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燃料ふるまいデータファイル
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燃料ふるまいデータファイル　－1985年版－

日本原子力研究所東海研究所燃料安全工学部
原山　泰雄・藤田　　操・渡辺　浩二*

（1986年6月25日受理）

原子炉燃料の安全性評価や健全性の研究において，燃料ふるまいのデータは，最高の基礎資料である。燃料安全第一研究室は，燃料の健全性および安全性を研究する国際計画に加盟することによって燃料ふるまいデータを入手してきた。それらのデータはそれぞれの実験の目的に使用されてきた。

しかし，もしそれらのデータが簡単に利用可能な形式に整理，収集されれば，他の目的の研究に利用することも可能である。そこで，国際計画から得られたデータに他の公開文献からのデータを加えて，“データファイル”を作成中である。この報告書は，1986年3月までに作成したデータファイルを基礎に編集したものである。

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Reactor Fuel Performance Data File - 1985 edition -

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(Received June 25, 1986)

In safety evaluation and integrity studies of reactor fuel, data on fuel performance are the most basic materials. The Fuel Reliability Laboratory No. 1 has obtained the fuel performance data by joining in some international programs to study the safety and integrity of fuel. Those data have only used for the studies in the above two fields.

However, if the data are rearranged and compiled in a easily usable form, they can be utilized in other field of studies. Then, a 'data file' on fuel performance is beeing compiled by adding data from open literatures to those obtained in international programs.

The present report is prepared on the basis of the data file compiled by March in 1986.

Keywords: Reactor Fuel, Assembly Rod, Fuel Performance, Data File, Compiled Data

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1. はじめに

原子炉燃料の健全性の研究や国が行う各種許認可や安全審査において，燃料ふるまいのデータは，第１等の基礎資料である。

燃料安全第一研究室は，燃料の健全性・安全性を目的に，いくつかの国際協力研究を通じ，燃料ふるまいの研究を行ってきた。例えば，

(1) ＯＥＣＤ，ハルデンプロジェクト計画

(2) Inter－，Over－，Demo－ramp計画（スウェーデン，Studvik研究所）

(3) ＨＢＥＰ（High Burnup Effect Program）（米国，バッテル研究所）

である。

これらの計画を通じ入手した資料は，燃料ふるまいの研究に利用してきた。また，安全性評価の手段の一つとして別途開発してきた燃料ふるまいコードの検証用としても利用している。

入手した資料およびそれに含まれる燃料ふるまいに関するデータは，かなりの量に達している。これらのうち燃料ふるまいに関するデータは，後の研究のためにも，役立つと考えられる種類のものであり，何らかの形で整理しておく必要が生じてきた。

この燃料ふるまいデータファイルの基本的目的は，上述の如きデータを後日の他の目的等に利用できるよう収集・整理することである。しかし，この目的は“制限的”には把えず，広く燃料ふるまいを考える上で必要と考えられるデータについては，他の公開文献等からも収集する方針にしている。

ある種のデータを計算機システム内に格納し“データベース”化することは，現在の一般的傾向である。このデータファイルも当初“データベース”を作成しようとの考えで出発した。その考えの基に試験的に入力システムを作成し，サンプル入力を行ってみた。しかし，その作業は中断せざるを得なくなった。

その理由は，通常のいわゆるデータベースとして扱っているデータと燃料に関するデータは，その性格がかなり異なっていることが分かってきたためである。

普通のデータベースのデータは，数個の条件が与えられればあるデータがただ一通りに定まる（一価関数）。ところが，原子炉燃料に関するデータは，まず，データを定める条件の数が一般的に多く，かつ多岐にわたる場合が多い。さらに，一定の条件を与えても一通りのデータとならないものもある（多価関数）。

例えば，燃料ふるまいを考える上で重要なパラメータである燃料棒のギャップサイズを考えてみる。いま，これが0.2 mmという値があったとしても，この数値の条件が，設計値か，仕様値あるいは測定値なのかどうかということが規定されなければ，他のデータとの比較等は意味をもたなくなる。さらに，広く照射中，照射後試験のことまで考えると，規定しなければならない条件はさらに多くなる。測定値をもデータとして扱うことを考えると，値は，測定された回数だけデータが存在し，少なくとも一価関数として定まらない。

上記の例は，単なる１例にすぎないが，データを定める条件の数が多く，場合によっては多

価関数となるようなデータを統一的に扱うシステムをただちに構築することはきわめて困難と判断された。そのようなシステムを作成するには，まず最初にデータの持つ性格をデータ自身に即して正確に把握することが必要であると考えられた。そこで，最初から“データベース”を作成することを考えず，多くの種類に及ぶデータを報告されたオリジナルの形式のまま収集（編集上の多少の変更を除き）したデータファイルを作成することに変更した。しかし，将来“データベース”を作成する場合，このデータファイルは重要な基礎データであることに変りはない。

データを集積したシステムで，そのシステム上の重要事項の1つは，いかによい索引システムを設けるかである。しかし，先に述べたデータの持つ性格の多様性により，統一したデータ処理システムが未確立のため，このデータファイルの合理的な索引システムを作成することも難しかった。一方，このデータファイルは作成途中ではあるが，既に収集したデータは有効に利用したいとの要望もある。ファイルを公開し，データの不備あるいは補強すべきデータを利用を通じて明らかにすることは有益であると考えられた。

そこで，とりあえず，このデータファイルを使用するための索引システムとして，次の2つを用意することにした。1つはデータタイトルのKWIC（Key Word In Contents)であり，他の1つは収録した燃料集合体の収録番号からのデータ番号の索引である。いずれにしてもこれら索引から索引可能なデータの項目は大項目までである。各データに含まれる小項目（例えば，燃料棒の被覆の材質，ペレット寸法等）を上記の索引から得ることは，現在のところ不可能である。これらについては次版等で改良を加えたいと考えている。

