TERA

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

OCT 15 1979

MEMORANDUM FOR: Donald Hassell, OCM
George Eysymontt, OCM
John Stephens, OCM
Tom Gibbon, OCM
Vickie Harding, OCM

FROM: Marvin R. Peterson, Acting Assistant Director
Export/Import and International Safeguards
Office of International Programs

SUBJECT: HEU EXPORTS TO EURATOM

Attached for your information is a copy of a July 25 letter with enclosures from EURATOM's local office to DOE.

This letter was sent to IP by the EURATOM office on October 10 and addresses the technical justifications for several pending EURATOM HEU exports. These cases, many of which require Presidential approval, are still undergoing Executive Branch review.

Marvin R. Peterson, Acting Assistant Director
Export/Import and International Safeguards
Office of International Programs

Attachment:
July 25 ltr w/enclosures
from EURATOM's local
office to DOE

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cc w/encl.
R.Burnett, NMSS
J.Becker, OELD
J.Devine, OPE
C.Stoiber, OGC
J.Shea, IP
R.Moore, IP
T.Rehm, EDO
K.Cohen, IP

7911270 158

C.

DELEGATION OF THE COMMISSION OF THE EUROPEAN COMMUNITIES

EURATOM SUPPLY AGENCY

July 25, 1979



Dr. A. Travelli
Associate Director
Reactor Physics Department
Safety Test Facility
Argonne National Laboratory
Argonne, Illinois 60439

Dear Dr. Travelli:

Subject: Supply of HEU to European Communities' customers

Enclosed please find a letter which the Euratom supply Agency addressed to you on July 18, 1979. As you will see, the Supply Agency in this letter (namely in the 3rd paragraph of the first page and in the "summary" on page 5) is referring to the possibility "that you might have to reject some applications (of HEU export license) on the ground of insufficient technical justification".

We would like to indicate that the Supply Agency is of course completely aware of the fact that your laboratory is only in charge of making technical assessments of pending export license applications and of the data provided by the reactor operators and that it is up to the Executive Branch, based upon your technical assessment, to recommend NRC to withhold a certain application.

Please understand Supply Agency letter in this sense.

Sincerely,

Michael Goppel

M. Goppel

MG/JM/ajs

Enclosure: Supply Agency letter no. 43757 of 18 July 1979
(6 pages + enclosure)

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8-45787

EURATOM SUPPLY AGENCY

Brussels 18. VII. 1979
JJ/ml

Argonne National Laboratory
Applied Physics Division/RERTR Program
Attn. A. Travelli
9700 South Cass Avenue
Argonne (Illinois) 60439
U.S.A.

Subject: Supply of highly enriched uranium (HEU) to European Community customers

Gentlemen:

Please recall the discussions Euratom Supply Agency representatives and/or its customers had with your services at several occasions during the last months, since the U.S. adopted a new policy for HEU supplies as of late 1977 and since the Nuclear Non-Proliferation Act (NNPA) became law in March 1978.

These developments have been communicated by us to our customers; please find enclosed for your information and file copy of our corresponding circular letter AA/44/78 - 41660 of July 13, 1978.

When again discussing HEU supply problems late May 1979 in Washington and with you - via phone contacts of our Washington Delegation - we learned that in several cases of applications to export HEU pending with NRC and actually under Executive Branch review, you indicated that you might have to reject some applications on the grounds of insufficient technical justification, i.e. because of a too large HEU inventory and the potential for conversion into high(er) density fuel with "middly (20 to 45% U-235) enriched" uranium (MEU). Such reasoning might apply for instance in the cases of

| | | |
|---|---|---|
| 1) | XSNM-1391 | 113 kgs of HEU for CEN's BR-2 (AG/1418) |
| 2) | XSNM-1425 | 35 kgs of HEU for GKSS' FRG-1 and -2 |
| 3) | XSNM-1428 | 3.8 kgs of HEU for OSGAE's ASTRA |
| 4) | XSNM-1429 | 21,5 kgs of HEU for KfA's FRJ-2 |

and particularly for

| | | |
|---|---|---|
| 5) | XSNM-1236 | 5,7 kgs of HEU for PTB's FMRB (AG/1276) |
| 6) | XSNM-1444 | 14 kgs of HEU for Garching's FRM |
| 7) | XSNM-1459 | 6,8 kgs of HEU for HMI's BER-II |

Whereas the first abovementioned case (BR-2) has already been argued at your offices May 24, 1979, and you received additional data (our letter 43485 of June 1, 1979), we have now discussed the supplies for FMRB, FRM and BER-II (cases 5 thru 7 above) with our customers and the convertor/fuel manufacturer Nukem.

