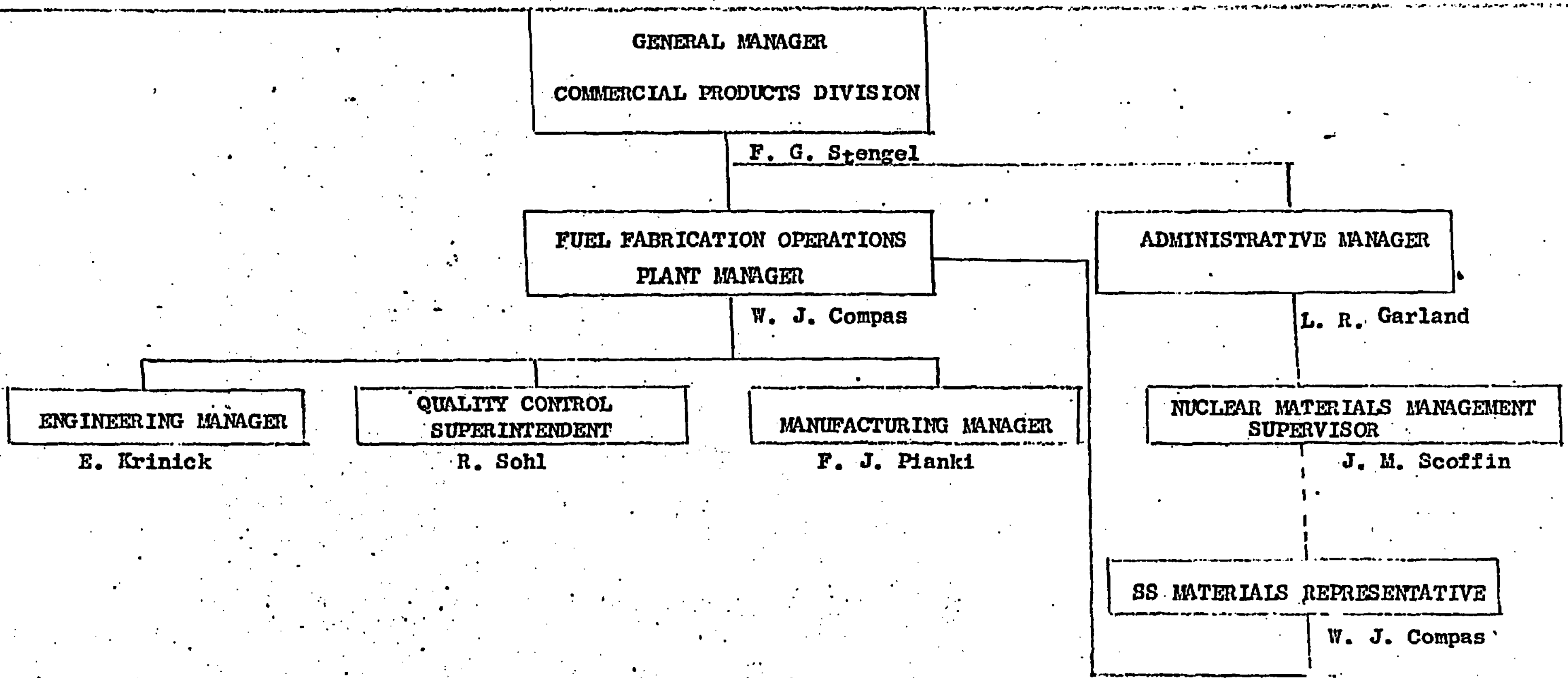
Figure 204-I

No.

EFFECTIVE:

ISSUED: October 31, 1968

SUPERSEDES: New



COMMERCIAL PRODUCTS DIVISION

FUEL FABRICATION OPERATIONS ORGANIZATION

LICENSE: SNM-777, Docket: 70-820

Figure 204-II

NO.:

EFFECTIVE:

ISSUED: October 31, 1968

SUPERSEDES: New

205. Process Control

* 1. General

Commercial Products Division policy requires that supervision at all levels assure themselves that all handling, processing, storing and shipping of SNM, is given prior review and approval by the Nuclear and Industrial Safety Department, that suitable control measures are prescribed, and that all pertinent regulations, controls procedures relative to nuclear criticality safety or radiological safety, are followed by supervision and all operating personnel.

Approval by the Nuclear and Industrial Safety Department shall be in accordnace with criteria established by the license. The mechanism of such approval is described in more detail in Subsection 206.

2. Recovery Operations

Control of the process is maintained through a system of standard procedures and parameters, and provisions for reporting and correcting abnormal occurences.

2.1 Operating Procedures

Issued by the Process Engineer, provide detailed instructions for equipment operation and material handling, including specific safety requirements. S.O.P.'s are the basic control document; before issuance or revision they require Engineering, Production, Nuclear and Industrial Safety and SNM Management approval by signature.

2.2 Process Parameter Sheets

Issued by Process Engineer, establish and communicate detailed parameters for each job, within limits established by S.O. P.

2.3 Operating Reports

Operating reports are used and prepared as required for production planning and control.

3. Fuel Fabrication Operations

Control of the process is maintained through a system of written operating procedures and provisions for reporting and correcting abnormal occurrences. Operations involving SNM require prior written approval by the Nuclear and Industrial Safety Department. This is accomplished by the posting of signs with nuclear criticality safety and health physics control limits. These signs will be prepared and issued in accordance with Sections 300 and 400.

206. Nuclear and Industrial Safety Controls

1. Responsibility

On-site nuclear and industrial safety control is exercised by Operating Supervision with overchecks performed by Process Engineers and the Nuclear and Industrial Safety Representative. Operating Supervision must assure that nuclear criticality safety and health physics control procedures are followed as defined by approved operating procedures or posted control limits.

* 2. Nuclear and Industrial Safety Department Approval

NIS Department approval on equipment and operating procedures is identified by signature of the NIS Department Representative on the operating procedures and/or criticality signs. This approval shall only be granted when:

2.1 Deleted

2.2 (a) Nuclear criticality safety evaluation has been performed by the NIS Representative based on the criteria and standards of Section 300.

(b) The NIS Representative's evaluation has been reviewed by the Nuclear Safety Specialist or Nuclear and Industrial Safety Department Manager. This review is based on the criteria and standards of Section 300 and includes verification of each of the following:

1. assumptions
2. correct application of criteria of Section 300
3. completeness and accuracy of the evaluation
4. familiarity of the installation.

(c) Health Physics criteria of Section 400 have been fulfilled.

* 3. Records

Records of NIS evaluations and approvals will be maintained for a period of at least six (6) months after use of the operation has been terminated.

* 4. Suspension of Operations

Primary responsibility and authority to suspend unsafe operations is placed with Operating Supervision. Within their respective responsibilities the members of the Nuclear and Industrial Safety Department also have authority to suspend operations not being performed in accordance with approved procedures.

*Indicates Change

207. Inspections and Audits

1. General

A continuous re-appraisal of the safety program is provided through a system of daily checks, regular inspections, and audits. Health physics personnel, thoroughly familiar with regular operations, make daily checks to determine that there has been no change in the parameters or conditions of operations, that may affect the safety of these operations. A planned schedule of regular inspections is established by the Department Manager. Infractions and violations are corrected on the spot with the concurrence of the cognizant Specialist and/or Manager of Industrial Safety. Results of inspections and audits are included in the department monthly report.

2. Daily Checks

Daily checks and visits are observations made routinely by Health Physics Technicians who observe, note, and make general observations in addition to their radiation survey functions.

* 3. Inspections

Inspections are performed by NIS Department Representative (non-resident), Specialist or NIS Manager. An inspection includes a review of checks to determine the area or areas requiring more detailed observation. Generally, a specific area will be observed for a sufficient time to indicate corrective action if needed. Inspections are documented and maintained as a record for at least one year. These inspections will be performed as follows:

Function	Minimum Frequency#
Health Physics	2 months
Nuclear Criticality Safety	2 months

#The minimum frequency is increased when new operations are in the startup phase.

*Indicates Change

207. Inspections and Audits (continued)

4. Audits

An audit is a more thorough inspection in which the results of previous checks, inspections or audits are also reviewed, as an evaluation on the effectiveness of the program. All aspects of the activities involved, including the equipment, facilities and operator's knowledge are covered. A review of the follow-up action taken on previous audits and inspections, the recommended corrective action, and a schedule date which such action will be accomplished are also covered. These audits may also involve a detailed review of non-safety documents such as operating procedures, route cards, etc. It may also include a review of the nuclear materials management program. These audits are documented by a formal report to the Division General Manager. Records of audits are
* maintained for at least one year. An audit is performed once a year by a team appointed by the General Manager.

*Indicates Change

Approved

LICENSE: SNM-777, Docket: 70-820
SECTION: 200 - ORGANIZATION, PERSONNEL AND ADMINISTRATION
Subsection: 208 - Training

ISSUED October 31, 1968

SUPERSEDES New

208. Training

1. Purpose

The purpose of the training program is to inform and instruct all employees in the policy and programs of the company as they relate to nuclear criticality safety, health physics and industrial safety, and proper and safe performance of their assignments.

2. New Employees

The indoctrination of new employees in the safety aspects of the facility is conducted by, or under the supervision of Specialist in the various topics. The indoctrination topics include but are not limited to:

a) Fundamentals of nuclear criticality safety and controls.

b) Fundamentals of the health physics program and controls.

c) Emergency Alarms and actions required.

d) A review of the facility operations.

e) On the job training, under direct line supervision and/or by experienced personnel.

3. Continued Training

The training and personnel safety program is continued with on the job training supplemented by regularly scheduled meetings conducted by line supervision and specialist in the subjects covered. Included are topics in nuclear safety, health physics and radiation safety, use of personnel protection equipment, industrial safety and accident prevention and other topics applicable to the facility operations.

UNITED NUCLEAR CORPORATION

COMMERCIAL PRODUCTS DIVISION

POSITION General Manager, Commercial Products Division

PERSON Frederick G. Stengel

EXPERIENCE

Mr. Stengel has fifteen years experience in development and fabrication of nuclear core fuel materials, fuel elements, and assemblies. His developmental experience includes several prototype naval reactors, PWR, and HTGR. He has extensive background in the development of uranium alloy, carbide, and ceramic fuel materials, and in management of related technicalprograms.

FORMER POSITIONS

1965 - 1967	Chemical Operations Manager, Fuels Division, Hematite, Missouri
1963 - 1965	Manager, Process Engineering, General Atomic, Fuel Operations Division
1958 - 1963	Supervisor, Westinghouse Electric Corporation, Bettis Atomic Power Division, West Mifflin, Pennsylvania
1952 - 1958	Junior to Senior Engineer, Westinghouse Electric Corporation, Bettis Atomic Power Division, West Mifflin, Pennsylvania.

EDUCATION

B. S., Metallurgical Engineering, Massachusetts Institute of Technology, [redacted] Ex. 6

Business Administration, University of Pittsburgh, 1959.

5/22/68

UNITED NUCLEAR CORPORATION

COMMERCIAL PRODUCTS DIVISION

POSITION Chemical Operations Plant Manager

PERSON Robert M. Barto, Jr.

EXPERIENCE

Mr. Barto has 17 years industrial experience in manufacturing industries, ten years of which have been line management. Experience has included Naval reactor fuel and structural fabrication and assembly. Developmental experience has been in the field of mechanical, electromechanical and electronic equipment associated with the electrostatic photocopy industry.

FORMER POSITIONS

1967 - 1968	Director of Research and Development, Copystatics Manufacturing Corporation, Miami, Florida.
1961 - 1967	Manager, Quality Assurance and Inspection, Veeder-Root Company, Hartford, Connecticut
1956 - 1961	Manager, Quality Control and Inspection, Combustion Engineering, Nuclear Division, Windsor, Connecticut
1951 - 1956	Process Engineer, Remington Arms Company, Lake City Arsenal, Independence, Missouri.

EDUCATION

William Jewell College - A.B. Physics & Mathmatics
Cornell University & Mohawk College - Engineering Courses
Syracuse University - Graduate Work, Physics

8/19/68

UNITED NUCLEAR CORPORATION

COMMERCIAL PRODUCTS DIVISION

POSITION Recovery Operations Superintendent

PERSON Russell P. Smith

EXPERIENCE

Mr. Smith has had more than fourteen years experience in various phases of the chemical processing of enriched Uranium. His experience has included Research and Development work, process engineering and management of these and related technical programs.

FORMER POSITIONS

1965 - 1967	Process Engineer, Fuels Recovery Plant, Fuels Division, United Nuclear Corporation, Wood River Junction, Rhode Island
1955 - 1965	Process Engineer and Supervisor of Enriched Uranium Scrap R covery, Y-12 Plant, Union Carbide Corporation, Oak Ridge, Tennessee
1953 - 1955	Process Development Engineer, Fuels Conversion Process, Oak Ridge Gaseous Diffusion Plant, Union Carbide Corporation, Oak Ridge, Tennessee

EDUCATION

B.S., Chemical Engineering, Grove City College, Pennsylvania, [redacted] Ex. 6

5/22/68

UNITED NUCLEAR CORPORATION

COMMERCIAL PRODUCTS DIVISION

POSITION Fuel Fabrication Operations Plant Manager

PERSON William J. Compas

EXPERIENCE

Mr. Compas has had fifteen years experience in technology of nuclear reactor cores and nuclear material fabrication and testing, with particular emphasis on uranium alloys, Zircaloy and hafnium. He has extensive background in quality control and process development. and improvement.

FORMER POSITIONS

1965 - 1967	Quality Control Manager, Naval Products Department, Fuels Division, United Nuclear Corporation, New Haven, Connecticut.
1962 - 1965	Manager, Manufacturing Engineering, Fuels Division, United Nuclear Corporation, New Haven, Connecticut.
1961 - 1962	Superintendent of Engineering, Fuels Division, United Nuclear Corporation, New Haven, Connecticut
1958 - 1961	Technical Project Supervisor, Nuclear Fuel Operation, Olin Mathieson Chemical Corporation, New Haven, Connecticut.
1957 - 1958	Senior Process Engineer, Nuclear Fuel. Operation, Olin Mathieson Chemical Corporation, New Haven, Connecticut.
1956 - 1957	Process Engineer, Nuclear Fuel Operation, Olin Mathieson Chemical Corporation, New Haven, Connecticut.
1954 - 1956	Supervisor, Process Development in Establishing Roll Bond Tube in Sheet Technology, Olin Mathieson Chemical Corporation, East Alton, Illinois.
1952 - 1954	Research Metallurgist, Ames Laboratory (AEC), Iowa State University, Ames, Iowa.

EDUCATION

B.S., St. Louis University, [redacted] Ex. 6

Graduate studies at Iowa State University, 1952-54.

5-22-68

UNITED NUCLEAR CORPORATION

COMMERCIAL PRODUCTS DIVISION

POSITION: Nuclear and Industrial Safety Manager

PERSON Louis J. Swallow

EXPERIENCE

Mr. Swallow has thirteen years experience in the nuclear fuel industry. His experience includes plant design and construction, quality control, production, special nuclear material accountability, and specifically, six years of nuclear safety including criticality evaluations, health physics, and license preparation.

FORMER POSITIONS

1967 - 1968	Construction Manager, SWOPP Task Force, Chemicals Operation, Commercial Products Division, United Nuclear Corporation, Hematite, Missouri
1964 - 1967	Operations Control Manager, Chemicals Operation, Fuels Division, United Nuclear Corporation, Hematite, Missouri
1958 - 1964	Research and Development Engineer, Quality Control Engineer, Nuclear Safety Engineer, Chemicals Operation, Fuels Division, United Nuclear Corporation, Hematite, Missouri
1955 - 1958	Project Engineer, Uranium Division, Mallinckrodt Chemical Works St. Louis and Weldon Springs, Missouri

EDUCATION

B. S., Mechanical Engineering, Washington University, St. Louis, Missouri, [redacted] Ex. 6

M. S., Mechanical Engineering, Washington University, St. Louis, Missouri, 1955

Oak Ridge National Laboratory, Nuclear Safety School, October, 1959

5/22/68

UNITED NUCLEAR CORPORATION

COMMERCIAL PRODUCTS DIVISION

POSITION Special Projects Manager

PERSON Robert I. Hanfling

EXPERIENCE

Mr. Hanfling has seven years experience in the Nuclear Industry. His experience includes production, planning and control, and nuclear reactor design and development.

FORMER POSITIONS

1968 - to present	Special Project Manager, Commercial Products Division, United Nuclear Corporation, New Haven Connecticut
1967 - 1968	Project Manager - KAPL Contract, Naval Products Division, United Nuclear Corporation, New Haven, Connecticut
1967 -	Manager, Operations Control, Naval Products Division, United Nuclear Corporation, New Haven, Connecticut
1966 - 1967	Manager, Planning and Control, Naval Products Department, Fuels Division, United Nuclear Corporation, New Haven, Connecticut
1966 -	Project Director - "136" Contract, Naval Products Department, Fuels Division, United Nuclear Corporation, New Haven, Connecticut
1962 - 1966	Project Engineer, MCR; NDA and UNC Research and Engineering Center (formerly Development Division)
1962 -	(Temporary Assignment) Supervisory Engineer, Navy Core Assembly, Fuels Division, United Nuclear Corporation
1961 - 1962	Engineer, Reactor Design and Analysis, Nuclear Development Corporation of America

EDUCATION

Rensselaer Polytechnic Institute, B.S., Chemical Engineering, [redacted] Ex. 6
West Virginia University, M.S., Nuclear Engineering, 1961
City College of New York, M.B.A., 1966

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UNITED NUCLEAR CORPORATION

COMMERCIAL PRODUCTS DIVISION

POSITION Manager Facilities & Development Engineering, Commercial Products Division

PERSON James A. Rode

EXPERIENCE

Sixteen years experience in refining, production & fabrication of uranium and its compounds. His experience includes production, research & development involving UO_2, uranium, uranium carbides and mixed oxides of uranium.

FORMER POSITIONS

1965 - 1967	Manager Research & Development Chemicals Operation, Hematite, Missouri
1964 - 1965	Technical Director - Chemicals Operation, Hematite, Missouri
1961 - 1964	Assistant Technical Director - Chemicals Division, Hematite, Missouri
1958 - 1961	Group Leader - Mallinckrodt Nuclear Corporation, Hematite, Missouri
1957 - 1958	Production Engineer & Production Supervisor Special Metals Division, Mallinckrodt, Hematite, Missouri
1955 - 1957	Project Engineer - Mallinckrodt Chemical Works Special Metals
1954 - 1955	Group Leader - Development Group, Mallinckrodt Chemical Works Uranium Division, St. Louis, Missouri
1953 - 1954	Research Chemist, Development Engineer Production Engineer Mallinckrodt Chemical Works, Uranium Division, St. Louis, Missouri

EDUCATION

B. S. Chemical Engineering, University of Texas, [redacted] Ex 6

10-23-68

UNITED NUCLEAR CORPORATION

COMMERCIAL PRODUCTS DIVISION

POSITION Administrative Manager, Commercial Products Division

PERSON Laurence R. Garland

EXPERIENCE

Has extensive background in financial management in manufacturing as well as plant management experience.

FORMER POSITIONS

1964 - 1967	Chemical Operations Administrative Manager
1962 - 1964	Plant Manager - Walworth Company, East St. Louis, Illinois
1958 - 1962	Division Controller - Walworth Company, East St. Louis, Illinois
1942 - 1958	Works Accountant and Cost Accountant - Various Plants, Walworth Company
1937 - 1942	Accountant - Northern Indiana Public Service Co.

EDUCATION

B. S. In Business Administration, University of Notre Dame, [redacted] Ex. 6

10-23-68

UNITED NUCLEAR CORPORATION

COMMERCIAL PRODUCTS DIVISION

POSITION Nuclear Safety Specialist

PERSON Robert E. Kropp

EXPERIENCE

Mr. Kropp has over fifteen years experience in nuclear safety, reactor hazards analysis, reactor physics and reactor design. His experience covers the design, fabrication and operation of Swimming Pool, Pressurized Water and High Temperature Gas Cooled Reactors. He has extensive background in directing nuclear safety programs, preparing manuals and procedures for criticality control and reactor operations and preparing computer programs for health and safety analysis. Also, Mr. Kropp has been licensed as a reactor operator.

FORMER POSITIONS

1965 - 1968	Nuclear Safety Specialist, Fuels Division, United Nuclear Corporation, New Haven, Connecticut.
1963 - 1965	Staff Associate, Nuclear Analysis and Reactor Physics Department and Member, Criticality Safeguard Committee, John J. Hopkins Laboratory for Pure and Applied Sciences, General Atomic, San Diego, California.
1958 - 1963	Lead Engineer, Criticality Control Standards, Bettis Atomic Power Laboratory, Westinghouse Electric Corporation, Pittsburgh, Pennsylvania.
1956 - 1957	Test Engineer, Reactor Operations and Hazards Group, Convair, Fort Worth Division, Fort Worth, Texas.
1952 - 1956	Aerological and Research Officer, U. S. Navy.
1951 - 1952	Meteorological Aid, U. S. Weather Bureau, Spartanburg, South Carolina.

EDUCATION

B.S., Meteorology, Florida State University, [redacted] Ex.6

Graduate Physics, University of California, 1954-55.

Graduate Physics, Texas Christian University, 1956-57.

Bettis School of Reactor Engineering, 1958-61.

Graduate Computing Sciences, Carnegie Institute of Technology, 1962-63.

5/22/68

UNITED NUCLEAR CORPORATION

COMMERCIAL PRODUCTS DIVISION

POSITION   Health Physics Specialist

PERSON   David G. Darr

EXPERIENCE

Mr. Darr has fourteen years' experience in Health Physics involving source and special nuclear materials, by-product materials, x-ray equipment and particle accelerators. His background includes planning and administering Health Physics programs, preparing manuals and procedures for Health Physics controls, equipment and facility design, and environmental sampling and evaluation.

He has four years' experience in nuclear safety involving audit functions for both reactor component fabrication and special nuclear materials processing. One year of this experience included performing basic nuclear safety evaluations and reviewing and preparing manuals and procedures for criticality control.

FORMER POSITIONS

1967 - 1968	Nuclear Licensing and Safety Specialist, Fuels Division, United Nuclear Corporation, Hematite, Missouri.
1964 - 1967	Health Physics and Safety Supervisor, Fuels Division, United Nuclear Corporation, Hematite, Missouri.
1961 - 1964	Health Physics Officer, Member of Isotope Committee and Consulting Industrial Physicist, Nuclear Consultants Corp., St. Louis, Missouri.
1957 - 1961	Health Physics Supervisor, Nuclear Fuels Operation, Olin Mathieson Chemical Corp., New Haven, Connecticut
1956 - 1957	Technician, Health Physics Department, Uranium Division, Mallinckrodt Chemical Works, St. Louis, Missouri.
1954 - 1956	NCOIC, Operations Group, 1st Radiological Safety Support Unit, U. S. Army, Nevada Test Site and Ft. McClellan, Alabama.

EDUCATION

Engineering, Central Missouri State College, [redacted] Ex. 6

Engineering, Washington University, 1957

Physics, New Haven College, 1960

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UNITED NUCLEAR CORPORATION

COMMERCIAL PRODUCTS DIVISION

POSITION Nuclear and Industrial Safety Department Representative

PERSON Elmer A. Barton

EXPERIENCE

Mr. Barton has elevan year experience in Health Physics, Nuclear Materials Management and Nuclear Criticality Safety. His experience includes administering operational health physics, nuclear criticality and nuclear materials management programs at chemical recovery and fuel component fabrication plants. Health physics experience includes implementing policies and procedures, supervising routine health physics operations and actual performance of the routine health physics operations. Nuclear criticality safety experience includes inspection of recovery operations and reviewing operating documents and manuals for conformance with approved licenses. Nuclear Materials Management experience included routine records keeping, auditing and other associated duties.

FORMER POSITIONS

1965 - 1968	Nuclear Licensing and Safety Department Representative, Fuels Division, United Nuclear Corporation, Wood River Junction, Rhode Island.
1963 - 1965	Health Physics and Safety Technician (Senior), Fuels Division, United Nuclear Corporation, Wood River Junction, Rhode Island
1961 - 1963	Health Physics and Safety Technician, Fuels Division, United Nuclear Corporation, New Haven, Connecticut
1960 - 1961	Materials Control Technician, Nuclear Fuels Operation, Olin Mathieson Chemical Corporation, New Haven, Connecticut
1957 - 1960	Accountibility Technician, Nuclear Fuels Operation, Olin Mathieson Chemical Corporation, New Haven, Connecticut

EDUCATION

Education, Lynden (Vermont) Teachers College, [redacted] Ex. 6

5-22-68

UNITED NUCLEAR CORPORATION

COMMERCIAL PRODUCTS DIVISION

POSITION   Supervisor of Nuclear Materials Management

PERSON   James M. Scoffin

EXPERIENCE

Mr. Scoffin has ten years experience in the nuclear fuel industry. His experience includes SS Material Control in production, irradiation test experimentation, and as SS Material Accountability representative.

FORMER POSITIONS

1965 - present	Supervisor of Nuclear Materials Management, United Nuclear Corporation, Hematite, Missouri
1962 - 1965	Production Control Coordinator, General Atomic Fuels Division, San Diego, California
1958 - 1962	Research Assistant, General Atomic, San Diego, California

EDUCATION

B. A., Mathematics, San Diego State College, [redacted] Ex 6

Business Administration, San Diego State College, 1960 - 61.

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UNITED NUCLEAR CORPORATION

COMMERCIAL PRODUCTS DIVISION

POSITION Fuel Fabrication Operations Engineering Manager

PERSON Eugene Krinick

EXPERIENCE

Mr. Krinick has fifteen years experience in the fabrication of nuclear fuel elements. Work in this field includes development and production on aluminum-uranium alloys, stainless steel UO_2 dispersion plates, rolling, machining and casting of uranium and critical experiments; fabrication of plate type and tubular aluminum fuel elements for research and test reactor use, and the fabrication of UO_2 pellet - Zircaloy tubular clad fuel elements for many utility power reactors.

FORMER POSITIONS

1967 - 1968	Engineering Manager, Fuels Division, United Nuclear Corporation, New Haven, Connecticut.
1965 - 1967	Supervisor of Mechanical Design, Fuels Division, United Nuclear Corporation, New Haven, Connecticut
1961 - 1965	Engineering Specialist, Fuels Division, United Nuclear Corporation, New Haven, Connecticut
1959 - 1961	Engineering Specialist, Nuclear Fuel Operations, Olin Mathieson Chemical Corporation, New Haven, Connecticut
1955 - 1959	Supervisor, Mechanical Engineering, Sylvania-Corning Nuclear Corporation, Hicksville, New York.
1954 - 1955	Project Engineer, Sylvania-Corning Nuclear Corporation, Hicksville, New York.
1953 - 1954	Rocket Design Engineer, U. S. Army.
1952 - 1953	Mechanical Engineer, Atomic Energy Division, Sylvania Electric Products, Inc., Hicksville, New York.
1951 - 1953	Mechanical Engineer, Norfolk Naval Shipyard, Portsmouth, Virginia.

EDUCATION

B. S., Mechanical Engineering, Brooklyn Polytechnic Institute, [redacted] Ex. 6

M. S., Industrial Engineering, New York University, 1958.

5-22-68

UNITED NUCLEAR CORPORATION

COMMERCIAL PRODUCTS DIVISION

POSITION Fuel Fabrication Operations Manufacturing Manager

PERSON Francis J. Pianki

EXPERIENCE

Mr. Pianki has sixteen years experience in the field of fuel element and nuclear materials production and development, and this production and development experience includes aluminum, stainless steel, zirconium and many other special type fuel elements. He has also been engaged in research and development of fabrication methods for nuclear fuel materials.

FORMER POSITIONS

1966 - 1967	Manufacturing Manager, Fuels Division, United Nuclear Corporation, New Haven, Connecticut.
1965 - 1966	Supervisor of Metallurgical Functions Engineering, Fuels Division, United Nuclear Corporation, New Haven, Connecticut.
1964 - 1965	Manufacturing Engineering Superintendent, Fuels Division, United Nuclear Corporation, New Haven, Connecticut
1963 - 1964	Manufacturing Superintendent, Fuels Division, United Nuclear Corporation, New Haven, Connecticut
1961 - 1963	Commercial Development Supervisor, Fuels Division, United Nuclear Corporation, New Haven, Connecticut
1959 - 1961	Commercial Development Supervisor, Nuclear Fuel Operations, Olin Mathieson Chemical Corporation, New Haven, Connecticut.
1957 - 1959	Supervisor of Production Engineering, Sylvania-Corning Nuclear Corporation, Hicksville, Long Island, New York.
1956 - 1957	Senior Engineer, Sylvania-Corning Nuclear Corporation, Bayside New York
1955 - 1956	Senior Engineer, Westinghouse Atomic Power Division, Bettis Field, Pittsburgh, Pennsylvania.
1952 - 1955	Engineer, Atomic Energy Division, Sylvania Electric Products, Inc., Bayside, New York.
1952 - 1952	Metallurgist, Spery Gyroscope Co., Lake Success, Long Island, New York

EDUCATION

Metallurgical Engineering, Purdue University, [redacted]

B. S., Metallurgical Engineering, Polytechnic Institute of Brooklyn, [redacted] Ex. 6

Graduate Metallurgy, Polytechnic Institute of Brooklyn

5-22-68

UNITED NUCLEAR COPRORATION

COMMERCIAL PRODUCTS DIVISION

POSITION Quality Control Superintendent

PERSON Raymond C. Sohl

EXPERIENCE

Mr. Sohl has 21 years experience in quality control including seven years in nuclear fuel fabrication.

FORMER POSITIONS

1961 - 1967	Supervisor, Quality Control Commercial Products Department Fuels Division, United Nuclear Corp. New Haven, Connecticut
1947 - 1961	Quality Engineer, Thompson Ramo Woolridge, Inc. Cleveland, Ohio

EDUCATION

Graduate, Case Institute of Techonlogy, 1944
B. S. Engineering, Ohio State University, [redacted] Ex. 6

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UNITED NUCLEAR CORPORATION

COMMERCIAL PRODUCTS DIVISION

POSITION Recovery Operations Process Engineer

PERSON Clifford E. Smith, Jr.

EXPERIENCE

Mr. Smith has had eight years experience in laboratory and developmental chemistry, the last four years as Supervisor and Assistant Chemical Process Engineer at the Fuels Recovery Plant. He has assisted in the development and processes now in use and supervision of these operations.

FORMER POSITIONS

1964 - 1967 Operations Supervisor and Process Engineer, Fuels Recovery Plant, Fuels Division, United Nuclear Corporation, Wood River Junction, Rhode Island

1960 - 1964 Quality Control Chemist, Bird & Son, Inc., Walpole, Massachusetts

EDUCATION

B. S., Chemistry, University of Rhode Island, [redacted] Ex. 6

5-22-68

UNITED NUCLEAR CORPORATION

COMMERCIAL PRODUCTS DIVISION

POSITION Recovery Operations Plant Administrator

PERSON Frederick R. Thoennes

EXPERIENCE

Mr. Thoennes has one year experience in Divisional accounting procedures. He is trained in standard accounting practices and has received on the job training in Nuclear Materials Management.

FORMER POSITIONS

1967 - 1967 Junior Cost Accountant, Fuels Division, United Nuclear Corporation, New Haven, Connecticut

EDUCATION

B. S., Accounting and Business Management, Bob Jones University, [redacted] Ex. 6

5-22-68

UNITED NUCLEAR CORPORATION

COMMERCIAL PRODUCTS DIVISION

POSITION Recovery Operations Plant Chemist

PERSON David H. Nichols

EXPERIENCE

Mr. Nichols has five years experience in industrial research and applied chemical analytical techniques. His experience includes three years in the uranium processing industry.

FORMER POSITIONS

1967 - Present	Recovery Operations Plant Chemist, Fuels Division, United Nuclear Corporation, Wood River Junction, Rhode Island
1965 - 1967	Chemist, Fuels Division, United Nuclear Corporation, Hematite, Missouri.
1963 - 1965	Research Chemist, Dennis Chemical Company, St. Louis, Missouri

EDUCATION

B. S., Mathematics, Southeast Missouri State College [redacted] Ex.6

5-22-68

UNITED NUCLEAR CORPORATION

COMMERCIAL PRODUCTS DIVISION

POSITION Recovery Operations Production Supervisor

PERSON James H. Wakefield

EXPERIENCE

Mr. Wakefield has had 17 years experience in industry related to nuclear fuels and uranium processing. This includes 4 years in enriched uranium recovery operations.

FORMER POSITIONS

1965 - Present	Recovery Operations Production Supervisor, Commercial Products Division, United Nuclear Corp., Wood River Junction, R. I.
1954 - 1965	Shift Process Foreman, Union Carbide Corp., Oak Ridge, Tennessee.
1951 - 1954	Chemical Operator, Union Carbide Corp., Paducah, Ky.
1949 - 1951	Shift Supervisor, Alabama Power Co., Underground Gasification Projects, Gargas, Alabama.

EDUCATION

B. S., Chemistry and Mathematics, Florence State College, [redacted] Ex. 6

9/25/68

UNITED NUCLEAR CORPORATION

COMMERCIAL PRODUCTS DIVISION

POSITION Recovery Operations Production Supervisor

PERSON Robert A. Nelson

EXPERIENCE

Mr. Nelson has eight years of experience in the chemical and nuclear fuel industry. His experience includes laboratory development in analytical chemistry, research and development in ceramic fuel materials, process engineering and production supervision in the uranium processing industry.

FORMER POSITIONS

1965 - Present	Recovery Operations Production Supervisor, Commercial Products Division, United Nuclear Corp., Wood River Junction, Rhode Island
1961 - 1965	Chemist, Fuels Division, United Nuclear Corp., Hematite, Mo.
1960 - 1961	Analytical Chemist, Mallinckrodt Chemical Works, St. Louis, Mo.

EDUCATION

B. A., Chemistry, Wisconsin State College, [redacted] Ex. 6

M. S., Physical Chemistry, Iowa State University, 1960

9/25/68

UNITED NUCLEAR CORPORATION

COMMERCIAL PRODUCTS DIVISION

POSITION Recovery Operations Production Supervisor

PERSON William R. Pearson

EXPERIENCE

Mr. Pearson has 15 years of experience in the chemical and nuclear fuels industry. Experience includes design and development of a UF_6 manufacturing plant, management of a small chemical plant and operation of the utilities operations of a chemical plant. Mr. Pearson has 5 years experience in enriched uranium recovery operations.

FORMER POSITIONS

1964 - Present	Recovery Operations Production Supervisor, Commercial Products Division, United Nuclear Corp., Wood River Junction, R.I.
1962 - 1964	Supervisor, Utilities Operations Production Sub-Division, Goodyear Atomic Corp., Piketon, Ohio.
1958 - 1962	General Foreman, Flouride Generation and Feed Vaporization Facility, Goodyear Atomic Corp., Piketon, Ohio.
1953 - 1958	Foreman, Flouride Generation and Feed Vaporization Facility, Goodyear Atomic Corp., Piketon, Ohio.

EDUCATION

Certificate, Textile Chemistry, New Bedford Textile Institute, 1948

B.S., Chemistry, Northeastern University, [redacted] Ex. 6

Graduate Management, Ohio University, 1958 - 1962

9/25/68

SECTION 300

UNITED NUCLEAR
CORPORATION

LICENSE: SNM-777, Docket: 70-820
SECTION: 300 - NUCLEAR CRITICALITY SAFETY STANDARDS

Approved

ISSUED October 31, 1968

SUPERSEDES New

TABLE OF CONTENTS

301. Statement of Policy

It is the policy of United Nuclear Corporation to establish management controls, plant facilities and equipment designs, and operating procedures to reduce the possibility of a nuclear criticality accident to a minimum. The standards contained in this section 300, describe the controls and criteria applicable to the implementation of this policy.

302. General Requirements

1. Purpose

1.1 These standards provide basic nuclear criticality safety criteria for:

1.1.1 Design of new plant facilities and equipment, or

1.1.2 Modification of existing facilities and equipment, or

1.1.3 UNC Commercial Products Division internal evaluations, reviews and authorizations in lieu of obtaining formal AEC license approval.

* 1.2 The type of activities for which these standards are applicable are those described in Sections 700 and 900.

2. Basic Principles

2.1 All new and revised plant facilities, and equipment intended for processing, handling or storing special nuclear material shall be designed for nuclear criticality safety. The nuclear criticality safety evaluation shall be based on principle that at least two unlikely and unrelated events must occur before accidental criticality can result.

* 2.2 All evaluations shall assume complete water reflection and optimum moderation unless mechanical or physical controls are present which prevent these conditions under normal and abnormal conditions.

2.3 In cases in which different SNM are present in an area at the same time, the limits for the more reactive SNM will apply to all SNM in the area.

*Indicates Change

303. Evaluations

1. Purpose

Evaluations will be performed considering factors which may affect the criticality of the system. These include:

1.1 Enrichment

1.2 Geometry

1.3 Moderation

1.4 Reflection

1.5 Mass

1.6 Volume

1.7 Concentration

1.8 Interaction

1.9 Structural Integrity

1.10 Poisons (if applicable)

1.11 Homogeneity and Heterogeneity of the System

2. Determination of Safe Values

2.1 Individual Units

The tables and graphs in Subsection 309 contain the basic limits which are used to obtain operating criticality safety limits. These graphs and tables have safety factors incorporated into them.

2.2 Interaction

When evaluating interaction between units of an array or group of arrays, the following techniques will be applied:

2.2.1 Solid Angle Method - Solid angle of the most reactive units shall be calculated in accordance with the following:

2.2.1.1 The criteria set forth in TID-7016, Rev. 1.

* 2.2.1.2 Keff values listed in Table XVII and footnote 6 on page 30, K-1019, Rev. 5, will be utilized except for specific values used and explicitly quoted in Section 800.

2.2.1.3 Solid angles equal to or less than 0.005 steradians will be neglected.

2.2.2 K-Λ Method - Solid angles shall be calculated using the figures in Y-1272.

*Indicates Change

303. Evaluations (continued)

2.2.3 Criticality Zones

The interaction between criticality zones may not be specifically evaluated if the following are met:

a) The SNM in each criticality zone is separated from SNM in other criticality zones by at least one (1) foot.

b) The plant average surface density of SNM does not exceed 175 grams U-235 per square foot of aspect area. The aspect area applies to plant areas where SNM is processed and handled. This value may be used if the SNM in the criticality zone has a fraction critical which does not exceed 0.3. The maximum size units in each zone shall be evaluated as illustrated in attached Nuclear Safety Evaluation.

* Storage devices are not considered criticality zones. Interaction between storage devices and criticality zones is considered only when adjacent criticality zones are not isolated in accordance with the criteria of Subpart 303.2.2.4.

2.2.4 Isolation

Individual units or arrays are considered isolated from neutron interaction when separated by one of the following:

* a) Eight (8) inches of solid concrete with a density of 140 pounds per cubic foot. Less dense concrete may be used, provided the thickness is increased in inverse proportion to the concrete density. This is applicable only to units no more reactive than those of Table 309-II (refer to attached Nuclear Safety Evaluation, Concrete Isolation).

b) Twelve (12) feet or the greatest distance across the orthographic projection of the largest unit or array on a plane perpendicular to a line joining the center of that unit or array to other units or arrays, whichever is greater.

*Indicates Change

12 pgs w/h in entirety

LICENSE: SNM-777, Docket: 70-820
SECTION: 300 - NUCLEAR CRITICALITY SAFETY STANDARDS
Subsection: 304 - Structual Integrity

Approved

ISSUED October 31, 1968

SUPERSEDES New

304. Structural Integrity

1. Purpose

Whenever nuclear criticality safety is directly dependent on the integrity of a fixture, container, storage rack or isolation structure, the fixture, container, storage rack or isolation sturcture shall be designed in accordance with the following criteria.

2. Specifications

2.1 Materials shall be selected to be fire and corrosion resistant.

2.2 The safety factor is at least five (5) (applicable to ultimate strength of material at design conditions). Assurance that the conditions of this Section are met will be accomplished by test or design by an engineer knowledgeable in material properties and design.

2.3 Records of test results and design calculations will be maintained as provided in Subsection 206.

3. Inspections

Fixtures, containers, storage racks, or isolation structures which maintain a safe geometry or spacing will be inspected to assure the continued reliability of such devices.

3.1 Fixtures Exposed to Corrosive Enviornments

3.1.1 Fixtures such as pickling fixtures will be visually inspected for defects such as cracks at least monthly. These checks will be performed by operating supervision who will maintain a record of these checks.

3.1.2 Defective fixtures will be withdrawn from service and repaired. Fixtures shall be inspected by operating supervision to insure that original design conditions have been restored.

3.2 Other Devices

3.2.1 Devices such as storage racks and containers shall be checked by NIS personnel during inspections and audits.

3.2.2 Devices requiring repair shall be identified and repaired. Repaired devices shall be inspected by NIS personnel or operating supervision to insure that original design conditions have been restored.

305. Nuclear Poisons

305.1 Use of Nuclear Poisons

Nuclear poisons are used only as secondary nuclear criticality control. The following types may be used.

1.1 Boro-silicate Glass Raschig Rings

Boro-silicate glass raschig rings may be used in vessels containing solutions when primary nuclear criticality safety is maintained by concentration control. Such use shall be as described herein.

1.1.1. Boro-silicate glass raschig rings shall be constructed of a low expansion corrosion resistant type glass compatible with the chemical and physical enviornment.

1.1.2. Raschig rings shall be Corning Glass 7740 type or equivalent containing nominal four (4) w/o natural Boron with a range to 11.2 to 13.8 w/o B_2O_3.

1.1.3. Raschig rings are small hollow cylinders with length and diameter approximately equal. Wall thickness is a maximum of 1/4".

1.1.4. The raschig rings will be uniformly distributed in the vessel and will occupy at least 22% of the volume.

1.1.5. Maximum solution concentration is 10 grams U-235/liter.

* 1.1.6. Deleted

1.2 Inspections

1.3.1 Samples of the raschig rings from the bottom of the vessels or from a selected sample point typical of the vessel contents will be evaluated at least once each year.

Raschig rings shall be replaced when the material is damaged or the Boro content of the glass is reduced to less than 3 w/o as determined by analysis.

1.3.2 Vessels will be checked monthly to insure that the tank contains the required amount of raschig rings and that the material is intact and in a planned location.

*Indicates Change

305. Nuclear Poisons (continued)

2.1 Soluble Salts

Soluble boron or cadmium salts may be added to drums of solutions such as pickle liquids, analytical laaboratory residues or other solutions when primary nuclear criticality safety is based on concentration control. Such use shall be as described herein.

2.1.1 Specifications

Maximum solution concentrations are 10 grams U235 per liter. Quantity of salt shall be established to maintain equal molal quantities of U235 and boron or cadmium . (Reference: TID 7016, Rev. 1, page 32, Soluble Poisons)

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LICENSE: SNM-33 & SNM-777, Docket: 70-36 & 70-820	Issued 2/6/70
SECTION: 300 - NUCLEAR CRITICALITY SAFETY STANDARDS	Supersedes 10/31/68
Subsection: 306 - Criticality Zones	Approved
	Amendment No.

306. Criticality Zones

306.1 General

Nuclear Criticality Safety control may be achieved by subdividing the manufacturing or process area into logical work stations or process regions called criticality zones.

306.2 Criticality Zone Specifications

2.1 Boundary

Criticality zone boundaries are established such that SNM within the zone is a minimum of one foot from the SNM in an adjacent zone except when transferring in or out of the zone.

2.2 Zone Control Limits

Nuclear criticality safety control limits within a zone are established as described in Subsection 303.

2.3 Interaction between Zones

Interaction between zones is controlled as described in Subsection 303.

2.4 Type of Criticality Zones

2.4.1 Wet Zones

Wet zones are established when there are no controls against introduction of moderating materials. In general, wet zones are applicable to chemical and ceramic processing, and chemical laboratories, and pickling, rinsing and degreasing operations in fuel element machining and fabrication areas.

* 2.4.2 Special Zones

Special zones are established when there are specific controls against introduction and/or use of moderating materials. These controls include:

a) Provision for free drainage of the zone or exclusion of liquids, no water lines connected to the equipment, specific limits and controls on the quantity of water or other moderating materials (such as plastics, wood, paper).

*Indicates Change

* 2.4.2 Special Zones (continued)

b) The effect of moderating materials permitted is included in the nuclear criticality safety evaluation performed for the activities within the zone.

In general, special zones are applicable to Fuel Element Fabrication Operations and dry box operations in the Chemical and Ceramic process operations.