2. データファイルの構成

このデータファイルは，

(1) データ部

(2) 索引の部

で構成されている。計算機上のデータファイルシステムの詳細については，データの入力形式等を含め，別に報告書にまとめる予定なので，本書では省略する。

この燃料ふるまいデータファイルのシステムは，日本原子力研究所の計算機システム上に構成している。データの入・出力を含めすべての処理はFORTRAN−77で行っている。

2.1 データの部

本書に収録しているデータ項目をTable 1に示す。データには，データタイトルの外にそのデータのデータ番号を付してある。このデータファイルシステムでは，このデータ番号をFiling Data Numberと呼ぶこととし，FDNと略称する。データの収録の順序はFDNの小さい番号から大きい番号へとなっている。

FDNに6桁の整数を与えている。FDNの6桁目の数によりデータ内容による分類を行っ

価関数となるようなデータを統一的に扱うシステムをただちに構築することはきわめて困難と判断された。そのようなシステムを作成するには，まず最初にデータの持つ性格をデータ自身に即して正確に把握することが必要であると考えられた。そこで，最初から“データベース”を作成することを考えず，多くの種類に及ぶデータを報告されたオリジナルの形式のまま収集（編集上の多少の変更を除き）したデータファイルを作成することに変更した。しかし，将来“データベース”を作成する場合，このデータファイルは重要な基礎データであることに変りはない。

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FDNに6桁の整数を与えている。FDNの6桁目の数によりデータ内容による分類を行っ

た。すなわち，

(1) 100001～199999
設計，仕様，製造時等の照射前データ

(2) 300001～399999
照射中のデータ

(3) 500001～599999
この番号に相当するＦＤＮは現在使用していない。将来，照射履歴データ等を収録する予定にしている。

(4) 700001～799999
照射後試験データを中心とする。

(5) 900001～999999
そ の 他

としている。

この分類は，あまり厳密ではない。データ内容によっては上記の分類の２つ以上に関係するもの等もあるため，そのようなものは適宜，適当と思われる分類のＦＤＮを付している。

ＦＤＮの100001～199999の照射前データについては，さらに，

(1) 100001～109999
原子炉炉心データ

(2) 110001～119999
原子炉炉心データ（主として軽水炉）

(3) 120001～129999
燃料集合体データ

(4) 130001～139999
燃料棒データ

(5) 140001～149999
燃料ペレットデータ

(6) 150001～159999
燃料被覆データ

(7) 160001～169999
燃料に関する部品等に関するデータ

と区分けしている。

データ内容の分類について，以上に述べた区分を行ったほかは，各データのＦＤＮは原則として収録の順番のシリーズ番号となっている。ただ，入力を手分けして行う等の必要から飛び番になっている個所，あるいは，他のデータと統合したため欠番となったもの等がある。本来ならば，同質のデータを１箇所に集める等の再編集を行えば，データ集としては，もっと見やすくなることは自明であるが，この作業は行わないこととした。主たる理由は，データの全体像がなかなか把握できないためである。また，再編集を行うと，ＦＤＮの変更を伴うことになる。しかし，ＦＤＮの変更を行うと，データ相互間の関係を関係づけている互いの参照関係の

ＦＤＮをも変更しなければならず，この作業はきわめて困難なためである。

このデータファイルの主目的は，研究室で入手した実験用燃料集合体あるいは燃料棒に関するデータを整理することである。しかし，これら実験の最終目的は一般の炉心燃料の健全性評価に役立てることである。そのため，燃料を含む原子炉炉心データも必要と考え，収録することにしている。また，燃料のふるまいを考える上で，燃料および被覆等の物性値，計算モデル等も収録可能なものは収録することにしている。

データの入力処理は，FORTRAN－77によっている。使用するシステムの制限のため，現在，入力可能なデータは，表形式のものと文章形式のものに限定されている。データとしては図形式のものが扱えれば，データファイルとして充実することは明らかであるが，現在のところ図を扱うことは不可能になっている。ただ，ラインプリンターで近似できる図については，二，三試みている。

2.2 索引の部

このデータファイルのデータを索引する索引システムとして，現在２つの方法を用意している。

１つは，各データのデータタイトルに含まれるwordsをkey wordとして索引する方法である。他の１つはデータに含まれる特定の燃料から索引を行う方法である。

データタイトルから索引する方法としてＫＷＩＣ方式（Key Word In Contents)を利用している。この場合，索引対象となるデータは全データである。特定の燃料からの索引は，燃料を特定していないデータ等があるため，すべてのデータが索引対象とはなっていない。データ中，燃料集合体等を特定したデータに限られる。

3. 使　　用　　法

3.1 データの編集形式

先に，2.1で述べたように，このデータファイルに収録したデータは，表と文章形式のものである。

収録したデータの１例をFig.1に示す。これはＦＤＮ－700027なので，照射後試験データに含まれる１つである。データタイトルから，このデータは，スタッズビック（スウェーデン）のインターランププロジェクトから得られた燃料棒の重量増加の記録であることが分かる。

以下，Fig.1中の符号①～⑥について説明する。

① ： ＦＤＮ（Filing Data Number)で，このデータファイルでの収録番号である。Numberingによるデータの分類については，2.1を参照されたい。

② ： このデータのデータタイトルを示す。

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以下，Fig.1中の符号①～⑥について説明する。

① ： FDN（Filing Data Number)で，このデータファイルでの収録番号である。Numberingによるデータの分類については，2.1を参照されたい。

② ： このデータのデータタイトルを示す。

③ ： データ編集上，どの燃料に関するものであるかを示す。この例のデータはすべて

Inter ramp に関するものであるが，異なった燃料を2個以上示す場合は，その下方の数値等がその燃料のデータであることを指示する。

④ : データの小項目を示す。左方の（　）付の数値は，データ入力上付された数値であって，特に意味はないので，無視してよい。単位を持つ項目については，原則として単位を付している。しかし，FORTRANで処理しているため，小文字，添字等が使えず，すべて大文字となっているので，注意されたい。