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As a result of these discussions we want to submit the following reasoning:

A) Timing

According to our experience of the last two years it can easily take up to 18 months or more from the date of an application for a license to export HEU out of the US until such license is issued. Recent examples (last HEU export license issuance by NRC):

| kgs HEU | for | license N° XSNM- | date of application | date of issuance | our reference |
|---|---|---|---|---|---|
| 19.8 | HFR Petten | 1212 | Oct 13, 1977 | April 11, 1979 | AG/1282 |
| 23 | ILL's HFR | 1232 | Nov 23,1977 | Apr.10,79 | /1400 |
| 20 | HFR Petten | 1238 | Dec 1, 1977 | " 11,79 | 1402 |
| 22 | KfA's FRJ-1 | 1241 | Dec 8,1977 | " 19,79 | 1309 |
| 22 | Swedish R-2 | 1247 | Dec 29,1977 | " 11,79 | 1296 |
| 17 | " " | 1248 | Dec 29,1977 | " 11,79 | 1401 |

where the requests were deposed before or very shortly after the cut-off date of December 1, 1977 for more elaborate 'technical and economic justification' and anyhow before the NNPA became law. Even if we hope that the still rather lengthy NRC plus Executive Branch review and authorisation procedure should only become faster and more reliable experiences of the past are not encouraging to that effect and we have to take into account that our more recent applications are subject to still more thorough US administration scrutiny as required under the NNPA.

Further it has to be taken into account that only after license issuance we can proceed with the procurement of the HEU either

- a) by concluding a Short Term Fixed Commitment enriching services contract with DOE (a subsequent arrangement as per Sec. 303 of the NNPA, the time requirements for which we had not yet to test because we did not use this procurement method up to now]

- b) by concluding a contract to purchase separative work units in excess under an existing DOE toll enriching agreement, or

- c) by concluding a straight purchase contract for HEU.

This of course takes some time: apart from the preparation and execution of the necessary contractual arrangements 180 days lead time or more pass for a and b above between order and product delivery if DOE does not waive its right for such term by delivering HEU from stock 90 days after feed has been transferred as it fortunately did/does. Thus, at least four months elapse after license issuance until product delivery, which brings the total to (18+4=) 22 months.

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As you are aware transport of significant HEU quantities from the US to Europe must be subject to stringent physical protection measures. In consequence and as incited by US authorities, military air transport has been used in the recent past. For such transport there are no regular schedules, thus it can easily take 1 to 2 months bringing the total delay to (22 + 2=) 24 months.

Finally, time to convert the hexafluoride and to fabricate the fuel, dependent on the contingencies at the manufacturer's plant as well as on the regularity of supply flow, can be estimated to be about 8 months. In consequence, at least (24+8=) 32 months can slip by between applying for an export license with NRC and receiving reload fuel. You will understand that our customers want a three years inventory or even a bit more to continuously operate their facility, particularly since above lead times have always been increasing since the NRC took office in January 1975.

B) Inventories

1) PTB's FMRB (XSNM-1236 of Dec. 1, 1977) - AG/1276

FMRB's actual inventory of 13 fresh 11-plate fuel elements* will keep the reactor in operation - assuming economical fuel utilization - until mid 1982 (annual consumption 3 to 4 elements, next reloading autumn 1979), since only up to 35% burn-up can be achieved in this reactor.

In addition, a power increase from 1 to 3 MW is anticipated in order to cope with accumulating requests for higher neutron flux densities (shorter irradiation times). New 23-plate fuel will then become necessary and consumption will triple. The request for supply of new fuel was initiated early in view of past lead time experience and of the envisaged power increase: should a license to operate the reactor at 3 MW be issued earlier than expected new fuel would be needed sooner

2) Garching's FRM (XSNM-1444 of January 24, 1979)

FRM will need a fresh fuel reload at the end of 1982. The export license was applied for early because of the existing lead time experience (see above under A), but further since Savannah River (SROO) is to reprocess 16 irradiated Munich fuel elements with subsequent separative work and natural uranium component credit for reenrichment.