*Indicates Change

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LICENSE: SNM-33 & SNM-777, Docket: 70-36 & 70-820
SECTION: 300 - NUCLEAR CRITICALITY SAFETY STANDARDS
Subsection: 307 - Marking and Labeling

Supersedes 10/31/68

Approved

Amendment No.

307. Marking and Labeling

1. Criticality Limits

Signs listing approved nuclear criticality safety limits shall be posted so that information is readily discernible to employees. This posting may be for individual pieces of equipment or groups of equipment, depending on the nature of the operations covered.

1.1 Signs are prepared and issued by the NIS Representative.

1.2 Signs must be posted prior to use of SNM in the equipment or at the work station.

* 1.3 Criticality limit signs are signed in approval by the Nuclear and Industrial Safety Representative and the Production Manager.

2. Process Containers

Empty containers used for SNM shall be identified or marked as empty.

Process containers will have information readily available to allow identification of their contents.

*Indicates Change

SUBJECT: LICENSE: SNM-777, Docket: 70-820
SECTION: 300 - NUCLEAR CRITICALITY SAFETY STANDARDS

ISSUED October 31, 1968

Subsection: 308 - Equipment Design

SUPERSEDES

308. Equipment Design

1. Purpose

Certain criteria apply to the all phases of equipment design. These criteria are considered in the design of all equipment used in the processing of SNM.

2. Specifications

2.1 Vessels of unsafe geometry shall be separated by air breaks or other positive method from safe geometry vessels used for SNM bearing solutions to prevent siphoning the SNM bearing solutions into the unsafe geometry vessels.

2.2 Catch pans which are located under some of the equipment are for the purpose of controlling any minor leaks or drips. This improves housekeeping, reduces the spread of contamination, and reduces SNM losses. The depth or volume of the pans shall not exceed the safe slab thickness or volume established for the area.

2.3 The diameter or volume of overflow and vent bottles shall not exceed the safe diameter or volume established for the process area.

2.4 Insulation on pipes and equipment which contain SNM bearing solutions will be made of impervious materials (e.g., foam glass) and provided with weep holes to prevent the possibility of obtaining greater dimensions (volume, diameter, etc.).

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* 309. Tables and Graphs

1. Purpose

The tables and graphs of this Subsection 309 are used in the nuclear criticality safety evaluation as described in Subsection 303.

2. Safety Factors

As used on the curves of this Subsection, the safety factor is the ratio of the safe unit to the critical unit.

In establishing a particular safety factor, consideration must be given to:

a) Accuracy of the data used to establish the critical unit.
b) Operating controls applicable, i.e., degree of administrative control required versus geometry control. In general, a larger safety factor is required when safety is primarily dependent on administrative controls as in the case of mass or batch control.

The safety factors applicable to the safe standards of this Subsection are the same as those in common use in the industry (reference TID-7016, Rev. 1). The critical data from which the standard safe data is developed has been reviewed and determined to be sufficiently accurate as not to warrant a further increase.

*Indicates Change

Safe Limits for Individual Units as Metal, Compound and Solution Systems

Safe Control Parameter	Safe Uranium Limits*		
	Metal Systems	Compound Systems	Solution Systems
Mass			
Cylinder Diameter			
Cross Sectional Area			
Volume			
Slab Thickness			

Ex. 4

*Applicable to:

1. Any U-235 enrichment.
2. Full water reflection.

*Specific Conditions to be Maintained:

1. For metal,
   a) Solid metal pieces with no re-entrant holes.
   b) Smallest individual piece is 4 kg U.
   c) Densities up to and including full density.
2. For compounds,
   a) Total U density vs. H/U ratio is not greater than that of UO_2 as per Figure 309-XXIV.
   b) Bulk density up to and including 4 kg U/liter.
3. For solutions,
   a) Total U density vs. H/U ratio is not greater than that of UO_2F_2 as per Figure 309-XXIV.

Source of Data:

a) Metal - Figures 1-4, TID-7016, Rev. 1
b) Compounds - Figures 309-XXV thru XXVIII and Nuclear Safety Evaluation, 4.8 liter sphere.
c) Solutions - Figures 1-4, TID-7016, Rev.1.

I. DESCRIPTION

A. The maximum sized container for U compound handling and storage will be 4.8 liters

B. The maximum density (bulk) of material to be placed in these container will not exceed 4 Kg U/liter.

II. ASSUMPTIONS

A. The maximum "crystal" density of material to be placed in these containers will not exceed that of UO_2 (9.66 Kg U/liter).

B. The UO_2 - Water data of LA-3612 is applicable.

C. The calculational method set forth in Section 2.2, NDEO-1050, will be used to determine reflector savings(δ) and keff values.

D. The density vs. H/U ratio relationship will be per Fig 309-XXIV.

III. CALCULATIONS

See attached tables

CONCLUSIONS

This volume is subcritical when ~~moderated~~ and reflected for materials with densities not exceeding 4 Kg U/liter. The keff values at a density of 4 Kg U/liter are:

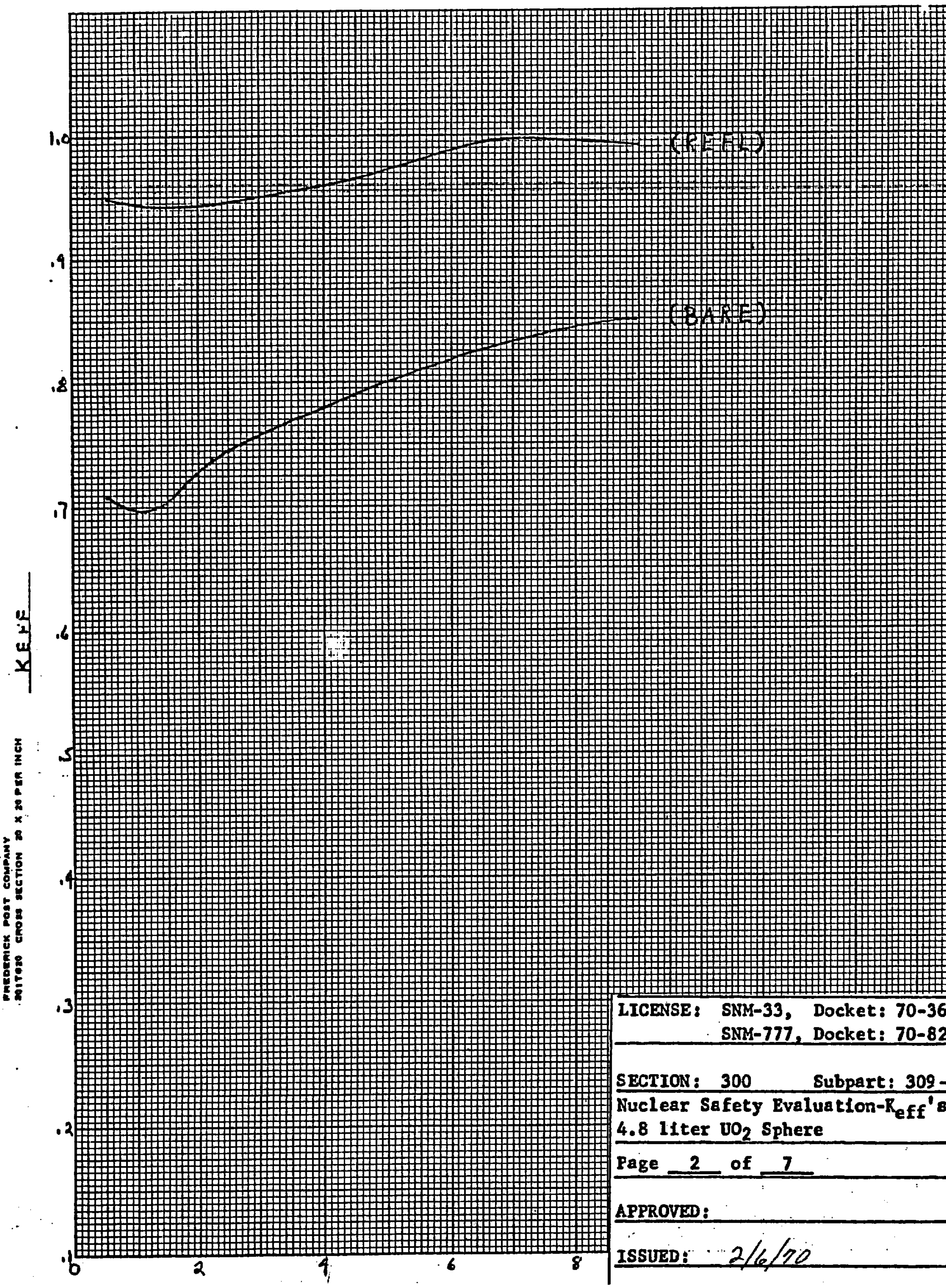
keff (reflected) = [redacted]

keff (bare) = [redacted]

Ex. 4

LICENSE: SNM-33, DOCKET: 70-36
LICENSE: SNM-777, DOCKET: 70-82
SECTION: 300, SUB PART: 309-
NUCLEAR SAFETY EVALUATION-
KEFF'S OF 4.8 LITER UO_2 SPHER

APPROVED
ISSUED 2/6/70



LICENSE: SNM-33, Docket: 70-36
SNM-777, Docket: 70-820

SECTION: 300 Subpart: 309-I

Nuclear Safety Evaluation-K_{eff}'s of 4.8 liter UO_2 Sphere

Page 2 of 7

APPROVED:

ISSUED: 2/6/70

5 pgs w/h
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Ex. 4

Safe Limits for Individual Units of Metal and Compounds

Degree of Moderation H/U-235 More Than	Degree of Moderation H/U-235 Not More Than	Mass Limits* (Kgs. U-235)	Keff Reflected	Keff Bare

Ex. 4

*Applicable to:

1. Any U-235 enrichment.
2. Full water reflection.

*Specific Conditions to be Maintained:

1. Interspersed moderation does not exceed listed H/U atom ratio.
2. Total U density vs. H/U atom ratio is not greater than that of metal or compound per Figure 309-XXIV.

Source of Data:

1. TID-7016, Rev. 1., Table IV (modified)
2. Nuclear Safety Evaluation, Table 309-II.

7pgs w/h
entirety
Ex. 4

LIMITS FOR WET ZONES

CONTROL PARAMETER		LIMIT
Safe Linear Density*	Ex. 4	
Safe Mass		

LIMITS FOR DRY ZONES

CONTROL PARAMETER		LIMIT
Safe Mass	Ex. 4	
Safe Linear Density*		

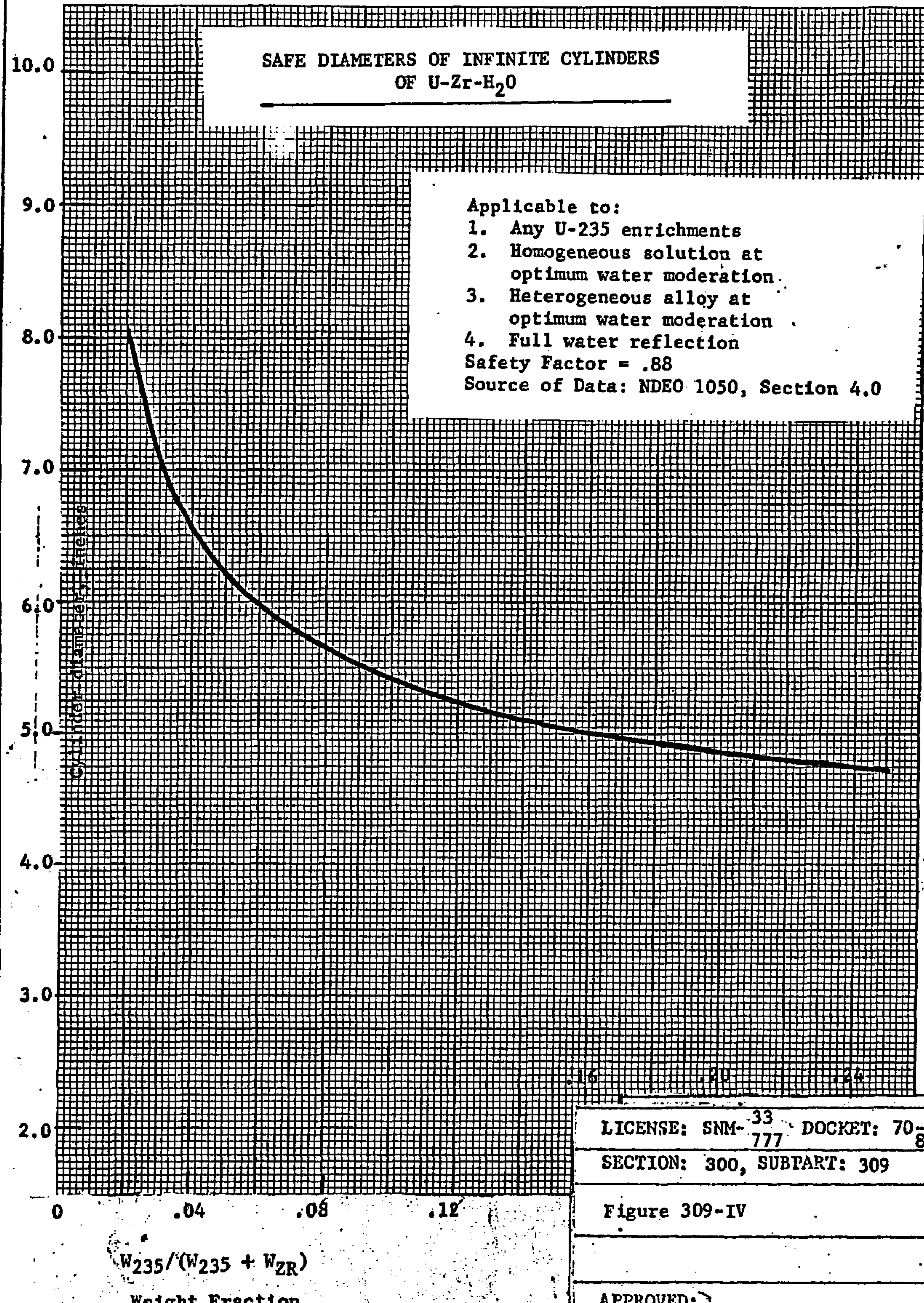
*NOTE: The safe linear density limits will be maintained irrespective of the arrangement of fuel pieces.

Applicable to:
1. Fuel fabrication operations for purpose of establishing safe piece count.
2. Any U-235 enrichment.
3. Full water reflection.
4. Wet zone limits for:
   Uranium solutions; alloys of U-Al & U-SS, up to 50 weight % U-235; and U-Zr up to 25 weight % U-235.
5. Dry zone limits for:
   Alloys of: U-Al and U-SS up to 50 weight % U-235; U-Zr up to 25 weight % U-235.

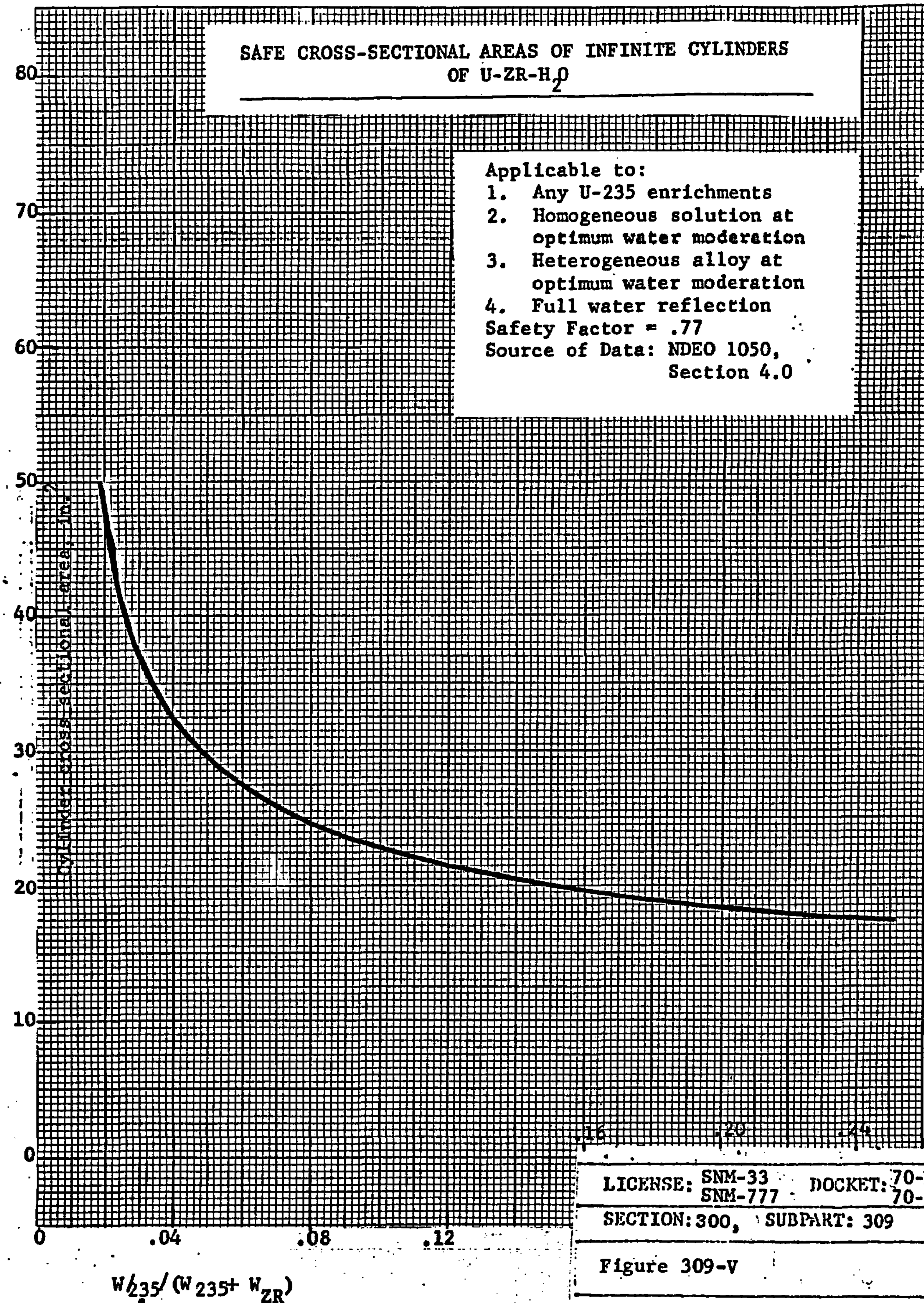
Specific conditions to be maintained:
1. Wet and dry zone controls specified in Subsection 306.2.4.1.

Source of Data:
1. Wet Zone - Safe Mass for Table 309-I
   Safe Linear Density NDEO-1050.
2. Dry Zone - Twice wet zone limits.

LICENSE: SNM-33 SNM-777 DOCKET: 70-36 70-820
SECTION: 300 SUBPART: 309
Table III, Special Limits
Page 1 of 1
ISSUED: 2/6/70
SUPERSEDES: 10/31/68
APPROVED: AMENDMENT NO.:



LICENSE: SNM-33 777	DOCKET: 70-36 820
SECTION: 300, SUBPART: 309	
Figure 309-IV	
APPROVED:	
ISSUED: 2/6/70	



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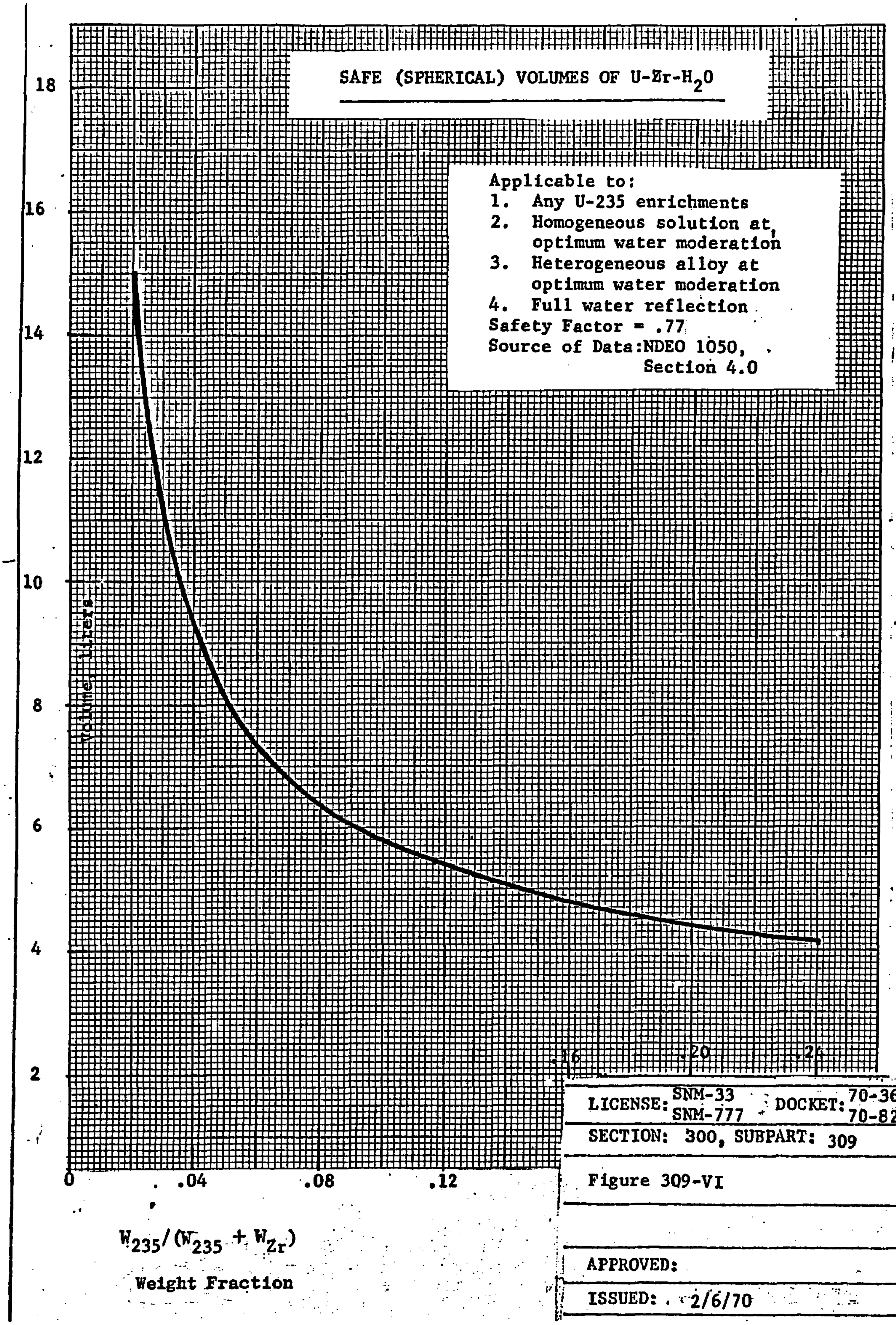
SECTION: 300,	SUBPART: 309
Figure 309-V	
APPROVED:	
ISSUED: 2/6/70	
SUPERSEDES: [illegible]	



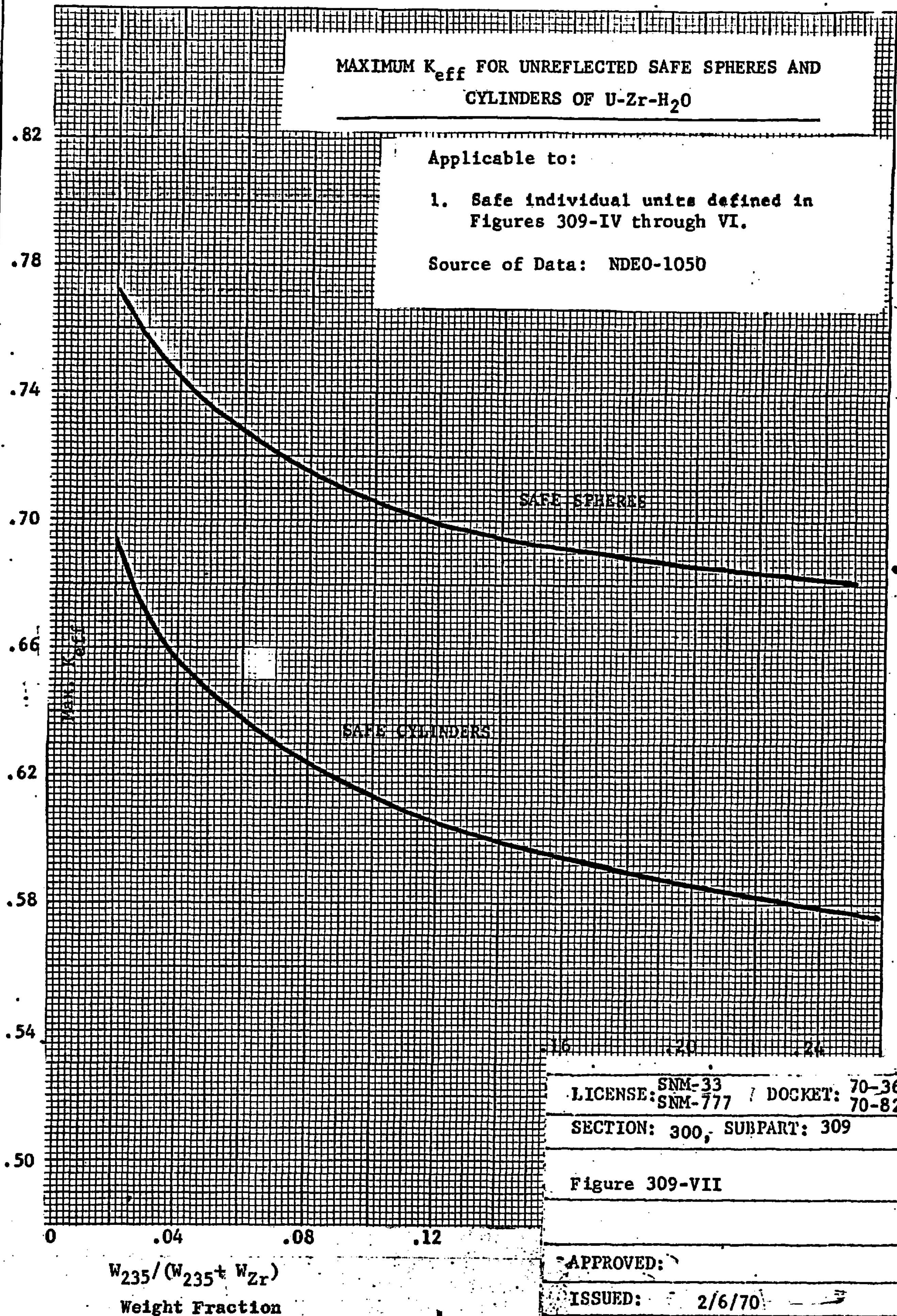
LICENSE: SNM-33, SNM-777	DOCKET: 70-36, 70-820
SECTION: 300, SUBPART: 309	
Figure 309-VI	
APPROVED:	
ISSUED: 2/6/70	

MAXIMUM K_{eff} FOR UNREFLECTED SAFE SPHERES AND CYLINDERS OF U-Zr-H_2O

Applicable to:

1. Safe individual units defined in Figures 309-IV through VI.

Source of Data: NDEO-1050



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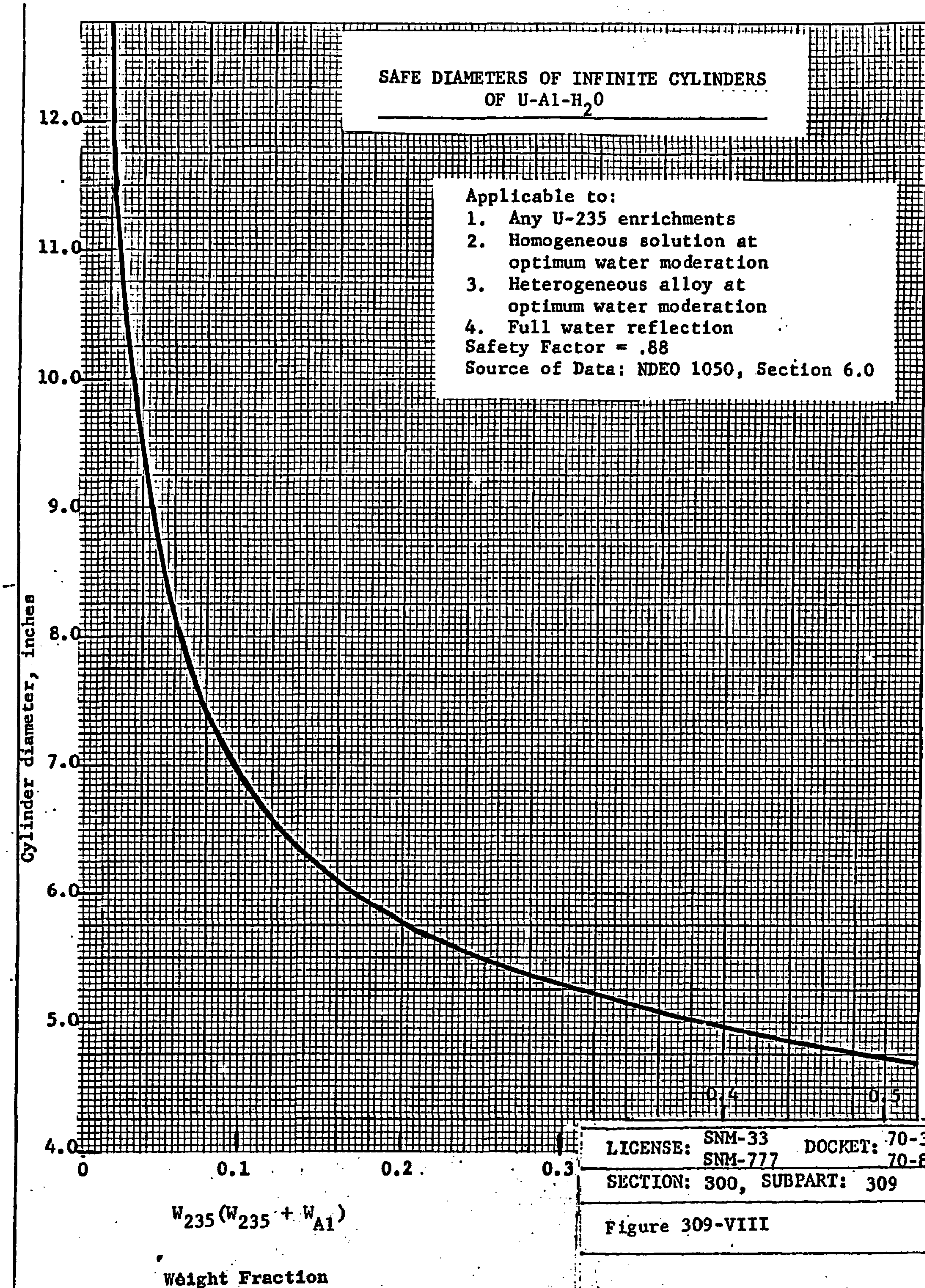
SECTION: 300, SUBPART: 309	
Figure 309-VII	
APPROVED:	
ISSUED: 2/6/70	
SUPERSEDES: 10/31/68	



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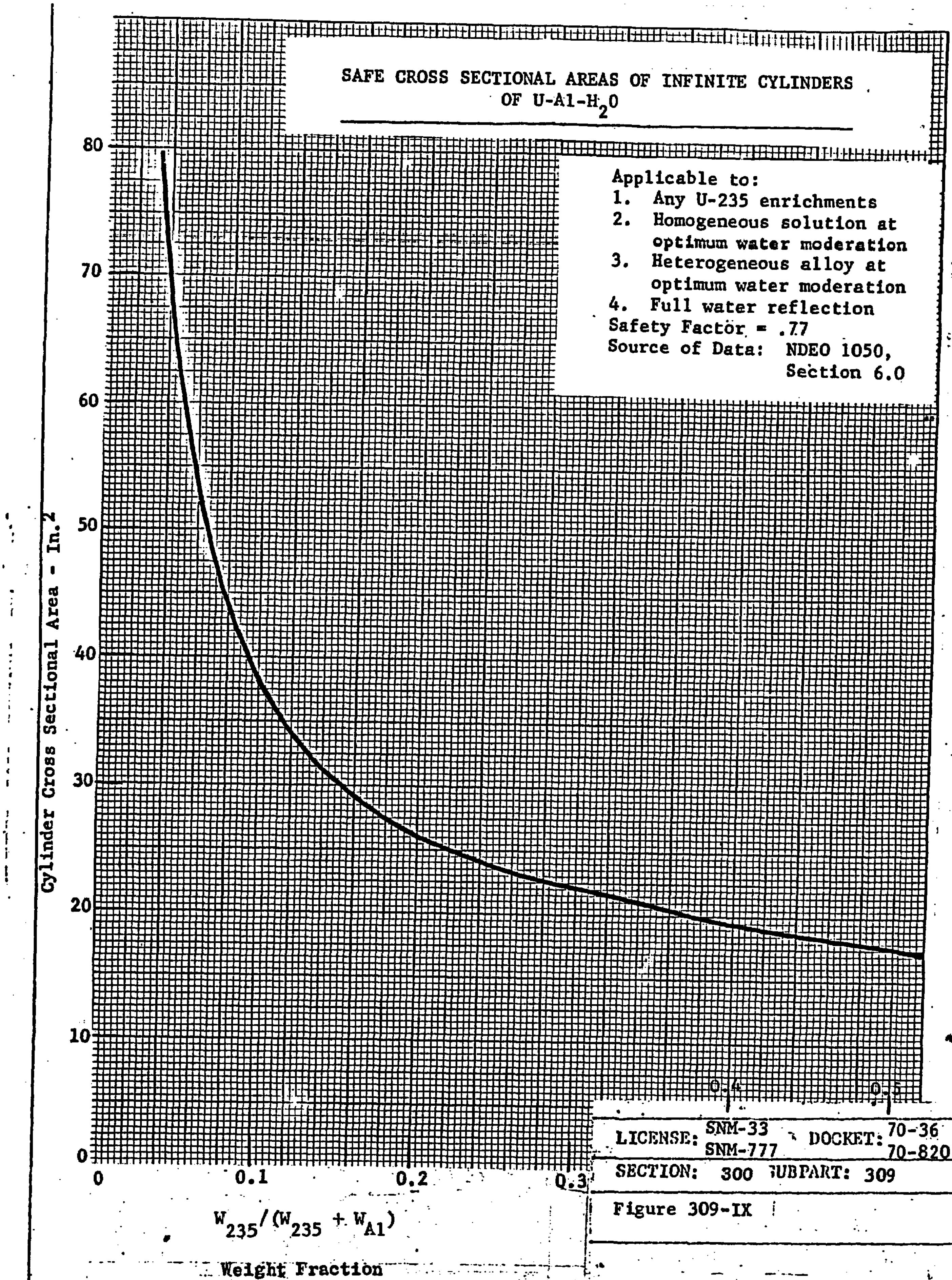
SECTION: 300, SUBPART: 309	
Figure 309-VIII	
APPROVED:	
ISSUED: 2-6-70	



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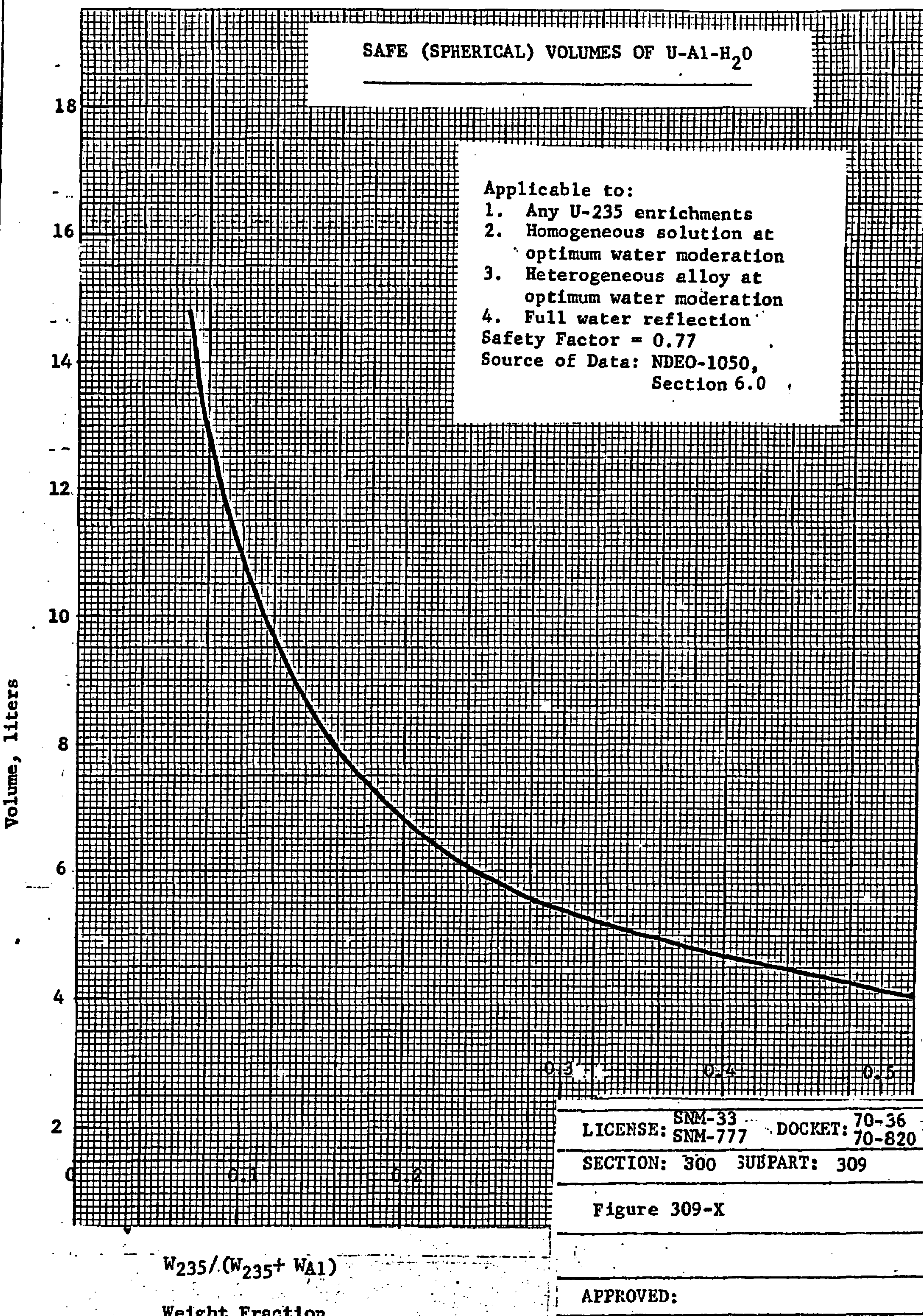
SECTION: 300	SUBPART: 309
Figure 309-IX	
APPROVED:	
ISSUED: 2/6/70	
SUPERSEDES: 10/31/68	



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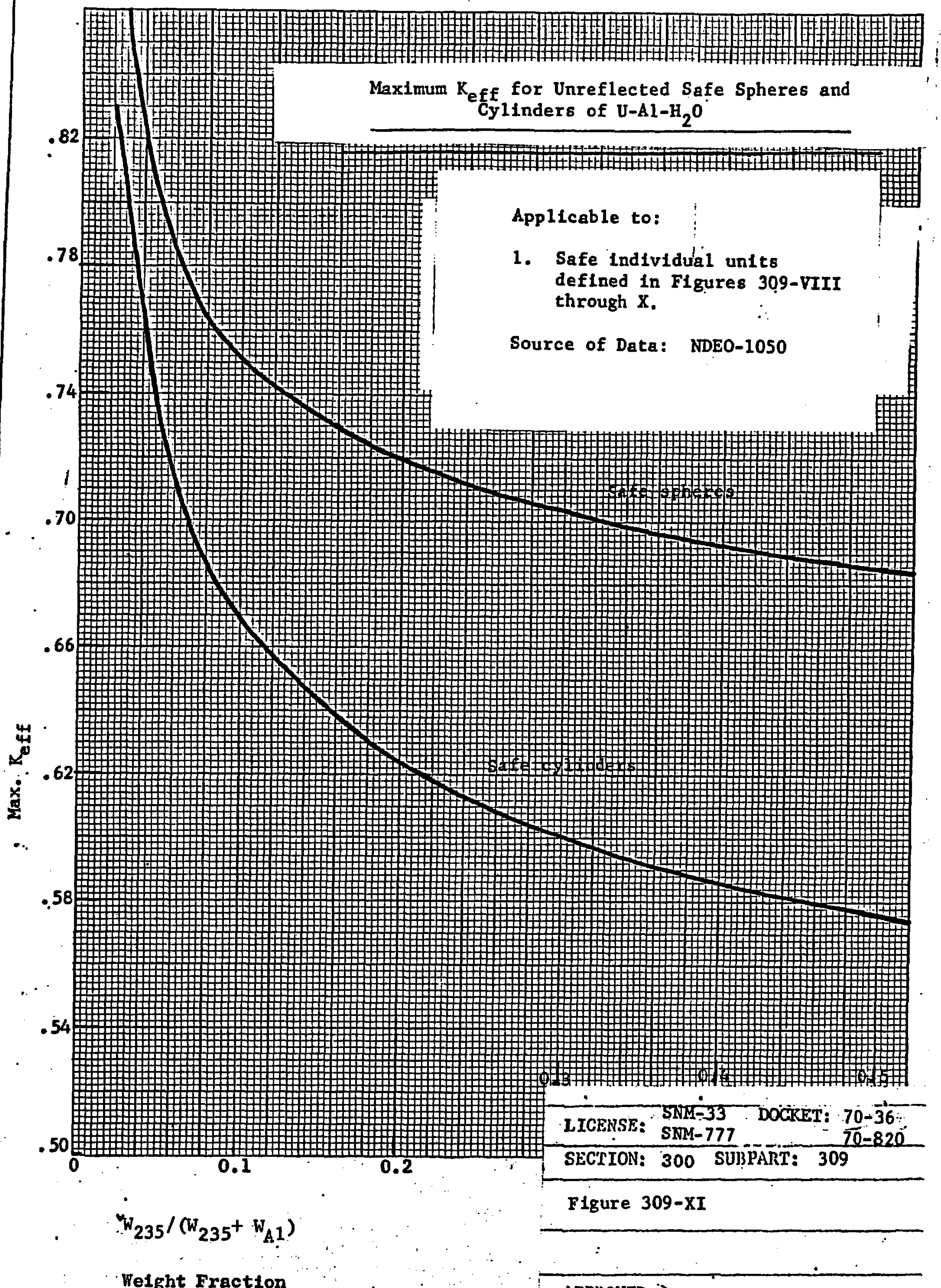
SECTION: 300 SUBPART: 309

Figure 309-X

APPROVED:

ISSUED: 2/6/70



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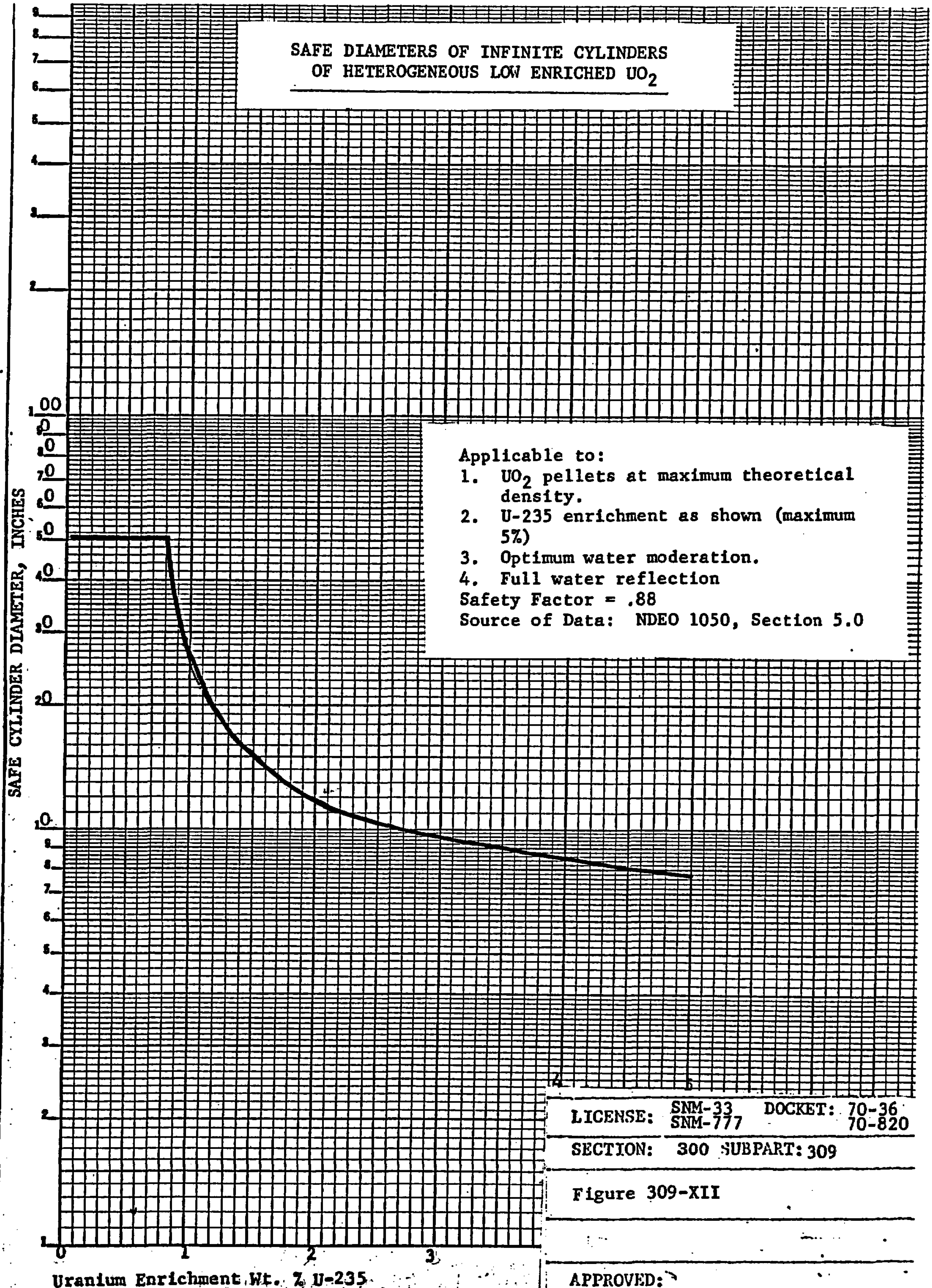
SECTION: 300	SUBPART: 309

Figure 309-XI

APPROVED:

ISSUED: 2/6/70



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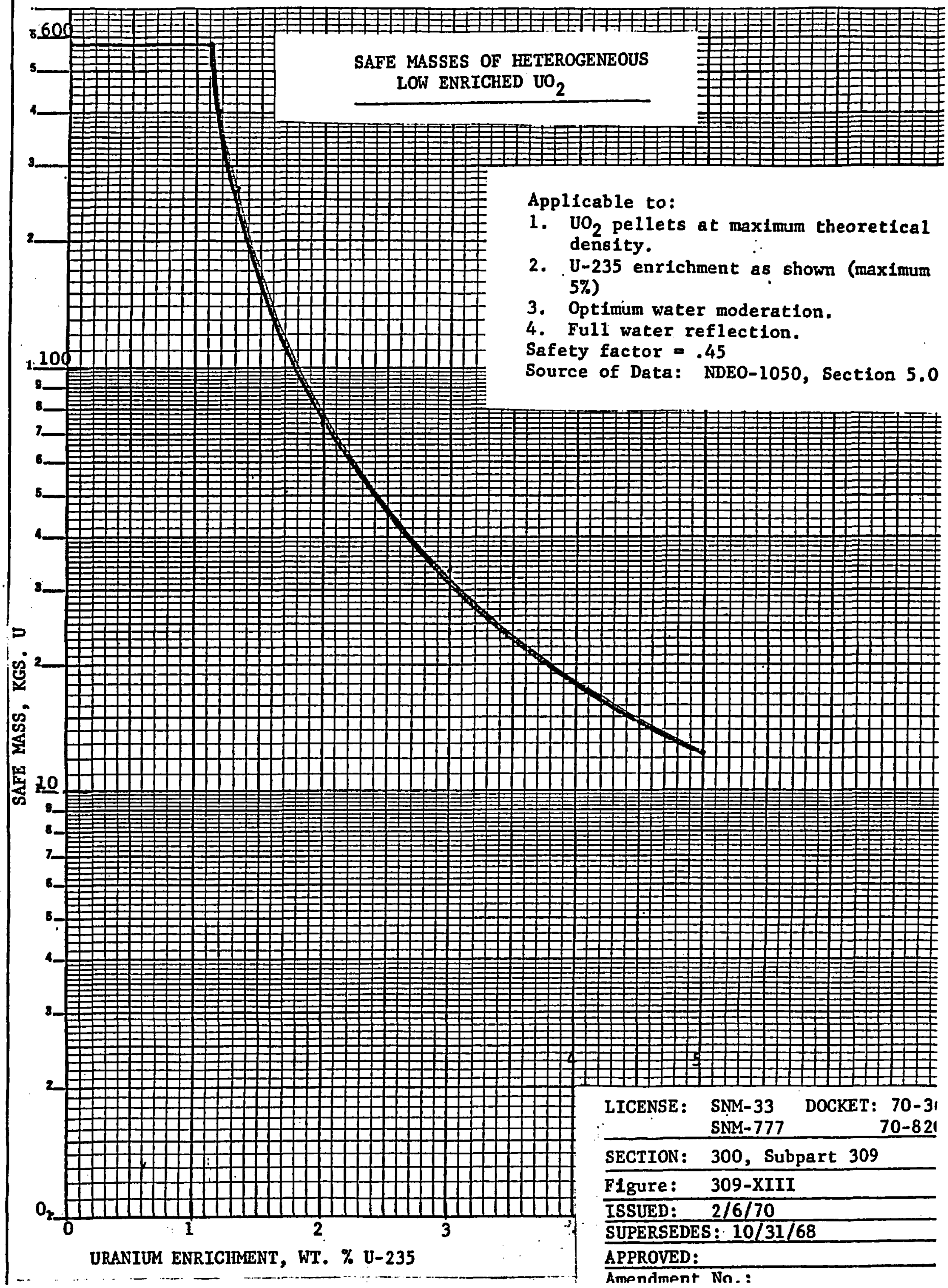
SECTION: 300	SUBPART: 309

Figure 309-XII

APPROVED:

ISSUED: 2/6/70



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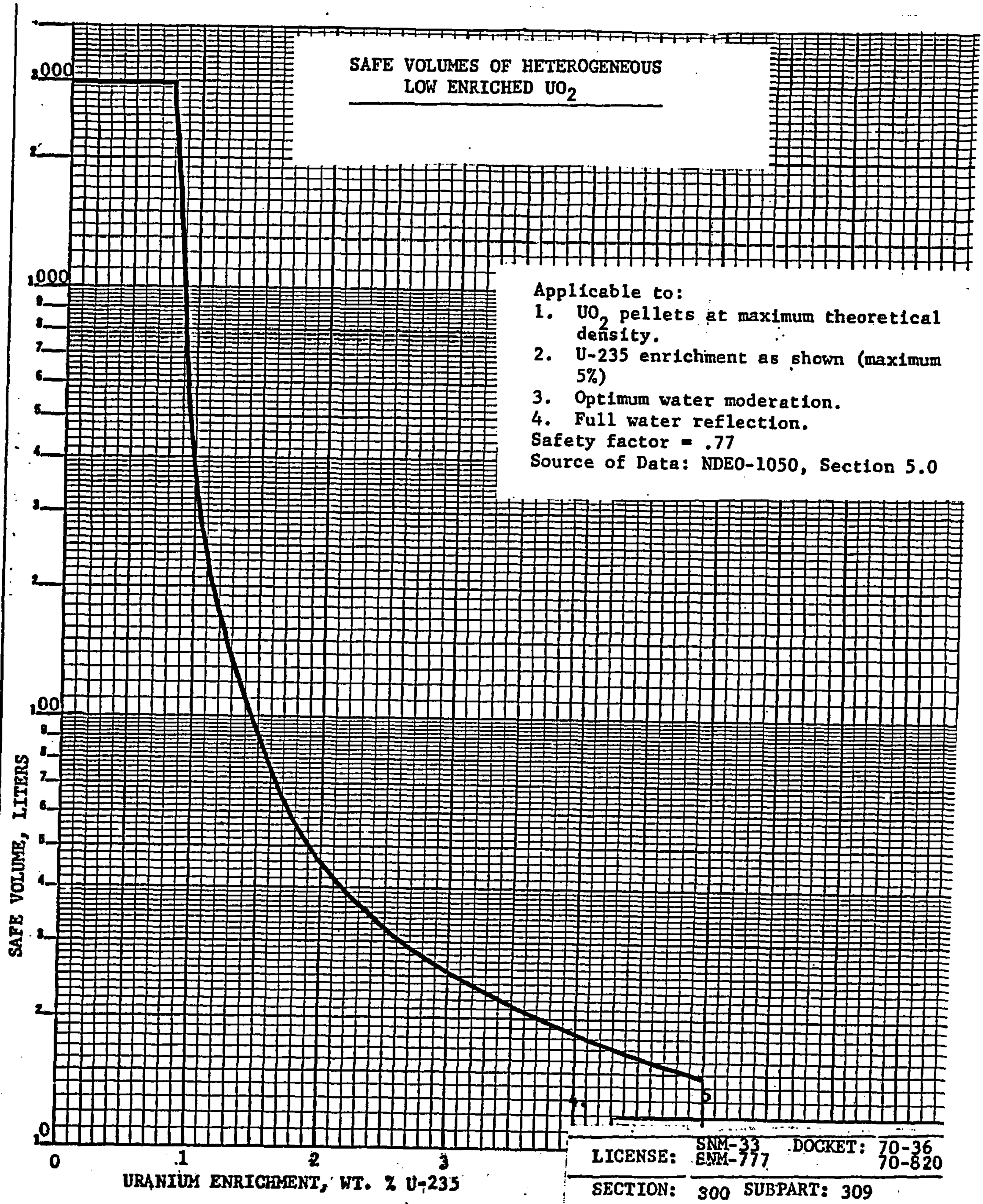
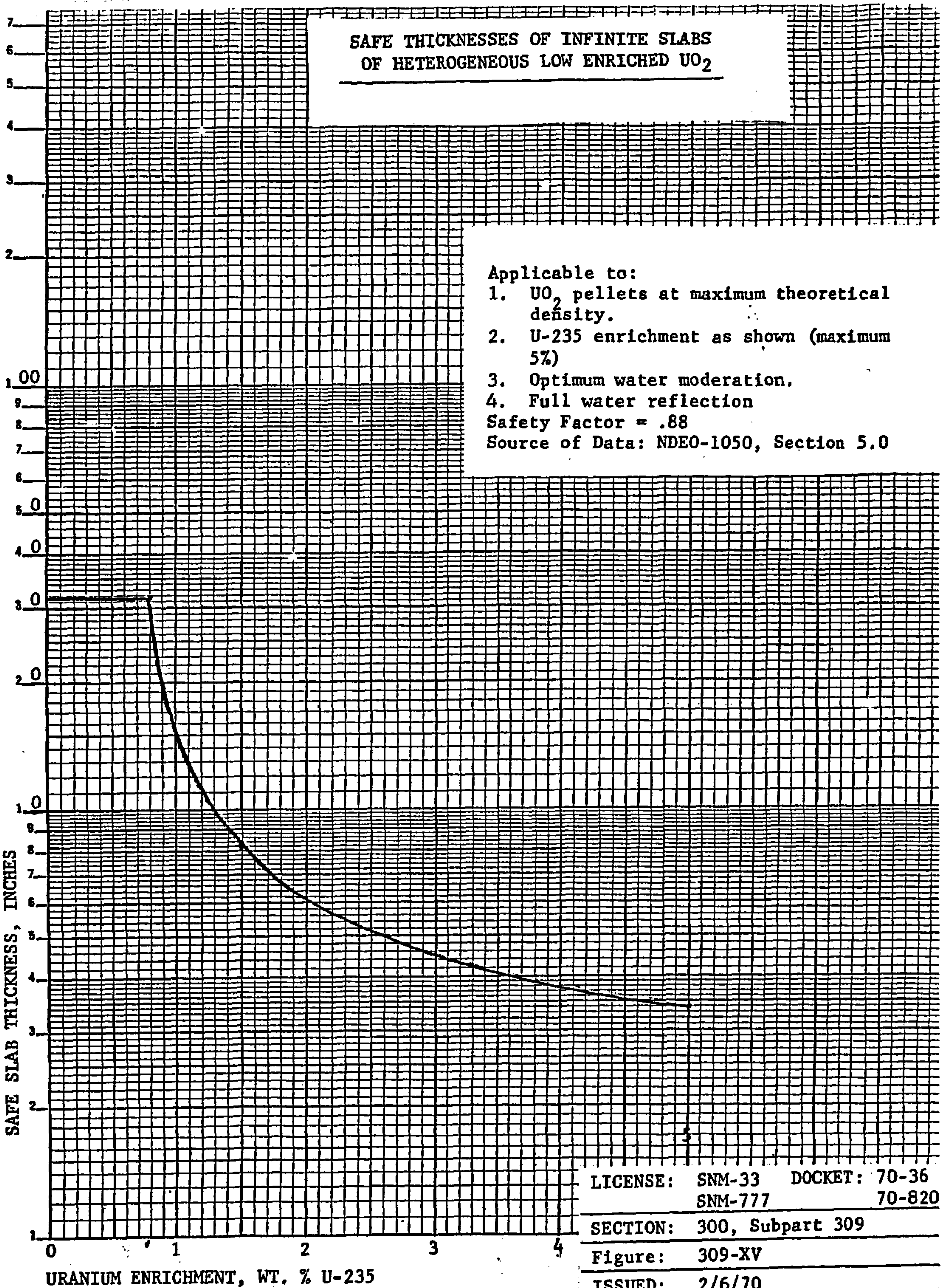
	SNM-777 70-82
SECTION:	300, Subpart 309
Figure:	309-XIII
ISSUED:	2/6/70
SUPERSEDES:	10/31/68
APPROVED:	
Amendment No.:	



LICENSE: SNM-33 SNM-777	DOCKET: 70-36 70-820
SECTION: 300	SUBPART: 309
Figure 309-XIV	
APPROVED:	
ISSUED: 2/6/70	
SUPERSEDES: 10/31/68	



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SECTION:	300, Subpart 309		
Figure:	309-XV		
ISSUED:	2/6/70		
SUPERSEDES:	10/31/68		
APPROVED:			
Amendment No.:			

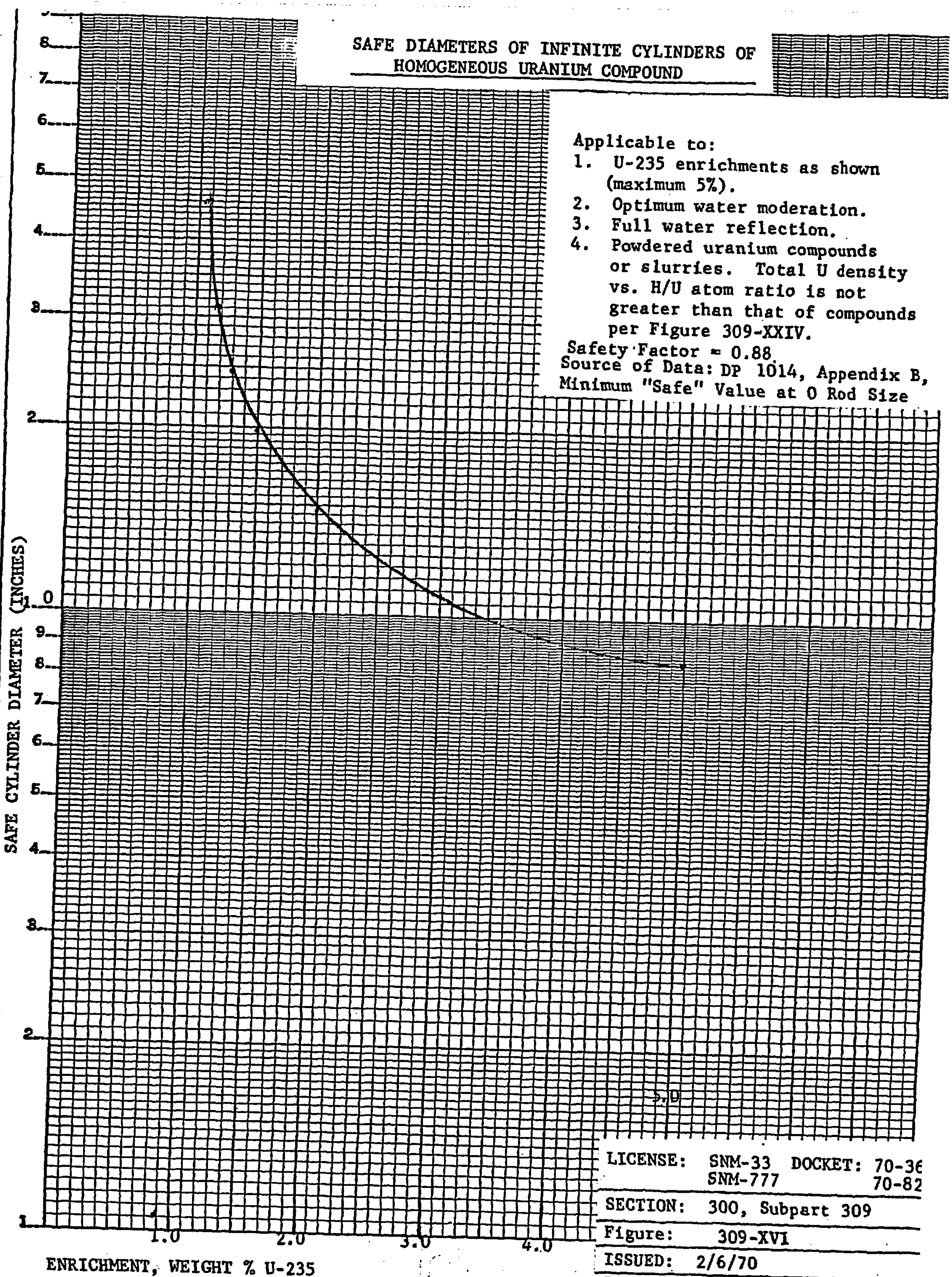
SAFE DIAMETERS OF INFINITE CYLINDERS OF HOMOGENEOUS URANIUM COMPOUND

Applicable to:

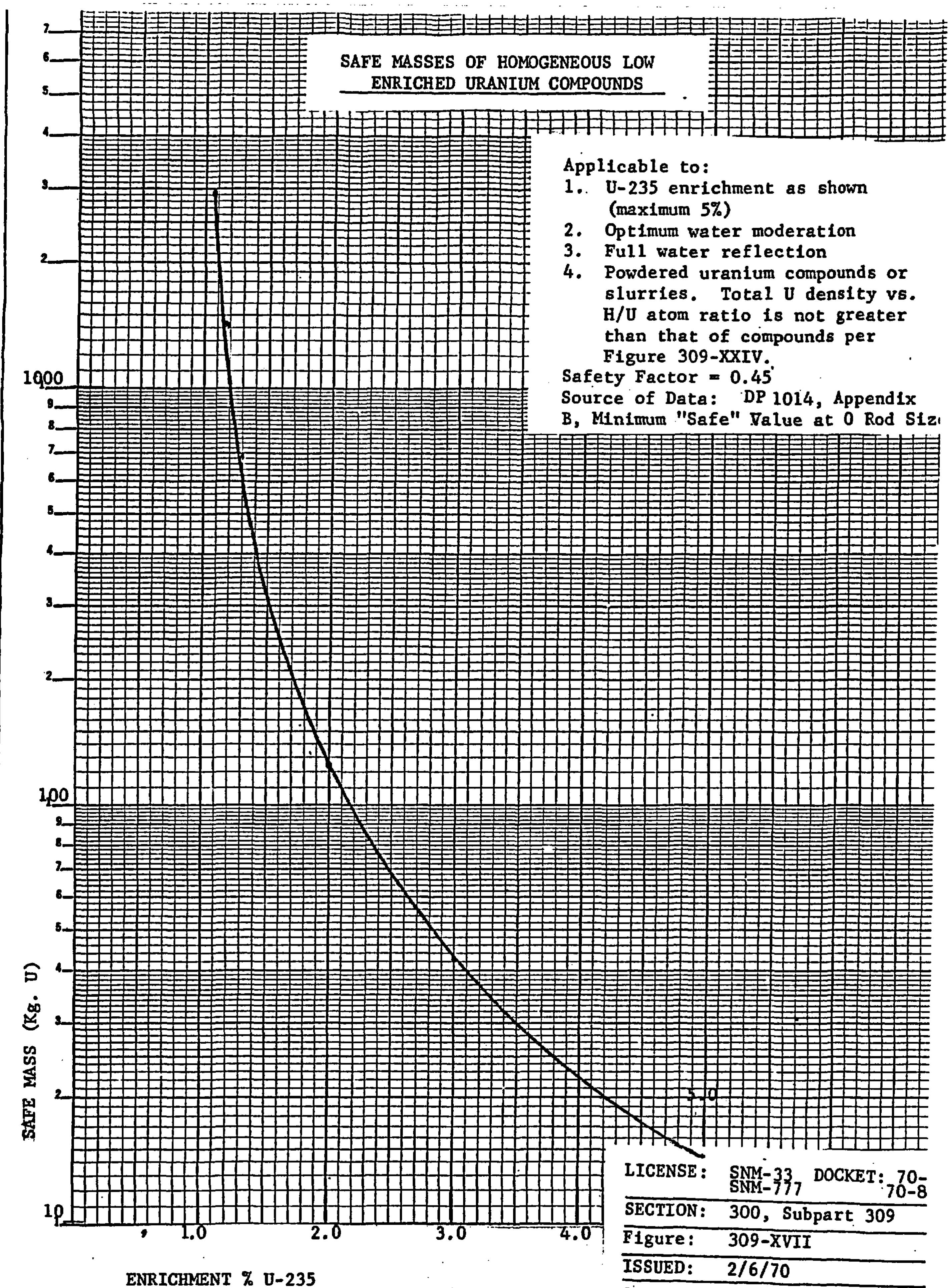
1. U-235 enrichments as shown (maximum 5%).
2. Optimum water moderation.
3. Full water reflection.
4. Powdered uranium compounds or slurries. Total U density vs. H/U atom ratio is not greater than that of compounds per Figure 309-XXIV.

Safety Factor = 0.88

Source of Data: DP 1014, Appendix B, Minimum "Safe" Value at 0 Rod Size

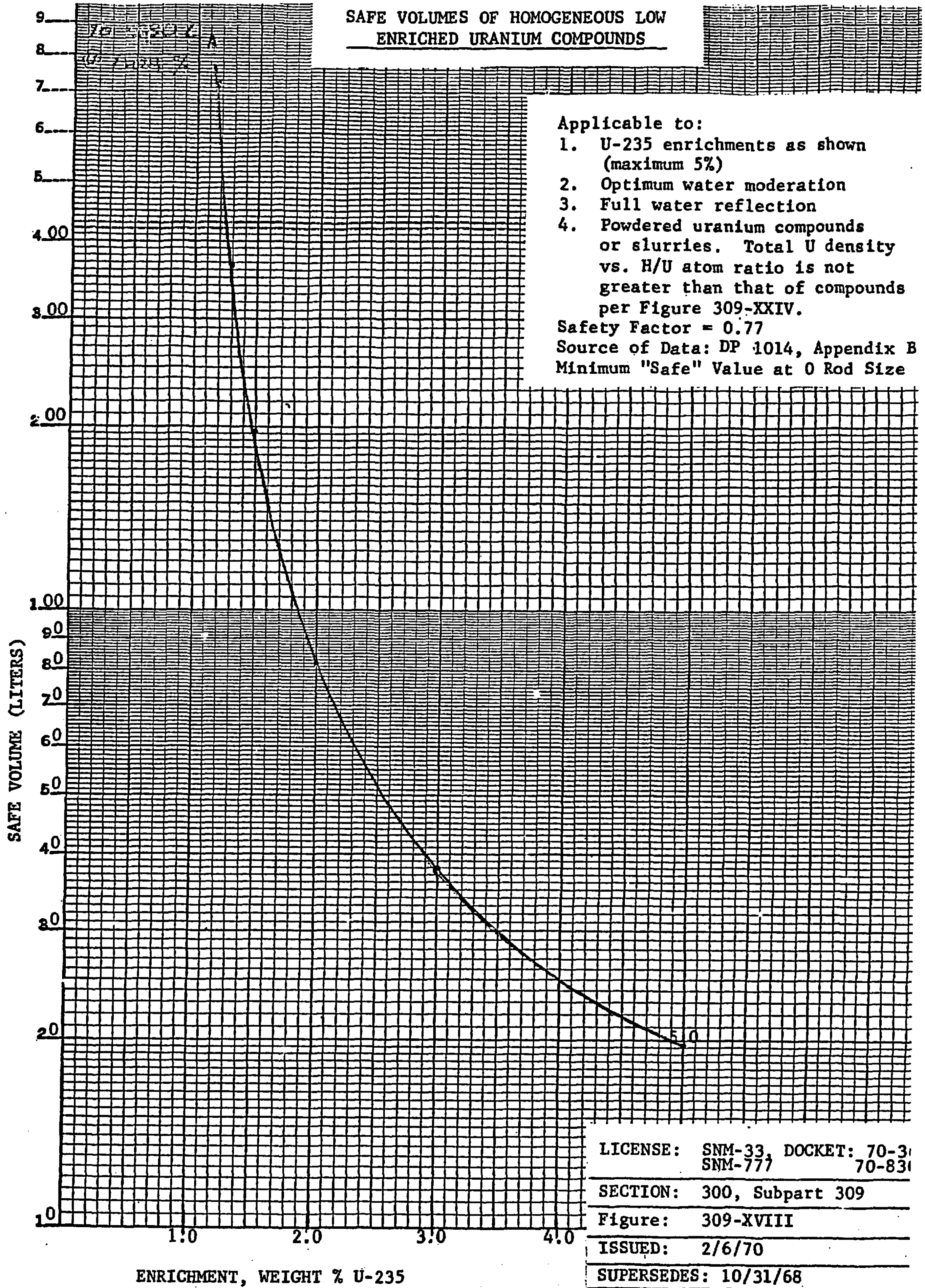


LICENSE: SNM-33 SNM-777	DOCKET: 70-36 70-82
SECTION: 300, Subpart 309	
Figure: 309-XVI	
ISSUED: 2/6/70	
SUPERSEDES: 10/31/68	
APPROVED:	
Amendment No.:	



LICENSE:	SNM-33 SNM-777 DOCKET: 70- 70-8
SECTION:	300, Subpart 309
Figure:	309-XVII
ISSUED:	2/6/70
SUPERSEDES:	10/31/68
APPROVED:	
Amendment No.:	

SAFE VOLUMES OF HOMOGENEOUS LOW ENRICHED URANIUM COMPOUNDS



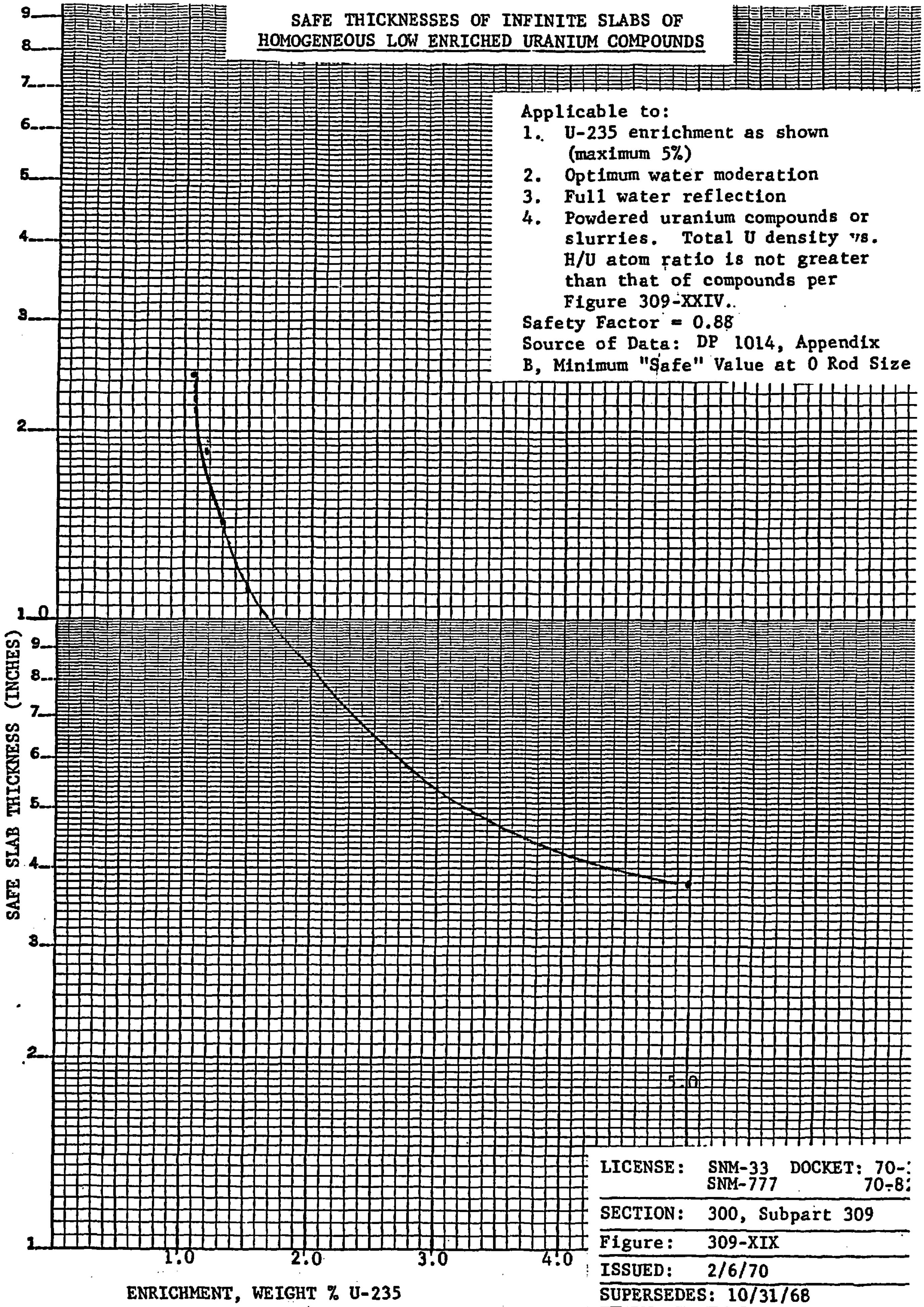
Applicable to:

1. U-235 enrichments as shown (maximum 5%)
2. Optimum water moderation
3. Full water reflection
4. Powdered uranium compounds or slurries. Total U density vs. H/U atom ratio is not greater than that of compounds per Figure 309-XXIV.

Safety Factor = 0.77
Source of Data: DP 1014, Appendix B
Minimum "Safe" Value at 0 Rod Size

LICENSE:	SNM-33, DOCKET: 70-3 SNM-777 70-83
SECTION:	300, Subpart 309
Figure:	309-XVIII
ISSUED:	2/6/70
SUPERSEDES:	10/31/68
APPROVED:	

SAFE THICKNESSES OF INFINITE SLABS OF HOMOGENEOUS LOW ENRICHED URANIUM COMPOUNDS



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SECTION:	300, Subpart 309
Figure:	309-XIX
ISSUED:	2/6/70
SUPERSEDES:	10/31/68
APPROVED:	
Amendment No.:	

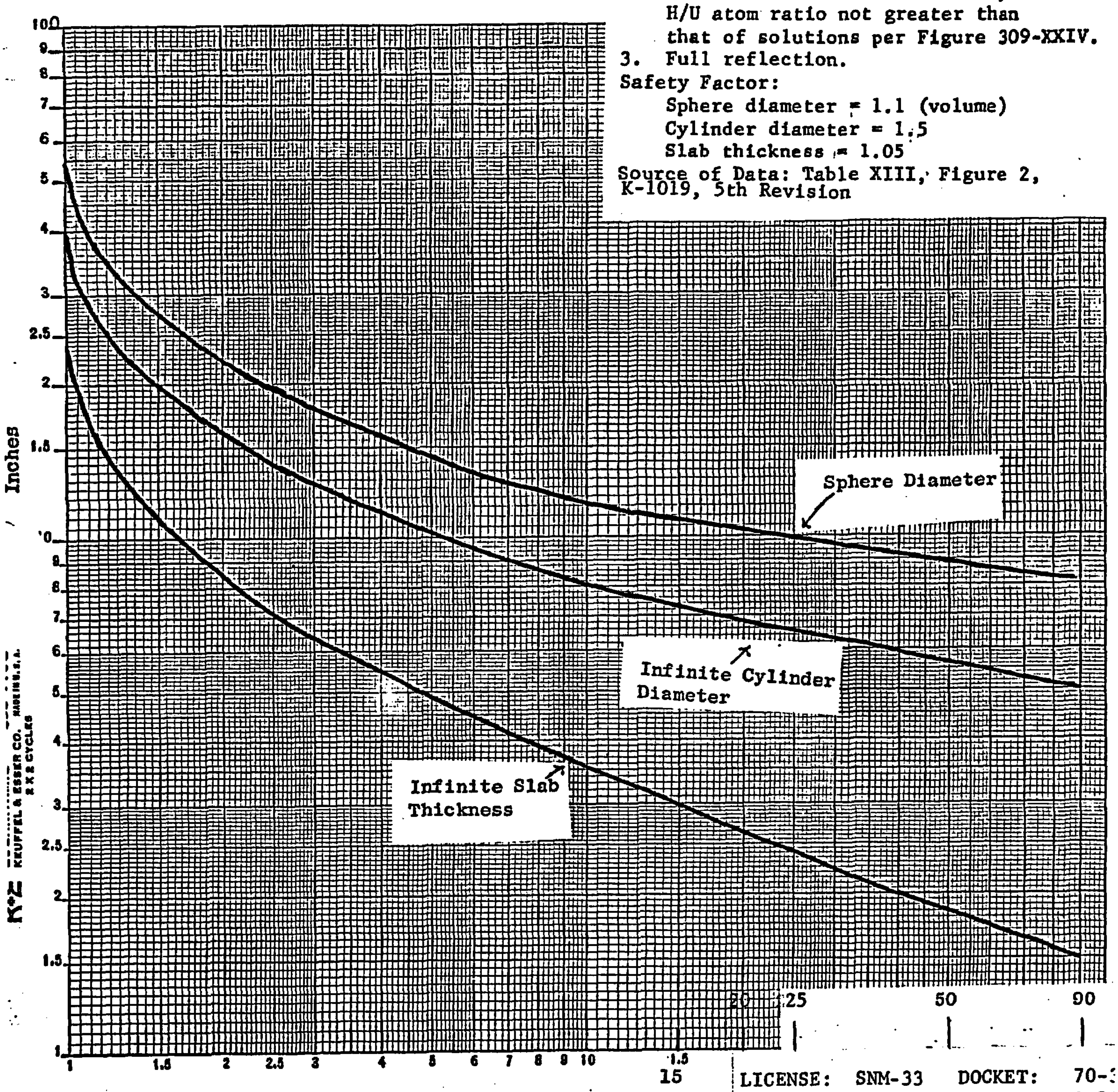
SAFE GEOMETRIC VARIABLES

FOR SPECIFIED U-235 ENRICHMENTS

Applicable to:
1. All U-235 enrichments.
2. Solutions with total U density vs. H/U atom ratio not greater than that of solutions per Figure 309-XXIV.
3. Full reflection.

Safety Factor:
Sphere diameter = 1.1 (volume)
Cylinder diameter = 1.5
Slab thickness = 1.05

Source of Data: Table XIII, Figure 2, K-1019, 5th Revision



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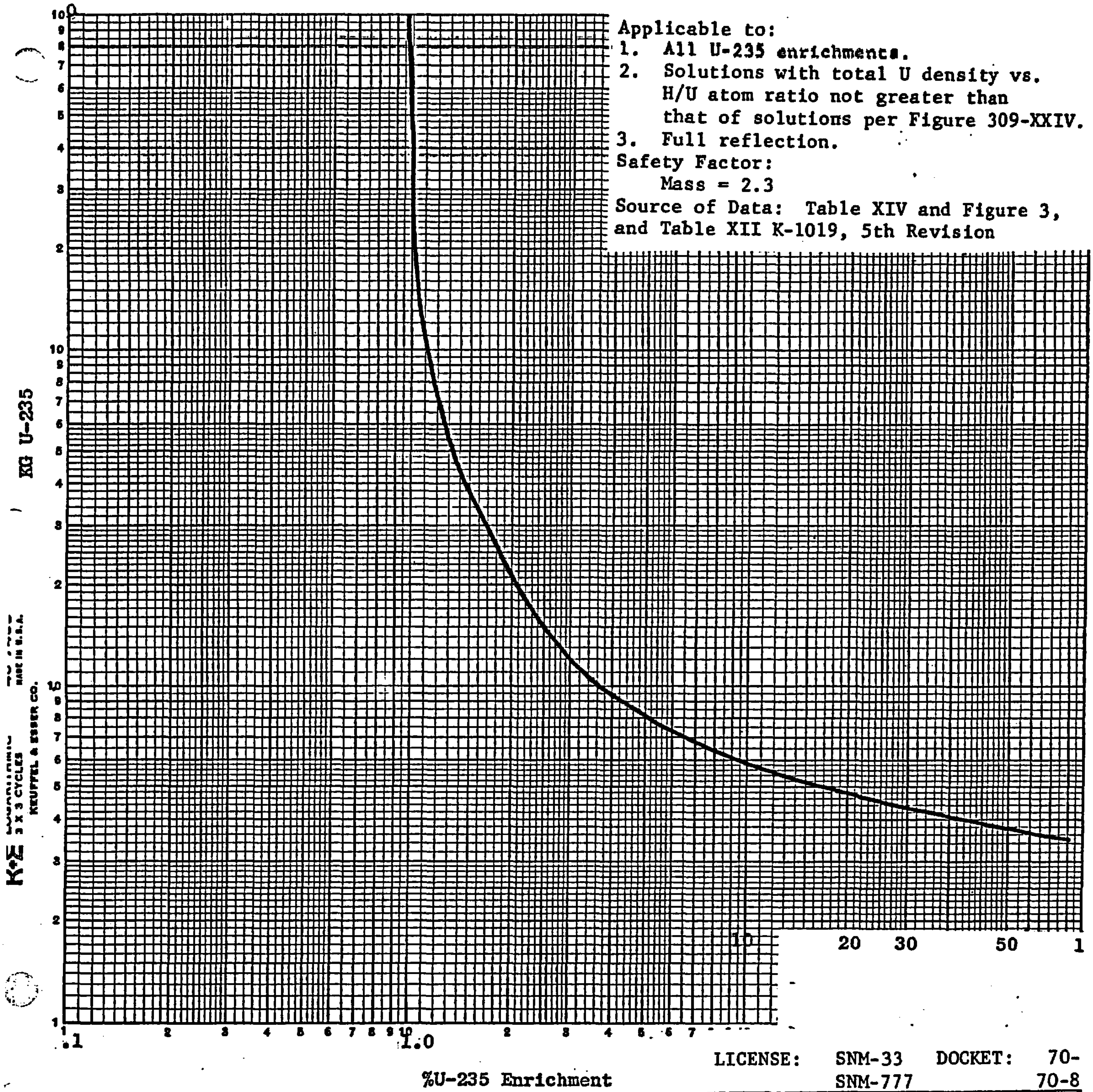
SECTION:	300, Subpart 309		
Figure:	309-XX		
ISSUED:	2/6/70		
SUPERSEDES:	10/31/68		
APPROVED:			

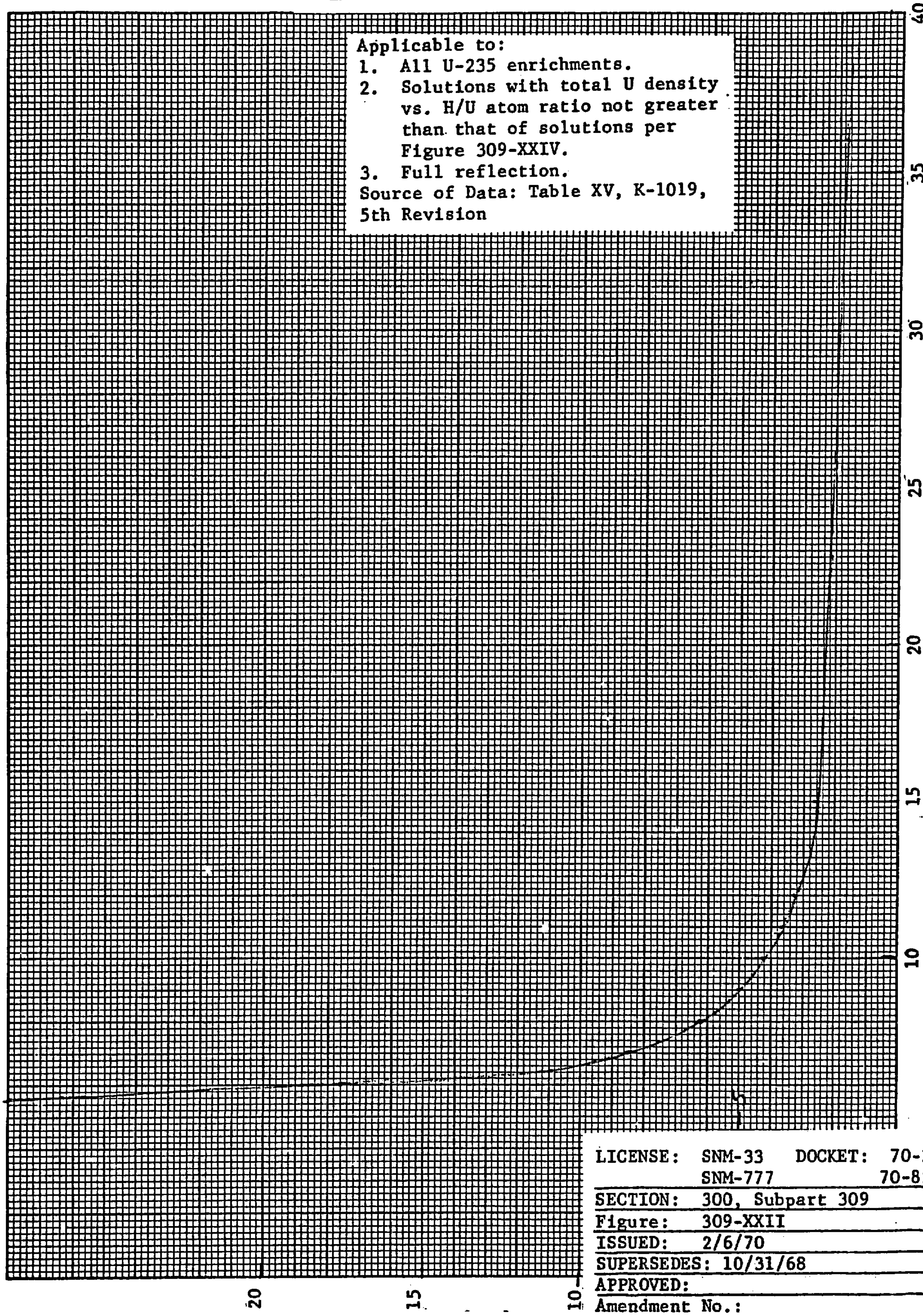
SAFE MASSES FOR

SPECIFIED U-235 ENRICHMENT



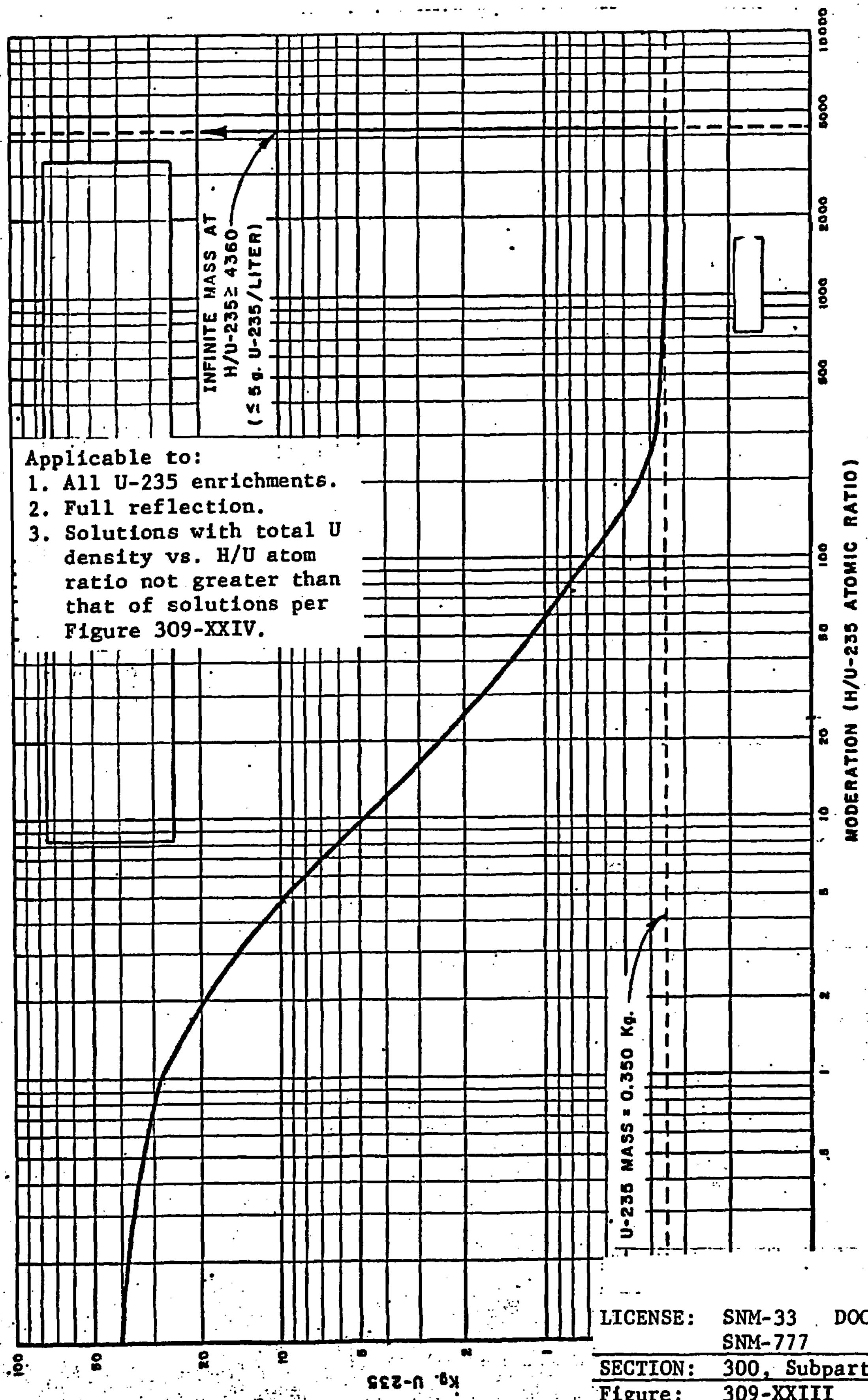
LICENSE:	SNM-33 SNM-777	DOCKET:	70- 70-8
SECTION:	300, Subpart 309		
Figure:	309-XXI		
ISSUED:	2/6/70		
SUPERSEDES:	10/31/68		
APPROVED:			
Amendment No.:			