⑤ : 各項目に対するデータを示す。原則として8キャラクターに1つの数値が与えられるように配慮している。しかし，寸法公差等を表示すると，8キャラクターに収容できないもの等はその下段等に収録した。また，公差で±0.1等は＋－0.1のように表示している。元のレポート等の表示の判読不可能だった値，疑問の数値あるいは検討を要するもの等には？を付している。

⑥ : 各データには，原則として出典をReferencesとして明示した。出典は可能な限り詳しく記載したが，このデータファイル作成計画以前に集めておいたデータ等で，出典が判らなくなったものもある。雑誌等から収集したデータは，通常の略記法で記載している。また，データの大部分を占めるスタッズビックのインターランプ計画，ハルデン計画関係のレポートについては，レポートタイトル，著者等を省略し，レポート番号のみにした。例えば，

HPR …… Halden Project Report

STIR …… Studvik Inter Ramp Report

のようになっている。

場合により，データにはNotes, Remarks を付している。原則的には，そのデータに関する注等はNotes として収録し，他の文献等との関係はRemarksとして収録した。しかし，元文献にRemarksとなっているもの等は，そのままRemarksとして収録した。なお，データ中の略号等は，原則としてNotesにその意味を記載した。

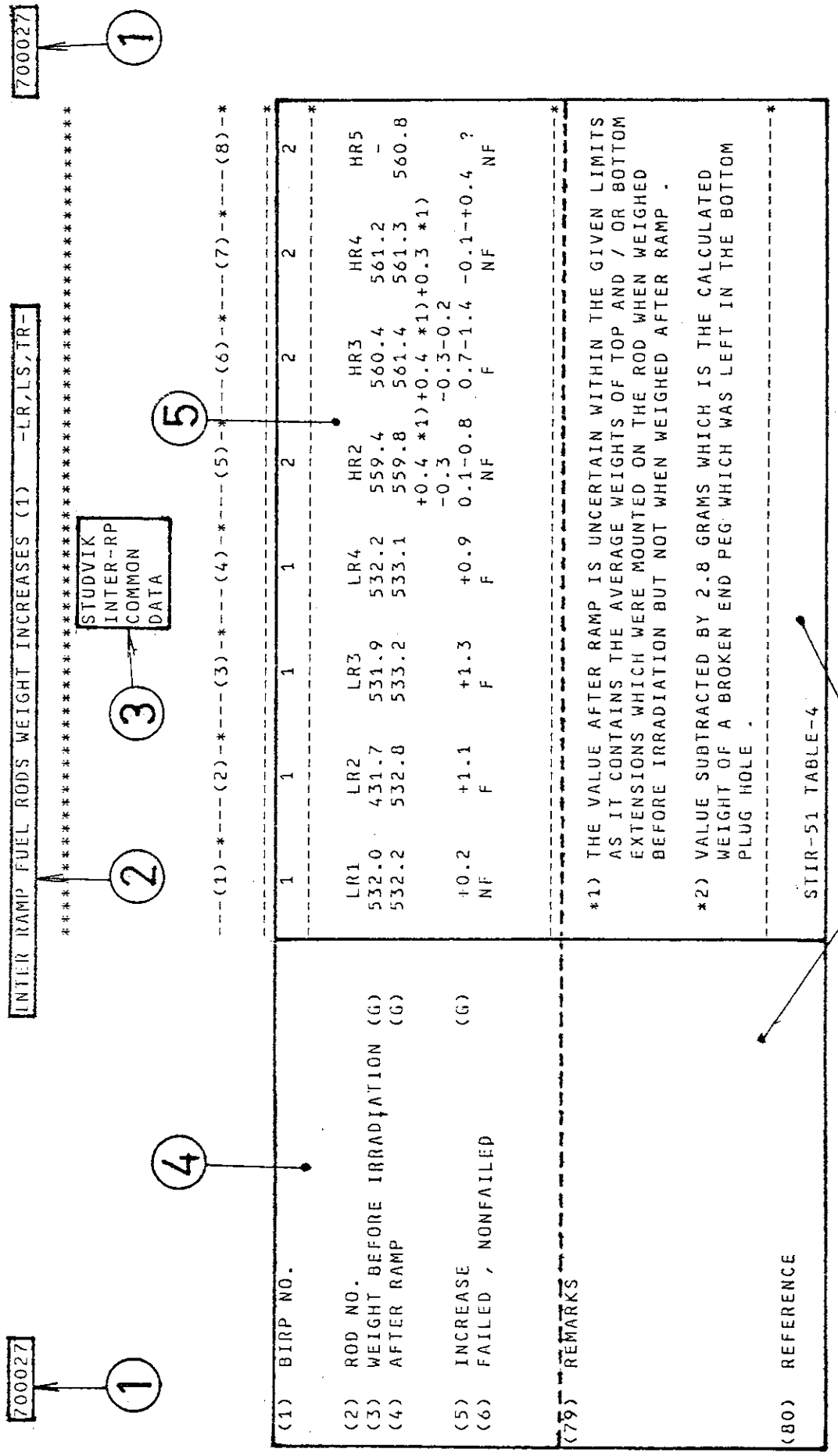

Fig. 1 A sample of fuel performance data

3.2 索引法

必要とするデータへの接近法として，現在2通りの方法がある。

1. Table 3のデータタイトルのＫＷＩＣを利用する。
2. Table 4とTable 5を使って，燃料集合体等の指定番号から接近する方法。

である。

3.2.1 ＫＷＩＣシステムによる索引

ＫＷＩＣシステムは，ある与えられたデータの文字列の集合を与えた要素文字列でソートする。

このデータファイルシステムでは，データの文字列としてデータタイトルのすべてを与え，検索文字列としてアルファベットを使用した。

いま，例としてＦＤＮ－150501のタイトル，Typical Zircaloy Cladding Tube Specification Dataを取り上げると，これは，検索文字列として

Cladding，Data，Specification，Tube，Typical，Zircaloy

の順にソートされることになり，それぞれの検索文字列の6箇所にＦＤＮとデータタイトルが記載される。

Table 3は，このデータファイルのデータタイトルをＫＷＩＣシステムで処理した結果である。左側に検索文字列（Index words）を与えている。順序はアルファベット順となっている。次に“＜”から始まるものはデータタイトル（Item list），左側から2番目の数字は，データのファイリング番号（ＦＤＮ）を示す。最も右側はデータが記載されているTable 2における通し頁数をＤ－〇〇として与えている。