3) HMI's BER-II (XSNM-1459 of February 14, 1979)

BER-II also has a fresh fuel inventory to assure reactor operation at its actual 5 MW until the end of 1982. As for FRM above the license has already been applied for not only taking into account the long lead times but also since reenrichment of feed resulting from SROO reprocessing of 26 irradiated Berlin fuel elements is anticipated.

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* An additional information request from DOS concerning check list

Further, BER-II intends to double its power to 10 MW for reasons similar to those given for FMRB (see 1 above). It is hoped to receive the corresponding permit around the end of 1981, in which case the actual fuel inventory would not last thru 1982.

C) Introduction of new MEU fuel

1) General

Please recall the draft of the Final Report of INFCE Working Group 8 (INFCE/WG8/14 of May 31, 1979) and in particular Chapter 6 "Summary and Findings" of Subgroup C - Research Reactors Final Reports as established under US Cochairmanship. Criteria for utilizing lower enriched fuel in existing research reactor are enumerated under point (3), these are reiterated by our customers. There is further under point (10) said: ".... in some countries it may take five years or more after the decision of modification before the reactor is operating on the lower enriched fuel cycle ...", and under point (12): .... introduction of these fuels has to be considered as a long term objective ....".

More specifically you might want to recall that the Government of the Federal Republic of Germany - as announced during INFCE - has launched a 5 1/2 years R & D program on high density fuel, in which KfK, KfA, GKSS, Interatom, Nukem collaborate and German licensing authorities participate, which, at a cost of about 20 million DM ($\pm$ 11 million US $) is intended to examine the use of U Alx, changes of fuel configuration (thicker plates), and sophisticated fuels on uranium silicide or nitride base.

You will further recall European collaboration in the IAEA/ Vienna Advisory Group preparing a 'Program on Research Reactor Core Conversion to Use Less Enriched Uranium instead of HEU' and its actual efforts to develop a 'Guide Book' to help research reactor operators in not highly industrialized nations to cope with the problems of uranium assay reduction.

You are finally aware (and this appears to be the most time consuming factor when addressing the problems of putting MEU into use) that no operation license for any new fuel will be issued until such has been thoroughly examined. Such tests (irradiation of small platelets in a special rig and interpretation of results) might easily take two years; thereupon operators need to test prototype elements and only after that a full core conversion can be planned in detail and executed. It is estimated that a full core conversion with U Alx fuel of 45 instead of 93% uranium - 235 might occur 5 to 6 years from now; use of other configurations (thicker plates) or exotic fuel ($U_3Si$) at enrichments below 45% could request still more time, except where reactors are available which are not subject to normal licensing procedures.

We will not discuss here but wonder about reprocessing possibilities for new fuel.

2) Remarks from customers

Apart from the ironic sidelight that possible improvements of fuel are not used to increase flux densities thus facilitating research work but to reduce enrichment, reactor operators cannot do much at present: they might request an authorisation to operate their facility at a lower enrichment but will not receive the corresponding license until competent authorities have been satisfied concerning the safe operation (conditio sine qua non) of the installation, i.e. when R & D has resulted in satisfactory and complete results.

As to the use of MEU and apart from safety/licensing considerations, the operators' opinion can be summarised as follows:

a) the neutron yield of the installation (at the irradiation positions) must not decreas., at least not significantly, i.e.

b) disadvantages must be tolerable (e.g. $<5\%$) and that is true also for

c) economic penalties, which are to be minimized, in particular since most operators depend on public budgets.

D) Summary

From the above explanations we hope that you are able to conclude that HEU supplies as requested must not be rejected because of insufficient technical justification: taking into account the present lead times inventories are not too large and the potential for (full core) conversion to MEU use even if principally existing can only be employed after completion of the corresponding R & D and acceptance of the results by licensing authorities. It is almost impossible to estimate the delays involved, since there are as well political considerations (public acceptance of nuclear energy, discussions of INFCE results after spring 1980), to be taken into account which we deliberately bypassed in this letter; more than 5 to 6 years from now appears to us a conservative evaluation.

Of course, all considerations above are also valid for requests (1 and 2 to 4 mentioned in tially: (BR-2) GKSS' FRG-1 and -2, OSGAE's ASTRA, KfA's [illegible]-2) as well as others from Community customers pending with US authorities, except that actual inventory data might be slightly different. But

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such data should be known to you from the check lists/ questionnaires submitted. We do not believe excess inventories to exist at research facilities or fuel manufacturers, therefore we believe also these other requests to be 'technically and economically justified'.