SAFE CYLINDERS
ANY U-235 ENRICHMENT

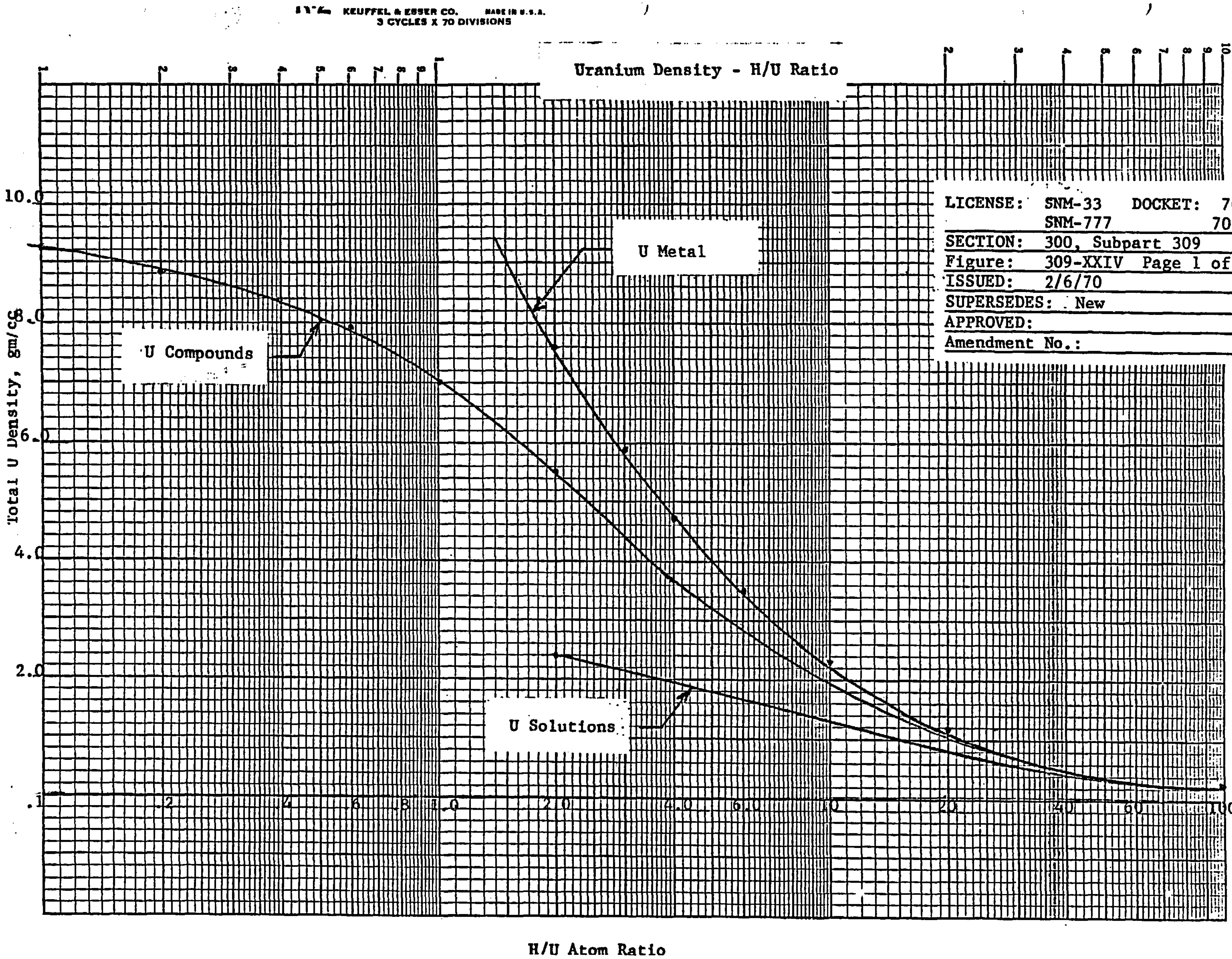


LICENSE:	SNM-33 DOCKET: 70-[illegible]
	SNM-777 70-8[illegible]
SECTION:	300, Subpart 309
Figure:	309-XXII
ISSUED:	2/6/70
SUPERSEDES:	10/31/68
APPROVED:	
Amendment No.:	

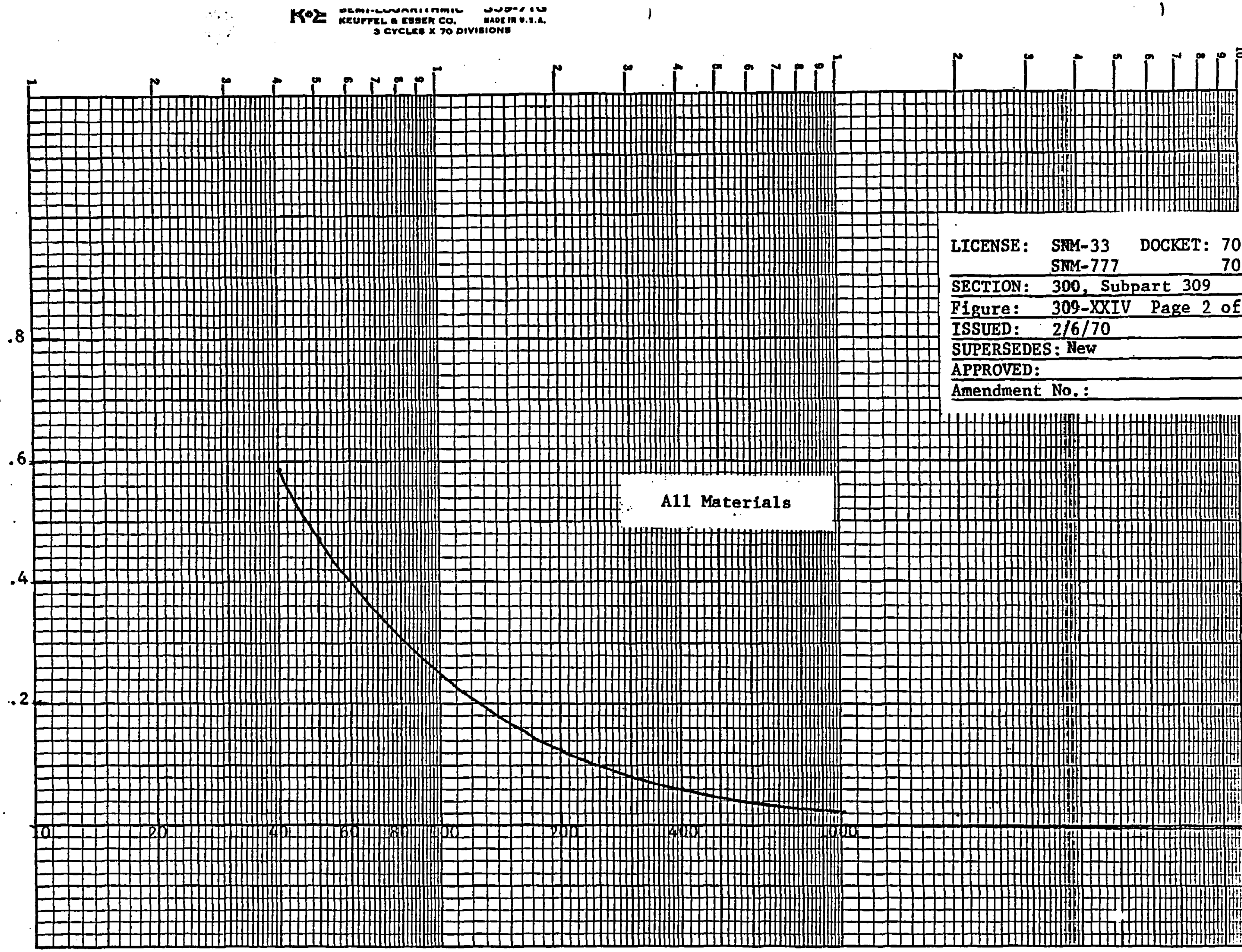
NUCLEARLY SAFE MASSES FOR SPECIFIED MODERATION



LICENSE:	SNM-33	DOCKET:	70-3(
	SNM-777		70-82(
SECTION:	300, Subpart 309		
Figure:	309-XXIII		
ISSUED:	2/6/70		
SUPERSEDES:	10/31/68		
APPROVED:			
Amendment No.:			



LICENSE:	SNM-33	DOCKET:	70-3
	SNM-777		70-82
SECTION:	300, Subpart 309		
Figure:	309-XXIV Page 1 of 2		
ISSUED:	2/6/70		
SUPERSEDES:	New		
APPROVED:			
Amendment No.:			



H/U Atom Ratio

LICENSE:	SNM-33 DOCKET: 70-36
	SNM-777 70-820
SECTION:	300, Subpart 309
Figure:	309-XXIV Page 2 of 2
ISSUED:	2/6/70
SUPERSEDES:	New
APPROVED:	
Amendment No.:	

Uranium Density vs. H/U Ratio

I. General

Nuclear criticality safety parameters are a function of uranium density and the degree of moderation of neutrons within the uranium system. Unless specifically stated otherwise, hydrogen in water is the most efficient moderator for which nuclear safety parameters have been established. The degree of moderation is measured by the ratio of the hydrogen to uranium atoms ($\frac{H}{U}$) of the system considered. Generally throughout the literature, the U-235 isotope is used as the reference for defining the density and moderation effects; however individual publications are usually confined to one enrichment level and use of U-235 as the reference is convenient. At the Commercial Products Division plants, uranium of all enrichments is processed. To standardize nuclear safety parameters, it is more convenient to work in terms of total uranium as it applies to density and degree of moderation; therefore, unless specifically stated otherwise, total uranium will be used in all discussions and data involved in the relationship between density and H/U ratio.

II. Material Types

The types of material processed at Commercial Products Division facilities falls into four physical categories:

- Solutions
- U Metal and compound water mixtures
- U Metal
- U alloys with aluminum, zirconium and stainless steel

The relationship of uranium density and H/U ratio for water mixtures of metal and compounds and solution is shown on Figure 1. Based on this figure, there are three standard curves for uranium density and H/U ratio. These are for:

- Uranium Metal
- Uranium Compounds
- Uranium Solutions

A. Uranium Compounds

The density vs. H/U relationship of UO_2 is the maximum for uranium compounds processed by CPD.

Uranium Compounds (continued)

Water mixtures of uranium compounds are subject to the most variation of the density and H/U relationship which is caused by the variation of the maximum theoretical density of the individual compounds and weight fraction of uranium in the compound. The typical compounds processed by CPD are UO_2, U_3O_8, UF_4, UO_2F_2, UO_4, and ADU (ammonium diuranate). Of these UO_2 has the maximum density for a given H/U level. This is illustrated on Figure 1 and Table 1. For purposes of establishing standard nuclear criticality safety parameters for compounds, the total uranium density vs. H/U relationship for UO_2 is established as the upper limit for which such standards are applicable.

The maximum theoretical density has been used to develop the data of Table 1 and Figure 1. These maximum densities can be achieved only by special ceramic processing such as the process of making UO_2 pellets from UO_2 powder. These densities are not possible from the chemical process of converting UF_6 to UO_2 or recovery of uranium from scrap and residues; these processes result in a UO_2 powder having a maximum bulk density of 4 kg U/liter corresponding to an H/U of 4. Accordingly, standards for compounds in homogeneous form are applicable to this level. Standards for compounds having bulk densities in excess of 4 kg U/liter are applicalbe to densities up to the theoretical maximum.

Experiments to determine effect on density when water is added to dry UO_2 powder were unsuccessful. The water would not "wet" the powder without special agitation causing a reduction of the density.

This is typical of plant applications. The oxide does not achieve the upper density levels except when it has been dried. The maximum density limit is just that, i.e., dry powder introduced into a wet process is either added to the liquid in incremental quantities (which action reduces its density) or the liquid is added to the powder (which action requires mechanical mixing) also reducing the density.

B. <u>Uranium Solutions</u>

The density vs. H/U relationship for UO_2F_2 solutions is the maximum for uranium solutions processed at CPD.

Historically, UO_2F_2 solutions have been used in experimental measurements of critical parameters because it permitted the highest concentration and lowest non-fissioning absorption cross section of solutions generally processed. A review of solutions processed at CPD confirms this; the most typical solution being uranyl nitrate. These data are also illustrated in Figure 1 and Table 1.

For purposes of establishing standard nuclear criticality safety parameters for solutions the density vs. H/U relationship of UO_2F_2 solutions is established as the upper limits for which the standards will be applicable.

C. Uranium Metal

The relationship of metal density versus H/U shown on Figure 1 is that obtained from Table 1, TID 7028. This is the maximum possible density for any form of uranium. Safe parameter standards for uranium metal are based on this relationship.

D. Alloys

The effect of the relationship of uranium density to H/U ratio for alloys has been included in the special calculations (NDEO 1050) performed for the alloys. Safe parameters are reported as a function of the U-235 content of the alloy.

III. Development of the Density vs. H/U Ratio

A. Compounds and Water Mixtures

The relationship for uranium compounds and water mixture is based on the maximum theoretical density of the compound and the volume additive mixtures of the compound with water. Specifically H/U ratios were calculated from the formula:

$$\frac{H}{U} = \frac{\text{Weight } H_2O \times 2\,\frac{\text{atom H}}{\text{mole } H_2O} \times 238\,\frac{\text{weight U}}{\text{mole U}}}{18\,\frac{\text{weight } H_2O}{\text{moles } H_2O} \times \text{weight U} \times 1\,\frac{\text{atom U}}{\text{mole U}}}$$

$$= 26.45 \left(\frac{\text{weight } H_2O}{\text{weight U}}\right)$$

The data plotted on Figure 1 and calculated by the above formula is tabulated on Table 1.

B. Metal Water Mixtures

The relationship for uranium metal and water mixtures has been obtained from the data of Figures 1 through 4, TID-7016, Rev. 1.

SNM-33, Docket 70-36
LICENSE: SNM-777, Docket 70-820
SECTION: 300, Figure 309-XXIV
Nuclear Safety Evaluation, Density vs. H/U Ratio
Page 3 of 4
APPROVED:
ISSUED: 2/6/70
SUPERSEDES: New

C. Solutions

The data for solutions has been obtained from Figure 1, K-1019, 5th Revision.

In examining Figure 1 it can be seen that all of the curves converge into a single curve at an H/U ratio of approximately 20 and a density of approximately 1. This single curve follows that of the solution curve for H/U ratios in excess of 20. Unless specifically stated otherwise, safe parameters for all systems with H/U ratios greater than 20 will therefore follow those of solutions.

TABLE 1

Ex.4

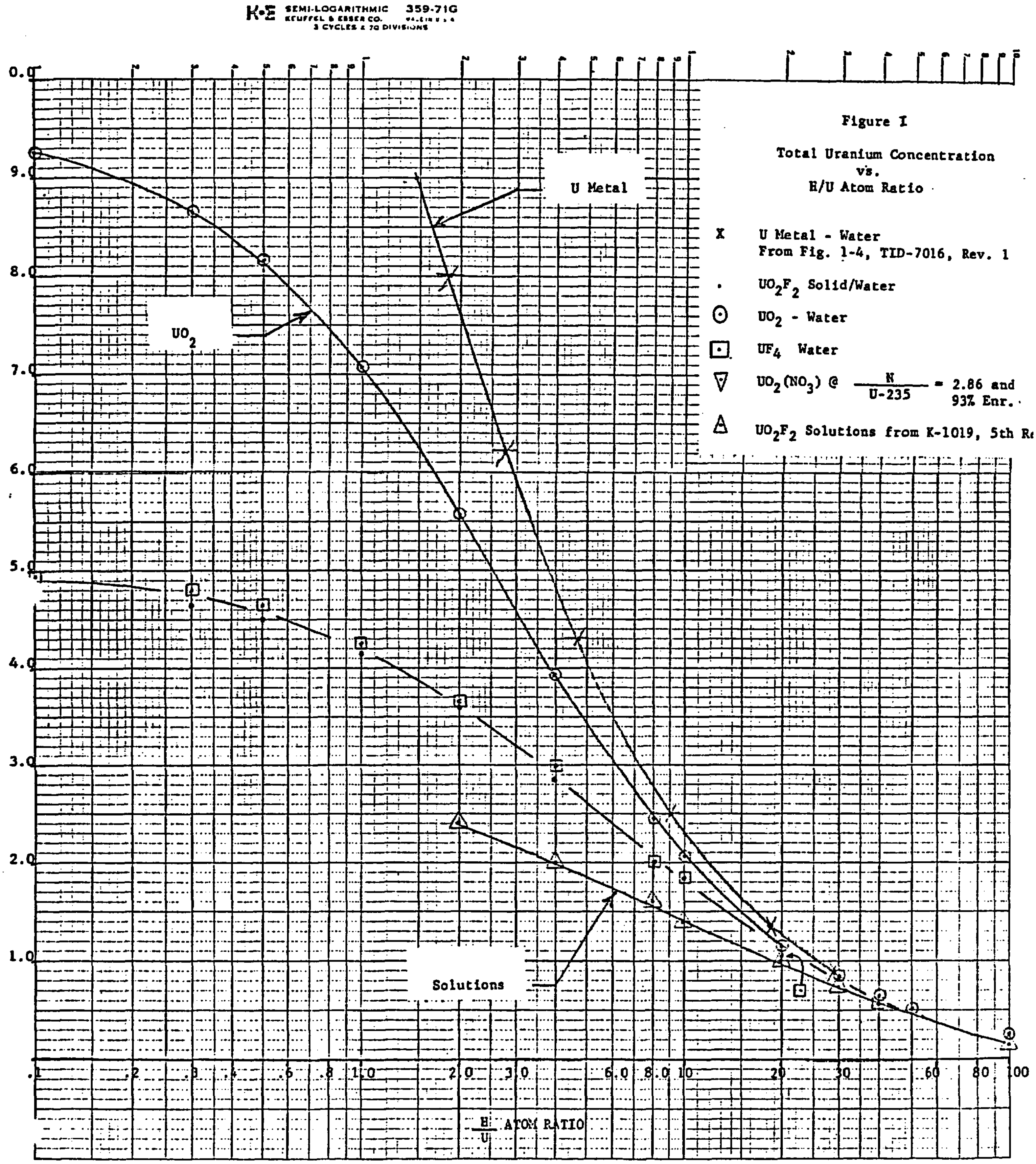
$\frac{H}{U}$	Density, grams U/cc					
					(UO_2) (NO_3) @ N/U-235 = 2.86 Enriched *	
	UO_2	UF_4	UO_2F_2 Solid	UO_2F_2 Solution [2]	H/U	Density
0						
.1						
.3						
.5						
1						
2						
4						
8						
10						
20						
30						
40						
50						
100						
200						
600						
1000						

Ex. 4

(1) Based on maximum theoretical density of compound reported by Katz & Rabinowitch, The Chemistry of Uranium, First Edition.

(2) Figure 1, K-1019, 5th Rev.

* Figure 2.5 NDEO-1050


K+E SEMI-LOGARITHMIC 359-71G
KEUFFEL & ESSER CO.
3 CYCLES X 70 DIVISIONS
Figure I
Total Uranium Concentration
vs.
H/U Atom Ratio
X U Metal - Water
From Fig. 1-4, TID-7016, Rev. 1
UO2F2 Solid/Water
UO2 - Water
UF4 Water
UO2(NO3) @ N/U-235 = 2.86 and 93% Enr.
UO2F2 Solutions from K-1019, 5th R
U Metal
UO2
Solutions
0.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
.1
.2
.3
.4
.6
.8
1.0
2.0
3.0
6.0
8.0
10
20
30
60
80
100
H/U ATOM RATIO

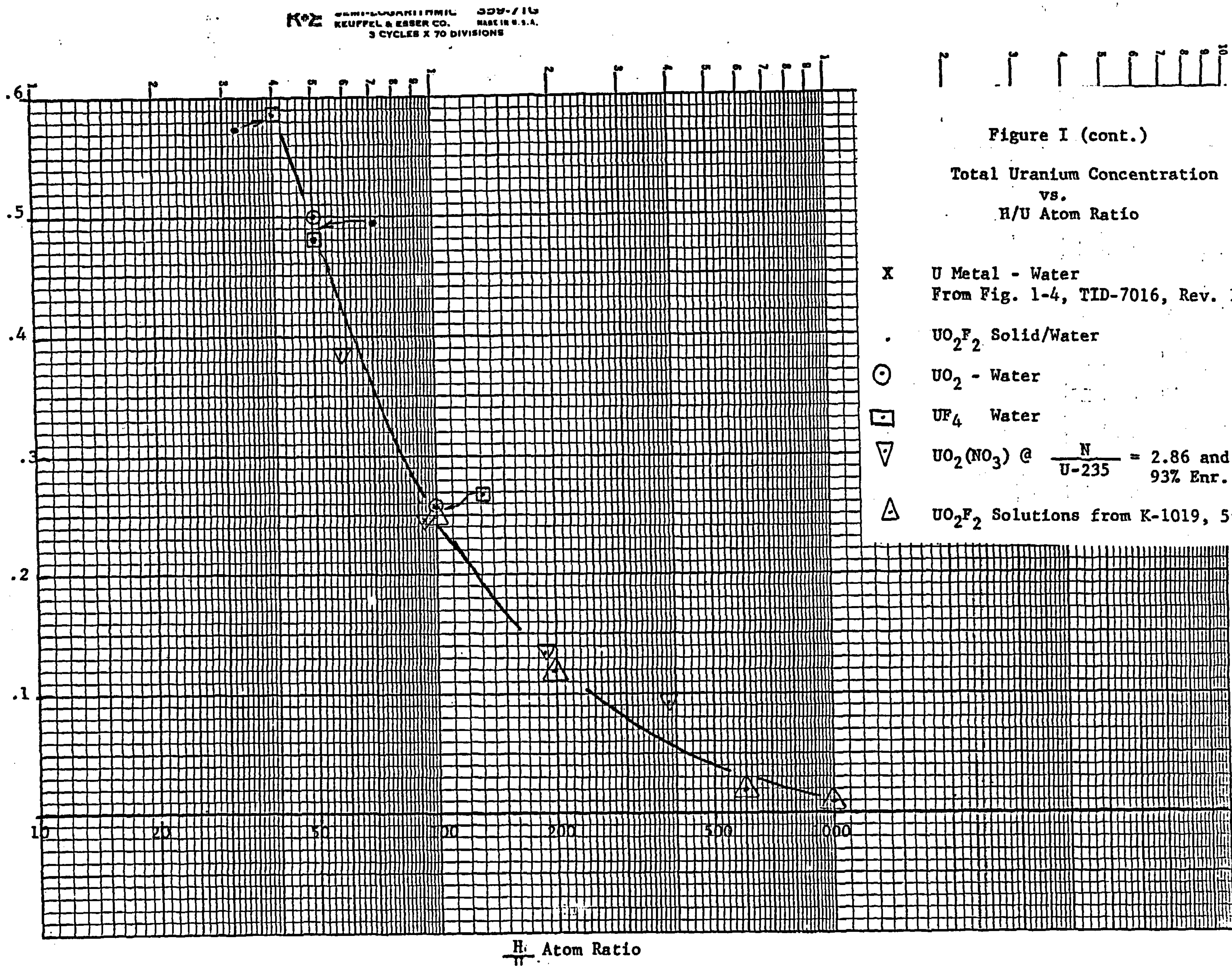


Figure I (cont.)

Total Uranium Concentration
vs.
H/U Atom Ratio

X U Metal - Water
From Fig. 1-4, TID-7016, Rev. 1

· UO_2F_2 Solid/Water

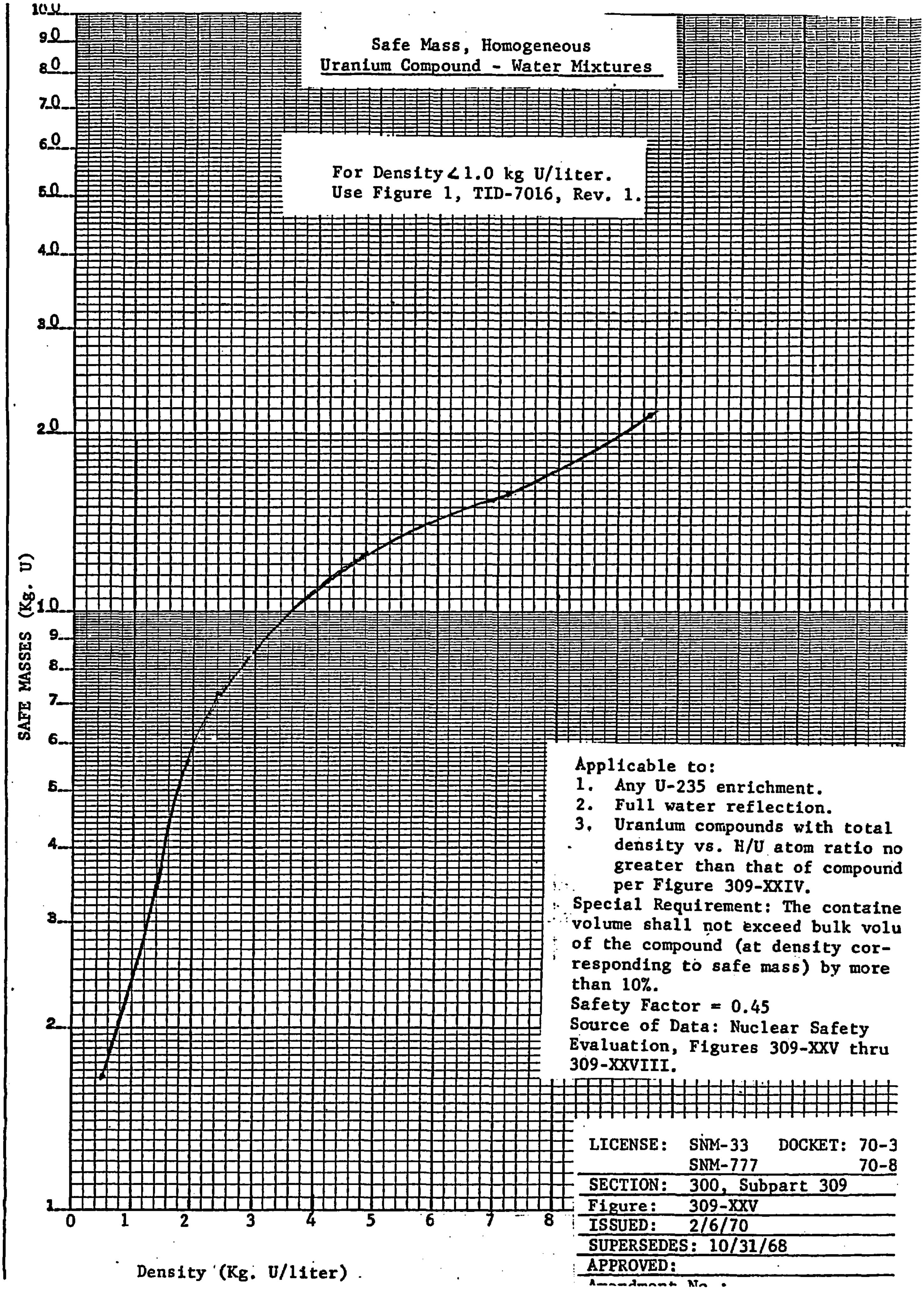
⊙ UO_2 - Water

⊡ UF_4 Water

▽ $UO_2(NO_3)$ @ $\frac{N}{U-235}$ = 2.86 and 93% Enr.

△ UO_2F_2 Solutions from K-1019, 5th R

Safe Mass, Homogeneous Uranium Compound - Water Mixtures



For Density ∠ 1.0 kg U/liter.
Use Figure 1, TID-7016, Rev. 1.

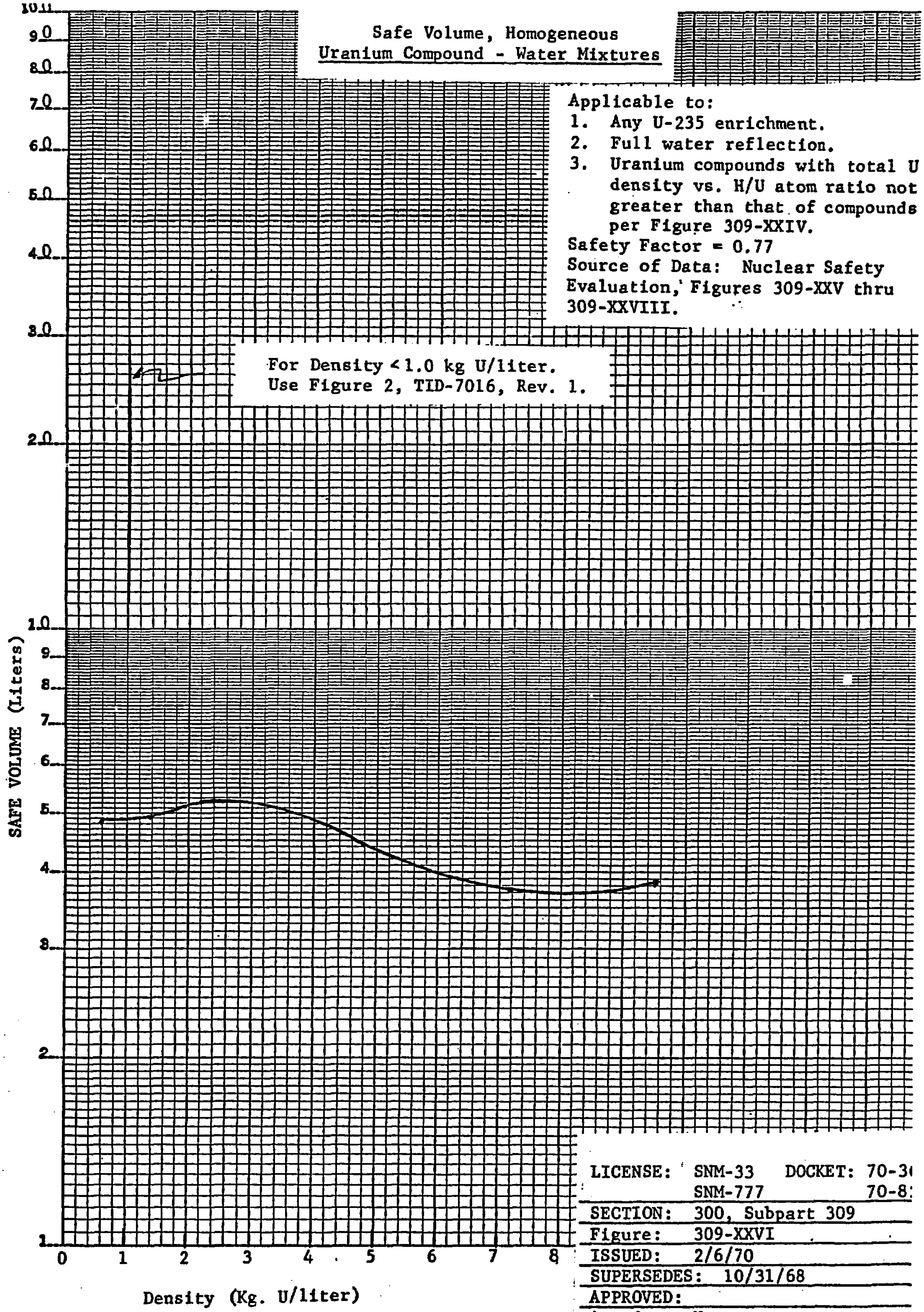
Applicable to:
1. Any U-235 enrichment.
2. Full water reflection.
3. Uranium compounds with total density vs. H/U atom ratio no greater than that of compound per Figure 309-XXIV.

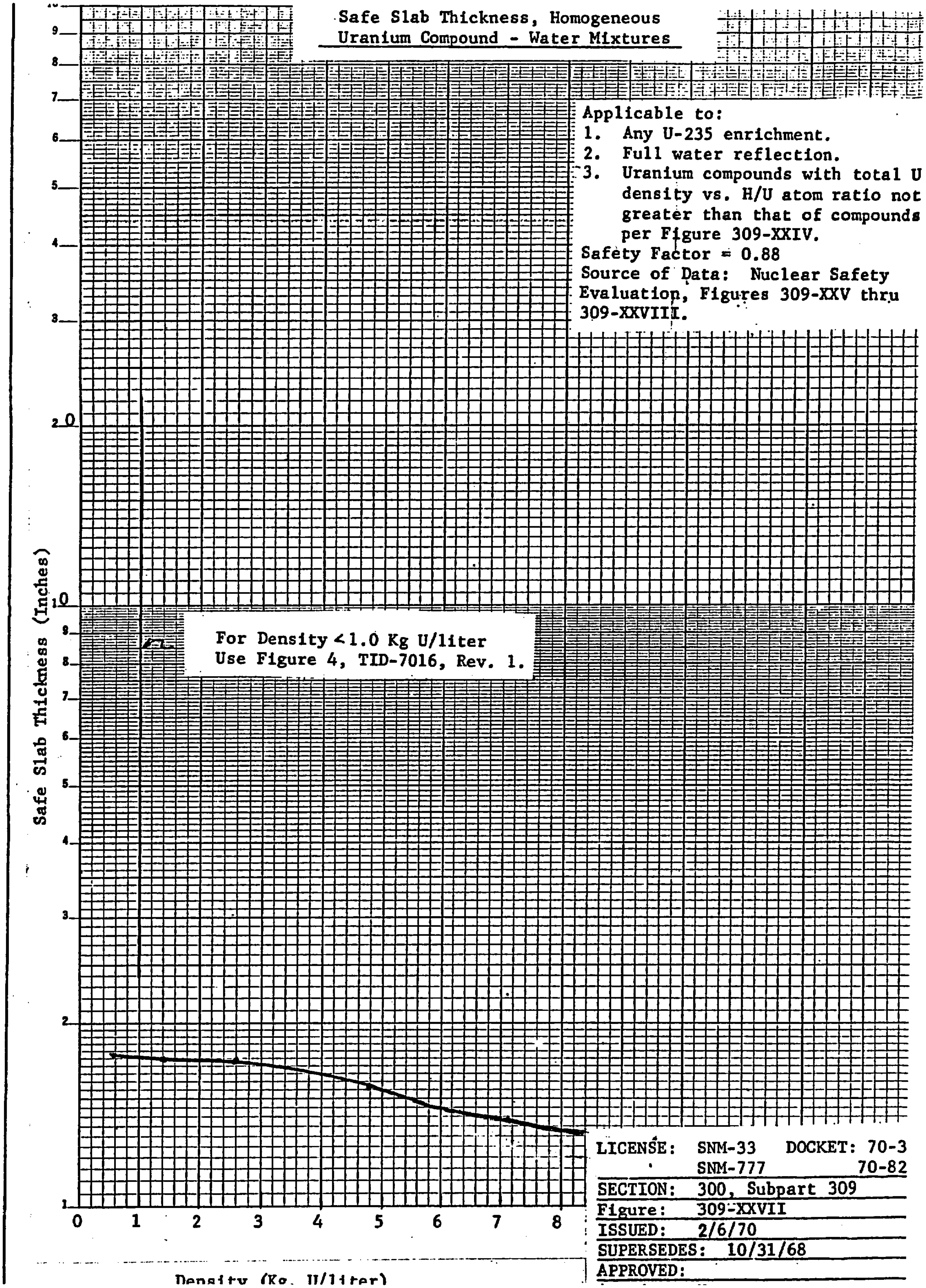
Special Requirement: The containe volume shall not exceed bulk volu of the compound (at density corresponding to safe mass) by more than 10%.

Safety Factor = 0.45

Source of Data: Nuclear Safety Evaluation, Figures 309-XXV thru 309-XXVIII.

LICENSE:	SNM-33	DOCKET:	70-3
	SNM-777		70-8
SECTION:	300, Subpart 309		
Figure:	309-XXV		
ISSUED:	2/6/70		
SUPERSEDES:	10/31/68		
APPROVED:			
Amendment No.:			


Safe Volume, Homogeneous
Uranium Compound - Water Mixtures
Applicable to:
1. Any U-235 enrichment.
2. Full water reflection.
3. Uranium compounds with total U density vs. H/U atom ratio not greater than that of compounds per Figure 309-XXIV.
Safety Factor = 0.77
Source of Data: Nuclear Safety Evaluation, Figures 309-XXV thru 309-XXVIII.
For Density < 1.0 kg U/liter.
Use Figure 2, TID-7016, Rev. 1.
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
9
8
7
6
5
4
3
2
1
SAFE VOLUME (Liters)
0
1
2
3
4
5
6
7
8
Density (Kg. U/liter)
LICENSE: SNM-33 DOCKET: 70-3
SNM-777 70-8
SECTION: 300, Subpart 309
Figure: 309-XXVI
ISSUED: 2/6/70
SUPERSEDES: 10/31/68
APPROVED:



LICENSE:	SNM-33	DOCKET: 70-3
	SNM-777	70-82
SECTION:	300, Subpart 309	
Figure:	309-XXVII	
ISSUED:	2/6/70	
SUPERSEDES:	10/31/68	
APPROVED:		

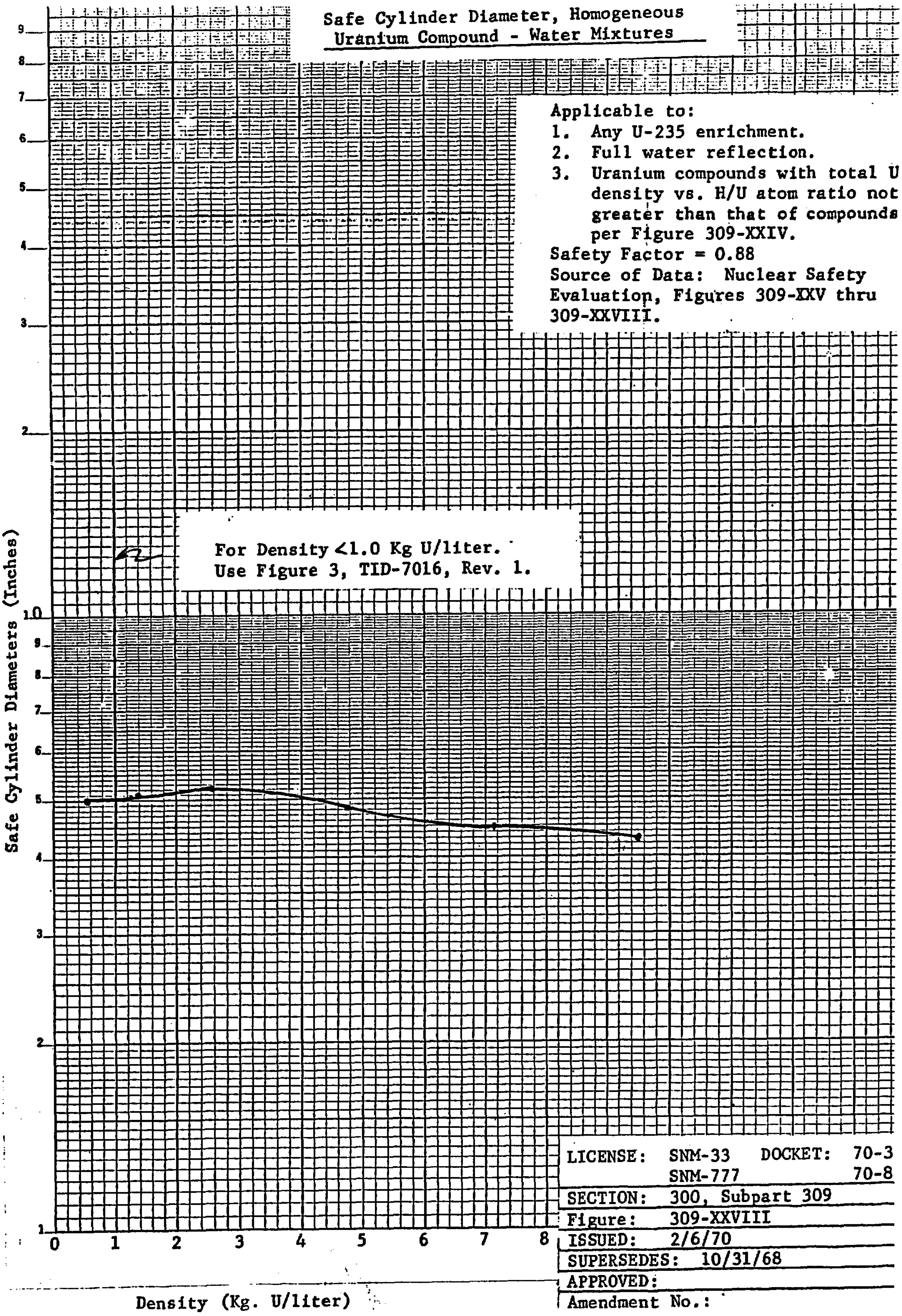
Safe Cylinder Diameter, Homogeneous Uranium Compound - Water Mixtures

Applicable to:

1. Any U-235 enrichment.
2. Full water reflection.
3. Uranium compounds with total U density vs. H/U atom ratio not greater than that of compounds per Figure 309-XXIV.

Safety Factor = 0.88

Source of Data: Nuclear Safety Evaluation, Figures 309-XXV thru 309-XXVIII.