3.2.2 燃料集合体等の登録番号からの検索

いくつかの燃料については，このデータファイル内での識別番号を付けている。燃料の区別として，例えばプラント，炉型，炉心，集合体，燃料棒等による区別が考えられるが，このデータファイルでは，燃料の区分の基準として燃料集合体を採用した。ただし，実験燃料等では，燃料棒が基準単位になっているものも多いので，場合によっては燃料棒となっているものもある。

Table 4に，このデータファイルでの識別番号と名称（略称）を示す。識別番号は9桁の2組の整数である。原則として最初の数（ＮＡＳＳと表示）で燃料集合体を，後の数（ＮＲＯＤと表示）でその集合体内の燃料棒以下の区別を行うことにしている。

Table 5は，Table 4の燃料集合体等の識別番号をもとに，そのような燃料のデータを含むデータのＦＤＮとデータタイトルをソートした結果である。

最も左側の番号（ＥＤＩＴ No.）は，ソートにおける編集上の番号でTable 4のＥＤＩＴ No.と一致する。各燃料の識別番号と略称の下にその燃料に関するデータを含むデータタイトルとＦＤＮが示される。

Table 4には存在するがTable 5には対応するものがないものは，この編集時にその燃料に

関するデータは未収録であることを意味する。

4. 謝　　辞

このデータファイルの作成を開始するに当り，次の各位から多くの援助や助言を得た。燃料ふるまいに関するデータを整理してみようとの提案は，市川逵生氏（燃料安全工学部次長）による。最初のデータの分類，サンプルデータの収集は泉文男氏，収録すべき内容，収録方法について川崎了氏（燃安第一室長），森島淳好氏（特別研究員）等の助言を得た。研究室の内田正明，鈴木元衛，中島鉄男，中村仁一の各氏には，データの出典，内容の検討等につき多くの教示を得た。

以上にその氏名を記して謝意を表す。

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4. 謝　　辞

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以上にその氏名を記して謝意を表す。

5. 表　目　次

Table Contents

表－1　データタイトル

(Table 1 List of data title)

TITLE SERIES NO.	DATA TITLE	*FDN-*
1	CONSTITUTION OF FILING DATA NUMBER FOR FUEL PERFORMANCE DATA	1
2	TYPICAL NUCLEAR POWER REACTOR DATA (1)	100001
3	TYPICAL NUCLEAR POWER REACTOR DATA (2)	100002
4	DATA OF PWR AND HCPWR (APWR)	100003
5	MAIN CORE CHARACTERISTICS - AVERAGE POWER DENSITY -	100004
6	SPECIFICATION OF CANDU STANDARD DESIGN	100005
7	GENERAL DESCRIPTION OF REACTOR CHARACTERISTICS (1)	110001
8	GENERAL DESCRIPTION OF REACTOR CHARACTERISTICS (2)	110002
9	GENERAL DESCRIPTION OF REACTOR CHARACTERISTICS (3)	110003
10	MAIN CORE PARAMETERS - MODERATOR/FUEL VOLUME RATIO -	110004
11	NUCLEAR DESIGN PARAMETERS - PWR -	110005
12	REACTIVITY BALANCE AT BOL - EXAMPLE -	110006
13	REACTIVITY COEFFICIENT - PWR, MIHAMA -	110007
14	NUETRON FLUX - TYPICAL EXAMPLE -	110008
15	OPERATIONAL REQUIREMENTS FOR LWR FUEL - TYPICAL VALUES -	110009
16	CORE DESIGNS FOR OPTIMUM PERFORMANCE - HISTORICAL BWR -	110201
17	PEAK-TO-AVERAGE POWER RATIOS (PEAKING FACTOR) IN BWR CORES	110202
18	BASIS FOR FUEL DESIGN - DESIGN CRITERIA -	110203
19	DEFINITION OF FUEL DAMAGE	110204
20	FUEL LINEAR HEAT-GENERATION RATES	110205
21	SUMMARY OF FUEL ASSEMBLY	120001
22	TEST ASSEMBLY DATA - IFA-106 -	120002
23	TEST ASSEMBLY DATA - IFA-106 - (CON'T)	120003
24	CONNECTICUT YANKEE FUEL SUPPLIERS AND DESIGN PARAMETERS	120004
25	CONNECTICUT YANKEE FUEL SUPPLIERS AND DESIGN PARAMETERS (CON'T)	120005
26	JOYO (FBR) MK-I FUEL ASSEMBLY DESIGN PARAMETERS	120006
27	DESCRIPTIONS OF FUEL ASSEMBLY STRUCTURE DESIGN	120007
28	FUEL ROD ARRAYMENT OF MIXED-OXIDE FUEL ASSEMBLY - BWR -	120008
29	SUMMARY OF MIXED-OXIDE FUEL DESIGN PARAMETER - BWR -	120009
30	FUEL FABRICATION QUALITY CONTROL FLOW CHART -INTER RAMP-	130001
31	OVERALL FLOW SCHEME FOR THE INTER-RAMP EXPERIMENTAL FUEL	130002
32	FUEL ROD COMPONENTS AND SPECIFICATIONS -INTER RAMP-	130003
33	ROD DESIGNATION - CHARACTERISTIC SETS OF PARAMETER VALUES	130004
34	DRAWINGS REFERENCE - PELLET, FUEL ROD, ASSEMBLY, PARTS -*	130005
35	TEST FUEL ROD DATA -INTER RAMP LR,LS,TR-	130006
36	TEST FUEL ROD DATA -INTER RAMR LS,TS,DR,HR-	130007
37	TEST FUEL ROD DATA -INTER RAMP HS,BR-	130008
38	TEST ROD DIMENSIONS AND WEIGHTS -INTER RAMP LR-	130009
39	INTER RAMR FUEL RODS SPECIFICATION -LR,LS,TR-	130010
40	INTER RAMP FUEL RODS SPECIFICATION -LS,TS,DR,HR-	130011
41	INTER RAMP FUEL RODS SPECIFICATION -HS,BR-	130012
42	DEMO RAMP FUEL RODS SPECIFICATION -BWR (1)-	130013
43	DEMO RAMP FUEL RODS SPECIFICATION -BWR (2)-	130014
44	SUPER RAMP FUEL RODS SPECIFICATION -PWR (1)-	130015
45	SUPER RAMP FUEL RODS SPECIFICATION -PWR (2)-	130016
46	SUPER RAMP FUEL RODS SPECIFICATION -PWR (3)-	130017
47	SUPER RAMP FUEL RODS SPECIFICATION -PWR (4)-	130018
48	SUPER RAMP FUEL RODS SPECIFICATION -BWR (1)-	130019