If you need any further information on above or other HEU requests, please do not hesitate to contact us.

Sincerely yours,

for J.B. MENNICKEN
Director General

Enclosure:

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EURATOM SUPPLY AGENCY /78 № 41660

Brussels 13. VII. 1978
JJ/ml

Circular letter to customers of highly enriched uranium (HEU) of US origin

Subject: New US criteria and justification for approving exports (and retransfers) of HEU

This is to recall and complete earlier informations on above matter.

As you are aware, US AEC, then ERDA, now Department of Energy (DOE) was/is the only practical source of significant amounts of HEU for Community customers. Supply is governed by the actual EUR/US Additional Agreement for Cooperation of June 11, 1960, as amended, and in particular its Art. I Bis A:

> "The enriched uranium supplied under this Agreement may contain up to twenty percent (20%) in the isotope U-235. A portion of the isotope U-235 so supplied may be made available as material containing more than twenty percent (20%) in the isotope U-235 when the use of such material is technically or economically justified".

Whereas US supply of HEU proceeded rather smoothly until 1975 and justification of need was furnished by fuel inventory data compiled in a one page check list and by an uncomplicated end use statement, worldwide and particularly US concern on proliferation risks associated with HEU supplies retarded export licensing as of that time; the then installed Nuclear Regulatory Commission (NRC) developed new and slower procedures to assess problems involved with export licensing (see our circular letters 34013 and AA/46/75 - 35341 of April 15 and October 30, 1975 as well as AA/42/76 - 37610 of September 24, 1976 to toll enriching customers (and members of our Advisory Committee)).

By Executive Order 11902 of February 2, 1976, President Ford introduced an U.S. Executive Branch review of export license applications prior to NRC action (circular letter AA/6/76 - 36123 of February 18 1976 to transporters of nuclear material) and retransfers of nuclear material became subject to similar scrutiny (circular letter AA/40/76 - 37591 of September 24, 1976).

The new US policy was further explained in an October 28, 1976, Presidential statement on Nuclear Export and Non-Proliferation Policy (circular letter AA/53/76 - 37902 of November 4, 1976); consequent delays were recognised by US authorities (circular letter AA/3/77 - 38500 of February 3, 1977 to toll enriching customers). Some exports were

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additionally detained since 1976 and in 1977 by interventions from (US) environmental organisations (see correspondence with the many customers concerned).

In context with pending applications for licenses to export HEU for use in Community facilities, US authorities in September and December 1977 made up (bilaterally) more detailed inquiries on data such as fuel inventories/core loading/operation mode and corresponding fuel consumption of such facilities. They finally published their new criteria November 20, 1977, inclusive a new check list of information required (circular letter AA/36/77 - 40295 of December 2, 1977).

Customers' reaction to this new US policy was requested (circular letter AA/10/78 - 40607 of January 31, 1978) and a meeting organised (circular letters AA/19/78 - 40894 and AA/27/78 - 41050 of March 10, 1978 and April 12, 1978). Annexed to the last referenced circular letter was an US letter of March 29, 1978, explaining further the new policy, and a revised copy of the new HEU Check List. Our latest circular letter on this matter so far (AA/36/78 - 41448 of June 16, 1978) answered some of the questions discussed at our April 10, 1978, meeting and gave further detailed information.

In the meantime, other information with impact on HEU exports (and retransfers) became available and has to be taken into account also, such as

- NRC's rules on export and import of nuclear facilities and materials (circular letters AA/18 and 35/78 - 40811 and 41397 of February 27 and June 8, 1978 and the
- Nuclear Non-Proliferation Act (NNPA) of 1978 and the procedures established by the US Executive Branch pursuant to it (circular letters AA/38 and 43/78 - 41543 and 41624 of June 28 and July 7, 1978 - see the first one for lead times in comparison with point 5, (1) - (7) of AA/36/78 cited above).

Finally, the Euratom Supply Agency had late June 1978 discussions with US authorities on the implementation of the new policies.

During these discussions it was confirmed that the new policy is employed for all applications filed since December 1977 and that therefore data as per the new check list (see AA/27/78 above) are requested.

In this context we learned that, even if sufficient information on fuel inventories is available in most pending cases, it is not yet fully conclusive - in particular sometimes reactor core data are missing - to allow specialists from Argonne National Laboratory (ANL) to evaluate the feasibility of going to lower U-235 assays in the respective facilities.