LICENSE:	SNM-33	DOCKET:	70-3
	SNM-777		70-8
SECTION:	300, Subpart 309		
Figure:	309-XXVIII		
ISSUED:	2/6/70		
SUPERSEDES:	10/31/68		
APPROVED:			
Amendment No.:			

Critical and Safe Homogeneous Uranium Compound - Water
Cylinder Diameters and Slab Thicknesses at all Enrichments

	Density		Cylinder				Slab			
H/U-235	U-235 (Kg./L)	Total U Kg. U/L	$R_{c,r}$ (cm)	$D_{s,r}$ (1) (in.)	$R_{c,b}$ (cm)	$D_{s,b}$ (1) (in.)	$T_{c,r}$ (cm)	$T_{s,r}$ (2) (in.)	$T_{c,b}$ (cm)	$T_{s,b}$ (2) (in.)
0										
0.98										
2.94										
8.96										
20.60										
43.90										

Ex. 4

NOTE: (1) $D_s = \frac{2 R_c \text{(cm)}}{2.54 \text{ (cm/in.)} \times 1.13 \text{ s.f.}} = .693 R_c$, where R_c values are obtained from Table V-K, LA-3612

(2) $T_s = \frac{T_c \text{(cm)}}{2.54 \text{ (cm/in.)} \times 1.13 \text{ s.f.}} = .346 T_c$, where T_c values are obtained from Table V-K, LA-3612

Subscripts: c = critical
s = safe
b = bare
r = full water reflector
s.f. = safety factor

Critical and Safe Homogeneous Uranium Compounds - Water Volumes and Masses at all Enrichments

% U-235	Density U-235 (Kg./L)	Density Total U Kg U/L	Sphere $V_{c,r}$ (1) (Liters)	$V_{s,r}$ (2) (Liters)	$V_{c,b}$ (1) (Liters)	$V_{s,b}$ (2) (Liters)	Mass $M_{c,r}$ (3) (Kg. U-235)	$M_{s,r}$ (4) (Kg. U)	$M_{c,b}$ (3) (Kg. U-235)	$M_{s,b}$ (4) (Kg. U)
.98										
.94										
.96										
.60										
.90										

Ex. 4

NOTE: (1) $V_c = 4/3 \pi R_c^3$ where R_c values are obtained from Table V-K, LA-3612

(2) $V_s = .77 V_c$

(3) $M_c = V_c \rho$

(4) $M_s = \frac{.45 M_c}{.935}$

Subscripts: c = critical
s = safe
b = bare
r = full water reflector

LICENSE: SNM-33 Docket: 70-36	
SNM-777 70-820	
SECTION: 300, Subpart 309	
Nuclear Safety Evaluation-Data fo Figures 309-XXV thru XXVIII	
Page 2 of 2	
ISSUED: 2/6/70	
SUPERSEDES: New	
APPROVED:	

SECTION 400

SECTION 400 - HEALTH STANDARDS

LICENSE: SNM-777, Docket: 70-820
SECTION: 400 - HEALTH PHYSICS STANDARDS
Subsection: .401 - General Health Physics Requirements

Approved

ISSUED October 31, 1968

SUPERSEDES New

401. General Health Physics Requirements

The Radiation Protection Program shall comply with the standards established in Title 10, Code of Federal Regulations, Part 20, the Standards of this Subsection and the requirements of other regulatory agencies.

Internal procedures and/or data forms are used in performing and documenting the health physics functions in accordance with this section. Changes to these procedures shall be reviewed by the Health Physics Specialist or Health Physic Consultant prior to approval by the Manager of the Nuclear and Industrial Safety Department, Commercial Products Division.

1. Surface Contamination*

1.1 Restricted Areas (As defined in 10 CFR 20)

Action	Contamination Action Level (Excluding Process Equipment)
Immediate Cleanup	10,000 alpha dpm/100 cm^2 removable (smear)
	100,000 beta dpm/100 cm^2 removable (smear)
End of Shift Cleanup	5,000 alpha dpm/100 cm^2 removable (smear)
	50,000 beta dpm/100 cm^2 removable (smear)

Material on processing equipment or fixed on surfaces shall be limited as required to control airborne radioactivity and external radiation exposures.

1.2 Unrestricted Areas (Release of Materials and equipment but does not include the abandonment of buildings)

1.2.1. The maximum amount of fixed alpha radioactivity in disintegrations per minute per 100 square centimeters shall not exceed 25,000.

1.2.2 The average amount of fixed alpha radioactivity in disintegrations per minute per 100 square centimeters shall not exceed 5,000.

1.2.3 The maximum amount of removable (capable of being removed by wiping the surface with a filter paper or soft absorbent paper) radioactivity (alpha or beta) in disintegrations per minute per 100 square centimeters shall not exceed 1,000.

1.3.4 The maximum level at one centimeter from the most highly contaminated surface measured with an open-window beta-gamma survey meter through a tissue equivalent absorber of not more than seven milligrams per square centimeter shall not exceed one millirad per hour.

*Apply to uranium, natural thorium and mixed fission and activation products.

401. General Health Physics Requirements (Con't)

The average radiation level at one centimeter from the contaminated surface measured in the same manner shall not exceed 0.2 millirad per hour.

2. Air and Gaseous Effluents

The radioactivity concentration limits of 10 CFR 20 will be followed.

3. Records

Records of Personnel Monitoring, Monitoring Surveys, Respiratory Protective Program Personnel Instructions and Instrument Maintenance and Calibration shall be maintained by Health Physics.

LICENSE: SNM-777, Docket: 70-820
SECTION: 400 - HEALTH PHYSICS STANDARDS
Subsection: 402 - Personnel Monitoring

402. Personnel Monitoring

Personnel Monitoring shall be supplied to each individual who is likely to receive a dose in excess of 25% of the applicable limits in 10 CFR 20 and those personnel who routinely work in the process areas.

1. Dosimetry

The personnel dosimeters shall be sensitive to an exposure of 25 millirem. Hand exposures will be determined by surveys. Exposures in excess of 25% of the applicable limits shall be investigated.

2. Bioassay

The urine analyses shall be sensitive to concentrations of 10 alpha dpm/liter. Insofar as possible, samples are collected after two days off the job as follows:

2.1 At the start and termination of employment.

2.2 On a routine schedule consistent with the degree of exposure and results of past samples but at least as follows:

Minimum Bioassay Frequency*

Area	Frequency
Clean or clear areas	Employment and termination
Intermediate or limited contaminated areas.	6 months
Contaminated or restricted areas	3 months
If respiratory protection is required, or if the radionuclides are in a soluble form	monthly

2.3 Following a suspected potential overexposure or ingestion of contaminated material.

2.4 The investigation and action levels follow:

2.4.1 All samples above 50 dpm/liter shall be investigated.

2.4.2 A sample in excess of 100 dpm/liter will require immediate restriction of the individual to jobs where airborne radioactivity levels are not expected to exceed 25% MPC. The individual will remain on restricted jobs until two consecutive samples less than 50 dpm/litter are obtained.

402. Personnel Monitoring

- 2.4.3 More intensive investigation shall be performed on the circumstances of exposure for persons who remain on restriction for three (3) or more resamplings.

* These frequencies apply to personnel spending 10% or more of their assigned work schedule in the area listed.

LICENSE: SNM-777, Docket: 70-820
SECTION: 400 - HEALTH PHYSICS STANDARDS
Subsection: 403 - Respiratory Protection Program

Approved

ISSUED October 31, 1968

SUPERSEDES New

403. Respiratory Protection Program

1. In circumstances in which adequate limitation of the inhalation of radioactive materials by use of process or other engineering controls is impractical, United Nuclear Corporation may permit an individual in a restricted area to be exposed to average concentrations of airborne radioactive materials in excess of the limits specified in Appendix B, Table I, Colum 1 of 10 CFR 20 provided:

1.1 The individual uses respiratory or other appropriate protective equipment such that the total intake, in any period of seven consecutive days by inhalation, ingestion or absorption, would not exceed that intake which would result from breathing the concentrations specified in Appendix B, Table I, Column 1 of 10 CFR 20 for a period of 40 hours.

1.2 UNC shall advise each respirator user that he may leave the area for relief from respirator use in case of equipment malfunction, physical or psychological discomfort, or any other condition that might cause reduction in the protection afforded the wearer.

1.3 UNC shall maintain a respiratory protection program adequate to assure that the objectives of 1.1 above is met. Such program shall include:

1.3.1 Air sampling and other surveys sufficient to identify the hazard, to evaluate individual exposure, and to permit proper selection of the respiratory protective equipment;

1.3.2 Procedures to assure proper selection, supervision and adequate training of personnel using such protective equipment;

1.3.3 Procedures to assure the adequate fitting of respirators and the testing of equipment for operability;

1.3.4 Procedures for maintenance to assure full effectiveness of respiratory protective equipment, including issuance, cleaning and decontamination, inspection, repair and storage.

1.3.5 Bio-assays of individuals and other surveys as may be appropriate to evaluate individual exposures and to assess protection actually provided; and

1.3.6 Records sufficient to permit periodic evaluation of the adequacy of the respiratory protective program.

403. <u>Respiratory Protection Program</u> (continued)

1.4 UNC has evaluated the protective equipment [(1)] and has determined that, when used to protect against radioactive material under the conditions of use to be encountered, such equipment is capable of providing a degree of protection at least equal to the protection factors listed in Table 403-I.[(2)]

2. United Nuclear Corporation shall not assign protection factors in excess of those given in Table 403-I, in selecting equipment.

(1) In evaluating respiratory protective equipment for use against radioactive materials to assure that the equipment provides the protection factors listed in Table 403-I, UNC may accept equipment approved under appropriate test schedules of the U. S. Bureau of Mines to the extent pertinent.

(2) The factors listed apply only to protection against radioactive materials. Additional precautions may have to be taken to protect against concurrent non-radiation hazards.

PROTECTION FACTORS FOR RESPRATORS

Description	Modes[1]	PROTECTION FACTORS 2/ Particulates and Vapors and Gases Except Tritium Oxide[3]	Tritium Oxide
I. AIR-PURIFYING RESPIRATORS			
Facepiece, half-mask		10	1
Facepiece, full		100	1
II. ATMOSPHERE-SUPPLYING RESPIRATOR			
1. Air-line respirator			
Facepiece, half-mask	CF	100	2
Facepiece, half-mask	D	100	2
Facepiece, full	CF	1000	2
Facepiece, full	D	500	2
Facepiece, full	PD	1000	2
Hood	CF	1000	2
Suit	CF	4/	4/
2. Self-contained breathing apparatus (SCBA)			
Facepiece, full	D	500	2
Facepiece, full	PD	1000	2
Facepiece, full	R	1000	2
3. Combination respirator			
Any combination of air-purifying and atmosphere supplying respirator.		Protection factor for type and mode of operation as listed above.	

1/ CF: continuous flow
D : demand
PD: pressure demand (i.e., always positive pressure)
R : recirculating

2/ (a) For purposes of this authorization the protection factor is a measure of the degree of protection afforded by a respirator, defined as the ratio of the concentration of airborne radioactive material outside the respiratory protective equipment to that inside the equipment (usually inside the facepiece) under the conditions of use. It is applied to the airborne concentration to determine the concentration inhaled by the wearer, according to the following formula:

$$\text{Concentration Inhaled} = \frac{\text{Airborne Concentration}}{\text{Protection Factor}}$$

2/ (b) The protection factors apply:

(i) only for individually fitted respirators worn by trained individuals and used and maintained under supervision in a well-planned respiratory protection program.

(ii) for air purifying respirators only when high efficiency particulate filters and/or sorbents appropriate to the hazard are used.

(iii) for atmosphere supplying respirators only when supplied with adequate respirable air.

3/ Excluding radioactive contaminants that present an absorption or submersion hazard.

4/ Appropriate protection factors must be determined taking account of the permeability of the suit to the contaminant under conditions of use. No protection factor greater than 1000 shall be used except as authorized by the Commission.

NOTE 1: Protection factors for respirators as may be approved in the future by the U. S. Bureau of Mines according to approval schedules for respirators to protect against airborne radionuclides may be used in lieu of the protection factors listed in this Table. Where additional respiratory hazards other than radioactive ones are present, especially those immediately dangerous to life, the selection and use of respirators shall also be governed by the approvals of the U. S. Bureau of Mines in accordance with their applicable schedules.

LICENSE: SNM-777, Docket: 70-820
SECTION: 400 - HEALTH PHYSICES STANDARDS
Subsection: 404 - Facility and Equipment Requirements

Approved

ISSUED October 31, 1968

SUPERSEDES New

404. Facility and Equipment Requirements

1. Zoning

The facility shall be zoned to define contamination areas, limited contamination areas and clear areas. Protective clothing or special clothing, shower and change facilities shall be provided for use in the contamination area. A sink and aplha survey meter or hand monitor shall be provided at the exit from the contamination area.

2. Ventilation

Air flow sahll be from the areas of lower to areas of higher contamination. Hoods, glove boxes, or local exhaust shall be provided as required to maintain airborne and surface contamination in the work areas within the limits under normal conditions. The type of equipment will depend upon the operation being ventilated, i.e., very dusty operations will be performed in glove boxes, while highly localized contamination sources such as product takeoff or grab sampling ports are ventilated with local exhaust, and the routine handling of uncontained SNM is performed in hoods. Fire prevention shall be considered in the design of ventilation equipment. Where operations are exhausted which generate high effluent temperatures, fire resistant filters will be used. Consideration will also be given to the potential for generating explosive atmospheres in glove boxes and appropriate safe design implemented. Ventilation equipment is required for operations generating airborne concentrations in excess of 25% of MPC with minimum air movement requirements as follows:

Fume hood face velocity	-	75 feet per minute
General purpose hood face velocity	-	150 feet per minute
Local exhaust	-	150 feet per minute
Glove boxes	-	sufficient negative pressure to control the operational hazard (except inert atmosphere boxes)

All process exhaust generating more than 25% of MPC during operations shall be filtered through high efficiency filters (nominal 99.97% for particles larger than 0.3 microns) or a scrubber system.

404. Facility and Equipment Requirements (continued)

3. Liquid Effluent

Process waste and laundry water is transferred to a lagoon or liquid handling system prior to discharge. Where particulate contaminants constitute a significant radioactive component of the liquid, filtration may be required before discharge. The contamination level of these effluents is monitored.

LICENSE: SNM-777, Docket: 70-820
SECTION: 400 - HEALTH PHYSICS STANDARDS
Subsection: 405 - Instrumentation

Approved

ISSUED October 31, 1968

SUPERSEDES New

405. Instrumentation

The minimum instrumentation required for operational surveillance is listed below. All instruments are calibrated quarterly or in accordance with the manufacturer's recommendations. The manufacturer's calibration of flowmeters, velometers, rotameters and orifices are used.

1. Nuclear Alarm System

The nuclear alarm system consists of gamma sensitive detectors, audible alarms and remote indicator panel at or near the guard station. The requirements for this alarm system follow:

1.1 Detector units shall have a pre-set alarm level of not less than 5 MR/hr or greater than 20 MR/hr.

1.2 Detector units shall also have a response time no greater than 3 seconds at a radiation level of 20 MR/hr.

1.3 Detectors shall be located so as to be capable of detecting and operating the alarm from an incident of the magnitude that would result in a gamma flux of 3×10^5 mrem/hr one (1) foot from the source of radiation.

1.4 Detectors shall be installed within 120 feet of every location where 500 grams or more of Special Nuclear Material is handled, used, or stored.

1.5 Whenever possible, the location and spacing of the detectors is chosen to avoid the effect of shielding by massive equipment or materials. Low density materials of construction such as 2 x 4 stud construction walls, plaster or metal corrugated panels, asbestos panels, doors, panel walls and steel office partitions are disregarded in determining the spacing. The spacing is reduced where high density building materials such as brick, concrete, concrete or cinder blocks, or lead-lined x-ray rooms, shield a potential accident area from the detector.

Calculations to determine adequate coverage through significant shielding materials is performed using the following formula:

$$I = \frac{I_0 (e^{-\mu t})}{d^2}$$

where I = gamma intensity at the detector (minimum for calculations will be 20 mrem/hr)

405. Instrumentation (continued)

I_o = Unattenuated gamma intensity one (1) foot from the flux source

μ = mass absorption cross section of the shielding material x density of the shield

t = thickness of shield in centimeters. Where angle of incidence θ is not 90° to the plane of the barrier, t will assume the dimension, csc θ t.

d = distance from source in feet.

Such calculations will not include the effect of broad beam attenuation. An example of the calculational technique is shown in the health physics evaluation for this subsection.

1.6 The detector and alarm circuits shall be equipped with an auxilliary self starting diesel generator which will automatically supply power to the system in the event of disruption of primary power. This backup power system will be checked at least quarterly.

1.7 The system will be tested by sounding the alarm at least monthly and at the time of each practice evacuation drill.

1.8 Automatic monitors shall give warning in case of any malfunction which renders the system inoperable.

1.9 The alarm shall be clearly audible in all portions of areas in which Special Nuclear Materials are handled, used, or stored and in all adjacent areas where significant exposure to radiation may result from an incident.

2. Alpha Counting System

Minimum detectability - 10 DPM

3. Alpha Survey Meter

Minimum counting efficiency - ~ 30% (calibrated to read 2π)
Minimum Range - 0 - 100,000 counts per minute

4. Air Sampling Equipment

Routine - Nominal 20 liters per minute sampling rate

405. Instrumentation (con't)

5. Beta-Gamma Survey Meter

GM type with maximum window thickness of not more than thirty milligrams per square centimeter.

Minimum range - 0 - 60,000 counts per minute

0 - 20 mr/hr

6. Beta Gamma Counting System

Minimum detectability - 200 dpm

Emergency instrumentation is listed in Section 600.

NUCLEAR ALARM SYSTEM COVERAGE CALCULATIONS

I. Following are calculations of the effectiveness of nuclear alarm system coverage through significant barriers encountered in facility construction.

Using the Formula $$I = \frac{I_o (e^{-\mu t})}{d^2}$$

A. Barrier: 8" Concrete Block
Thickness, t = 7.625 cm/in = 19.37 cm.
$\mu = 0.0317\ cm^2 \times 1.22\ gm/cm^3 = 0.0387\ cm^{-1}$

$$d^2 = \frac{3 \times 10^5\ mr/hr\ (e^{-0.750})}{20\ mr/hr}$$

$d^2 = 7.10 \times 10^3$

d = 84 ft. maximum permitted distance of source from detector to provide coverage.

B. Barrier: 12" Concrete Block
Thickness t = 11.625" x 2.54 cm/in = 29.6cm
$\mu = 0.0317\ cm^2 \times 1.17\ gm/cm^3 = 0.0371\ cm^{-1}$

$$d^2 = \frac{3 \times 10^5\ mr/hr\ (e^{-1.10})}{20\ mr/hr}$$

$d^2 = 5 \times 10^4$

d = 70.7 ft. maximum permitted distance of source from detector to provide coverage.

C. Barrier: 8" Poured Concrete Wall
Thickness t = 8" x 2.54 cm/in = 20.3 cm.
$\mu = 0.317\ cm^2 \times 2.3\ gm/cm^3 = 0.735\ cm^{-1}$

$$d^2 = \frac{3 \times 10^5\ mr/hr\ (e^{-1.49})}{20\ mr/hr}$$

$d^2 = 3.375 \times 10^3$

d = 58.1 ft. maximum permitted distance of source from detector to provide coverage.

II. The effectiveness of the nuclear alarm system when a barrier is interposed between the source and the detector at an angle which is not normal to the line between them is calculated using the following formula:

$$I = \frac{I_o \left[e^{-\mu t(\csc\theta)} \right]}{d^2}$$

where θ is the angle of incidence of the line between the source and detector with respect to the plane of the barrier.

In this manner, increased attenuation caused by angular incidence of the beam on a barrier of given thickness is calculated.

LICENSE: SNM-777, Docket 70-82   SECTION: 400,   Subsection: 405.1
Health Physics Evaluation   Nuclear Alarm System Coverage
APPROVED:
ISSUED: October 31, 1968
SUPERSEDES: New
Page 1 of 1

406. Surveillance

1. Special Surveys

All new, non-routine and spill cleanup operations shall be performed under the congizance of Health Physics.

With the exception of incidents requiring immediate evacuation, major spills or other accidental releases shall be cleaned up immediately. Criticality restrictions on the use of containers and water shall be followed at all times. The Foreman and Health Physics must be notified immediately of such incidents. Appropriate precautions such as use of respirators shall be observed.

2. Routine Surveillance

Surveys shall be conducted on a regularly scheduled basis consistent with plant operation and survey results. The frequency of survey depends upon the contamination levels common to the area, the extent to which the area is occupied, and the probability of personnel exposures.

3. Surface Contamination

Corrective action and/or cleanup is initiated when contamination exceeds the action levels.

4. Airborne Concentrations in Restricted Areas

4.1 Airborne levels in excess of 25% of the maximum permissible concentration require posting in accordance with 10 CFR 20 and an investigation of the causes.

4.2 Airborne levels in excess of the maximum permissible concentration require exposure evaluation. Controls to restrict the personnel to 40 MPC hours per week shall be required.

5. Air and Gaseous Effluents

Systems will be reviewed and/or checked for malfunctions whenever the concentration exceeds 25% of the applicable limit.

Inasmuch as process stacks are equipped with high efficiency filters and manometers designed to indicate filter pressure drop, such stacks will be sampled during initial operations (at least three (3) samples per stack). Thereafter, each process stack shall be sampled no less frequently than once per quarter. Stacks using a scrubber system are monitored continuously during operations.

406. Surveillance (continued)

5. Air and Gaseous Effluents (con't)

Process and/or system changes shall require that the effluent air from the exhaust system(s) thus affected should again be sampled at least three (3) times during operations to re-establish the effectiveness of the filtering system.

A weekly inspection of all process exhaust systems will be made. This will include intake velocity measurements and inspection of the degrees of filter loading. Velocity measurements are made with a velometer; filter loading is determined by pressure drop readings. The filter loading inspection may be omitted if the stack is sampled continuously during operations.

Filters in the exhaust system shall be changed when the air flow at the hoods served by the systems falls below the limits, or if by inspection, the filters are found to be plugged, or a manometer or stack sample indicates a filter failure.

6. Water Samples

6.1 Plant Waste Effluent

The contamination level of liquid effluent is measured at the point of discharge from the waste handling system. A representative sample of the outflow shall be collected and analyzed for alpha and betta activity and pH. In addition, grab samples from a lagoon must be collected and evaluated prior to discharge.

Where liquid wastes are discharged into a river or stream, a grab sample sahll be collected monthly from above and below the plant outfall and analyzed for alpha and beta activity and pH.

SECTION 600

UNITED NUCLEAR CORPORATION	PAGE 1 OF 1
LICENSE: SNM-777, Docket: 70-820 SECTION: 500 - Nuclear Material Management	Approved
	ISSUED October 31, 1968
	SUPERSEDES New

500. Nuclear Material Management

This section has been submitted under separate cover dated August 20, 1968 to:

Mr. Dale Smith
AEC Division of Nuclear Materials Safeguards
Division of Materials Licensing
U. S. Atomic Energy Commission
4915 St. Elmo Place
Bethesda, Maryland 20014

SECTION 600

UNITED NUCLEAR CORPORATION

NO.	
PAGE OF	
Approved:	
ISSUED	October 31, 1968
SUPERSEDES	New

SUBJECT: LICENSE: SNM-33 Docket: 70-36
SNM-777, Docket: 7-820

SECTION: 600 - EMERGENCY CONTROL PLAN
Table of Contents

601. General Objectives

This Emergency Control Plan is applicable to the Chemical Operations Plant, Hematite, Missouri (SNM-33) and Recovery Operations Plant, Wood River Junction, Rhode Island (SNM-777).[1]

It is the policy to anticipate, insofar as possible, those emergencies which may arise at plants within the Commercial Products Division, and minimize by organized action, any injury, loss of life or property damage.

Emergencies for which this plan is prepared include, but are not limited to, the following:

Nuclear Alarm - False and Accidental Criticality

Fire

Release of Radioactive Materials

Explosion or Building Collapse

Flood, Windstorm or other Natural Disasters

The plan for control of emergencies established personnel training requirements, requirements for emergency equipment and supplies, liaison with hospitals, ambulance corps and medical personnel, and State and Federal Agencies whose assistance may be required, means for establishing and maintaining current emergency procedures and post-accident investigation and reporting instructions.

Authority for audit and enforcement of plant emergency procedures and approval of emergency plans as described herein rests with the manager of the Nuclear and Industrial Safety Department, whose responsibility includes the coordination of emergency planning in Commercial Products Division Plants. Implementation of these plans is the responsibility of the operating group, as defined herein.

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[1] The Emergency Control Plan for the Fuel Fabrication Operations, New Haven, Conn. (SNM-777) is that plan applicable to the Naval Products Division, New Haven, Conn. (SNM-368, Docket: 70-731). The Naval Products Division has prime responsibility for establishing and maintaining emergency plans and proceedures for the fuel fabrication operations.

UNITED NUCLEAR
CORPORATION

LICENSE:	SNM-33, Docket: 70-36 SNM-777, Docket: 70-820
SECTION:	600 - Emergency Control Plan
Subsection:	602 - Establishment of Responsibilities

Approved

ISSUED October 31, 1968

SUPERSEDES New

602. Establishment of Responsibilities

Each Plant emergency organization is headed by the Emergency Director who is responsible for the direction and coordination of all activities during the emergency. Emergency duties will be carried out by in-plant personnel under the Emergency Director's supervision and control.

The Emergency Director is the senior member present of those selected supervisors designated in writing as Emergency Directors. Each member of this group is designated by the General Manager, Commercial Products Division, for the Hematite, Missouri and Wood River Junction, Rhode Island locations, and certified by the Manager of the Nuclear and Industrial Safety Department as having the proper qualifications and training to assume the indicated responsibility.

In the event of a continuing emergency situation, further responsibilities are assigned to the indivduals holding the positions listed below:

Responsibility	Assigned to
Security	Corporate Security Director, Supervisor of personnel services
Public Relations & Communications	General Manager (Commercial Products Division) Administration Manager or President's Office
Health Physics & Safety	Manager, Nuclear & Industrial Safety Health Physics Specialist/Nuclear & Industrial Safety Representative
Medical	Consultant Physician/Plant Physician/ Manager, Nuclear & Industrial Safety
Criticality Control (Nuclear Criticality Safety)	Manager, Nuclear & Industrial Safety/ Nuclear Criticality Safety Specialist

Procedures are available to plant personnel outlining required functions to be performed in above areas of responsibility prior to arrival of designated individuals.

In the absence of the above listed individuals, the Emergency Director assumes the indicated responsiblity except for plant re-entry under conditions not specified in the emergency procedures.

603. <u>Emergency Plans</u>

Because of the basic difference in required response, emergency plans are broken into four categories and detailed procedures or check lists are maintained in up-to-date form to implement each category. The categories are:

A. Nuclear Alarm - False and Accidental Criticality
B. Fire Alarm
C. Release of Radioactive Materials
D. Other non-nuclear emergency which may result in B. or C.

Procedures or check lists to implement the plans for each of these emergencies, will:

A. Be brief to permit reading during the emergency.
B. Be posted where they can be used.
C. Establish limitations of authority where needed.
D. Provide guidelines for emergency judgments.
E. Insure that all needed outside assistance is summoned in timely manner.
F. Provide for relocation in event of emergency assembly area becomes untenable.
* G. Include criteria for first-aid treatment and decontamination of personnel

603.1 <u>Nuclear Alarm</u>

603.1.1 Detailed Procedure Requirements
The detailed procedures will establish a sequence of required actions. This includes:

A. Immediate plant evacuation by all personnel upon sounding of the nuclear alarm.
B. Check list of instructions for the Emergency Director.

This will include but not be limited to:
a) Immediate accounting for all personnel
b) Identification of exposed personnel and initiating emergency treatment.
c) Preliminary radiation survey of emergency assembly building to insure safe occupation.
d) Implementation of Emergency Procedures.

C. A list of persons authorized to function as Emergency Director.

D. A check list of instructions to the plant guard. This includes establishing emergency road blocks.

E. A list of persons certified by the Nuclear and Industrial Safety Manager to function as a plant re-entry team. The Emergency Director will not normally be part of this team.

*Indicates Change

603. Emergency Plans (continued)

F. A check list of instructions for the plant re-entry team.

G. Criteria by which the Emergency Director will determine if the alarm was false or if an accidental criticality has occurred.

H. A check list for obtaining off-site assistance including telephone numbers and priority of notification.

The off-site assistance list includes:

a) Off-site Company personnel--Off-duty plant supervisory personnel and Nuclear and Industrial Safety Personnel.
b) Local police, fire department and civilian defense authorities.

(Arrangements are in effect with these local authorities to assist as requested by the Emergency Director.)

c) Medical Assistance. (Arrangements are in effect for obtaining assistance from competent medical personnel and hospital facilities.)
d) Atomic Energy Commission.
e) Plant and Company Management.

I. An outline of criteria to follow in effecting emergency rescue of personnel.

J. An outline of criteria to follow when the Emergency Director determines the need to shut down equipment left running.

603.1.2 Plant Re-Entry

A. Re-Entry Survey Team
The plant re-entry survey team shall consist of a minimum of two persons. The team sahll be equipped with a high range (0-500 r/Hr) and a low range (0-2500 mr/hr) beta/gamma survey meter.

B. Initial Re-Entry
The team will enter and survey all areas of the plant unless gamma radiation levels greater than 100 mr/hr are present. If radiations of 100 mr/hr or higher is found, the team shall immediately report back to the Emergency Director for further instructions.

C. Re-Entry for Emergency Rescue
The Emergency Director will determine the need for re-entry of the plant for emergency rescue. Re-entry procedures for

603. Emergency Plans (continued)

this purpose shall be based on National Bureau of Standards, Handbook 59, Permissible Dose from External Sources of Ionizing Radiation. Re-entry personnel will be kept cognizant through training of probable radiation effects for various exposures, means to reduce exposure, and additional criteria which will assist them in making such decisions.

D. Re-Entry for Equipment Shut Down
The Emergency Director will determine the need for re-entry for shut down of equipment left running. This determination will include an evaluation of the potential exposure to personnel against the hazard of permitting the equipment to run. Re-entry procedures for this purpose shall be based on National Bureau of Standards, Handbook 59, "Permissible Dose from External Sources of Ionizing Radiation." However, re-entry personnel will be kept cognizant through training of probable radiation effects for various exposures, means to reduce exposure, and additional criteria which will assist them in making such decisions.

E. Isolation of Affected Area
If radiation is excess of 100 mr/hr is present, barricades will be established to mark the 100 mr/hr boundary. Only personnel authorized by the Emergency Director will be permitted past this boundary.

603.1.3 All Clear

False Alarm
The Emergency Director will determine that a false alarm has occurred if:

a) There is no physical evidence that an accidental criticality has occurred.
b) No radiation is detected from indium foil contained in personnel badges.
c) No radiation levels, in excess of normal plant radiation levels are found by the re-entry team.

When these conditions have been fulfilled, the Emergency Director may release all personnel to return to the plant. Operation of the plant shall not resume until the nuclear alarm system is reset and operable. In event of defective monitor(s), operations, or any movement of nuclear material may be resumed only in the portion of the Plant covered by detectors, as defined in 10 CFR 70.24.

603.1.4 Accidental Criticality

When the Emergency Director determines (by physical evidence, radiation measurements or other means) that an accidental

603. Emergency Plans (continued)

criticality has occurred, he shall immediately start implementation of all requirements of this control plan.

603.2 Fire Alarm

Upon sounding of the fire alarm, the fire brigade shall assemble at the non-nuclear emergency assembly station.

The Emergency Director is responsible for:

a) Direction of the fire brigade.
b) Determining the need to summon assistance from the local Fire Department.

Arrangements have been made with the local Fire Department to comply with the Emergency Director's instructions.

c) Determining the need for plant evacuation and issuing appropriate instructions.

Outside Assistance
Call numbers for local fire companies and police are maintained in strategic locations in the Plant and in the emergency assembly building. In all cases of fire within the fenced perimeter, local fire companies will assist only under the direction of the Emergency Director.

Moderation Control
Use of fire hoses in process areas, which may result in accidental relocation of special nuclear materials or flooding will be avoided. Use of fogs and hydrogenous foams are not specifically prohibited, but will be used in process areas only if dry extinguisher supplies are ineffective and the fire must be controlled promptly to prevent development of more serious hazards. Any area in which the use of water is prohibited for any reason will be clearly indicated by posted signs.

603.3 Release of Radioactive Material

Release of radioactive material, i.e., uranium-bearing particles or mists requires an immediate but orderly evacuation of the room or plant area directly involved. Equipment shutdown may be done only under the direction of the Emergency Director with use of protective equipment mandatory.

603. Emergency Plans (continued)

All involved may, as required by the Nuclear & Industrial Safety Representative, furnish samples for bio-assay.

603.4 Other Non-Nuclear Emergencies

a) Sudden Emergencies
Authority for emergency action in event of chemical explosion, equipment or piping failure, building collapse, or other sudden unexpected event is placed with the Emergency Director.

b) Anticipated Emergency
In event of impending flood, windstorm, or other adverse happening, the Emergency Director will devise a specific plan of action to minimize the resultant hazards, obtaining qualified nuclear criticality safety and other advice as appropriate.

c) Emergency Movement of SNM
Should any emergency condition make advisable the relocation of uranium inventories, such movement may be authorized by the Emergency Director. If it becomes necessary to move such material to abnormal locations or by abnormal methods, such movement will require either greater spacing between safe units, or smaller units, or both, than normally provided. All such storage will be immediately reviewed under the direction of the Nuclear and Industrial Safety Department Representative for return to approved storage areas.

Basic training in nuclear criticality safety practices will be given all employees who may be called on to assist in such emergency movements.

Lists of those qualified to provide emergency nuclear criticality safety advice and means for contacting them shall be kept in strategic in-plant and emergency building locations.

d) Power Failure
Emergency power generating equipment is available at all locations, and have functioned well in the past (loss of main power has resulted in momentary dip in line voltage, with no interruption of coverage by Nuclear Alarm Detectors).

Supervisory personnel will determine what post-outage action is required and the number and type of personnel required to accomplish the task(s).

604. Coordination of Outside Agencies

Based on the initial assessment of the nature of the emergency, the Emergency Director or his designee will utilize the call lists available at the Emergency assembly station (or if evacuation has not been necessary at the primary guard post) to summon assistance from the police and/or fire departments, medical personnel or radiological safety organizations as necessary.

A. Police

Chemical Operations, Hematite, Missouri

The Sheriff's office, Hillsboro, Missouri, is manned on a 24 hour basis and procedures are available at the post to summon assistance from the State Police, Barnes Hospital, local ambulance corps, and the Hematite Fire Department.

Fuel Recovery Operations, Wood River Junction, Rhode Island

The Rhode Island State Police barracks at Hope Valley is manned on a 24 hour basis and procedures are available at that post to summon assistance from the State Council of Defense (radiological safety), the Hope Valley Amublance Corps, the Cross Mills Fire Department and local law enforcement personnel. State Police have received training in radiological and control procedures.

In addition to notification of other assistance agencies, the State Police and local police procedures provide for immediate action to cordon off plant access routes to restrict unauthorized personnel from entering the hazardous areas.

B. Fire

Chemical Operations, Hematite, Missouri

Personnel of area Fire Department at Hematite and Festus are familiar with plant layout and potential hazards in fire control. The procedures in effect require fire fighting personnel to stand by upon arrival for supervision by UNC trained personnel. Selected UNC employees constitute a plant fire brigade which is subject to periodic refresher training.

Fuel Recovery Operations, Wood River Junction, Rhode Island

Personnel of area Fire Departments at Alton, Shannock and Cross Mills are familiar with plant layout and potential hazards in fire control. The procedures in effect require fire fighting personnel to stand by upon arrival for supervision on UNC trained personnel. Selected UNC employees constitute a plant fire brigade which is subject to periodic refresher training.

604. Coordination of Outside Agencies (continued)

C. Medical

Physicians (All Plants)

The Plant Physician will be summoned by the Emergency Director or his designee immediately upon determination of injury or exposure to personnel. The Plant Physician has designated secondary medical personnel to be contacted in the event of his absence. The Plant Physician will in the event of serious radiation casualty cases, contact the Company Consultant Physician, a specialist in radiation casualty care, requesting he proceed to the hospital selected for victim care. The Plant Psysician will determine the hospital to which the casualty will be transported and will provide a complete description of patient condition and associated radiation hazards to the hospital. The emergency procedures provide for victim identification and collection of excretion samples.

Ambulance

Commercial Operations, Hematite, Missouri

Procedures are available at the Sheriff's Office, Hillsboro, Missouri to summon assistance from local ambulance corps. Secondary ambulance capability is also available through the radio network of the Festus Fire Department.

Fuel Recovery Operations, Wood River Junction, Rhode Island

Procedures are available at the Rhode Island State Police barracks at Hope Valley to summon assistance from the Hope Valley Ambulance Corps. Secondary ambulance capability is also available through the State Police notification network if necessary. Both the Westerly Ambulance Corps and the Cross Mills Emergency Squad have received training in the handling of radiological accident cases.

Hospitals

Chemical Operations, Hematite, Missouri

Based on the medical evaluation of condition of casualties or exposed personnel, and the number involved, the victim(s) will be dispatched to Barnes Hospital, St. Louis, Missouri.

Fuel Recovery Operations, Wood River Junction, Rhode Island

Based on the medical evaluation of conditions of casualties or exposed personnel, and the number involved, the victim(s) will be dispatched to Rhode Island Hospital, New England Deaconess Hospital, or Westerly Hospital.

604. Coordination of Outside Agencies (continued)

Victims whose condition presents a hazard from the standpoint of radiation or contamination will be sent to Rhode Island or New England Deaconess Hospitals.

LICENSE:	SNM-33, Docket: 70-36 SNM-777, Docket: 70-820 Fuel Recovery Operations	Approved
SECTION:	600 - Emergency Control Plan	ISSUED October 31, 1968
Subsection:	605 - Emergency Supplies and Equipment	SUPERSEDES New

605. Emergency Supplies and Equipment

A list of location(s) where emergency supplies are situated is kept by the local Nuclear & Industrial Safety Department Representative, each of the authorized Emergency Directors (and alternates) and at the Guard Post(s) adjacent to operating areas. A detailed listing is available at the Emergency Assembly station, together with maps of the building showing layout and floor plans.

Radiation Survey Equipment

2 - Beta-gamma portable survey meters low range sensitive (0-100 mr/hr)
1 - Gamma portable survey meter hi-range (at least 3 ranges) 0-500 R/hr.
1 - Alpha portable survey meter gas proportional 0-100,000 cpm
8 - Low range pencil dosimeters, 200 mrem
2 - High range pencil dosimeters, 200 R
1 - Dosimeter charger
Film badges (DuPont Pocket Type 544 or equivalent) and badges containing Idium foil to augment or replace normal personnel dosimetry

Air Sampling Equipment

1 - Battery powered air sampler
1 - High volume air sampler with annular Kinetic Impactor Head
2 - Vacuum Pumps with Inline Filter

Supporting Equipment

1 - Self contained Breathing Apparatus
1 - Resuscitator
2 - Absolute Filter Respirators
Protective clothing--includes head and foot cover
Marking equipment and tags
Plant outline drawings
Blankets
First Aid Kit including Disposable Litters and Splints
Flashlight

Additional supplies are available upon call from the unaffected location(s).

UNITED NUCLEAR CORPORATION

LICENSE:	SNM-33, Docket: 70-36	Approved
	SNM-777, Docket: 70-820	
	Fuel Recovery Operations	ISSUED October 31, 1968
SECTION:	600 - Emergency Control Plan	
Subsection:	606 - Employee Training and Drills	SUPERSEDES New

606. Employee Training and Drills

Training

The employee orientation program presents the general outline of required emergency actions; this is continued by the floor supervisors and augmented by drills conducted twice per year.

Drills

Drills will be conducted twice per year for continuing awareness and capability in execution of emergency procedures. These drills will include plant evacuation, use of health-physics monitoring equipment and practice in taking various enviornmental samples. To the extent practical, police, medical personnel, and ambulance corps personnel will be periodically involved in drills.

LICNESE:	SNM-33, Docket: 70-36 SNM-777, Docket: 70-820 Fuel Recovery Operations	Approved
SECTION:	600 - Emergency Control Plan	ISSUED October 31, 1968
Subsection:	607 - Public Relations and Communications - Emergency Procedure	SUPERSEDES New

607. Public Relations and Communications--Emergency Procedure

Releases to the public through the press, radio or television, shall be made by the Division General Manager. Where practical, the releases shall be typewritten in duplicate, and copy retained by the individual releasing the information. The Security Director (or authorized classifier) will assist in determining the security aspects of releases for publication prior to such release.

All communications to the Atomic Energy Commission will originate with the Emergency Director, Nuclear & Industrial Safety Manager, or General Manager, Commercial Products Division.

Approved

LICENSE:	SNM-33, Docket: 70-36
	SNM-777, Docket: 70-820
	Fuel Recovery Operations
SECTION:	600 - Emergency Control Plan
Subsection:	608 - Investigation and Reporting

ISSUED October 31, 1963

SUPERSEDES New

608. Investigation and Reporting

Reports

In accordance with 10 CFR 20.403, the Emergency Director, or Manager, Nuclear and Industrial member of Company Management will notify the Director, Division of Compliance, Region I or III (as appropriate) by telephone and telegraph either immediately or within 24 hours, depending upon the appropriate determinations of exposure, release of radioactive material, damage or operations interruption.

A. Accidental Criticality

The Investigation Staff, or a member of that staff, under the direction of the General Manager, will prepare a report in writing within 30 days for submission to the Director, Division of Compliance, U. S. Atomic Energy Commisssion, Washington, D. C. 20545 with a copy to the Director, Region I or III (as appropriate) of: (1) each exposure of an individual to radiation or concentrations of radioactive material in excess of any applicable limit in Part 20 or in the licensee's, (2) any incident for which notification is required by 20.403; and (3) levels of radiation or concentrations of radioactive materials (not involving excessive exposure of any individual) in an unrestricted area in excess of the times any applicable limit set forth in Part 20 or in the licnesee's license. The report shall describe the extent of exposure of persons to radiation or to radioactive material; levels of radiation and concentrations of radioactive material involved; the cause of the exposure, levels of concentrations; and corrective steps taken or planned to assure against a recurrence. The names of individuals who have received radiation exposure will be stated in a separate part of the report from the basic narrative.

B. Other

Radiation exposure other than from an accidental criticality will be reported as required in 10 CFR 20, by the Manager of Nuclear & Industrial Safety.

Investigation Staff

The General Manager will designate personnel responsible for compiling a comprehensive report as required under 10CFR 20.405, including:

1. Cause

2. Extent of injury to personnel to include radiation doses received.

3. Extent of property damage.

4. Extent of contamination

608. Investigation and Reporting (continued)

5. Decontamination procedures

6. Recommendation for improvment in handling emergency

7. Recommendation for corrective measures to preclude recurrences of incident.

SECTION 700

SECTION 700 - TRANSPORTATION

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UNITED NUCLEAR
CORPORATION

Issued 2/6/70

Supersedes 10/31/68

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Amendment No.

LICENSE: SNM-33 & SNM-777, Docket: 70-36 & 70-820
SECTION: 700 - TRANSPORTATION

Subsection: 701 - Introduction

701. Introduction

This section 700 describes the packages, handling and administrative procedures applicable to the shipment of Special Nuclear Material.

* The Manufacturing Departments are responsible (as described in Subsection 204) for administration of the procedures described in this section 700.

*Indicates Change

LICENSE: SNM-777, Docket 70-820

Approved

SECTION: 700 - Transportation
Sub-section: 702 - Shipping standards

ISSUED October 31, 1968

SUPERSEDES New

702. Shipping Standards

1. Purpose

1.1 To assure compliance with all UNC, local, State and Federal criteria, restrictions or regulations concerning the shipment of SNM.

1.2 To outline periodic inspection criteria to insure that shipping containers meet approved standards.

1.3 To list records and reports required.

2. Handling of Material of Unknown Enrichment

2.1 The material is treated as fully enriched unless a lower enrichment value has been verified.

3. Container Inspection

3.1 Prior to each use of any container, the container is inspected to insure that:

3.1.1 It has not been significantly damaged.

3.1.2 Original design conditions approved by AEC and DOT are maintained.

3.1.3 Marking and labeling is correct as required by the AEC and DOT approvals.

The Shipping Department is responsible for this inspection. The NIS Department overchecks as part of its audit function.

4. Records

4.1 A record of each shipment will be maintained for a period of 2 years.

4.1.1 The record will include (for unirradiated SNM only);

4.1.1.1 Identification of the container used by model number.

4.1.1.2 Details of any significant defects in the container, including the means used to repair the defects and prevent their recurrence.