TITLE SERIES NO.	DATA TITLE	*FDN-*
49	SUPER RAMP FUEL RODS SPECIFICATION -BWR (2)-	130020
50	SUPER RAMP FUEL RODS SPECIFICATION -BWR (3)-	130021
51	OVER RAMP FUEL RODS SPECIFICATION -PWR (1)-	130022
52	OVER RAMP FUEL RODS SPECIFICATION -PWR (2)-	130023
53	OVER RAMP FUEL RODS SPECIFICATION -PWR (3)-	130024
54	OVER RAMP FUEL RODS SPECIFICATION -PWR (4)-	130025
55	OVER RAMP FUEL RODS SPECIFICATION -PWR (5)-	130026
56	PELLET TYPE DESIGNATION - INTER RAMP -	140001
57	PELLET - CHEMICAL IMPURITIES -	140002
58	PELLETIZING PARAMETERS - INTER RAMP -	140003
59	MOISTURE CONTENT OF PELLETS - INTER RAMP -	140004
60	MIXED OXIDE PELLET - CHEMICAL COMPOSITION AND IMPURITIES -	140005
61	SPACER PELLET - CHEMICAL COMPOSITION AND IMPURITIES, INTER-RP.-	140006
62	UO-2 POWDER CHARACTERISTICS - INTER RAMP -	140007
63	JPDR-II FUEL PELLET DENSITY MEASUREMENT (1)	140008
64	JPDR-II FUEL PELLET DENSITY MEASUREMENT (2)	140009
65	JPDR-II FUEL PELLET DENSITY MEASUREMENT (3)	140010
66	JPDR-II FUEL PELLET DENSITY MEASUREMENT (4)	140011
67	JPDR-II FUEL PELLET DENSITY MEASUREMENT (5)	140012
68	JPDR-II FUEL PELLET DENSITY MEASUREMENT (6)	140013
69	JPDR-II FUEL PELLET DENSITY MEASUREMENT (7)	140014
70	THERMAL SINTERING TEST CONDITION FOR PELLET DENSIFICATION	140015
71	COMPARATIVE MANPOWER COSTS FOR FUEL FABRICATION PROCESSES	140016
72	EQUIVALENT BORON CONTENT - EBC -	140017
73	METHOD OF MEASUREMENT FOR PELLET GEOMETRICAL DENSITY	140018
74	ZIRCALOY TUBE CHEMICAL REQUIREMENTS - ASTM DESIGNATION -	150001
75	CLADDING MATERIAL - ZIRCALOY CHEMICAL COMPOSITION & IMPURITIES -	150002
76	ANALYSIS OF THE CONTENT OF GASEOUS CONSTITUENTS IN TUBES	150003
77	WALL THICKNESS OF TUBES - MEASUREMENT, INTER RAMP -	150004
78	MECHANICAL PROPERTIES OF ZIRCALOY TUBE TESTED AT ROOM TEMP.-ASTM	150005
79	MECHANICAL PROPERTIES OF CLADDING TUBES - INTER RAMP -	150006
80	BURST PROPERTIES FOR CLADDING TUBES	150007
81	CORROSION PROPERTIES FOR ZIRCALOY CLADDING TUBES	150009
82	HYDRIDE ORIENTATION METHOD AND RESULTS FOR CLADDING TUBES	150010
83	HYDRIDE ORIENTATION FACTOR (FN) FOR CLADDING TUBES - INTER-RP. -	150011
84	GRAIN SIZE IN ZIRCALOY TUBES - INTER RAMP -	150012
85	CLADDING MATERIAL - STAINLESS STEEL CHEMICAL COMPOSITION & IMP.-	150013
86	JPDR TEST ASSEMBLY NO.1 ZRY-2 TUBES AND BARS TEST DATA (1/3)	150014
87	JPDR TEST ASSEMBLY NO.1 ZRY-2 TUBES AND BARS TEST DATA	150015
88	JPDR TEST ASSEMBLY NO.1 ZRY-2 TUBES AND BARS TEST DATA	150016
89	JPDR TEST ASSEMBLY NO.1 ZRY-2 TUBES AND BARS TEST DATA (1/6)	150017
90	JPDR TEST ASSEMBLY NO.1 ZRY-2 TUBES AND BARS TEST DATA (2/6)	150018
91	JPDR TEST ASSEMBLY NO.1 ZRY-2 TUBES AND BARS TEST DATA (3/6)	150019
92	JPDR TEST ASSEMBLY NO.1 ZRY-2 TUBES AND BARS TEST DATA (4/6)	150020
93	JPDR TEST ASSEMBLY NO.1 ZRY-2 TUBES AND BARS TEST DATA (5/6)	150021
94	JPDR TEST ASSEMBLY NO.1 ZRY-2 TUBES AND BARS TEST DATA (6/6)	150022
95	JPDR TEST ASSEMBLY NO.1 BARS TEST DATA (1/2)	150023
96	JPDR TEST ASSEMBLY NO.1 BARS TEST DATA (2/2)	150024
97	JPDR TEST ASSEMBLY NO.1 TUBE TEST DATA	150025
98	TYPICAL ZIRCALOY CLADDING TUBE SPECIFICATION DATA	150501