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ANL staff recommended either and preferably to answer questions as per point C 5 and E of the new check list or to furnish as complete as possible data under points A, B, C, and D of the check list.

Since the check list questions are kept rather general in order to cover all aspects, ANL staff refers to a recently published questionnaire, established by the American Nuclear Society in view of editing a new directory of US research, training and test reactors, and recommends interested parties to employ it when adressing the problem of answering most check list (A, B, C, D) questions.

Please find enclosed one copy of that questionnaire.

The Euratom Supply Agency would appreciate to further receive possible comments from customers on the abovementioned issues. We shall keep you informed of any new developments.

Applications at present pending for licenses to export HEU from the US are probably best handled individually and depending on the date of the original request (before or after November/December 1977).

for J.B. MENNICKEN
Director General

Enclosure: Questionnaire form

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QUESTIONNAIRE FORM

RESEARCH, TRAINING AND TEST REACTOR DIRECTORY

Instructions:

1. Insert the best available information adjacent to each item.

2. Leave unknowns blank.

3. Insert not applicable in not applicable sections.

4. Insert metric units if known. Otherwise, use your most frequently used units.

5. Please enclose a reproducible copy of a reactor diagram if you have one available.

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RESEARCH, TRAINING, AND TEST REACTOR DIRECTORY

1. GENERAL

1.1 Reactor Name (Acronym) ____________________

1.2 License Number ____________________

1.3 NRC Docket Number ____________________

1.4 Reactor Address ____________________

____________________

____________________

____________________

____________________

1.5 Reactor Telephone ____________________

1.6 Reactor Owner ____________________

1.7 Reactor Operator ____________________

1.8 Reactor Administrators ____________________

____________________

____________________

____________________

____________________

____________________

1.9 Reactor Facility Staff

a. Scientific/Technical ____________________

b. Operations ____________________

c. Support ____________________

d. Normal Number of Personnel in Reactor Containment/Confinement ____________________

1.10 Reactor Architect/Engineer ____________________

____________________

1.11 Reactor Constructor ____________________

____________________

1.12 Organization/Country Supplying Nuclear Technology ____________________

____________________

1.13 Reactor Setting ____________________

____________________

1.14 Reactor Operating Status

a. Initial Criticality Date ____________________

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b. Full Power Date

c. Operating Cycle

d. Full Power Hours/Year

e. Pulses/Year, Average Energy

1.15 Reactor Facility Cost

1.16 Annual Operating Budget

2. REACTOR

2.1 Reactor Type

.2 Reactor Vessel

a. Configuration

b. Overall Dimensions

c. Material

d. Normal Operating Pressure

e. Normal Operating Temperature

2.3 Core

a. Volume

b. Overall Dimensions

c. Lattice Configuration

d. Number of Elements

1. Standard

2. Control

e. Maximum Number of Grid Locations That can be used for Fuel

f. Normal Core $^{235}U$ Content

g. Subdivided Core

1. Number of Subdivisions

2. Subdivision Differentiating Characteristics

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3. Number of Elements per Subdivision ______

2.4 Containment

a. Type ______

b. Volume ______

c. Material ______

2.5 Moderator ______

2.6 Blanket Gas ______

2.7 Reflectors ______

______

2.8 Thermal Shield ______

______

9 Biological Shield ______

______

a. External Radiation Levels ______

______

2.10 Power Level

a. Normal Steady State ______

b. Pulsing ______

2.11 Normal Average Thermal Power Density

a. Volumetric (2.10.a/2.3.a) ______

b. Linear (2.10.a/(Number of Plates/ Pins x Plate/Pin Length)) ______

12 Normal Specific Power (2.10.a/2.3.f) ______

2.13 Reactor Control

a. Safety Rods

1. Number ______

2. Shape and Dimensions ______

______

3. Material and Loading ______

4. Normal Withdrawal/Insertion Speed ______

5. Scram Insertion Speed ______

6. Total Reactivity ______

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7. Average Reactivity Addition Rate ______