4.1.1.3 Volume and identification of coolant (where applicable).

4.1.1.4 Type and quantity of SNM in each package.

LICENSE: SNM-777, Docket 70-820

Approved

SECTION: 700 - TRANSPORTATION
Subsection: 702 - Shipping Standards

ISSUED October 31, 1968

SUPERSEDES New

702. Shipping Standards (continued)

4.1.1.5 Total quantity of SNM in each shipment.

4.1.1.6 Date of Shipment.

4.1.1.7 For Fissile Class III, any special controls exercised.

4.1.1.8 Name and address of the transferee.

4.1.1.9 Address to which shipment was made.

4.1.1.10 Results of inspection described in Subpart 702.3 above.

LICENSE: SNM-777, Docket: 70-820

Approved

SECTION: 700 - TRANSPORTATION
Subsection: 703 - Shipping Containers

ISSUED October 31, 1968

SUPERSEDES New

703. Shipping Containers

The following shipping containers will be used for the transportation of SNM:

Shipping Container Model Number	AEC Approval or Amendment Number	Date of Approval or Amendment
UNC-740	71-9	1-4-68
UNC-1001	71-10	1-4-68
UNC-1351	71-11	1-4-68
UNC-1483	71-12	1-4-68
UNC-1634	71-4	7-5-67
UNC-1886	71-5	7-28-67
UNC-2400	71-7	1-4-68
UNC-2600	71-3	2-6-67
UNC-2800	71-6	10-17-67
UNC-2900	71-14	6-17-68
UNC-3000	71-13	2-13-68

The use of these containers is subject to the conditions specified in the above listed AEC amendments and to the conditions specified in this license.

LICENSE: SNM-777, Docket: 70-820

SECTION: 700 - TRANSPORTATION
Subsection: 704 - Handling of Incoming & Outgoing Shipments

ISSUED October 31, 1968

SUPERSEDES New

704. Handling of Incoming and Outgoing Shipments

1. Storage of Undamaged Containers

Storage of as-received containers or containers awaiting shipment may be stored anywhere within the fenced area.

The specific location shall be covered by the nuclear criticality monitoring and alarm system. The storage arrangement shall be one of the methods listed below:

1.1 The same arrangement that they occupied on the transportation vehicle.

1.2 Under controlled storage conditions, the total number of containers meet a "100 unit" rule (i.e., no more than that number of containers whose assigned radiation units can be summed to a maximum value of 100.0). Controlled storage is here defined as an area where a positive safeguard is provided against the inadvertent addition of a moderating media (i.e., in a roofed warehouse or covered area including use of a water-proof tarpaulin).

When the storage conditions do not meet the definition for controlled storage, the total number of containers meet a "75 Unit" rule.

1.3 Separation of arrays described in 1.1 and 1.2 above is maintained in accordance with criteria of Subsection 303.

2. Unloading and Handling of Contents

During unloading and the subsequent handling, incidental to receipt and storage, the contents of received shipping containers will be handled and stored to the enrichment as certified by the shipper. If the enrichment is unknown or doubtful, the material will be handled and stored as fully enriched until enrichment has been determined by analyses.

3. Damaged Containers

Containers received in a damaged condition will be held separate from other SNM (in accordance with criteria of subsection 303).

Prior to further handling or unloading, the extent of damage will be evaluated to establish proper action. Results of the evaluation and action to be taken shall be reviewed and approved by the NIS Representative.

SECTION 800

SECTION 800 - FUEL FABRICATION OPERATION

SUBSECTION 810 - STORAGE

TABLE OF CONTENTS

LICENSE: SNM-777, Docket: 70-820
SECTION: 800 - FUEL FABRICATION OPERATION
Subsection: 810 - Storage
Subpart: 811 - General Considerations
811.1 - Outside Storage

Approved

ISSUED October 31, 1968

SUPERSEDES NEW

811.1 OUTSIDE STORAGE

SNM bearing materials may be stored outside the buildings of the Fuel Fabrication Operation within the fenced-in area if the SNM is in a shipping container. Arrays of containers will be stored as described in Subsection 704.

811.2 INSIDE STORAGE

SNM may be stored in buildings in specified locations, in shipping containers. Arrays of containers will be stored as described in Subsection 704.

After unloading from shipping containers, SNM will be stored in storage areas or devices described in this Subsection.

In-process storage devices are placed throughout the buildings to retain SNM during processing or between process steps. These devices are metal racks or concrete bunkers which provide spacing between safe cross section metal boxes or ports, or safe piece count batches.

LICENSE: SNM-777, Docket: 70-820
SECTION: 800 - FUEL FABRICATION OPERATION
Subsection: 810 - Storage
Subpart: 812 - 19H Fuel Storage Area
812.1 - General

812.1 GENERAL

A locked, controlled storage area is located in Building 19H which is used primarily for the storage of incoming SNM. Uranium metal, uranium compounds such as UO_2, UALX, uranium-aluminum alloy recycle material and various uranium bearing scraps are currently stored in this area. The various storage devices in this area are described in further detail in the remainder of this subpart. The layout of this area is shown on Sketch 812.1-I.

A small hood and a work table or desk are provided in this area for routine nuclear materials management and process work. Examples of types of operations to be performed in this hood and work table or desk are:

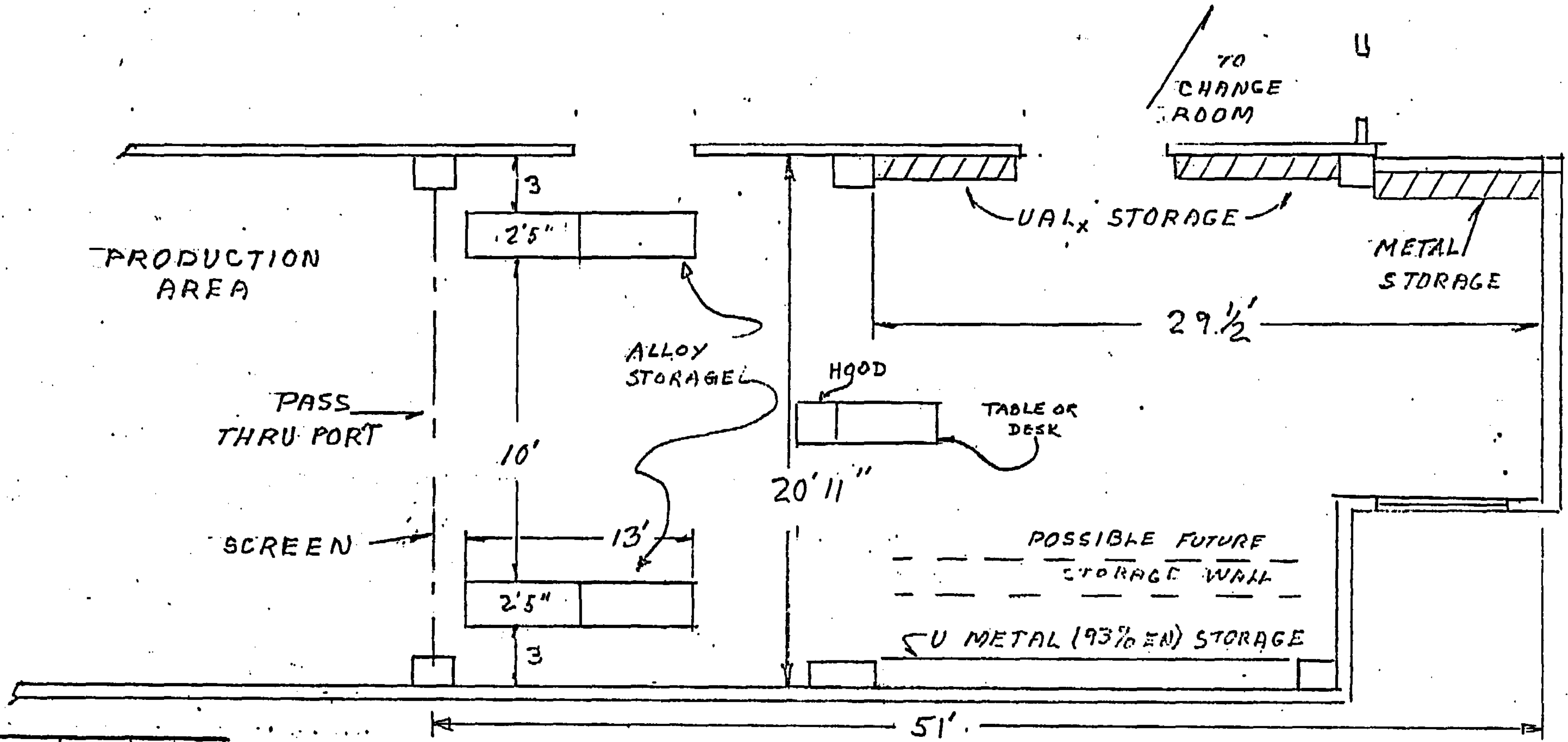
1. Weighing as received shipping containers.

2. Transfer of material from one container to another.

3. U-AL alloy change preparation.

Work involving opening containers, transfers of powders (except UALX) etc. will be performed only in the hood. The hood and table or desk will be centrally located in the area at least 5 feet from any other SNM in racks.

The hood will be limited to two safe geometry containers plus 700 grams of U-235 as loose pieces, such as cores, etc. Each container and the loose pieces will be separated 12 inches using administrative control. Safe geometrics will be obtained using the Figs. in Subsection 309. The same safety requirements apply to the work table or desk.



FUEL STORAGE - 19H

LICENSE: SNM-777; DOCKET: 70-82

SECTION: 800, SUBPART: 812.1

SKETCH 812.1 - I

PAGE 1 of 1

APPROVED

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UNITED NUCLEAR
CORPORATION

Issued 2/6/70

LICENSE: SNM-33 & SNM-777, Docket: 70-36 & 70-820
SECTION: 800 - FUEL FABRICATION OPERATION
Subsection: 810 - Storage
Subpart: 812 - 19H Fuel Storage Area
812.2 - High Enrichment Uranium Metal Storage

Supersedes 10/31/68

Approved

Amendment No.

812. High Enrichment Uranium Metal Storage

1. Description

These racks will be used primarily for the storage of high enrichment uranium metal after unloading from the as received shipping container and prior to processing. Miscellaneous process scrap, residues and other such material in bottles or cans may also be stored on this type of arrangement. Racks are formed by individual holders placed on an existing concrete block wall. Other walls of this type may be provided at a later date and these other walls willbe constructed of mortored 8" high density concrete blocks, or equivalent, to insure effective isolation. See Sketch 812.1-I.

Uranium metal will be stored in as received containers. These containers will be 5½"ID x 4-3/4" high (1.85 liters) maximum and will be limited to 10 kgs U-235. Process scrap, residues and other such material will be in 6" ID x 10" high (1 gallon capacity) plastic or metal bottles, jars or cans.

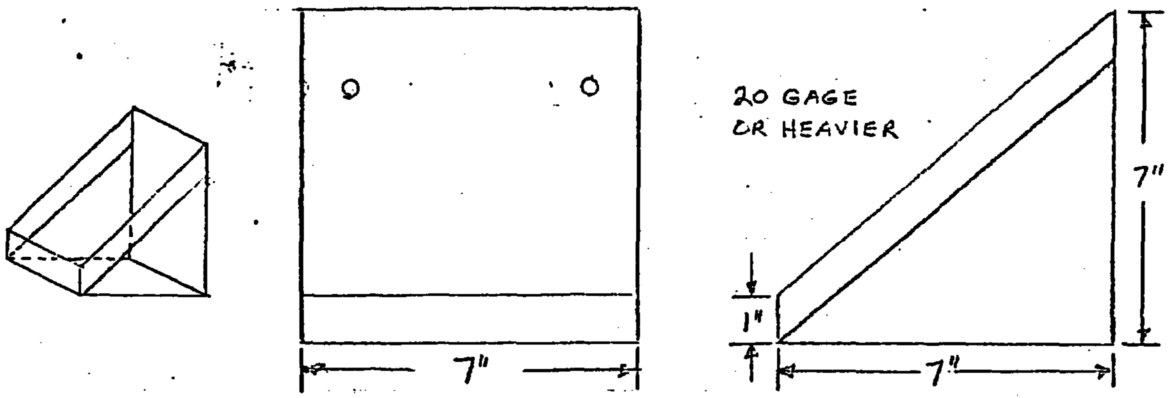
Racks will be constructed with individual holders fastened to a concrete block wall. These holders will be 7"x7"x7"-20 gage or heavier welded steel with two or more powder actuated bolts holding them to the wall. Individual holders will be arranged in a 4x12 arrangement with 16.8" center to center side separation and 24" center to center top to bottom separation.

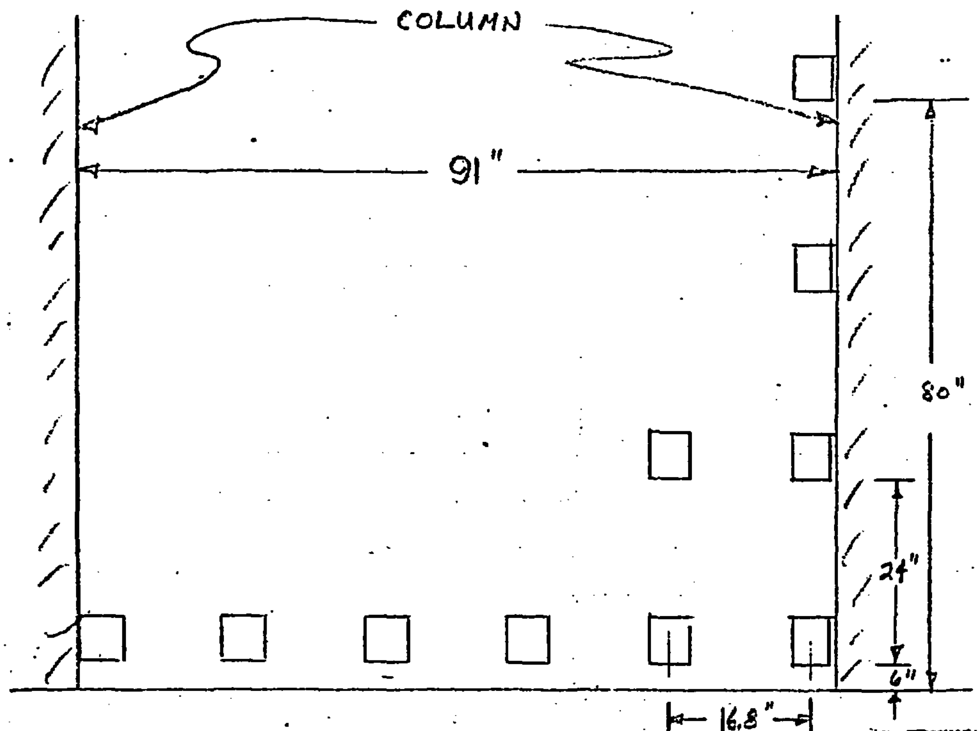
Details of this arrangement are shown on Sketch 812.2-I.

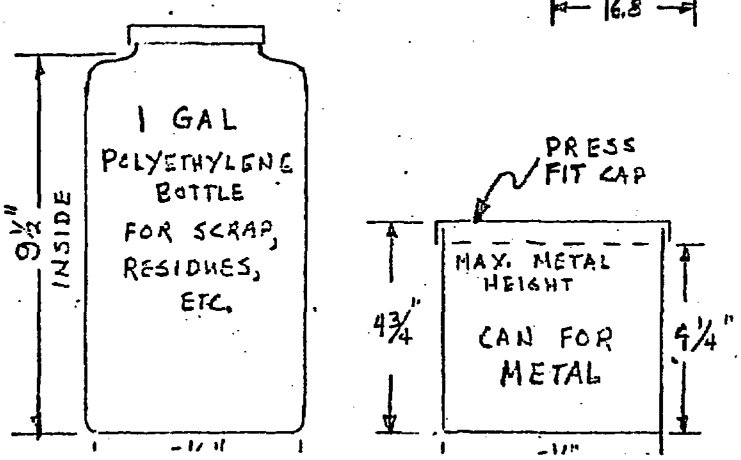
2. Nuclear Safety

Cans for metal provide a safe volume when limited to 10 kgs U-235. The 1 gallon bottle is safe for densities up to and including 3.2 grams U-235 per cubic centimeter. Containers meet the maximum unit quantities listed in Table V, LA-2063. Groups of containers on each wall form planar arrays which are separated by 8" to 12" of high density concrete. As stated on page 41, LA-2063, "two arrays are effectively isolated from one another if the arrays are completely separated by concrete at least 8" thick".

*Indicates Change







LICENSE: SNM-777; DOCKET: 70-82

SECTION: 800, SUBPART: 812.2

SKETCH 812.2 - I

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APPROVED

ISSUED: OCTOBER 31, 1968

I. DESCRIPTION

1. The maximum size container will be 1 gallon (6" OD x 10").

2. Holders (ports) are spaced 16.8" side-by-side and 24" top to bottom.

3. Arrays will be isolated in accordance with the criteria of Subpart 303.2.3.

II. NUCLEAR SAFETY OF INDIVIDUAL UNITS

Metal will be stored in 1.85 liter cans limited to 10 Kgs U-235 each. A 1.85 liter volume is subcritical for U-235 densities not exceed in 10 Kgs U-235 per liter as shown on Fig. 9, TID-7028. A mass of 10 Kgs U-235 is subcritical for densities greater than 225 Kgs U-235 per liter as shown on Fig. 8, TID-7028. Therefore, 10 Kgs U-235 in a 1.85 liter volume is subcritical. A one (1) gallon volume is nuclarly safe for material with a density not exceeding 3.2 kg per liter as shown in Table 309-I.

III. INTERACTION CALCULATIONS

The nuclear safety of a planar array of units on a wall will be evaluated using the solid angle method. The most reactive unit which will be stored in this arrangement will be a one gallon bottle.

1. Contribution from Units Above and Below Centermost Unit (#1 Units)

$r = 3"$, $h = 19"$

$$\Omega_1 = 2\pi(1-\cos\theta) \quad \text{where } \tan\theta = \frac{r}{h} = \frac{3"}{19"} = .158$$

$$= 6.28\ (1-.988) = 6.28\ (.012) \quad \cos\theta = .988$$

$$= .075$$

$$\Omega_1\ (\text{Total}) = 2 \times \Omega_1 = 2 \times .075 = .15 \text{ steradians}$$

2. Contribution from Units on Each Side (#2 Units)

d = 6", L = 10", L/2 = 5", h = 14"

$\Omega_2 = \frac{2d}{h} \sin \theta$ where $\tan \theta = \frac{L/2}{h} = \frac{5"}{14"} = .375$

$= \frac{12"}{14"} (.336)$ $\sin \theta = .336$

$= .288$

$\Omega_2 \text{ (Total)} = 2 \times \Omega_2 = 2 \times .288 = .576$ Steradians

3. Contribution from Nearest Units in Next Row (#3 Units)

a = diagonal = $\sqrt{6^2+10^2} = \sqrt{136} = 11.7"$, b = diameter = 6", q = 23.5"
h = 19", r = 14"

$\Omega_3 = \frac{(ab)}{(q^2)} \cos \theta$ where $\tan \theta = \frac{r}{h} = \frac{14"}{19"} = .737$

$= \frac{(11.7 \times 6)}{(23.5)^2} (.805) = \frac{70.2}{552} (.805)$ $\cos \theta = .805$

$= .127 \times .805 = .102$

$\Omega_3 \text{ (Total)} = 4 \times \Omega_3 = 4 \times .102 = .408$ steradians

4. Contribution from Next Nearest Units in Next Row (#4 Units)

a = diagonal = 11.7", b = diameter = 6", q = 45", h = 43", r = 14"

$\Omega_4 = \frac{(ab)}{(q^2)} \cos \theta$ where $\tan \theta = \frac{r}{h} = \frac{14"}{43"} = .326$

$= \frac{(11.7 \times 6)}{(45)^2} (.950) = \frac{70.2}{2025} (.950)$ $\cos \theta = .950$

$= .0347 \times .95 = .033$

$\Omega_4 \text{ (Total)} = 2 \times \Omega_4 = 2 \times .033 = .066$ steradians

5. Contribution from Nearest Units in Second Row (#5 Units)

a = diagonal = 11.7", b = diameter = 6", q = 36.5", h = 31", r = 14"

$\Omega_5 = \frac{(ab)}{(q^2)} \cos \theta$ where $\tan \theta = \frac{r}{h} = \frac{14"}{31"} = .452$

$= \frac{(11.7 \times 6)}{(36.5)^2} (.911) = \frac{70.2}{1330} (.911)$ $\cos \theta = .911$

$= .053 \times .911 = .048$

$\Omega_5 \text{ (Total)} = 4 \times \Omega_5 = 4 \times .048$
$= .192$ steradians

6. Contribution from Next Nearest Units in Second Row (6 Units)

a = diagonal of unshielded portion = 8.5", b = diameter of unshielded portion = 3"

q = 51.5", h = 48", r = 14"

$$\Omega_6 = \frac{(ab)}{(q^2)} = \cos \theta \qquad \text{where } \tan \theta = \frac{r}{h} = \frac{14''}{48''} = .292$$

$$\cos \theta = .960$$

$$= \frac{(8.5x3)}{(51.5)^2} (.860) = \frac{25.5}{2650} (.860)$$

$$= .00964 \times .96 = .00925$$

Ω_6 (Total) = 4 x Ω_6 = 4 x .00925 = .037 steradians

7. Contribution from All Other Units in Array

All other units in the array are shielded.

8. Total Interaction

Total $\Omega = \Sigma \Omega_1$ (Total) + ... + Ω_6 (Total) = 1.43 steradians

9. Allowable Interaction

From Figure XVII, K-1019, Rev. 5, the allowable interaction for a 4.8 liter (approximately 1 gallon) volume is 1.9 steradians

IV. CONCLUSIONS

The storage arrangement is nuclearly safe.

LICENSE: SNM-33, Docket: 70-36
SNM-777, Docket: 70-820
SECTION: 800 - FUEL FABRICATION OPERATION
Subsection: 810 - Storage
Subpart: 812 - 19 H Fuel Storage Area
812.3 - High Enrichment Alley Storage

Approved

ISSUED February 6, 1970

SUPERSEDES October 31, 1968

812.3 HIGH ENRICHMENT ALLOY STORAGE

1. Description

These racks will be used to store U-AL alloy. The material will be in the form of pieces, melting splatter, residues left from core punching, etc. or cast ingots or rolled slabs. Two racks, maximum, will be placed end-to-end forming individual arrays. There will be two such arrays side-by-side separated by 10 feet in this Storage Area. See Sketch 812.1-I for the rack arrangement.

The small pieces will be held in metal tote boxes. These boxes are constructed of 1/16" aluminum with 3"x6"x16" inner dimensions. Large pieces (ingots and slabs) will be limited so that the thickness and width do not exceed 18 sq. inches (3"x6").

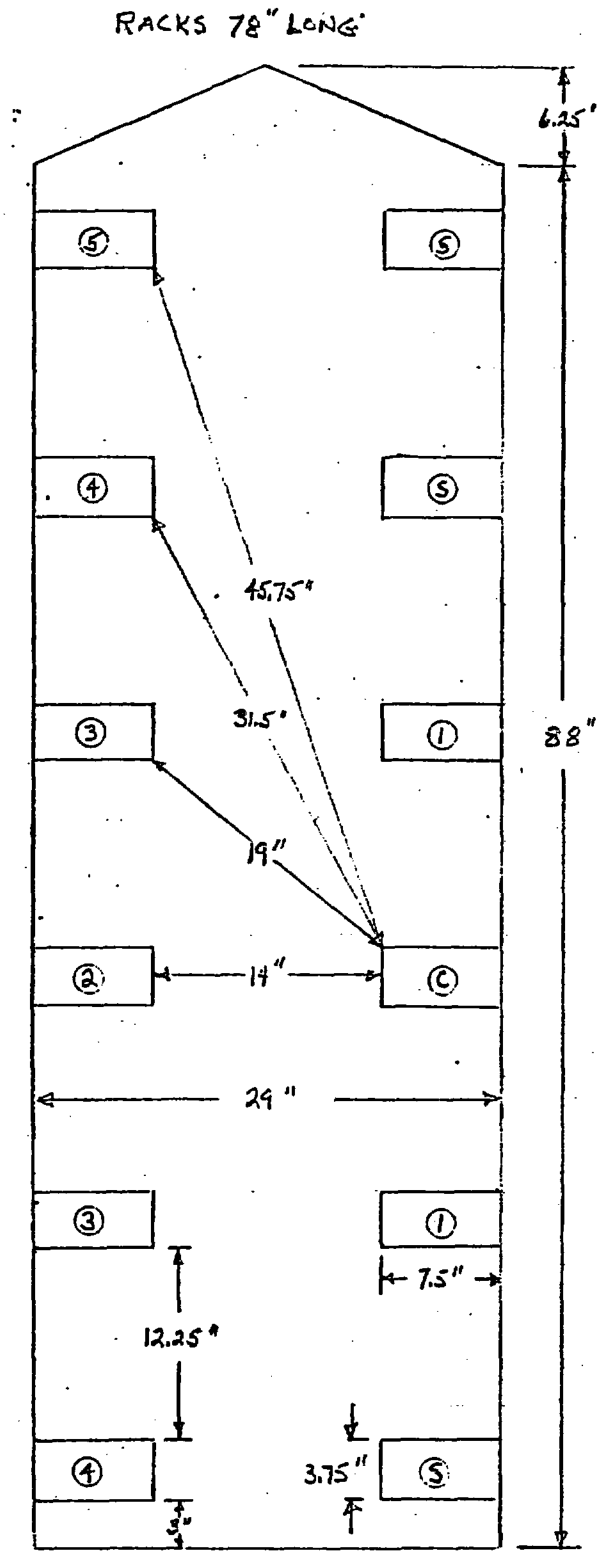
Racks will be constructed of 3/16" slotted angle bolted together. The outside will be covered with a thin metal (24 gage or heavier) to provide 14" edge-to-edge and 12-1/2" top to bottom separation between ports. Ports are long troughs running the entire length of the rack with a maximum 3-3/4"x7-1/2" opening. Steel hasps with 16 gage steel plates welded to them are welded along the length of each opening to provide closures which ensure retention of the tote boxes or ingots or slabs. Racks are fastened to the floor by bolting with powder actuated bolts.

Details of construction are shown on Sketch 812.3-I.

2. Nuclear Safety

* The tote boxes or the ingot or slab geometrics provide a safe cross section for the material to be stored. The nuclear safety of this storage arrangement is evaluated in the attached Nuclear Safety Evaluation.

*Indicates Change



LICENSE: SNM-777; DOCKET: 70-8
SECTION: 800, SUBPART: 812.3

SKETCH 812.3 - I

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APPROVED

ISSUED: OCTOBER 31, 1968

23 pgs w/h
entirely

Ex. 4

LICENSE: SNM-777, Docket: 70-820
SECTION: 800 - FUEL FABRICATION OPERATION
Subsection: 810 - Storage
Subpart: 814 - Clad SNM Storage
814.4 - Low Enrichment UO_2 Finished Component Storage

Approved

ISSUED OCTOBER 31, 1968

SUPERSEDES NEW

814.4 Low Enrichment UO_2 Finished Component Storage

1. Description

Finished UO_2 components will be stored along the north wall of Building 50H. The rack contains spaces for 16 components on 18" centers. This arrangement consists of hanging components from 2" x 1-1/4" steel bars which are welded on 18" centers to an 8" x 8" wide flange H beam. The H beam is supported from the floor by six 5" Schedule 40 steel pipes and secured through the cinder block wall in six locations. An adjustable clamping bar contains each component at its bottom fitting to prevent it from coming into contact with adjacent fuel elements.

Structural calculations indicate that the storage arrangement would support a total of 13,600 lbs. or 16 components weighing 850 lbs.

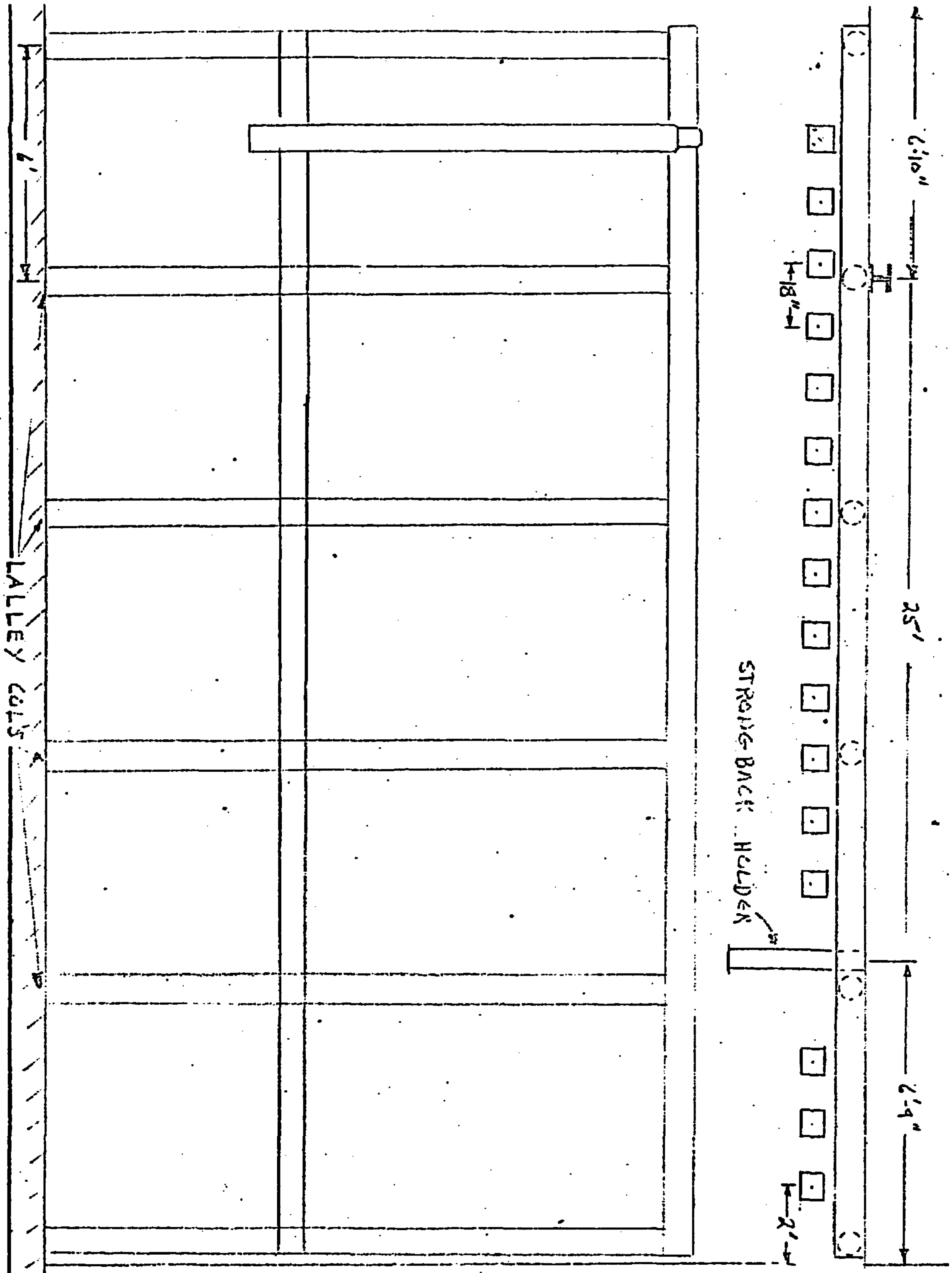
Details of this storage arrangement are shown on Sketch 814.4-I.

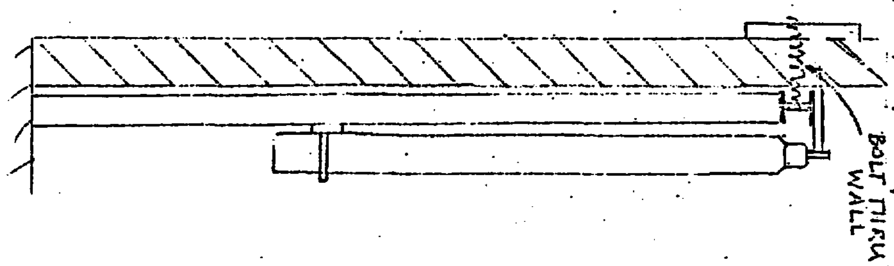
2. Nuclear Safety

Individual components will be nuclearly safe by themselves. The solid angle subtended by the centermost component in the array when one other component is in transit is

Type of Component	Solid Angle
Dresden	1.35 steradians
Yankee	2.4 steradians

No more than one (1) component will be permitted to be in transit at any one time. Other SNM bearing material in the general vicinity of this rack will be spaced at least four (4) feet from the rack.





LICENSE: SNM-777; DOCKET: 70-8

SECTION: 800, SUBPART: 813.4

UO_2 FINISHED COMPONENT STORAGE

SKETCH 814.4-I

PAGE 1 of 1

APPROVED

ISSUED: OCTOBER 31, 1968

SUPERSEDES: NEW

LICENSE: SNM-777, Docket: 70-820	Approved
SECTION: 800 - FUEL FABRICATION OPERATION	ISSUED October 31, 1968
Subsection: 810 - Storage	
Subpart: 814 - 50 H Storage 814.3 - Low Enrichment UO_2 Rod Inprocess Storage	SUPERSEDES New

814.3 Low Enrichment UO_2 Rod Inprocess Storage

1. Description

These racks will be used to store UO_2 rods not exceeding 5% enriched during processing. They will be placed individually or in groups formed by placing racks end-toend but never side by side.

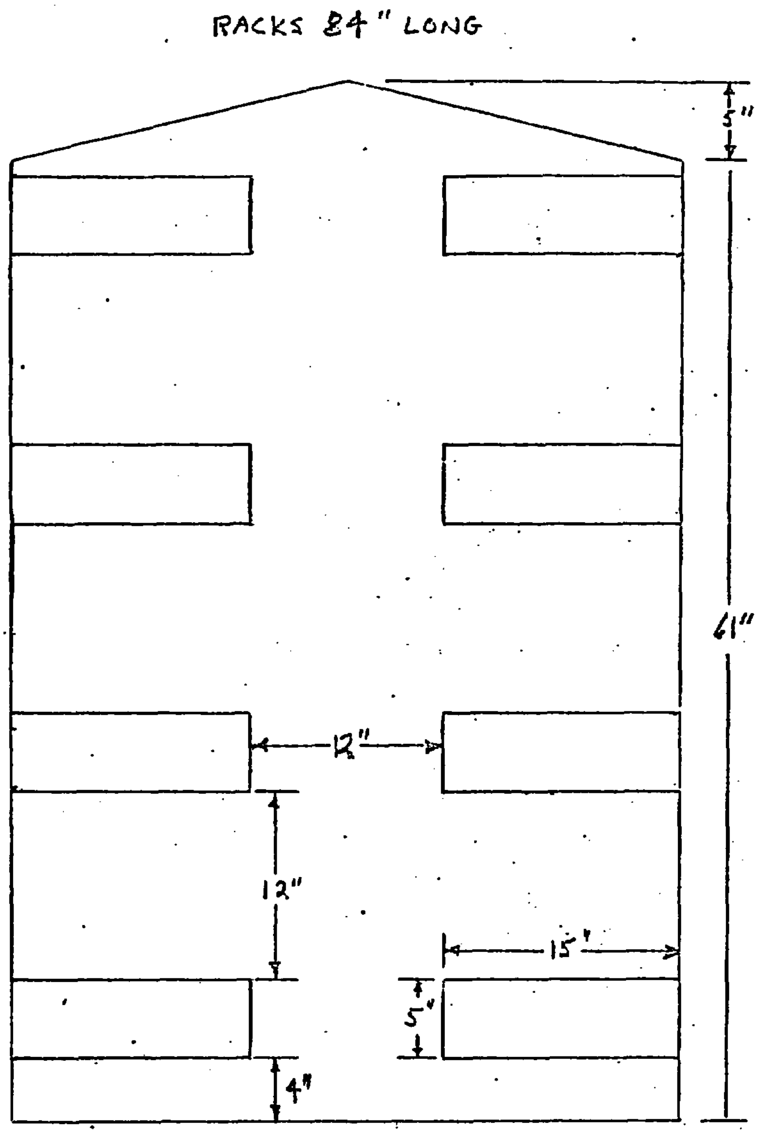
Rods are contained in modules for ease in handling. These modules are open end troughs or channels made of 1/16" or 16 gage stainless steel. 3/8" diameter drain holes are placed 4" apart approximately 9/16" above the module bottom along the entire length of the module. 16 gage safety bars or lids may be placed over the top of the module for product protection. Modules have 1-1/2"x 2-3/4" x various length inside dimensions.

Racks are constructed of 1" x 1" x 1/8" frame steel angle welded together. The outside is covered with at least 20 gage steel to provide 12" edge-to-edge and top to bottom separation between ports. Ports are long troughs running the entire length of the rack with a maximum 5" x 15" opening. Steel hasps with 16 gage steel plates welded to them are welded along the length of each opening to provide closures which ensure retention of the modules and tubes. These racks may form one or two planer arrays.

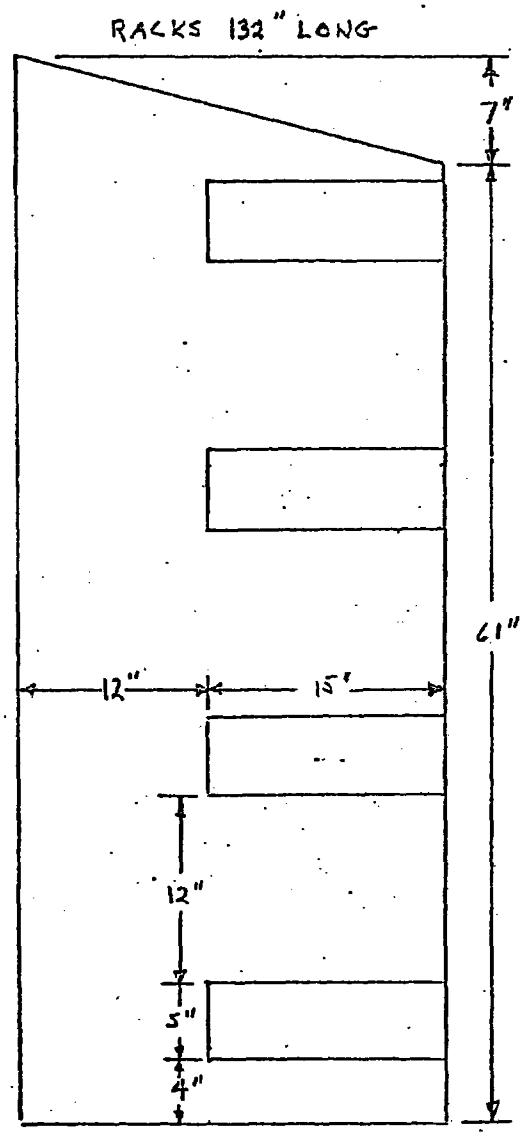
Details of construction are shown on Sketch 814.3 - I and - II.

2. Nuclear Safety

Under normal conditions, these racks are unmoderated and unreflected and are nuclearly safe. They are also safe under accident conditions of optimum water moderation and complete water reflection. The ports or openings are safe when filled with uranium not exceeding 2.8% enrichment. The storage of higher enrichments require reduced opening sizes so the material is safe under accident conditions. Details of their nuclear safety are set forth in Nuclear Safety Evaluation 814.3.



LICENSE: SNM-777; DOCKET: 70-82
SECTION: 800, SUBPART: 814.3
UO_2 ROD IN PROCESS STORAGE RACK DOUBLE RACKS - SKETCH 814.3-I
PAGE 1 of 1
APPROVED
ISSUED: OCTOBER 31, 1969



LICENSE: SNM-777; DOCKET: 70-8

SECTION: 800, SUBPART: 814.3

UO_2 ROD IN PROCESS STORAGE RAC
SKETCH: 814.3-II

PAGE 1 of 1

APPROVED

ISSUED: OCTOBER 31, 1968

SUPERSEDES:

I. DESCRIPTION

1. Rods will be stored in metal modules.
2. Up to 15 modules (3x5) may be stored in each port opening.
3. Ports are separated 12 inches edge-to-ege.
4. There will be no hydrogeneous material (e.g., paper, polyethylene, etc.) with the rods or modules in each port.
5. SNM will be restricted to UO_2 pellets with enrichments not exceeding 5.0% which are encased in metal (usually zircaloy or stainless steel) to form rods.
6. Racks may be placed end-to-end to form planar arrays.
7. Individual racks or planar arrays formed by racks placed end-to-end will be separated at least 3 feet side-by-side.

II. NUCLEAR SAFETY OF INDIVIDUAL PORTS

Under normal conditions, there will be no moderating material in the ports with the SNM. As indicated on page 10, TID-7028, "unmoderated uranium cannot become critical if the U-235 content is below 5 or 6 wt. %".

Each port opening has a cross sectional area of

$$A = 5'' \times 15'' = 75 \text{ sq.in.}$$

This cross section corresponds to a cylinder diameter of 9.78 inches.

$$A = 75 \text{ in}^2 = \frac{\pi d^2}{4}, \quad d = \sqrt{\frac{4A}{\pi}} = \sqrt{\frac{300}{\pi}} = \sqrt{95.5} = 9.78''$$

This is a safe diameter for enrichments up to and including 2.8% as shown in Figure 309-XII. Therefore, the SNM in a port would be safe even if accidentally flooded to cause optimum water moderation and complete water reflection. If higher enrichments are to be stored, the equivalent diameter will be reduced using Figure 309-XII.

III. INTERACTION CALCULATIONS

Under normal conditions, there will be no moderating material in the ports with the SNM or between the ports. As stated in II above, unmoderated material with enrichments less than 5% cannot become critical.

If accidental flooding should occur, individual ports will be separated by 12 inches of water. Twelve inches of water gives effective neutron isolation as indicated in TID-7016, Rev. 1. Since, the modules, ports and racks have many openings, there is no place for water retention. So, all water would "run out" of the modules, ports, and racks as the flooding subsided. Also, the rack construction is such that in the event of a water spray (eg., sprinkler release, water pipe rupture, etc.), it is considered unlikely that water would enter the modules, ports or racks. Therefore, these racks are safe under accident conditions.

IV. CONCLUSIONS

These racks are safe under normal or accident conditions.

I. DESCRIPTION

1. Components will be stored on 18" centers.

2. No more than 1 component will be permitted to be in transit at any one time.

3. Other SNM bearing material in the general vicinity of the rack will be spaced at least 4 feet from the rack.

II. NUCLEAR SAFETY OF INDIVIDUAL UNITS OR COMPONENTS

Individual components will be subscritical with optimum possible water moderation and complete water reflection. A summary of components and their effective multiplication factors is listed below:

Component Type	Keff	Reference
Dresden	.591	Nuclear Safety Eval.-Dresden I.F.E.-Subsection 823
Yankee	.852	Nuclear Safety Eval.-Yankee F.E.-Subsection 823

III. INTERACTION CALCULATIONS

The nuclear safety of planar array formed by the 16 components in a line will be evaluated using the K - Ω method.

1. Dresden Fuel Elements

h = active fuel length = 108.25", d = side dimension = 4.38",
e-e = 18" - 4.38" = 13.62"

$$\lambda = \frac{h}{d} = \frac{108.25''}{4.38''} = 24.7, \quad \sigma = \frac{e\text{-}c}{d} = \frac{13.62''}{4.38''} = 3.1$$

$$\bar{\Omega}_f = .035 \text{ from Fig. F-1.1, Y-1272}$$

Since the rack forms a planar array, the centermost element sees only two other elements in the array--the ones on each side of it. Assuming one element in transit at the same spacing, the centermost unit sees three elements.

$$\Omega_T = 4\pi \bar{\Omega}_f \times \text{number elements}$$

$$= 12.56 \times .035 \times 3 = 1.35 \text{ steradians}$$

III. INTERACTION CALCULATIONS

1. Dresden Fuel Elements (Continued)

From the Nuclear Safety Evaluation - Dresden I Fuel Elements (Subsection 823), the effective multiplication factor for one water moderated, unreflected element is

$K_{eff} = 0.306$

Therefore,

Allowable Ω = 9-10K = 9-3.06 = 5.94 steradians

This rack is safe for these components.