TITLE SERIES NO.	DATA TITLE	FDN-*
99	SUMMARY OF STRESS-INTENSITY LIMITS	150502
100	BASIC STRESS INTENSITY LIMITS - ASME VESSEL CODE SECTION III -	150503
101	CHEMICAL ANALYSIS OF ZIRCALOY BAR FOR FUEL ROD END PLUGS	160001
102	MECHANICAL PROPERTIES OF MATERIAL FOR FUEL ROD END PLUGS	160002
103	CHEMICAL ANALYSIS RESULTS OF FUEL HOLDDOWN SPRING MATERIAL	160003
104	MECHANICAL PROPERTIES OF HOLDDOWN SPRING MATERIAL	160004
105	IRRADIATION BEHAVIORS OF REACTOR FUELS	300001
106	CLASSIFICATION OF OBSERVED FUEL FAILURES - ZIRCALOY CLAD -	300002
107	TEST MATRIX OF THE INTER RAMP PROJECT (1) -LR,LS,TR-	700001
108	TEST MATRIX OF THE INTER RAMP PROJECT (2) -LS,TS,DR,HR-	700002
109	TEST MATRIX OF THE INTER RAMP PROJECT (3) -HS,BR-	700003
110	INTER RAMP IRRADIATION DATA (1) -LR,LS,TR-	700004
111	INTER RAMP IRRADIATION DATA (2) -LS,TS,DR,HR-	700005
112	INTER RAMP IRRADIATION DATA (3) -HS,BR-	700006
113	INTER RAMP (PRE-RAMP IRRADIATION DATA AT AXIAL PEAK POWER (1))	700007
114	INTER RAMP (PRE-RAMP IRRADIATION DATA AT AXIAL PEAK POWER (2))	700008
115	INTER RAMP (PRE-RAMP IRRADIATION DATA AT AXIAL PEAK POWER (3))	700009
116	INTER RAMP DIAMETER MEASUREMENT DATA (1) -LR,LS.TR-	700010
117	INTER RAMP DIAMETER MEASUREMENT DATA (2) -LS,TS,DR,HR-	700011
118	INTER RAMP DIAMETER MEASUREMENT DATA (3) -HS,BR-	700012
119	INTER RAMP MEASUREMENTS DATA (1) FOR B1RP-2 AND BIRP-4	700013
120	INTER RAMP MEASUREMENTS DATA (2) FOR BIRP-2 AND BIRP-4	700014
121	INTER RAMP MEASUREMENTS DATA (3) FOR BIRP-2 AND BIRP-4	700015
122	INTER RAMP MEASUREMENTS DATA (4) FOR BIRP-2 AND BIRP-4	700016
123	INTER RAMP HOT CELL PIE DATA (1) -LR,LS,TR-	700017
124	INTER RAMP HOT CELL PIE DATA (2) -LS,TS,DR,HR-	700018
125	INTER RAMP HOT CELL PIE DATA (3) -HS,BR-	700019
126	RESULTS OF SCC TESTING OF INTER RAMP MATERIAL *1)	700020
127	INTER RAMP ROD LENGTH MEASUREMENT DATA (1) -LR,LS,TR-	700021
128	INTER RAMP ROD LENGTH MEASUREMENT DATA (2) -LS,TS,DR,HR-	700022
129	INTER RAMP ROD LENGTH MEASUREMENT DATA (3) -HS,BR-	700023
130	INTER RAMP,PRE-RAMP IRRADIATION DATA AND RAMP IRRADIATION DATA 1	700024
131	INTER RAMP,PRE RAMP IRRADIATION DATA AND RAMP IRRADIATION DATA 2	700025
132	INTER RAMP,PRE RAMP IRRADIATION DATA AND RAMP IRRADIATION DATA 3	700026
133	INTER RAMP FUEL RODS WEIGHT INCREASES (1) -LR,LS,TR-	700027
134	INTER RAMP FUEL RODS WEIGHT INCREASES (2) -LS,TS,DR,HR-	700028
135	INTER RAMP FUEL RODS WEIGHT INCREASES (3) -HS,BR-	700029
136	INTER RAMP FISSION GAS REREASE DATA (1)	700030
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138	INTER RAMP CLAD TENSILE TESTING RESULT (1) -LS-	700032
139	INTER RAMP CLAD TENSILE TESTING RESULT (2) -LS-	700033
140	INTER RAMP CLAD TENSILE TESTING RESULT (3) -HR-	700034
141	INTER RAMP CLAD TENSILE TESTING RESULT (4) -TR-	700035
142	POWER RAMP TEST PARAMETER (PETTEN PWR (1))	700036
143	POWER RAMP TEST PARAMETER (PETTEN PWR (2))	700037
144	POWER RAMP TEST PARAMETER (PETTEN PWR (3))	700038
145	POWER RAMP TEST PARAMETER (GE R2 *BWR* (1))	700042
146	POWER RAMP TEST PARAMETER (GE R2 *BWR* (2))	700043
147	POWER RAMP TEST PARAMETER (INTER RAMP *BWR* (1))	700044