8. Scram Mechanism ______

b. Regulating Rods

1. Number ______
2. Shape and Dimensions ______
3. Material and Loading ______
4. Normal Withdrawal/Insertion Speed ______
5. Total Reactivity ______
6. Average Reactivity Addition Rate ______

c. Chemical Shim Control

1. Chemical ______
2. Loading ______
3. Control Mechanism ______
4. Total Reactivity ______

d. Burnable Poison

1. Isotopes Utilized ______
2. Location ______
3. Loading ______
4. Total Reactivity ______

3. FUEL

3.1 Standard Fuel Element

a. Configuration ______

b. Element Dimensions ______

c. Overall Plate/Pin Dimensions ______

d. Number of Plates/Pins per Element ______

e. Distance Between Plate/Pin Centerlines ______

f. Active Portion of Fuel Plate/Pin

1. Dimensions ______

______

2. Composition ______

3. $^{235}U$ Enrichment ______

4. Fissile Material Density ______

g. Reflector Portion of Fuel Plate/Pin

1. Composition ______

2. Dimensions ______

h. Clad

1. Composition ______

2. Thickness ______

i. Structural Material ______

3.2 Control Rod Fuel Element

a. Specify Differences from Standard Fuel Elements ______

______

______

______

______

3.3 Fuel Cycle

a. Criteria for Refueling ______

b. Frequency of Refueling ______

c. Normal Element Lifetime ______

d. Burnup

1. Average $^{235}U$ Burnup ______

2. Peak $^{235}U$ Burnup ______

3. Maximum Allowed $^{235}U$ Burnup ______

e. Number of Elements Replaced During Typical Refueling ______

f. Spent Fuel

1. Minimum Cooling Time ______

2. Maximum Amount in Storage ______

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g. Disposition of Spent Fuel

h. Spent Fuel Shipping Cask

i. Spent Fuel Handling

j. Fuel Failure Detection

3.4 Fuel Inventory

a. Current Fissile Material Inventory Status

1. New Fuel In-Process
2. New Fuel On Hand
3. Fuel In-Core
4. Spent Fuel In Storage
5. Spent Fuel Being Reprocessed
6. Non-Fuel Special Nuclear Material

b. Fissile Material Inventory Needed to Assure Continuity of Operations

1. New Fuel In-Process
2. New Fuel On Hand
3. Fuel In-Core

3.5 Fuel Source

a. Fuel Fabricator

b. Fuel Supplier

c. Fissile Material Origin

d. Enrichment Supplier

e. Method of Fabrication

f. Fuel Element Cost ______

4. HEAT TRANSFER DATA

4.1 Fuel Element Heat Transfer Area ______

(No. of Plates/Pins x Active Plate/Pin Surface in Contact with Coolant) ______

4.2 Fuel Element Flow Area ______

4.3 Fuel Element Wetted Perimeter ______

4.4 Fuel Meat Thermal Resistivity ______

4.5 Clad-Coolant Heat Transfer Coefficient (at Hot Spot) ______

4.6 Heat Flux at Plate Surface

a. Normal Average Heat Flux ______

b. Peak Heat Flux

1. Without Hot Chann . Factors ______
2. With Hot Channel Factors ______

c. Axial Peaking Factor in Hot Channel (from Axial Fission Rate Distribution)

1. Without Hot Channel Factors ______
2. With Hot Channel Factors ______

d. Hot Spot Location ______

4.7 Peak Operating Fuel Plate/Pin Temperature

a. At Plate/Pin Surface

1. Without Hot Channel Factors ______
2. With Hot Channel Factors ______

b. Inside Fuel Meat

1. Without Hot Channel Factors ______
2. With Hot Channel Factors ______

4.8 Primary Coolant ______

4.9 Coolant Flow

a. Flow Direction ______

b. Flow Induced by ______

c. Normal flow Rate ______

d. Maximum Flow rate ______

e. Mean Core Flow Velocity ______

f. Normal Core Inlet Temperature ______

g. Normal Core Temperature Rise (ΔT) ______

h. Peak Coolant Temperature Rise (ΔT) at Hot Spot

1. Without Hot Channel Factors ______

2. With hot Channel factors ______

i. Coolant Pressure at Core Outlet (Absolute) ______

j. Coolant Pressure at Hot Spot (Absolute)

1. Without Hot Channel Factors ______

2. With Hot Channel Factors ______

4.10 Hot Channel Factors (Including Only effects Other than Nuclear Peaking; Specify Breakdowns)

a. For Coolant Temperature Rise ______

______

b. For Film Temperature Rise ______

______

c. Others ______

______

______

4.11 Core Heat Dissipation System ______

______

______

4.12 Shutdown Heat Removal System ______

______

______

a. Worst Case Elapsed Time from Shutdown to Coolant Independence Without Fuel Distortion ______