2. Yankee Fuel Elements

h = active fuel length - 91", d = side dimension = 7.615",
e-e = 18" - 7.615" = 10.385"

$$\lambda = \frac{h}{d} = \frac{91''}{7.615''} = 12, \quad \sigma = \frac{e-e}{d} = \frac{10.385''}{7.615''} = 1.4$$

Ω_f = .063 from Fig. F-1.1, Y-1272

Since the rack forms a planar array, the centermost element sees only two other elements in the array--the ones on each side of it. Assuming one element in transit at the same spacing, the centermost unit sees three elements.

$\Omega_T = 4\pi\ \Omega_f$ x no. units = 12.56 x .063 x 3 = 2.4 steradians

From the Nuclear Safety Evaluation - Yankee Fuel Elements (subsection 823) the effective multiplication factor for one water moderated, unreflected element is

$K_{eff} = 0.595$

Therefore,

Allowable Ω = 9-10K = 9-5.95 = 3.05 steradians

This rack is safe for these components.

LICENSE: SNM-777, Docket 70-820	Approved
SECTION: 800 - FUEL FABRICATION OPERATION	ISSUED OCTOBER 31, 1968
Subsection: 810 - Storage	
Subpart: 815 - 11 H Storage	SUPERSEDES NEW
815.1 - Low Enrichment UO_2 Pellet Storage	

815.1 Low Enrichment UO_2 Pellet Storage

1. Description

UO_2 pellets will be stored in fibrepaks, or equivalent type inner container packages used with shipping containers, by placing them horizontally across the floor in one of the rooms in 11 H.

The pellet packages are stored in troughs and are resting on concrete blocks. The walls are standard concrete blocks (with two holes) butted together and not cemented. The block arrangement is held in place by angle iron supports around the outer edge which are bolted to the floor. This (1/8" thick) steel plates are used to cover the troughs. Loading and unloading the troughs will be done while standing on the concrete blocks as no aisles are located within this storage area.

2. Nuclear Safety

This storage arrangement provides a safe cross section for the material stored in each trough. The solid angle subtended by the centermost trough of the array is approximately 1,964 steradians.

1. SNM will be in Fibrepaks with inner dimensions of 8-1/2" diameter and 8" height or boxes with an 8" width and thickness.

2. Fibrepaks will be arranged upright, side by side; and boxes will be arranged end to end in troughs.

3. Troughs will be separated 12" edge-to-edge.

4. SNM will be restricted to UO_2 pellets with enrichments up to and including 2.34%.

II. NUCLEAR SAFETY OF INDIVIDUAL TROUGHS

The SNM in each trough is restricted to a 68 sqaure inch (8.5" x 8") cross sectional area. This cross sectional area corresponds to a cylinder diameter of 9.3"

$$A = 68 \text{ in}^2 = \frac{\pi d^2}{4}, \quad d = \sqrt{\frac{4A}{\pi}} = \sqrt{\frac{4 \times 68}{\pi}} = \sqrt{86.6} = 9.3 \text{ in.}$$

This is a safe diameter for enrichments not exceeding 3.25% as shown in Figure 309-XII.

III. INTERACTION CALCULATIONS

Since the storage arrangement is a planar array, the centermost trough sees only the trough on each side. A row of Fibrepaks placed side by side in a trough form a rectangle of SNM 8" x 8.5" x 35'. The solid angle would be

$$d = \text{thickness of SNM} = 8", \; L = 35' = 420", \; L/2 = 210", \; h = \frac{8.5"}{2} + 12" = 16.25"$$

$$\Omega = \frac{2d}{h} \sin \theta \qquad \text{where } \tan \theta = \frac{L/2}{h} = \frac{210"}{16.25"} = 12.92$$

$$= \frac{16"}{16.25"}(.997) = .985 \times .997 \qquad \sin \theta = .997$$

$$= .982$$

$$\Omega \text{ (Total)} = 2 \times \Omega = 2 \times .982 = 1.964 \text{ steradians.}$$

The geometric buckling for a trough of Fibrepaks is,

a = 8.5" = 21.6 cm, b = 8" = 20.3 cm, c = 35' = 420" = 1066.8 cm

$$Bg^2 = \frac{\pi^2}{(a+2\lambda)^2} + \frac{\pi^2}{(b+2\lambda)^2} + \frac{\pi^2}{(C+2\lambda)^2}$$

where λ = 2.5 cm from Fig. 3 TID - 7028

$$= \frac{9.8}{(21.6+5)^2} + \frac{9.8}{(20.3+5)^2} + 0$$

$$= \frac{9.8}{(26.6)^2} + \frac{9.8}{(25.3)^2} + 0$$

$$= \frac{9.8}{707.6} + \frac{9.8}{640} + 0 = .0138 + .0153$$

$$= .0291 \text{ cm}^2$$

Replotting the data from Appendix B and C, DP-1014, for 2.34% enriched UO_2 at the minimum critical diameter,

$$Bm^2 = .0115 \text{ cm}^{-2},\ M^2 = 32.2 \text{ cm}^2$$

The effective multiplication factor for a trough of Fibrepaks is

$$k\ eff = \frac{1+M^2Bm^2}{1+M^2Bg^2} = \frac{1+(32.2x.0115)}{1+(32.2x.0291)} = \frac{1.370}{1.937} = .707$$

The sllowable solid angle is

$$\Omega\ (\text{Allowable}) = 9-10\ k = 9-7.07 = 1.93 \text{ steradians}$$

IV. CONCLUSIONS

Although the actual solid angle slightly exceeds the allowable solid angle, the system is nuclearly safe since the solid angle method contains a large, though undefined, safety factor.

CRITICAL URANIUM OXIDE - WATER SYSTEMS

DATA FROM APPENDICES B & C, DP-1014

ENRICHMENT	ROD. DIA. (IN)	AUG. U-235 DENS (G/L)	U-235 MASS (Kgs.)	CYL. DIA. (C m)	MIGRATION Anea (cm^2)	BUCKLING (cm^{-2})	REFLECTOR Savings (cm
.80	1.2	38.08	149	156	36.85	.000906	6.54
.95	1.0	40.16	27.5	80.6	35.65	.002638	6.50
1.08	1.0	45.66	15.9	63.6	35.48	.003934	6.52
1.17	0.8	44.99	11.2	56.8	34.61	.004751	6.50
1.30	0.8	49.43	8.68	50.1	34.46	.005109	6.51
1.50	0.6	51.82	6.09	43.4	33.63	.007260	6.53
2.00	0.6	69.10	4.17	34.0	33.17	.010339	6.64
3.00	0.4	81.34	2.71	27.4	31.47	.014056	6.60
5.00	0.3	118.56	2.31	22.3	30.15	.017172	6.66

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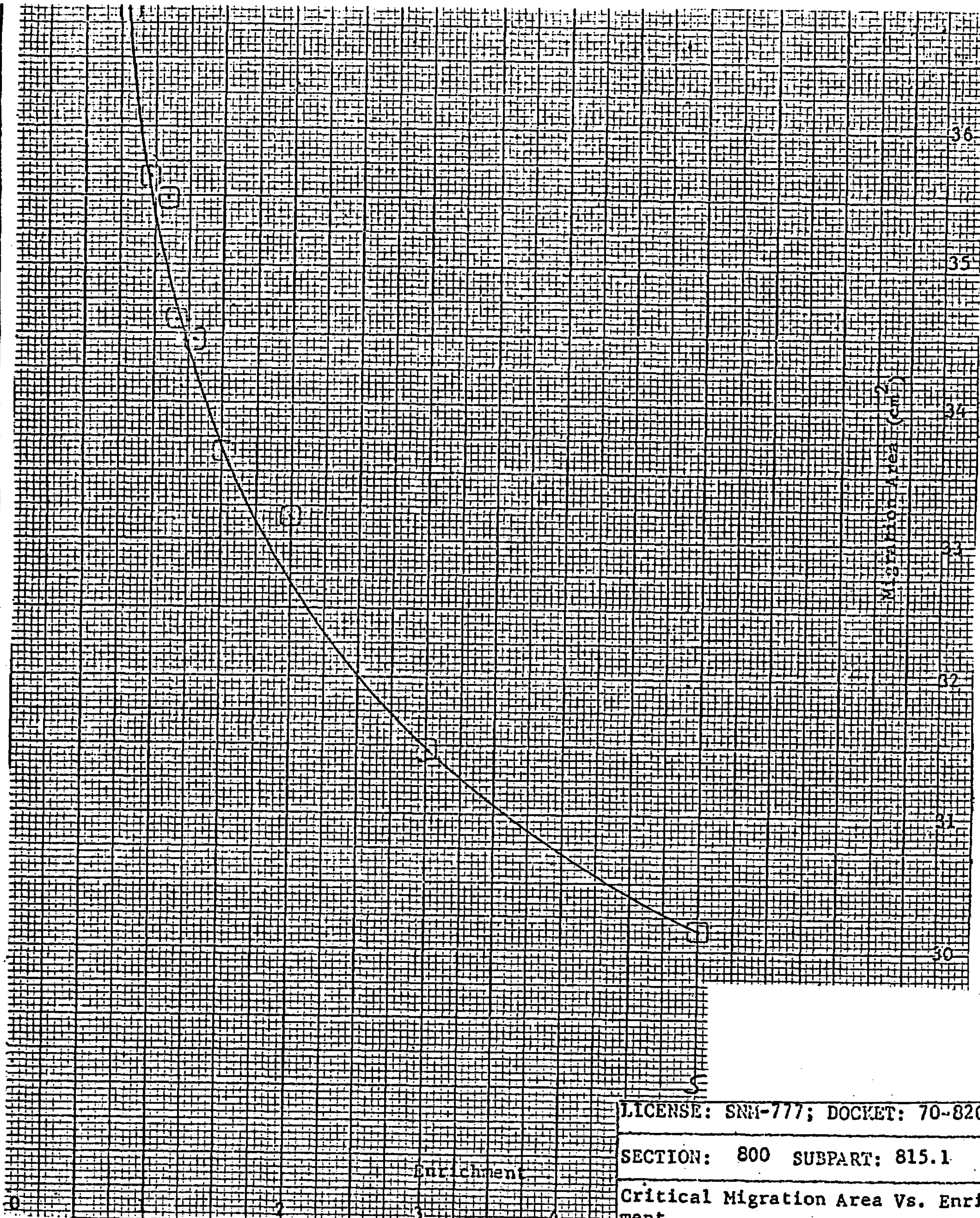
SECTION: 800, SUBPART: 815.1
DATA FROM APP. B&C, DP-1014
PAGE 1 of 1
APPROVED:
ISSUED: OCTOBER 31, 1968
SUPERSEDES: NEW



LICENSE: SNM-777; DOCKET: 70-820

SECTION: 800 SUBPART: 815.1

Critical Migration Area Vs. Enrichment

PAGE 1 OF 1

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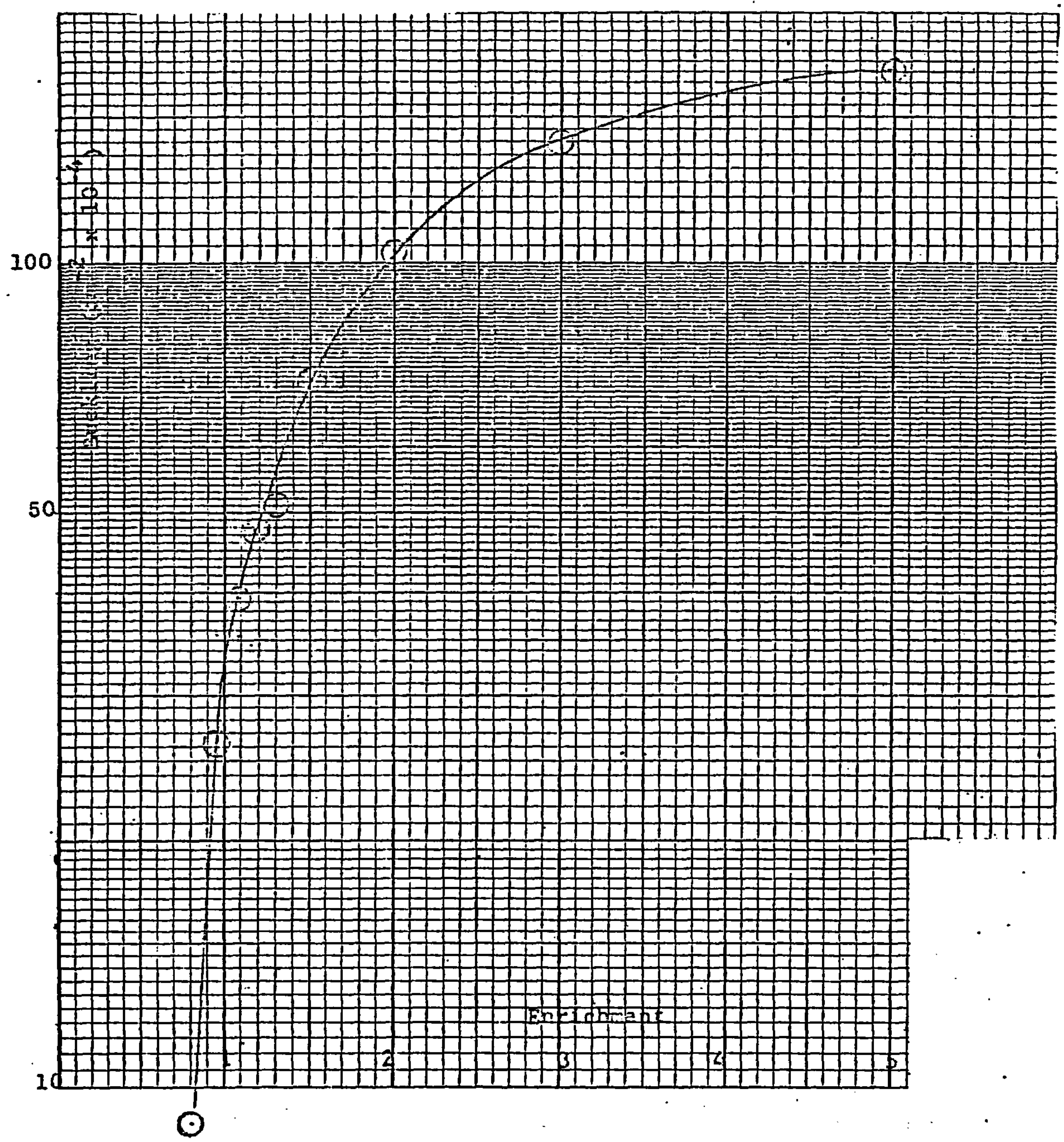
SUPERSEDES: NEW



LICENSE: SNM-777; DOCKET: 70-8

SECTION: 800 SUBPART: 815.1

Critical Buckling Vs. Enrichmen

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LICENSE:	SNM-777, Docket: 70-820	Approved
SECTION:	800 - FUEL FABRICATION OPERATION	ISSUED October 31, 1968
Subsection:	810 - Storage	
Subpart:	816 - Coat Storage	SUPERSEDES NEW
	816.1 - Low Enriched UO_2 Rod Mobile Work Tables	

816.1 LOW ENRICHED UO_2 ROD MOBILE WORK TABLES

1. Description

These carts will be used as mobile work tables during the processing of UO_2 Rods. They also may serve as temporary storage for these rods while they are awaiting further processing. Rods will normally be kept in modules for ease in handling. These modules are described in Subpart 814.3.

Carts are constructed of angle iron, usually 1/2" x 1/2" x 1/8", which is covered with a thin metal skin, usually 24 gage or heavier. The cart assembly is welded construction. These carts are designed with a horizontal trough down the middle for holding loose rods or rods in modules. Non-stacking devices will be placed in each side of the trough. Each cart is designed so that the cart width and length or added bumpers provide at least 12" separation from other SNM.

2. Nuclear Safety

The troughs will be restricted to a safe slab thickness, depending on the enrichment of the SNM being processed. Safe slab thickness valves will be obtained using Figure 309-XV. The interaction effects of Subpart 814.3 also apply to these tables.

SECTION 800 - FUEL FABRICATION OPERATION

SUBSECTION 820 - PROCESSING

TABLE OF CONTENTS

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SECTION: 800 - FUEL FABRICATION OPERATION
Subsection: 820 - Processing
Subpart: 821 - Introduction

Approvad

ISSUED OCTOBER 31, 1968

SUPERSEDES New

821 INTRODUCTION

1. The subsections which follow describe the handling, processing steps, and procedures which will be used in the fabrication of finished SNM bearing components. Operations, equipment items, safety limitations and considerations, and processing information are discussed and described in the appropriate subsections.

2. The use of up to and including 350 grams of U-235 at any enrichment is authorized for research, development, and pilot operations under the following conditions:

   2.1 Each 350 gram batch may contain any number of smaller units.

   2.2 The maximum amount of material to be so regulated is 10 kgs U-235 at any enrichment per room.

   2.3 Each work station, operation, zone, or piece of equipment will be separated a minimum of four feet from each 350 gram U-235 batch or any other SNM.

3. The interaction between process operations is not calculated. Generally, each process operation is separated by three feet and identified as a criticality zone. This separation is exclusive of ports or shelves in storage devices. In lieu of determining the interaction between these process operations, a process area limit has been established using a safe surface density of 175 qm U-235 per square ft. The Process Area Limits are:

Building	Process Area Limit
10H	122 Kg U-235
19H	1050 Kg U-235
50H	5075 Kg U-235

Details concerning these limits are set forth in Nuclear Safety Evaluation 821. The Possession Limits set forth in Section 100 will not be exceeded regardless of the Process Area Limit.

I. DETERMINATION OF SAFE SURFACE DENSITY VALUE

A safe surface density value of 175 gms U-235 per sq.ft. of floor area was used. Reference subsection 300.

II. PROCESS AREA LIMIT - BUILDING 10H

The Tube Loading Area has a floor area of approximately 788 sq.ft. Assuming that the inprocess storage devices occupy approximately 88 sq.ft. there is approximately 700 sq.ft. as process area.

Process Area Limit = 700 $ft.^2$ x 175 gm U-235/$ft.^2$ = 122 Kg U-235.

III. PROCESS AREA LIMIT - BUILDING 19H

The total floor area is approximately 6600 sq.ft. Assuming that inprocess storage devices occupy approximately 600 sq.ft., there is approximately 6000 sq.ft. as process area.

Process Area Limit = 6000 $ft.^2$ x 175 gm U-235/$ft.^2$ = 1050 Kg U-235

IV. PROCESS AREA LIMIT - BUILDING 50H

The total floor area is approximately 32,175 sq.ft. Assuming that inprocess storage devices occupy approximately 3,175 sq.ft., there is approximately 29,000 sq.ft. as process area.

Process Area Limit = 29,000 $ft.^2$ x 175 gm U-235/$ft.^2$ = 5,075 Kg U-235.

LICENSE: SNM-777, Docket:70-82(
SECTION: 800, Subpart 821
Nuclear Safety Evaluation- Process Area Limits
Page 1 of 1
Approved
Issued 10-31-68
Supersedes New

14 Pgs uph in enterety

Ex 4

The Babcock & Wilcox Company
Established 1867

DIVISION
GENERAL OFFICE
LYNCHBURG, VA.

ATOMIC ENERGY DIVISION
5061 FORT AVENUE
P. O. BOX 1260
LYNCHBURG, VA. 24505

TELEPHONE
AREA CODE 703
[illegible]6-7371

November 1, 1966

United Nuclear Corp.
365 Winchester Avenue
New Haven, Connecticut

ATTENTION: W. A. Cameron

Re: B&W Purchase Order
A-27859, 190x807

Dear Sir:

In accordance with your Mr. Kropp's request, we submit the following information to supplement our letter dated August 17, 1966, on multiplication and migration area values for the BAWTR fuel elements:

Recent calculations for the standard BAWTR fuel element (~[redacted] grams U_{235}) give the following results:

Case I Fuel homogenized over the area within the fuel boundaries

[redacted]

Ex. 4

Case II Fuel homogenized over entire element area [redacted]

[redacted]

The above calculations were made using the KATE-1[1], Program for Maxwellian averaged thermal constants, MUFT-5[2] Fast neutron spectrum program for the fast groups, and WANDA-5[3] neutron diffusion program. Thirty-four (34) group cross-sections were used.

REFERENCES

(1) H. J. Amster and J. B. Callaghan, KATE-1, "A Program for Calculating Wigner-Wilkins and Maxwellian Averaged Thermal Constants for the Philco-2000, WAPD-TM-232 (October 1960).

(2) H. Bohl, Jr. and A. P. Hemphill, MUFT-5, "A Fast Neutron Spectrum Program for the Philco-2000, WAPD-TM-218 (February 1961).

(3) O. J. Marlowe and M. C. Suggs, WANDA-5, "A One-Dimensional Neutron Diffusion Equation program for the Philco-2000, WAPD-TM-241 (November 1960).

We trust the above will be sufficient, however, if you have any questions, please do not hesitate to contact us.

Yours very truly,

THE BABCOCK & WILCOX COMPANY
Atomic Energy Division

R. A. Beal, Purchasing Agent

C. D. Carter, Jr./cbp

By C. D. Carter, Jr.

CDC,Jr./cbp

LICENSE:	SNM-:777, Docket: 70-820	Approved
SECTION:	800 - FUEL FABRICATION OPERATION	
Subsection:	820 - Processing	ISSUED October 31, 1968
	823 - Fabrication of Stainless Steel, Aluminum, or Zircaloy Clad Tubular Type UO_2 Pellet Assemblies	SUPERSEDES NEW
	823.1 - General Considerations	

823.1 GENERAL CONSIDERATIONS

1. This subsection covers preparation and processing of up to and including 5% enriched UO_2 fuel material as pellets and its fabrication into tubular type fuel rod assemblies or clusters with the pellets clad in Stainless Steel, Zircaloy, or Aluminum. Individual operations which may be performed, are shown on Diagram 823-I, and are listed in their expected sequence.

2. Operations on pellets will be performed in Building 10H. Rod and assembly fabrication will be performed in Building 50H.

3. Fuel assemblies which may be fabricated under the provisions of this Subsection will be limited to the following types of components:
   4.1 Dresden (BWR)
   4.2 Yankee (PWR)

4. Safe cross section valves used in Subpart 823.2 will be obtained using the safe diameter valves shown on Fig. 309-XII. The cross section will be calculated using

$$\text{Safe Cross Section} = \frac{\pi \times (\text{safe diameter})^2}{4}$$

5. Unless stated otherwise, safe values referenced in this Subpart will be obtained using the Figures referenced in the following table:

	Safe Value	Figure
5.1	Heterogeneous Diameter	309-XII
5.2	Heterogeneous Mass	309-XIII
5.3	Heterogeneous Volume	309-XIV
5.4	Heterogeneous Thickness	309-XV
5.5	Homogeneous Diameter	309-XVI
5.6	Homogeneous Mass	309-XVII
5.7	Homogeneous Volume	309-XVIII
5.8	Homogeneous Thickness	309-XIX
5.9	Geometric Variables for Specified U235 Enrichments	309-XX
5.10	Masses for Specified U235 Enrichment	309-XXI
5.11	Safe Cylinders for any U-235 Enrichment	309-XXII

6. K eff values will be determined by individual Nuclear Safety evaluations included in this Subpart (823).

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Subsection:	820 - Processing	ISSUED OCTOBER 31, 1968
	823 - Fabrication of Stainless Steel, Aluminum, or Zircaley Clad Tubular Type UO_2 Pellet Assemblies	SUPERSEDES New
Subpart:	823.2 - Process Description	

823.2 PROCESS DESCRIPTION

1. Receive Pellets

Pellets will be received and handled in accordance with Subsection 810.

2. Measure and Weigh Stack

This is a dry operation and will be limited to a safe heterogeneous mass. If pellets are damaged, they will be placed in safe heterogeneous diameter or volume or cross section containers or they will be placed in a container and limited to a safe heterogeneous mass If the pellets are sufficiently damaged so that UO_2 powder is found, the UO_2 powder will be placed in safe homogeneous diameter or volume or cross section containers or placed in a container and limited to a safe homogeneous mass.

3. Pellet Dryness Test

A few representative pellets are removed from each batch or lot and tested for dryness. This operation will be limited to a safe heterogeneous mass.

4. Load and Weld

Pellets are loaded into tubes and the end plugs added and welded to the tubes during this operation. It will be limited to a safe heterogeneous mass or a fixture may be used which provides a safe heterogeneous cross-section.

5. Machine or Hand Finish Welds

This operation is usually performed on individual loaded rods one at a time. It is limited to a safe heterogeneous mass.

6. Inspect

This operation will be limited to a safe heterogeneous mass,

7. Zyglo Test

Dye penetrantis brushed on the welded end caps and the welds checked. Test materials are removed by dipping the ends of the rods in a liquid. Since only the ends are placed in a liquid (approximately 1 to 2 inches), this operation is limited to a safe heterogeneous mass.

8. Leak Test by Alcohol Immersion

Prior to leak testing, rods are immersed in alcohol. This is a wet operation and is limited to a safe hetcorogeneous mass or the rods are held by a fixture or the equipment in a safe heterogeneous cross-section..

9. Helium Leak Test

This operation is dry and performed in leak tight vessels. Each vessel is limited to a safe heterogeneous mass or the rods are retained in a safe heterogeneous cross-section.

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Subsection: 820 - Processing
823 - Fabrication of Stainless Steel, Aluminum, or Zircaley Clad Tubular Type UO_2 Pellet Assemblies
Subpart: 823.2 - Process Description

10. Clean and Pickle

Typically, the sequence of operations are a detergent clean, a water rinse, an acid dip, a cold water and/or a hot water rinse, and a warm water soak. Tanks are spaced close together to allow quick transfer and each is roughly 1-1/2 ft. square and approximately 10 ft. deep. All SNM material is clad and fixtured. Fixtures are moved from tank to tank via an overhead crane one at a time. Only one fixture at a time is allowed in movement and one other fixture is allowed in one of the other tanks at any one time. Fixtures are designed to hold only a safe mass of SNM, or the SNM is retained in a safe cross-section, or the fixture has a k eff (bare) ≤ 0.65 and k eff (reflected) ≤ 0.9. The safe geometry for the fixture will be determined neglecting the affects of the cladding.

Fixtures are further designed to preclude accidental insertion of two fixtures into one tank. An acid tank is assumed to have enough acid to dissolve one batch completely. Acid tanks are continuously agitated, usually by air bubbling, which insures uniform mixing and pickling. No uranium is allowed in the solutions. Pickling solutions are checked, usually by sampling, before the start of each shift to determine how spent they are. If there is reason to believe that the solution contains SNM, the solution is sampled and analyzed for uranium content prior to processing additional SNM. Material is inspected after pickling. Any over-pickling or penetration to SNM causes rejection of the material and sampling of the pickle solution. In addition, the pickle lines are equipped with an automatic withdrawal system. The system will be designed to insure automatic withdrawal of the SNM material or dumping of the acid even in the event of loss of primary power. Therefore, the insertion of a fixture containing SNM into a solution containing SNM or the dissolution of the SNM, is considered unlikely. In addition, acid tanks are equipped with an automatic dump system to preclude SNM being in the tanks for extended periods due to electrical or mechanical failure. An example of a k eff calculation for a fixture of this type is shown in NDEO-107.

11. Load Autoclave and Corrosion Test

After pickling, the fixture containing SNM may undergo a water soak (if required), then is loaded into an autoclave and corrosion tested. Again, individual fixtures will hold only a safe mass of SNM, or the SNM is retained in a safe cross-section, or the fixture has a k eff (bare) ≤ 0.65 and k eff (reflected) ≤ 0.9. The interaction between autoclaves is approximately 1.82 steradians with 2.5 steradians allowed.

12. Visual Inspection

This operation is limited to a safe heterogeneous mass.

13. Storage/Issue for Assembly

Storage of rods will be in accordance with Subsection 810. During issue for assembly, loose rods will be retained in a safe heterogeneous cross-section container or limited to a safe heterogeneous mass.

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Subsection: 820 - Processing 823 - Fabrication of Stainless Steel, Aluminum, or Zircaley Clad Tubular Type UO_2 Pellet Assemblies	SUPERSEDES
Subpart: 823.2 - Process Description	New

14. Alpha Count

Prior to assembly, rods may be alpha counted for surface contamination. This operation is limited to a safe hetcorogeneous mass.

15. Assemble Elements

Rods are assembled with non-SNM components and welded (if required) into assemblies. This is a dry operation and limited to a safe mass or the assemblies will have a k eff (bare) $\leq$ 0.65 and k eff (reflected) $\leq$ 0.9.

16. Machine or Hand Finish

If required, excess weld material may be machined off or the assemblies hand finished. This operation is limited to that number of assemblies with a k eff (bare) $\leq$ 0.65 and k eff (reflected) $\leq$ 0.9.

17. Rivet Grids, Assemble End Fittings, etc.

This operation is limited to that number of assemblies with k eff (bare) $\leq$ 0.65 and k eff (reflected) $\leq$ 0.9.

18. Dimensional and Visual Inspect

Same considerations as Subpart 823.2.17.

19. Radiograph

Same considerations as Subpart 823.2.17.

20. Degrease or Water Rinse, etc.

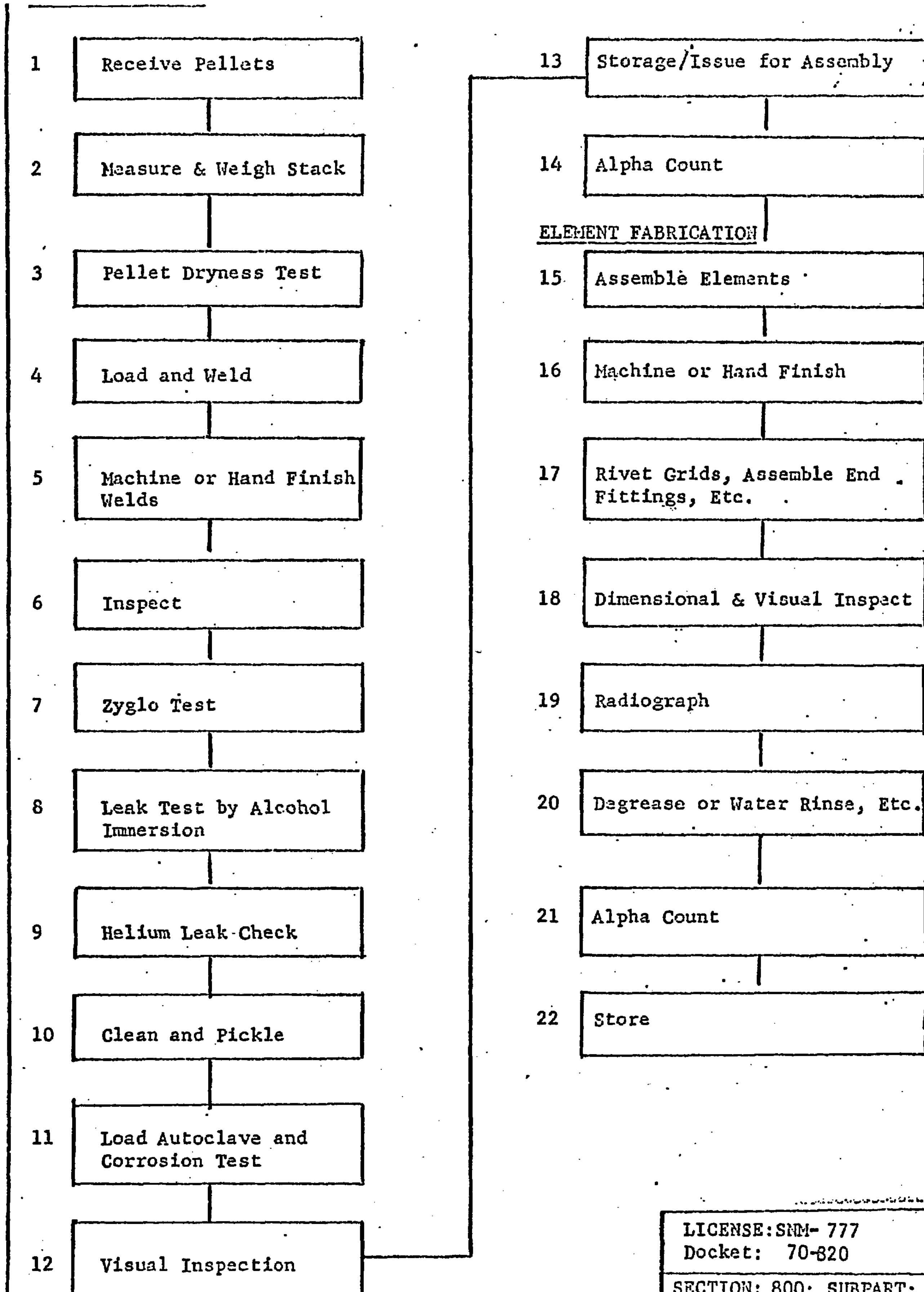
A final cleaning operation is performed. The number of assemblies will be limited such that k eff (bare) $\leq$ 0.65 and k eff (reflected) $\leq$ 0.9.

21. Alpha Count

Same considerations as Subpart 823.2.17.

22. Store

Assemblies will be stored in accordance with Subsection 810.



LICENSE: SNM- 777
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SECTION: 800; SUBPART: 823

Flow Diagram 823.-I

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ISSUED: October 31, 1968

SUPERSEDES: NEW

A. Pellet Description: 0.482" Ø x 0.6" 1.0" long

B. Rod Description:

1.

Type Rod	Fuel Stack Length	Tube Length	Wght.	Fuel Loading/Rod
Free End	108.25 ± .50	114.70"Length, Spring,Disc	8#	3251 ± 98 g (67.0 g U-235)
Fixed Type	108.25 ± .50	114.70"Length, Spring, Disc	8#	3251 ± 98 g (67.0 g U-235)
Remov. Type 1	108.25 ± .50	114.70"Length, Spring, Disc	8#	3251 ± 98 g (67.0 g U-235)
*Remov. Type 2	108.25 ± .50	114.70"Length, Spring, Disc	8#	3175 ± 95 g
PPC Type	108.25 ± .50	114.70"Length, Spring, Disc	8#	3251 ± 98 g (50.7 g U-235)
Segmented	17.54 ± .05 5 per Rod 12.63 ± .050 1 per Rod	114.70"Length, Spring, Disc	10#	3013 ± 90 g (62.1 U-235 Total)
Instrumented	None	114.70"Length, No Springs,Disc	3#	None

*Uranium Dioxide-Gadolinia (64.1 g U-235) (55.0 g Gd_2O_3)

2. Zircaloy-2 Tubing

Std Tube: 0.0370" ± .0025" W.T. x 0.4925" ± .0020" I.D.

Instru. Tube: 0.0293" ± .0025" W.T. x 0.540" ± .002" I.D.

C. Element Description

4.38" x 4.38" x
- Length Over Active Fuel - 108.25"
- Length Between Grids - 115.33"
- Length Overall - 134.35"
- 36 Rods Per Element

1.

Type Element	Required/Batch No 6
Type 1	53
Type 2	30
Instrumented	13

2. Type Rod	No Required Per Type I Element	No Required Per Type II Element	No Required Per Instrument Element
Free End	20	20	20
Fixed Type A	8	8	8
Remov.Type 1	1	-	-
Remov.Type 2	-	1	-
PPC Type	6	6	6
Segmented	1	1	1
Instrument	-	-	1

D. General Information

1. Enrichment

a. Normal Fuel 2.34 $\pm$ 0.05 w/o

b. Segmented Fuel 2.34 $\pm$ 0.05 w/o

c. PPC Fuel 1.77 $\pm$ 0.05 w/o

d. Gadolinia Content 1.74 $\pm$ 0.05 w/o (Remov.Type 2 Pellets Only With 2.34 $\pm$ 0.05 w/o U-235)

Note: Free End, Type A, Remov. No. 1 and Remov. No. 2 Know as "Normal"

2. Pellet Density: 93.5% Theoretical $\pm$ 2.0%

II. ASSUMPTIONS

A. The design reactivity information contained in NDEO-1033 is applicable and will be used to determine effective multiplication factors ($K\infty$ = 1.21 and M^2 = 39 cm^2)

B. Calculations will be performed using the following equations:

$$B^2 = \frac{\pi^2}{(\text{length} + 2\delta)} + \frac{\pi^2}{(\text{width} + 2\delta)} + \frac{\pi^2}{(\text{thickness} + 2\delta)^2} \quad \text{and}$$

$$K_{eff} = \frac{k\,\infty}{1 + M^2B^2}$$

C. Using Fig. 4-27 of ANL-5800, 2nd Edition, a reflector savings (δ) of 8 cm. for a full water reflector was selected.

* D. From Fig. 3 and 4 of TID-7028, an extrapolation length (also designated δ) of 2.5 cm. was selected for bare, moderated systems. This value is based on highly enriched uranium experimental data; however, it is consistent with the calculated results shown on Fig. 2.7 of DP-532. At lower enrichment DP-532 indicates a higher extrapolation length (approximately 4 cm.) which is probably due to calculated or experimental error or perhaps a real effect due to increasing system radii. This variation of extrapolation length from 2.5 to 4 cm. will yield minor reactivity changes, probably 10% or less in K eff.

elements is assumed. Under moderated conditions, this will yield higher k eff values than would occur if the elements were closely packed.

III. CALCULATIONS

A. One Element - envelope = 11.13 cm. x 11.13 cm. x 275 cm.

1. Reflected Case

$$B^2_{Refl.} = \frac{9.87}{(11.13 + 16)^2} + \frac{9.87}{(11.13 + 16)^2} + \frac{9.87}{(275 + 16)^2} = \frac{9.87}{(27.13)^2} + \frac{9.87}{(27.13)^2} + \frac{9.87}{(291)^2} = \frac{9.87}{736.04} + \frac{9.87}{736.04} + \frac{9.87}{84,861} = 0.0134 + 0.0134 + 0.0001 = 0.0269$$

$$K_{eff} = \frac{1.21}{1 + (39 \times 0.0269)} = \frac{1.21}{1 + 1.049} = \frac{1.21}{2.049} = \boxed{0.591}$$

2. Bare Case

$$B^2_{Bare} = \frac{9.87}{(11.13 + 5)^2} + \frac{9.87}{(11.13 + 5)^2} + \frac{9.87}{(275 + 5)^2} = \frac{9.87}{(16.13)^2} + \frac{9.87}{(16.13)^2} + \frac{9.87}{(280)^2} = \frac{9.87}{260.18} + \frac{9.87}{260.18} + \frac{9.87}{78,400} = 0.0379 + 0.0379 + 0.0001 = 0.0759$$

$$K_{eff} = \frac{1.21}{1 + (39 \times 0.0759)} = \frac{1.21}{1 + 2.9601} = \frac{1.21}{3.9601} = \boxed{0.306}$$

B. Two Elements - envelope = (11.13 + 1.91 + 11.13 = 24.17) = 24.17 cm x 11.13 cm x 275 cm.

1. Reflected Case

$$B^2_{Refl.} = \frac{9.87}{(24.17 + 16)^2} + \frac{9.87}{(11.13 + 16)^2} + \frac{9.87}{(275 + 16)^2} = \frac{9.87}{(40.17)^2} + 0.0134 + 0.0001 = \frac{9.87}{1613.63} + 0.0134 + 0.0001 = 0.0061 + 0.0134 + 0.0001 = 0.0196$$

$$K_{eff} = \frac{1.21}{1 + (39 \times 0.0196)} = \frac{1.21}{1 + 0.764} = \frac{1.21}{1.764} = \boxed{0.686}$$

2. Bare Case

$$B^2_{Bare} = \frac{9.87}{(24.17 + 5)^2} + \frac{9.87}{(11.13 + 5)^2} + \frac{9.87}{(275 + 5)^2} = \frac{9.87}{(29.17)^2} + 0.0379 + 0.0001 = \frac{9.87}{850.89} + 0.0379 + 0.0001 = 0.0116 + 0.0379 + 0.0001 = 0.0496$$

$$K_{eff} = \frac{1.21}{1 + (39 \times 0.0496)} = \frac{1.21}{1 + 1.934} = \frac{1.21}{2.934} = \boxed{0.412}$$

1. Reflected Case

$$B^2_{Refl.} = 0.0061 + 0.0061 + 0.0001 = 0.0123$$

$$K_{eff} = \frac{1.21}{1 + (39 \times 0.0123)} = \frac{1.21}{1 + 0.480} = \frac{1.21}{1.48} = \boxed{0.819}$$

2. Bare Case

$$B^2_{Bare} = 0.0116 + 0.0116 + 0.0001 = 0.0233$$

$$K_{eff} = \frac{1.21}{1 + (39 \times 0.0233)} = \frac{1.21}{1 + 0.909} = \frac{1.21}{1.909} = \boxed{0.634}$$

D. Nine Elements (3 x 3) - envelope (11.13 + 1.91 + 11.13 + 1.91 + 11.13 = 37.21 cm.) = 37.21 cm. x 37.21 cm. x 275 cm.

1. Reflected Case

$$B^2_{Refl.} = \frac{9.87}{(37.21 + 16)^2} + \frac{9.87}{(37.21 + 16)^2} + \frac{9.87}{(275 + 16)^2} = \frac{9.87}{(53.21)^2} + \frac{9.87}{(53.21)^2} + 0.0001 = \frac{9.87}{2831.30} + \frac{9.87}{2831.30} + 0.0001 = 0.0035 + 0.0035 + 0.0001 = 0.0071$$

$$K_{eff} = \frac{1.21}{1 + (39 \times 0.0071)} = \frac{1.21}{1 + 0.2769} = \frac{1.21}{1.2769} = \boxed{0.948}$$

2. Bare Case

$$B^2_{Bare} = \frac{9.87}{(37.21 + 5)^2} + \frac{9.87}{(37.21 + 5)^2} + \frac{9.87}{(275 + 16)^2} = \frac{9.87}{(42.21)^2} + \frac{9.87}{(42.21)^2} + 0.0001 = \frac{9.87}{1781.68} + \frac{9.87}{1781.68} + 0.0001 = 0.0055 + 0.0055 + 0.0001 = 0.0111$$

$$K_{eff} = \frac{1.21}{1 + (39 \times 0.0111)} = \frac{1.21}{1 + 0.433} = \frac{1.21}{1.433} = \boxed{0.844}$$

E. Sixteen Elements (4 x 4) - envelope = (11.13 + 1.91 + 11.13 + 1.91 + 11.13 + 1.91 + 11.13 = 50.25 cm) 50.25 cm x 50.25 cm x 275 cm.