TITLE SERIES NO.	DATA TITLE	*FDN-*
148	POWER RAMP TEST PARAMETER (INTER RAMP *BWR* (2))	700045
149	POWER RAMP TEST PARAMETER (INTER RAMP *BWR* (3))	700046
150	POWER RAMP TEST PARAMETER (DEMO RAMP *BWR* (1))	700047
151	POWER RAMP TEST PARAMETER (DEMO RAMP *BWR* (2))	700048
152	POWER RAMP TEST PARAMETER (SUPER RAMP *PWR* (1))	700049
153	POWER RAMP TEST PARAMETER (SUPER RAMP *PWR* (2))	700050
154	POWER RAMP TEST PARAMETER (SUPER RAMP *PWR* (3))	700051
155	POWER RAMP TEST PARAMETER (SUPER RAMP *PWR* (4))	700052
156	POWER RAMP TEST PARAMETER (SUPER RAMP *BWR* (5))	700053
157	POWER RAMP TEST PARAMETER (SUPER RAMP *BWR* (6))	700054
158	POWER RAMP TEST PARAMETER (OVER RAMP *PWR* (1))	700055
159	POWER RAMP TEST PARAMETER (OVER RAMP *PWR* (2))	700056
160	POWER RAMP TEST PARAMETER (OVER RAMP *PWR* (3))	700057
161	POWER RAMP TEST PARAMETER (OVER RAMP *PWR* (4))	700058
162	POWER RAMP TEST PARAMETER (OVER RAMP *PWR* (5))	700059
163	FISSION GAS RELEASE AND VOID VOLUME DATA FOR CONNECTICUT YANKEE	700208
164	FISSION GAS ANALYSIS SUMMARY	700209
165	FISSION GAS ANALYSIS SUMMARY (CON'T)	700210
166	FUEL BURNUP SAMMARY.	700211
167	FUEL BURNUP SUMMARY (CON'T)	700212
168	TENSILE TESTS ON ZIRCALOY CLADDING OF DRESDEN TYPE I FUEL.	700213
169	TENSILE TESTS ON ZIRCALOY-CLAD FUEL FROM AEC FUEL CYCLE PROGRAM	700214
170	BURST TESTS ON CLADDING OF DNP TYPE IIIF FUEL	700215
171	DESIGN AND PERFORMANCE OF 304 STAINLESS STEEL CLAD FUELS IN VBWR	700216
172	DESIGN AND PERFORMANCE OF 304 STAINLESS STEEL CALD FUELS IN VBWR	700217
173	DESIGN AND PERFORMANCE OF 304 STAINLESS STEEL CLAD FUELS IN VBWR	700218
174	PERIPHERAL FUEL ROD FLATTENING OBSERVATIONS	700219
175	VALUES OF BASIC NUCLEAR PARAMETERS - CRITICAL -	900001
176	SUMMARY OF FUEL MATERIAL PROPERTIES - PU-02 ETC.-	900002
177	MELTING AND BOILING POINTS OF OXIDE AND CARBORIDE FUEL	900003
178	VOLUME OF FISSION GAS FORMED AND XE-135 TO XE-136 CONVERSION (1)	900004
179	VOLUME OF FISSION GAS FORMED AND XE-135 TO XE-136 CONVERSION (2)	900005
180	HIGH TEMPERATURE PHYSICAL PROPERTIES OF FUEL ELEMENT MATERIALS-1	900006
181	HIGH TEMPERATURE PHYSICAL PROPERTIES OF FUEL ELEMENT MATERIALS-2	900007
182	PHYSICAL PROPERTIES OF ZIRCON	900008
183	ISOTOPIC ABUNDANCE OF ZIRCONIUM	900009
184	FISSION GAS RELEASE MODELS - DIVIDED INTO TEMPERATURE RANGES -	900010
185	FISSION GAS RELEASE MODEL OF HOFFMANN AND COPLIN	900011

表－２　燃料ふるまいデータ

(Table 2 Fuel performance data)

*** FUEL PERFORMANCE DATA *** DATE = 86-05 **PAGE** (D- 1)

<* 1 *> CONSTITUTION OF FILING DATA NUMBER FOR FUEL PERFORMANCE DATA ** 1 **

FDN	* CLASSIFICATION
000001:	FILING DATA NUMBERING.
100001:	DESIGN, SPECIFICATION, FABRICATION DATA.
300001:	IRRADIATION DATA.
500001:	SPARE NUMBER.
700001:	POST-IRRADIATION DATA
900001:	MATERIAL PROPERTIES AND MISCELLANEOUS DATA.

FND	* SUB-CLASSIFICATION OF FIRST OF FDN.
100001:	REACTOR CORE.
110001:	REACTOR CORE - LWR -
120001:	FUEL ASSEMBLY.
130001:	FUEL ROD.
140001:	FUEL PELLET.
150001:	CLADDING.
160001:	MISCELLANEOUS PARTS AND MATERIAL.

(998) REMARKS

FND : FILING DATA NUMBER.
THE NUMBER OF FND EXPRESSES A STARTING NO. OF EACH DATA GROUP.