4.13 Emergency Core Cooling System ______

______

______

______

5. NUCLEAR DATA

5.1 Fuel Loading

a. Minimum Critical Mass ______

b. Normal Core Loading (Beginning of Cycle at Rated Power) ______

c. Maximum $k_{excess}$ Components

1. Temperature ______
2. Equilibrium Xenon ______
3. Equilibrium Samarium ______
4. Xenon Override ______
5. Burnup (Including Burnable Poison) ______
6. Experimental Sample ______
7. Others ______
8. Total ______

d. Shutdown Margin ______

______

______

______

5.2 Reactivity Coefficients

a. Temperature

1. Moderator ______
2. Doppler ______
3. Fuel Expansion ______
4. Burnable Poisons ______

b. Void ______

5.3 Neutron Flux Densities

a. Steady State Average Thermal ______

b. Steady State Peak Thermal ______

c. Steady State Average Fast ______

d. Steady State Peak Fast ______

e. Peak Pulsing Power ______

f. Pulse Integrated Power ______

5.4 Pulsing Characteristics

a. Pulse Period ______

b. Full Width at Half Maximum ____________________

c. Maximum Frequency of Pulses ____________________

5.5 Fission Density

a. Normal Average ____________________

b. Peak ____________________

c. Axial Peak/Average Ratio for Typical Element ____________________

5.6 Maximum Fission Product Inventory ____________________

6. OPERATING EXPERIENCE

6.1 Forced Outages per 100 Full Power Operating Hours Since Criticality

a. Equipment Malfunction ____________________

b. Personnel Error ____________________

c. Total ____________________

7. SAFEGUARDS

7.1 Agency Responsible for Regulatory Jurisdiction ____________________

8. PAST MODIFICATIONS AND FUTURE PLANS

8.1 Past Major Modifications

a. Power Increase ____________________

b. Fuel Conversion ____________________

c. Other ____________________

d. Date ____________________

8.2 Future Major Modifications

a. Power Increase ____________________

b. Fuel Conversion ____________________

c. Decommissioning ____________________

d. Other ____________________

e. Date ____________________

8.3 Future Reactors

a. Type ____________________

b. Date ____________________

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| Irradiation Facilities | Description | Dimensions | Neutron Flux (n/cm²/sec) Thermal | Fast | Gamma Flux (Rad/hr) |
|---|---|---|---|---|---|
| Beamports | | | | | |
| | | | | | |
| | | | | | |
| Convertor Blocks | | | | | |
| | | | | | |
| | | | | | |
| Irradiation Racks | | | | | |
| | | | | | |
| | | | | | |
| Pneumatic Tubes | | | | | |
| | | | | | |
| | | | | | |
| Neutron Source | | | | | |
| | | | | | |
| | | | | | |
| Reactor Core | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| Reactor Pool | | | | | |
| | | | | | |
| | | | | | |
| Thermal Column | | | | | |
| | | | | | |
| | | | | | |

## 9.1 REACTOR, LABORATORY, AND EXPERIMENTAL FACILIT[illegible] Cont.d)

| Laboratory Facilities | Description |
|---|---|
| Accelerator | |
| Critical Assemblies | |
| Gamma Sources | |
| [illegible]t Cel[illegible]s | |
| Neutron Activation Analysis | |
| Neutron Generator | |
| Neutron Radiograph | |
| Neutron Spectrometer | |
| Radioisotope Laboratories | |

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## 10. RESEARCH AND TECHNICAL PROGRAM AND REACTOR UTILIZATION SUMMARY

### 10.1 Research, Technical, and Training Program

### 10.2 Principal Isotopes Produced

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11. COMPUTER CODES UTILIZED IN DESIGN

11.1 Neutronics

11.2 Structural Design

a. Reactor Vessel

b. Fuel

c. Containment

11.3 Heat Transfer

12 DECOMMISSIONED FACILITY DATA

12.1 Facility Structural Condition

12.2 Maintenance and Surveillance Program

12.3 Types and Quantity of Contamination Present

12.4 Types and Quantity of Stored Wastes Present

12.5 Facility Radionuclide Inventory

12.6 Planned Interim Disposition of Facility

12.7 Planned Ultimate Disposition of Facility

12.8 Estimate Volume of Radioactive Waste Generated by Decommissioning

13. FACILITY DESIGN AND OPERATION REFERENCE DOCUMENTS

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