1. Reflected Case

$$B^2_{Refl.} = \frac{9.87}{(50.25 + 16)^2} + \frac{9.87}{(50.25 + 16)^2} + \frac{9.87}{(275 + 16)^2} = \frac{9.87}{(66.25)^2} + \frac{9.87}{(66.25)} + 0.0001 = \frac{9.87}{4389.1} + \frac{9.87}{4389.1} + 0.0001 = 0.00224 + 0.00224 + 0.0001 = 0.00458$$

$$K_{eff} = \frac{1.21}{1 + (39 \times 0.00455)} = \frac{1.21}{1 + 0.1786} = \frac{1.21}{1.1786} = \boxed{1.027}$$

E. Sixteen Elements (continued)

2. Bare Case

$$B^2_{Bare} = \frac{9.87}{(50.25 + 5)^2} + \frac{9.87}{(50.25 + 5)^2} + \frac{9.87}{(275 + 5)^2} = \frac{9.87}{(55.25)^2} + \frac{9.87}{(55.25)^2}$$

$$+ 0.0001 = \frac{9.87}{3052.56} + \frac{9.87}{3052.56} + 0.0001 = 0.00323 + 0.00323 + 0.0001 =$$

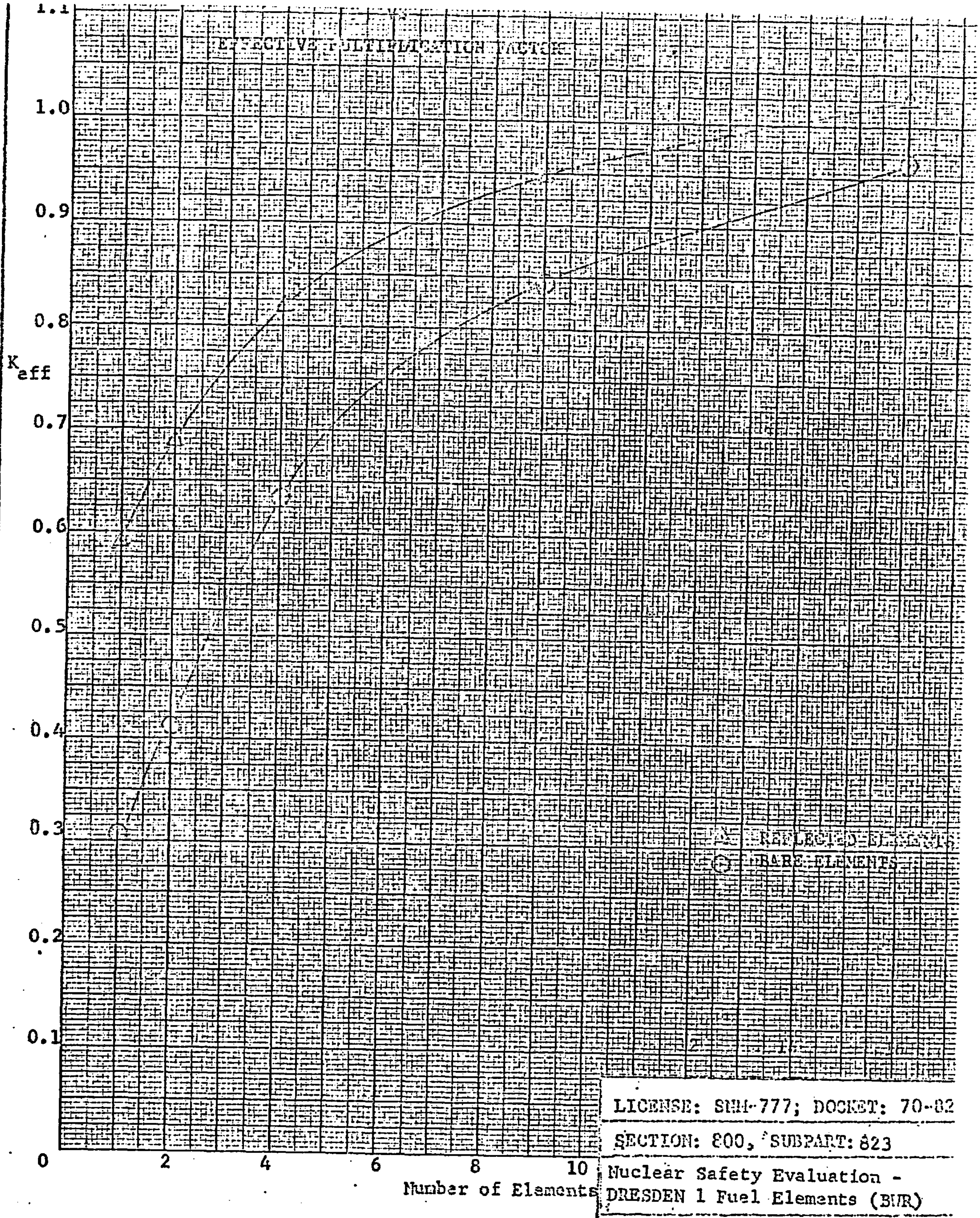
$$0.00656$$

$$K_{eff} = \frac{1.21}{1 + (39 \times 0.00656)} = \frac{1.21}{1 + 0.2558} + \frac{1.21}{1.2558} = \boxed{0.964}$$

IV. CONCLUSIONS

* A. These calculations indicate that 16 elements in a 4 x 4 array would be just critical. Calculations in NDEO-1033, -1164.-and 1501, indicate that 17 nominally fabricated elements would be required for criticality. Therefore, these calculations are representative.

*Indicates Change



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SECTION: 800, SUBPART: 823

Nuclear Safety Evaluation - DRESDEN 1 Fuel Elements (BWR)

PAGE 6 of 6

APPROVED

ISSUED: OCTOBER 31, 1968

SUPERSEDES: NEW

Supplement to
NUCLEAR SAFETY EVALUATION
DRESDEN FUEL ELEMENT (BWR)

I. Material Description

PuO_2 - UO_2 Fuel Rods and Elements.

A. General

This supplement provides additional information applicable to the shipment of Dresden PuO_2 - UO_2 fuel rods and elements. The orginial nuclear safety evaluation remains unchanged.

The rods and elements are the same type and with the same dimensions and arrangement as the previously described Dresden BWR elements.

B. Pellets

Pellets are sintered (high fired) ceramic of two types:

a) UO_2 2.34% U^{235} enrichment.

b) Mixed oxide PuO_2 - UO_2

Nominal composition:

97.7 ±	w/o UO_2 natural enrichment
2.3 ±	w/o PuO_2
100.0	

Nominal isotopic composition of Pu is:

Pu 238	0.37%
Pu 239	71.34%
Pu 240	20.63%
Pu 241	6.09%
Pu 242	1.57%
	100.00%

C. Rods

Two types

a) UO_2 pellets

Dimensions, weight and enrichment as described in Nuclear Safety Evaluation--Dresden I Fuel Elements (BSR) dated 9/15/67.

b) PuO_2 - UO_2 pellet

Net weight	PuO_2 - UO_2	3254 gms/rod
	UO_2	3179 gms/rod
	PuO_2	75 gms/rod
	U-235	19.9 gms/rod
	Pu	66 gms/rod

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Nuclear Safety Evaluation Dresden Fuel Element (BWR)
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APPROVED: AMENDMENT NO.:

D. Element

Type Rod	Number	Net Weight Per Rod, Grams	Net Weight Per Element, Grams
UO_2 Pellet, Free End and Fixed End	19	3251	61769
UO_2 Pellet, PPC	6	3251	19506
UO_2 Pellet,	1	3013	3013
UO_2 -Gd_2O_3 Pellet	1	3251	3251
PuO_2 - UO_2 Pellet, Free end and fixed end	9	3254]	29286
	36		116,825

II. Nuclear Criticality Safety

A. A. Elements

The PuO_2 - UO_2 elements are neutronically equivalent to standard UO_2 Dresden element. (Ref. NDEO 1501). The Nuclear Safety Evaluation for assembly and handling Dresden elements remains unchanged and is applicable to these elements.

B. Rods

The standard batch size will be 18 rods. As shown in NDEO-1771, 90 rods at the optimum moderating condition and fully reflected will have a K_{eff} not exceeding 0.92. Therefore, 18 rods will be subcritical by a larger margin and are nuclearly safe.

4 pgs w/ entirety
Ex. 4

I. BASIC INFORMATION

A. Pellet Description: 0.3145" Ø x 0.6" ⟶ 1.0" long

B. Rod Description:

1.

Type Rod	Fuel Stack Length	Tube Length	Weight	Fuel Loading/Rod
1	91.00 ± .25	94.57"	3.3 lbs.	1182.8 g UO_2 (36.49 g U-235)

2. Zircaloy-2 Tubing
Std. Tube: 0.020" W.T. x 0.368" ± 0.002" OD x 0.3210" ± 0.001" ID

C. Element Description

7.615" x 7.615" x {
Length Over Active Fuel - 91.00"
Length Between Grids - 95.44"
Length Overall - 111.9"
238 Fuel Rods Per Element
Pitch - 0.468"

D. General Information

1. Enrichment: 3.5 w/o

2. Pellet Density: 94% Theoretical

II. ASSUMPTIONS

A. The design reactivity information contained in NDEO-1134 is applicable and will be used to determine effective multiplication factors (K_∞ = 1.405 and M^2 = 40.9 cm^2)

B. Calculations will be performed using the following equations

$$B^2 = \frac{\pi^2}{(\text{length} + 2\delta)} + \frac{\pi^2}{(\text{width} + 2\delta)} + \frac{\pi^2}{(\text{thickness} + 2\delta)}$$ and

$$K\ \text{eff} = \frac{K_\infty}{1 + M^2B^2}$$

C. Using Fig. 4-27 of ANL-5800, 2nd Edition, a reflector savings (δ) of 8 cm for a full water reflector was selected.

* D. From Fig. 3 and 4 of TID-7028, an extrapolation length (also designated δ) of 2.5 cm. was selected for bare, moderated systems. This value is based on highly enriched uranium experimental data; however, it is consistent with the calculated results shown on Fig. 2.7 of DP-532. At lower enrichments, DP-532 indicates a higher extrapolation length (approximately 4 cm.), which is probably due to calculated or experimental error or perhaps a real factor due to increasing system radii. This variation of extrapolation length from 2.5 to 4 cm. will yield minor reactivity changes, probably 10% or less in k eff.

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Nuclear Safety Evaluation - Yankee Fuel Elements (PWR)
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SUPERSEDES: 10/31/68

*Indicates Change

elements is assumed. Under moderated conditions, this will yield higher k eff values than would occur if the elements were closely packed.

III. CALCULATIONS

A. One Element - envelope = 19.34 cm x 19.34 cm x 231 cm

1. Reflected Case

$$B^2_{Refl.} = \frac{9.87}{(19.34 + 16)^2} + \frac{9.87}{(19.34 + 16)^2} + \frac{9.87}{(231 + 16)^2} = \frac{9.87}{(35.34)^2} +$$

$$\frac{9.87}{(35.34)^2} + \frac{9.87}{(247)^2} = \frac{9.87}{1249} + \frac{9.87}{1249} + \frac{9.87}{61,009} = 0.0079 + 0.0079 + 0.0001 =$$

$$0.0159$$

$$K_{eff} = \frac{1.405}{1 + (40.9 \times 0.0159)} = \frac{1.405}{1 + 0.650} = \frac{1.405}{1.650} = \boxed{0.852}$$

2. Bare Case

$$B^2_{bare} = \frac{9.87}{(19.34 + 5)^2} + \frac{9.87}{(19.34 + 5)^2} + \frac{9.87}{(231 + 5)^2} = \frac{9.87}{(24.34)^2} +$$

$$\frac{9.87}{(24.34)^2} + \frac{9.87}{(236)^2} = \frac{9.87}{592} + \frac{9.87}{592} + \frac{9.87}{55,696} = 0.0166 + 0.0166 + 0.0001 =$$

$$0.0333$$

$$K_{eff} = \frac{1.405}{1 + (40.9 \times 0.0333)} = \frac{1.405}{1 + 1.362} = \frac{1.405}{2.362} = \boxed{0.595}$$

B. Two Elements - envelope=(19.34 + 1.91 + 19.34 = 30.59)=30.59 cm x 19.34 cm x 231 cm.

1. Reflected Case

$$B^2_{Refl.} = \frac{9.87}{(30.59 + 16)^2} + \frac{9.87}{(19.34 + 16)^2} + \frac{9.87}{(231 + 16)^2} = \frac{9.87}{(46.59)^2} + 0.0079$$

$$+ 0.001 = \frac{9.87}{2171} + 0.0079 + 0.001 = 0.0045 + 0.0079 + 0.001 = 0.0125$$

$$K_{eff} = 1 + \frac{1.405}{(40.9 \times 0.0125)} = \frac{1.405}{1 + 0.511} = \frac{1.405}{1.511} = \boxed{0.930}$$

B. Two elements (continued)

2. Bare Case

$$B^2_{Bare} = \frac{9.87}{(30.59 + 5)^2} + \frac{9.87}{(19.34 + 5)^2} + \frac{9.87}{(231 + 5)^2} = \frac{9.87}{(35.59)^2} + 0.0166 +$$

$$0.001 = \frac{9.87}{1267} + 0.0166 + 0.0001 = 0.0077 + 0.0166 + 0.0001 = 0.0244$$

$$K_{eff} = \frac{1.405}{1 + (40.9 \times 0.0244)} = \frac{1.405}{1 + 0.998} = \frac{1.405}{1.998} = \boxed{0.703}$$

C. Four Elements (2 x 2) envelope = 30.59 cm. x 30.59 cm.x 231 cm.

1. Reflected Case

$$B^2_{Refl.} = 0.0045 + 0.0045 + 0.0001 = 0.0091$$

$$K_{eff} = \frac{1.405}{1 + (40.9 \times 0.0091)} = \frac{1.405}{1 + 0.372} = \frac{1.405}{1.372} = \boxed{1.024}$$

2. Bare Case

$$B^2_{Bare} = 0.0077 + 0.0077 + 0.0001 = 0.0155$$

$$K_{eff} = \frac{1.405}{1 + (40.9 \times 0.0155)} = \frac{1.405}{1 + 0.634} = \frac{1.405}{1.634} = \boxed{0.860}$$

D. Nine Elements (3 x 3) - envelope (19.34 + 1.91 + 19.34 + 1.91 + 19.34 = 61.84 cm) = 61.84 cm x 61.84 cm x 231 cm.

1. Reflected Case - Critical

2. Bare Case

$$B^2_{Bare} = \frac{9.87}{(61.84 + 5)^2} + \frac{9.87}{(61.84 + 5)^2} + \frac{9.87}{(231 + 5)^2} = \frac{9.87}{(66.84)^2} +$$

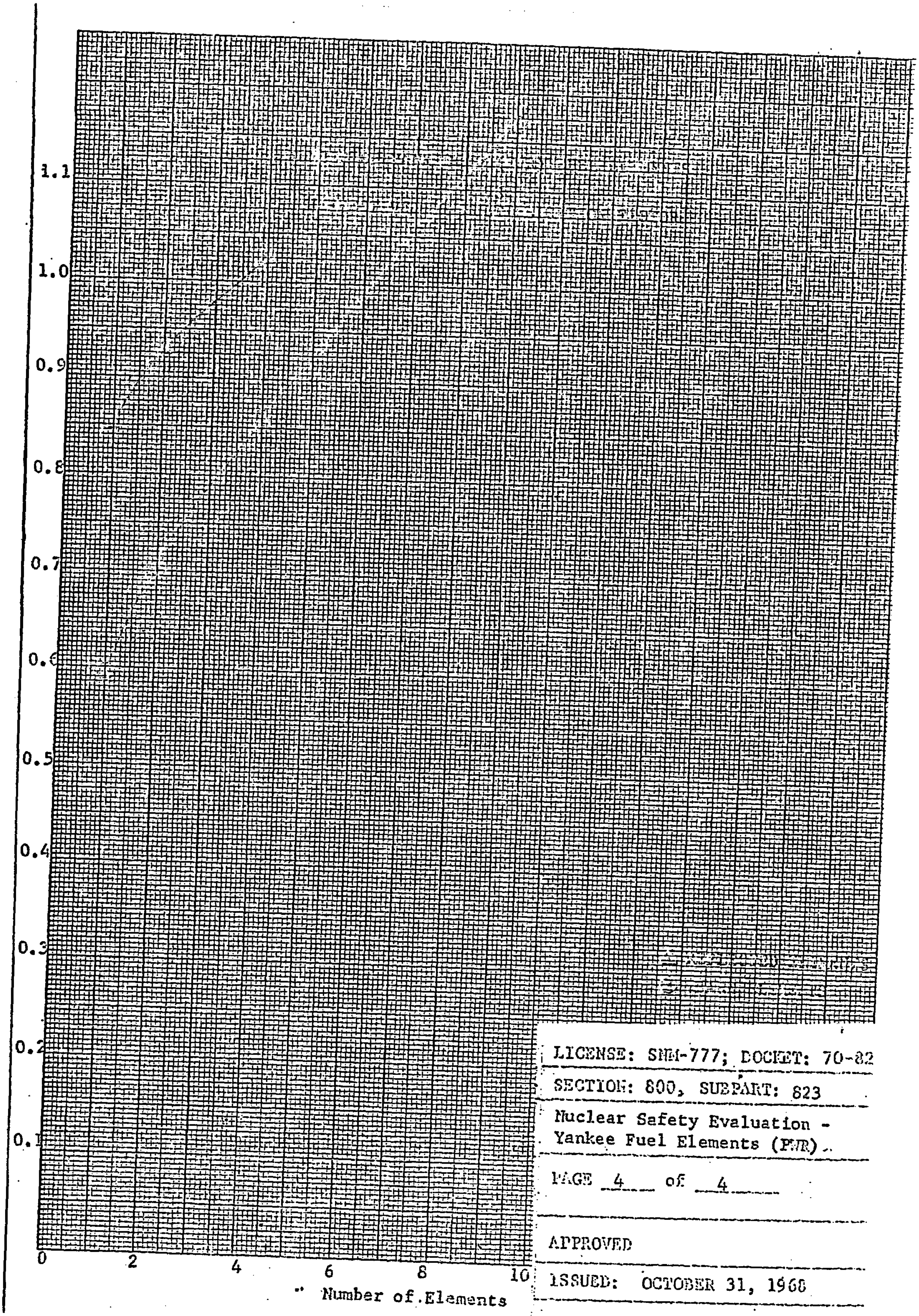
$$\frac{9.87}{(66.84)^2} + 0.0001 = \frac{9.87}{4468} + \frac{9.87}{4468} + 0.0001 = 0.0022 + 0.0022 + 0.0001 =$$

$$0.0045$$

$$K_{eff} = \frac{1.405}{1 + (40.9 \times 0.0045)} = \frac{1.405}{1 + 0.184} = \frac{1.405}{1.184} = \boxed{1.187}$$

IV. CONCLUSIONS

A. These calculations indicate that just greater than 3 elements would be required for criticality. NDEO-7034-1164 indicate that greater than 3 elements would be required for criticality. Therefore, these calculations are representative.



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SECTION: 800, SUBPART: 823

Nuclear Safety Evaluation - Yankee Fuel Elements (PWR)

PAGE 4 of 4

APPROVED

ISSUED: OCTOBER 31, 1968

SUPERSEDES: NEW

UNITED NUCLEAR CORPORATION • INTER-OFFICE MEMO

NDEO-1033

TO R. E. Kropp AT New Haven DATE May 19, 1967

FROM L. Goldstein AT Elmsford COPY TO W. Compas-New Hav, D. Cronin " ", E. Krinick " ", G. Sofer, B. Teer, P. Buck, R. Tomonto

SUBJECT Nuclear Information Required for Dresden Shipping Container Design

As per your request, nuclear information for Dresden Type 6 fuel elements is enclosed. Basic physics data and their calculational backup are presented first, followed by criticality safety data.

Physics Data and Backup

The basic physics data for the three types of United Nuclear fuel elements are given in Table 1 (as per DRC-2 dated 5/10/67). All evaluations were made for clean assemblies at 68°F.

Table 1 -

Fuel Element Type	Average Enrichment w/o U-235	k_∞	M^2
6C	2.24	1.210	39.0
6P	2.24	1.310	41.0
6I	2.24	1.310	41.0
3-F (G.E.)	2.24	1.210	39.0

The above data were computed using the LEOPARD[1] zero dimensional cross section calculation and depletion program. The code determines fast and thermal spectra using only basic fuel assembly geometry and temperature data, based on a modified FORM-TEMPEST slowing down-thermalization model. A correlation of the U^{238} resonance integral data is incorporated in the code to correct for resonance spatial and energy self-shielding effects. The multigroup Amouyal-Benoist method is used to calculate thermal self-shielding. The code computes fuel depletion effects for an infinite homogeneous reactor and recomputes the spectra and corresponding four-group cross sections before each discrete burnup step. All basic microscopic cross-section data are contained within the LEOPARD library, which was compiled by WAPD based on reported data. The LEOPARD cross sections do not contain any arbitrary adjustments to improve agreement with critical experiments.

The LEOPARD program is used routinely at UNC-REC as a basic tool for the generation of depletion dependent reactor constants for both PWRs and BWRs. The code has been checked extensively at REC against PWR and BWR experimental data, as well as against Monte Carlo calculations. Comparison with more than fifty oxide fueled critical and exponential experiments was performed by WAPD[2]. Both REC and WAPD evaluations of the LEOPARD program showed excellent agreement ($\pm 0.4\%$ in k_{eff}) with experiments in all cases.

Furthermore, when LEOPARD data are used to develop depletion dependent constants for use in the UNC-TRILUX fuel management program, excellent agreement is obtained with operational fuel cycle lengths and power distributions for both BWRs and PWRs. Fuel cycle lengths calculated by TRILUX with LEOPARD derived constants are within 5% of those actually achieved in Cycles 1 and 4 of Dresden 1, and also within 5% of the cycle length expected for Cycle 1 of the Trino Vercellese PWR. Calculated element-wise radial power distributions for Cycle 1 of the Trino PWR at about 4000 MWD/MTU deviate by less than 2% relative to experimental power distributions derived from Mn^{56} activations.

Criticality Safety Data

UNC Type 6C fuel is neutronically equivalent to the G.E. Type 3-F assembly. Furthermore, the nuclear properties of UNC Type 6I and 6P are neutronically equivalent to the G.E. Type 3-F with its gadolinia poison rod removed. Commonwealth Edison Company in Addenda (dated March 2, 1965) to Exhibit I in Submittal, dated December 24, 1964, for Amendment of Appendix A of License DPR-2 to Permit Operation with Type 3-F Fuel-Change Number 10; Docket 50-10; addendum Section V Safety Evaluation, reports minimum critical measurement data for Type 3-F fuel performed at Vallecitos by G.E. These data are given in Table 2.

Table 2 -

G.E. Fuel Type	Corresponding UNC Fuel Type	Minimum Number of Elements to Reach Criticality
3-F	6C	17
3-F Gd poison removed	6I, 6P	14

L. Goldstein

References:
1. WCAP-3269-26, LEOPARD-A Spectrum Dependent Non-Spatial Depletion Code for the IBM-7094, R. F. Barry, Sept. 1963.
2. WCAP-3269-25, "Calculation of Lattice Parameters and Criticality for Uniform Water Moderated Lattices", L. E. Strawbridge, September 1963.

UNITED NUCLEAR CORPORATION · INTER-OFFICE MEMO

NDEO-1077

TO F. Cronin AT New Haven DATE June 21, 1967

FROM J. R. Tomonto AT Elmsford COPY TO G. Sofer, J. O'Toole

SUBJECT Criticality of Dresden Fuel Rods During Corrosion and Pickling Operations

Summary

An analysis has been performed to determine the criticality safety limits for the Dresden regular enrichment UO_2 fuel rods during corrosion and pickling operations. The Dresden regular enrichment fuel rods analyzed were located in a maximum of five concentric rings around a central water region (OD = 3.88 in.) as shown in Dwg. D-302863-2. The outer ring of rods is located in a 10" diameter bolt circle. This pickling rack can be located in several types of autoclaves (ID from 11" to 20"). Therefore the approach was to determine that individual autoclaves would be subcritical when fully reflected for all possible conditions of partial to full loading of the pickling rack fuel rod locations and for variations in water density caused by heating and possible boiling.

The results of this analysis indicate:

1. The maximum k_∞ for a repeating array of Dresden regular enrichment fuel rods in water (T = 70°F) is 1.330 and occurs at a water to fuel volume ratio of 2.20.

2. The maximum k_{eff} for the fully reflected rack loaded with Dresden regular fuel rods is 0.854 and occurs at a water to fuel volume ratio of 2.2.

3. Removing either the center or outermost ring of Dresden regular fuel rods from the fully reflected pickling rack reduces k_{eff} to 0.765 (water/fuel volume ratio 2.20).

4. The k_{eff} of the bare but fully reflected and moderated pickling rack is 0.648 and occurs at a water/fuel volume ratio of 2.5.

Method of Analysis

Calculations of the fueled regions assumed a regular array of regular enrichment Dresden 1 reload fuel rods in water (T = 70°F). The Dresden regular fuel rods were selected because they are the most reactive of the three types of rods used in Type 6 Dresden reload assemblies. The fuel is 2.34 w/o enriched UO_2 pellets, (OD = 0.482") density 10.34 gm UO_2/cm^3, in Zircaloy tubing (ID = 0.4925", OD = 0.5625).

Calculations of k_∞ were performed using the LASER[1] code. This code is a one dimensional (cylindrical), multi-energy (85 groups) lattice-cell program which is based on the MUFT and THERMOS codes. Fast group parameters (E > 1.85 ev) are averaged over a semi-infinite medium spectrum calculated by the MUFT method. A correlation of the U^{238} resonance integral data is incorporated in the code to correct for resonance spatial and energy self-shielding effects. Thermal group constants were determined for a one dimensional THERMOS type calculation using the NELKIN scattering kernel. All basic microscopic cross section data are contained within the LASER library, which was compiled by WAPD based on recently reported experimental data. The LASER cross sections and calculational method have been extensively tested with experimental data and do not require any arbitrary adjustments to improve agreement with critical experiments[3].

Calculations of the pickling rack with internal and external water regions were performed using the AIM-6 one dimensional diffusion theory code with two neutron energy groups. Cross sections for the reflectors and autoclave wall were calculated with the FORM-TEMPEST codes.

Results

The calculated variation of k_∞ for a repeating array of Dresden 1 regular fuel rods is shown in Figure 1. A point noted on this figure corresponds to the calculated k_∞ for a completed Type 6P or 6I assembly[2] (having an average enrichment of 2.24). The maximum k_∞ of 1.33 occurs at a water to fuel ratio of 2.2.

Calculations were performed to determine k_{eff} of pickling racks when loaded into autoclaves and fully reflected. Because of the possibility of using several sizes of autoclaves, the calculations conservatively neglected the effects of the autoclave wall ($t \approx 2"$). The calculations were performed for an infinite cylinder containing the pickling rack and surrounded by a thick water reflector. The maximum calculated k_{eff} of 0.854 was found at a water to fuel volume ratio of 2.2 as shown in Figure 2.

In order to assess the potential positive reactivity associated with changes in the moderating properties of the central water region, a calculation was performed in which the absorption in water of the central region was neglected. The k_{eff}

for this condition was 0.919 for a water to fuel ratio of 2.2 in the fuel region and a thick outer water reflector. It is concluded that the maximum reactivity change that can be associated with loss of water from the central region is +7.5% Δk_{eff}. This is an upper limit on the worth of water in the central region.

Calculations were performed to determine the loss of reactivity when the inner or outermost ring of fuel rods were removed from the pickling rack. The calculated k_{eff} for both conditions was 0.765 for a water to fuel ratio of 2.2 in the fuel region and with a thick water reflector surrounding the pickling rack.

In analyzing the interaction between adjacent fully loaded autoclaves, at optimum internal moderation, the following situations are applicable:

1. Full water flooding between autoclaves - In this situation the presence of water essentially isolates each autoclave and the maximum k_{eff} is that calculated for the fully reflected pickling rack (e.g., from Figure 2, k_{eff} = 0.854).

2. No moderator between autoclaves - If the pickling rack is located in a 20" ID autoclave, it will be essentially fully reflected and therefore isolated from the other units ($k_{eff} \sim 0.86$). If the rack is located in a 14" ID autoclave, the calculated k_{eff} of an individual unit is 0.804. If the rack is located in an 11" ID autoclave, k_{eff} will be less than 0.8 because of the lack of reflector. In the latter two cases, there is a possibility of interaction between adjacent units even though the neutron flux is attenuated by the autoclave wall ($\sim$2" of iron).

The maximum k_{eff} of the pickling rack internally moderated but unreflected was calculated as 0.648.

References

1. WCAP-6073, "LASER - A Depletion Program for Lattice Calculations Based on MUFT and THERMOS", by C. G. Poncelet, April 1966.

2. Letter to R. E. Kropp from L. Goldstein, "Nuclear Information Required for Dresden Shipping Container Design", NDEO-1033, May 19, 1967.

3. Eich, W. J., "Analysis of PuO_2-UO_2 Critical Experiments", Trans. American Nuclear Society, Vol. 10-1 (June 1967).

James R. Tomonto

J. R. Tomonto

JRT:jk

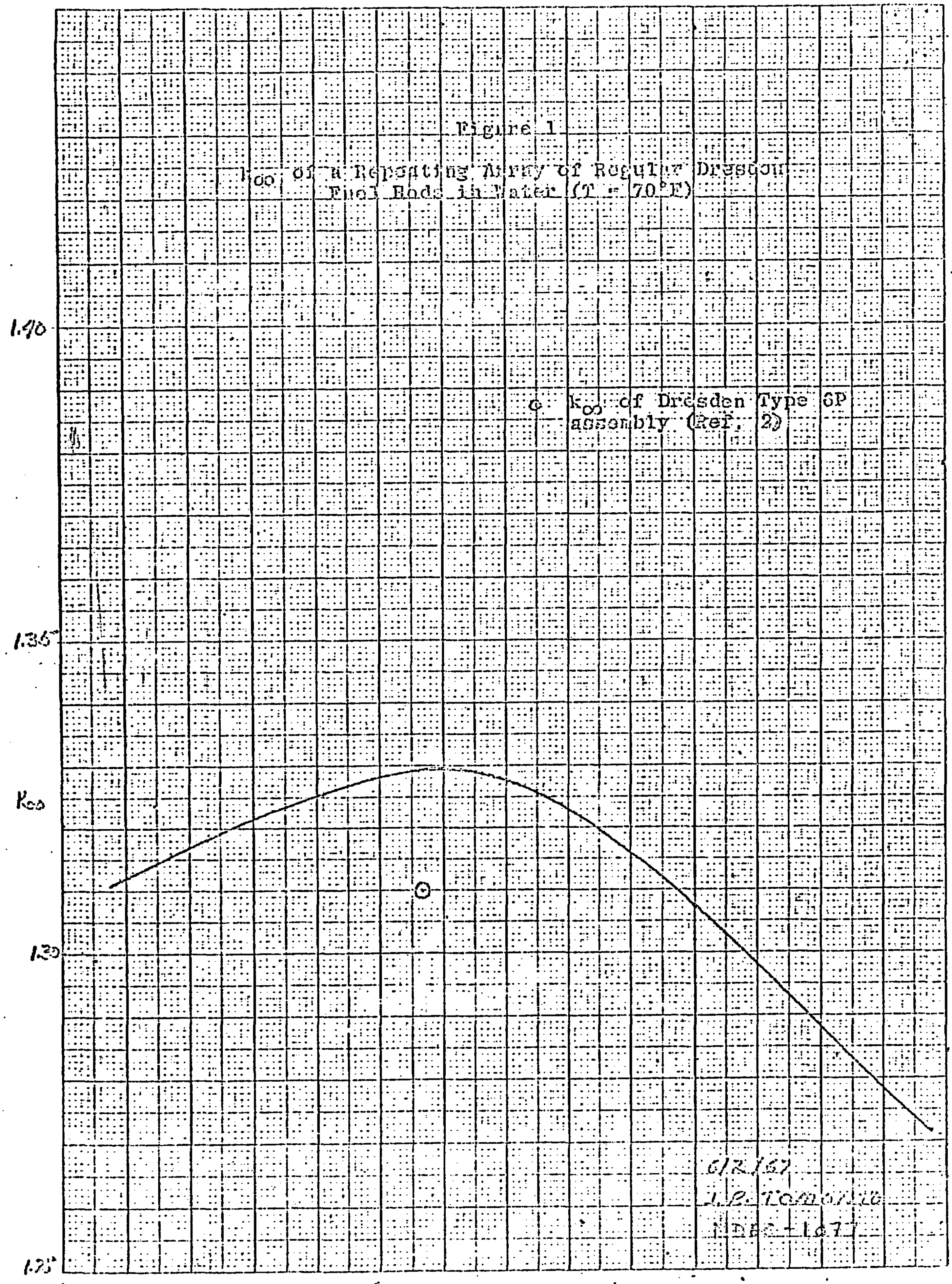


Figure 1
k_∞ of a Repeating Array of Regular Dresden Fuel Rods in Water (T = 70°F)
k_∞ of Dresden Type 6P assembly (Ref. 2)
1.40
1.35
1.30
1.25
K_∞

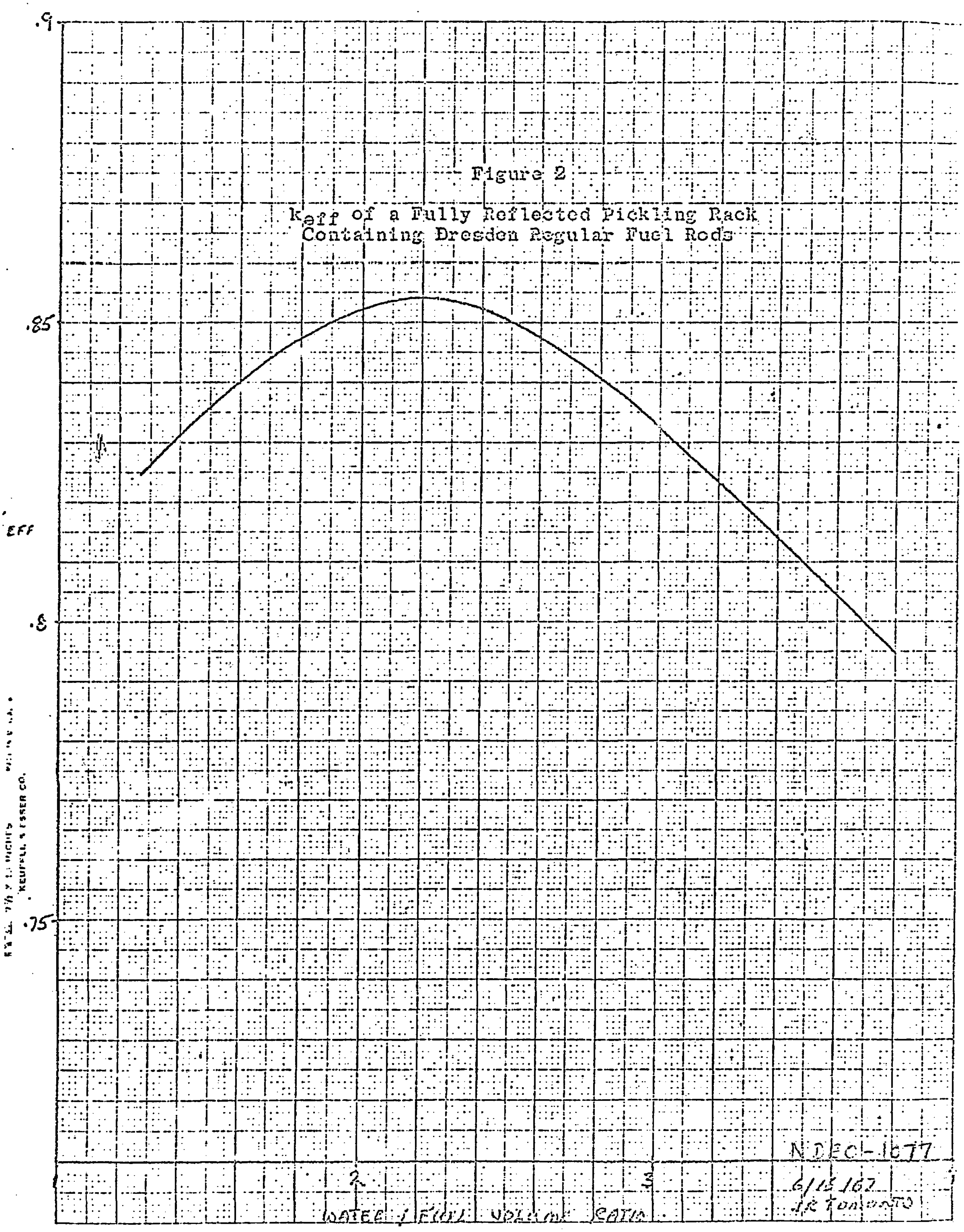
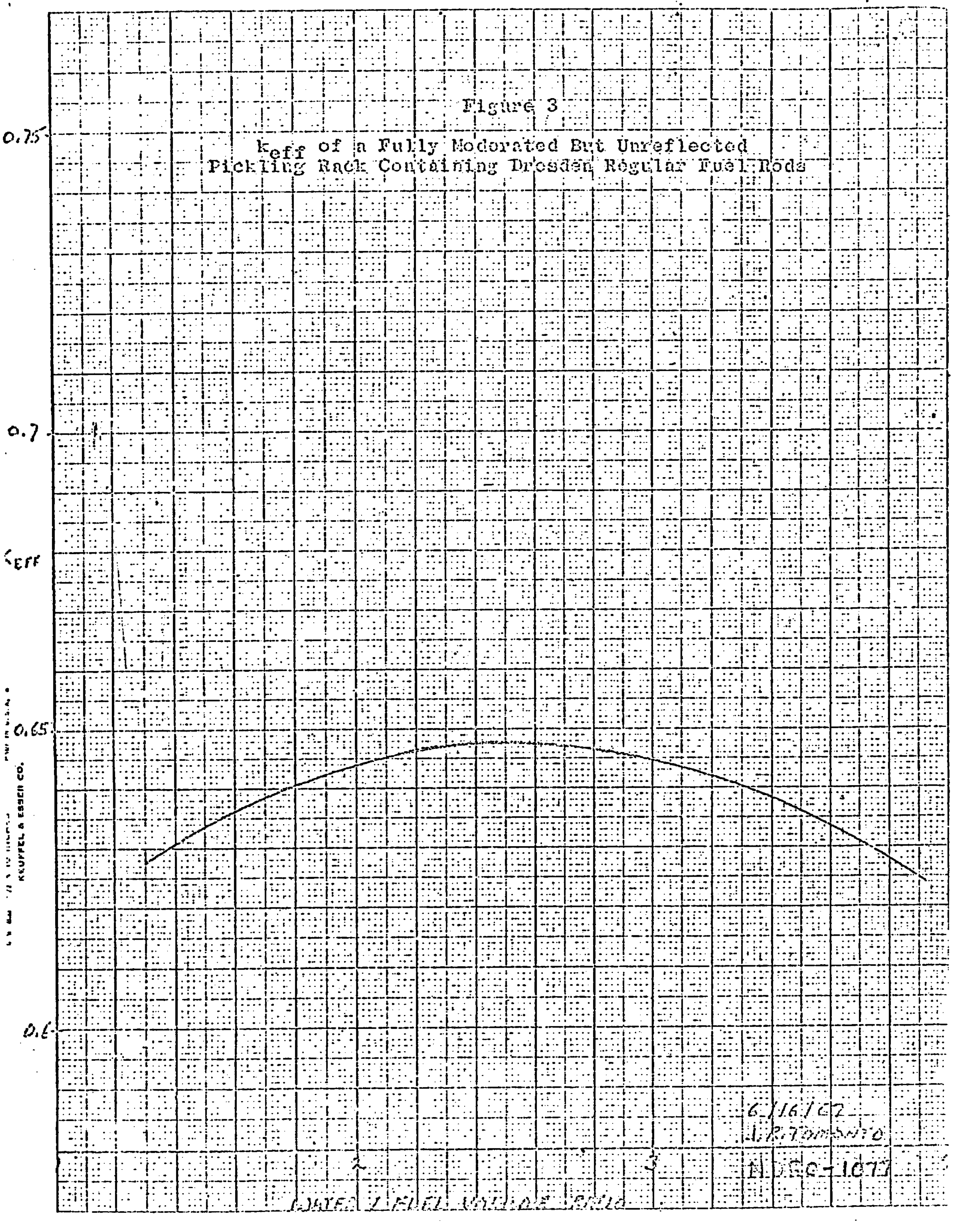


Figure 2

k_{eff} of a Fully Reflected Pickling Rack Containing Dresden Regular Fuel Rods

Figure 3

k_{eff} of a Fully Moderated But Unreflected Pickling Rack Containing Dresden Regular Fuel Rods



UNITED NUCLEAR CORPORATION • INTER-OFFICE MEMO

NDEO-1134

TO R. E. Kropp AT New Haven DATE August 15, 1967

FROM L. Goldstein AT Elmsford COPY TO W. Compas, D. Cronin, E. Krinik, G. Sofer, M. Labar, R. Tomonto, P. Buck

SUBJECT Nuclear Information Required For Shipping Yankee Fuel Bearing Components.

As per your request, nuclear information for Yankee fuel elements are given below. The k_∞ and M^2 data were obtained by the methods described in NDEO-1033.* The number of assemblies required to reach criticality was determined from the basic physics data (k_∞ & M^2) by calculating the critical buckling from which the dimensions of a fully reflected system were evaluated.

The required information for the Yankee fuel elements at 68°F is as follows:

Average Enrichment w/oU-235	k_∞	M^2	Minimun Number of Elements to Reach Criticality:
3.50	1.405	40.9	>3

For these elements, the k_{eff} of a fully reflected 2 element array is 0.921.

L. Goldstein (L.H)

L. Goldstein

LG/lh

*NDEO-1033, Nuclear Information Required for Dresden Shipping Container Design, L. Goldstein, May 19, 1967.

UNITED NUCLEAR CORPORATION • INTER-OFFICE MEMO

NDEO-1164

TO R. E. Kropp AT New Haven DATE Sept. 11, 1967

FROM L. Goldstein AT Elmsford COPY TO Distribution

SUBJECT Additional Information Required for Shipping Dresden I and Yankee Rowe Fuel Elements

Reference: NDEO-1033 and NDEO-1134

This memo is to confirm the numbers given by L. Goldstein to R. E. Kropp in a telephone conversation of 9/11/67 concerning H/U^{235} ratios inside the shroud for Dresden I and Yankee Rowe fuel elements. The data are as follows:

Fuel Element Type	H/U^{235}
Dresden I	165
Yankee Rowe	121

Data are for cold, clean, 0 void condition.

L. Goldstein

L. Goldstein

LG:JK

Distribution

W. Compas
D. Cronin
E. Krinik
G. Sofer
M. LaBar
J. R. Tomonto
P. Buck

UNITED NUCLEAR CORPORATION

INTER-OFFICE MEMO

NDEO-1359

TO F. Cronin AT DATE March 22, 1968

FROM J. R. Tomonto AT COPY TO

SUBJECT REACTIVITY CONTRIBUTION OF CLADDING IN DRESDEN 6P AND PATHFINDER FUEL RODS

References 1 and 2 present the results of a criticality safety evaluation of Dresden and Pathfinder fuel rods during corrosion and pickling operations. These evaluations were based on the most reactive arrangement of Zr clad fuel rods. The AEC has requested further information relating to the effort of cladding desolution during pickling operations. The following items apply:

(1) If some of the Zr clad is disolved, it would most likely remain in solution in the vicinity of the fuel rods and there would be a slight decrease in k_∞ of the lattice because of the reduced Zr thermal self-shielding factor.

(2) If the Zr clad is completely disolved, the fuel rods will collapse and fall to the bottom of the autoclave. This configuration would be less reactive than the configurations analyzed.

(3) The reactivity controlled by Zr absorptions is $+0.010\ \Delta k_\infty/k_\infty$ for the Dresden rods and $+.012\ \Delta k_\infty/k_\infty$ for the Pathfinder rods at optimum moderation.

J. R. Tomonto

JRT:jk

References

1. NDEO-1077, "Criticality of Dresden Fuel Rods During Corrosion and Pickling Operations", by J. R. Tomonto, 6/21/67.

2. NDEO-834, "Criticality of Pathfinder Fuel Rods During Corrosion and Pickling Operations", by J. R. Tomonto, 11/11/66.

Dresden 2.34 w/o PuO_2 - UO_2

Fuel Rod and Assembly Fabrication

1. Receive Rods & Assemblies
2. Open Containers & Check Packaging for Damage
3. Monitor & Verify Previously Determined Health Physics Limits
4. Remove Components from Containers. Load Elements on to carts & Place Rods in Modules
5. Visually Check Rods & Elements
6. Helium Leak Check Rods & Elements
7. Visually & Dimensionally Inspect Rods & Elements
8. Assemble PuO_2 - UO_2 & UO_2 Rods into Required Elements
9. Store

LICENSE: SNM-777 DOCKET: 70-820

SECTION: 800 SUBPART: 823

Flow Diagram 823-I A

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ISSUED: 2/6/70

SUPERSEDES: New

APPROVED:
AMENDMENT NO.:

LICENSE:	SNM-777, Docket: 70-820	Approved
SECTION:	800 - FUEL FABRICATION OPERATION	ISSUED October 31, 1968
Subsection:	820 - Processing	
Subpart:	824 - Fabrication of Enriched Uranium Metal	SUPERSEDES NEW
	824.1 - General Considerations	

824.1 General Considerations

1. This subsection covers the preparation and processing of up to and including fully enriched uranium metal from feed material through chopped stock (approximately 1/8" cubes). Individual operations which may be performed are shown on Diagram 824.I and are listed in their expected sequence.

2. All operations normally will be performed in Building 19H unless otherwise noted.

3. Unless stated otherwise, safe values referenced in the following Subpart will be obtained using the limits listed in Table 309-I.

4. For this undiluted uranium metal in which the U235 content is less than 93%, the U235 mass limit may be increased by the appropriate factor from Figure 20, TID-7016, Rev. 1.

21 pgs w/h
entirety

APPENDIX

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Errata Sheet	ISSUED October 31, 1968
	SUPERSEDES New

The words "special" and "dry" are synonymous when used to define a criticality zone.

APPENDIX

Annual Report, 1968

NDEO-1050

LICENSE:	SNM-777 Docket: 70-820
SECTION:	Appendix
ISSUED:	October 31, 1968
SUPERSEDES:	New

90 pgs w/h in
entirety
Ex. 4