<* 100001 *> TYPICAL NUCLEAR POWER REACTOR DATA (1) ** 100001 **

		(1) PWR (W)	(2) PWR (B&W)	(3) PWR (CE)	(4) BWR/6	(5) HTGR	(6) LMFBR	(7) GCFR	(8) CANDU PHW
(11) REACTOR TYPE									
(10) GENERAL DATA									
(12) THERMAL OUTPUT	(MW(T))	3411	3600	3800	3579	3000	2410	2530	1610
(13) ELECTRICAL OUTPUT	(MW(E))	1150	1200	1300	1200	1170	1000	1000	500
(14) EFFICIENCY	(%)	33.7	33.3	34.2	39.0	39.0	39.0	39.5	31.
(15) FUEL TYPE		UO2	UO2	UO2	UO2	UC, TH-O2	MOX	MOX	UO2
(16) COOLANT		H2O	H2O	H2O	H2O	HE	NA	HE	D2O
(17) STRUCTURAL MATERIAL		ZRY-4	ZRY-4	ZRY-4	ZRY-2	GRAPHITE	316SS	316SS	ZRY-4
(18) MODERATOR		H2O	H2O	H2O	H2O	GRAPHITE	-	-	D2O
(20) CORE DATA									
(21) ACTIVE LENGTH	(M)	3.66	3,63	3.81	3.76	6.34	0.91	1.48	4.1
(22) EQUIVALENT ACTIVE DIAMETER	(M)	3.37	3.52	3.63	3.66	8.44	2.22	2.7	6.8
(23) HEIGHT/DIAMETER		1.09	1.03	1.05	1.03	0.75	0.41	0.55	0.60
(24) ACTIVE CORE VOLUME	(L)	32800	37600	40000	63910	354000	6300	8510	130000
(25) AVERAGE CORE POWER DENSITY	(KW/L)	104.	95.7	95.	56.0	8.4	380.	297.	12.4
(26) FUEL WEIGHT	(TON)	90.2	94.9	103.	138.	39.	19.	28.	80.
(27) SPECIFIC POWER	(KW/KG-U)	37.8	37.9	36.9	25.9	77.	126.	90.	20.4
(28) BURNUP	(MWD/MTU)	33000	33000	33000	27500	98000	100000	100000	10000
(29) CONVERSION RATIO		0.5	0.5	0.5	0.5	0.7	1.3	1.5	0.45
(30) FUEL ASSEMBLY DATA									
(31) TYPE		SB	SB	SB	CN-SB	HGP	HCB	HCB	PTB
(32) NUMBER OF ASSEMBLIES		193.	205.	241.	732.	3944.	394.	347.	473.
(33) FUEL-ELEMENT ARRAY		17X17	17X17	16X16	8X8	132 PINS.	HEX	HEX	PRESS. TUBES.
(34) ASSEMBLY DIMENSION	(MM)	214X214	217X217	203X203	140X140	350X790	120X120	170X170	80X500
(35) ASSEMBLY PITCH	(MM)	215.	218.	207.	305.	361.	124.	175.	279.
(36) NO. OF FUEL ELEMENTS/ASSEMBLY		264	264	236	63	132	217	225	28
(37) TOTAL NUMBER OF FUEL LOCATIONS		50952	54120	56876	46116	35496	85464	77031	13244
(40) FUEL ELEMENT DATA									
(41) TYPE		CR	CR	CR	CR	GRP-UC, THO2 ROD	W.-W. CR	VENTED CR	CR
(42) FUEL-ELEMENT PITCH	(MM)	12.5	12.7	12.8	16.2		7.25	11.4	16.5
(43) FUEL ELEMENT O.D.	(MM)	9.4	9.6	9.7	12.5	15.6	5.79	8.05	15.2
(44) PITCH/DIAMETER		1.32	1.32	1.33	1.30		1.25	1.41	1.08
(45) CLAD THICKNESS	(MM)	0.572	0.597	0.635	0.864		0.38	0.295	0.38
(46) FUEL-PELLET DIAMETER	(MM)	8.19	8.23	8.25	10.56	15.6	6.6	7.39	14.4
(47) PELLET-CLAD GAP	(MM)	0.082	0.10	0.089	0.08		0.12	0.12	
(48) FUEL ENRICHMENT	(%)	2.1 2.6 3.1	2.91	1.9 2.4 2.9	2.2- 2.7	93.5	10.- 15.	10.- 15.	NAT. U
(50) THERMAL HYDRAULIC DATA									
(51) SYSTEM PRESSURE	(BAR)	155.	155.	155.	72.	50.	14.	86.	89.
(52) COOLCNAT FLOW	(TON/HR)	62000	68000	72000	47000	5000	50000	10000	23900
(53) AVE. LINER POWER DENSITY	(W/CM)	178.	178.	175.	206.	78.7	295.	217.	200.
(54) MAX. LINER POWER DENSITY	(W/CM)	426.	483.	410.	440.	229.	492.	390.	528.
(55) AVERAGE HEAT FLUX	(W/CM**2)	68.5	64.	65.	50.3	20.4	105.	93.	50.
(56) MAXIMUM HEAT FLUX	(W/CM**2)	183.	168.	173.	111.5	58.3	237.	168.	115.
(57) MINIMUM DNBR		1.3	1.4	1.3	1.9	-	-	-*	
(58) INLET TEMPERATURE	(DEG-C)	300.	300.	296.	269.	337.	380.	332.	249.
(59) OUTLET TEMPERATURE	(DEG-C)	332.	333.	328.	286.	755.	552.	642.	293.
(61) MAX. FUEL TEMPERATUE	(DEG-C)	1788.	2021.	1882.	1829.	1410.	2000.	2200.	1500.

(997) NOTES

SB : SQUARE BUNDLES
CN-SB : CANNED SQUARE BUNDLES.
HGP : HEXAGONAL GRAPHITE PRISMS.
HCB : HEXAGONAL CANNED BUNDLES.
PTB : PRESSURE TUBE BUNDLES.
CR : CLAD ROD
GRP-UC : GRAPHITE UC, THO2 ROD.
W.-W. : WIRE-WRAP CLAD ROD.

CANDU-PHW : SEE REMARKS OF FDN-100005.

(999) REFERENCES

?, P.634-635.

<* 100002 *> TYPICAL NUCLEAR POWER REACTOR DATA (2) ** 100002 **

		HCPWR KWU TRIANGLE	PWR 16X16 KWU	PWR 17X17 STD.	ATR EXP.	FBR EXP.
		---(1)-*---(2)-*---(3)-*---(4)-*---(5)-*---(6)-*---(7)-*---(8)-*				
(2) REACTOR TYPE		HCPWR -KWU	PWR -KWU	PWR(N)	ATR	FBR
(4) THERMAL OUTPUT	(MW)	3782	3782	3423	1930	2600
(6) REACTOR SYSTEM PRESS.	(KG/CM2-G)	157	157	157	-	-*
(7) PRIMARY COOLANT FLOW RATE	(T/HR)	59400	67680	60100	-	-*
(8) FULL-POWER-DAYS/CYCLE	(DAYS)	290	300			
(13) CORE EQIVALENT DIAMETER	(M)	3.70	3.643	3.37	6.95	3.3
(14) CORE HEIGHT	(M)	2.33	3.90	3.66	3.7	1.0
(15) AVERAGE POWER DENSITY	(KW/L)	151	93	104.5	13.7	300.
(17) FUEL INVENTORY	(TON-HEAVY METAL)	121.5	103.5	-	-	-*
(18) AVE. SPECIFIC HEAT RATE	(KW/KG-HM)	31.0	36.4	38.	20.	90.
(41) MODERATOR/FUEL VOLUME RATIO		0.53	2.0	2.0	-	0.9
(37) AVE. FUEL ENRICH. OR PU-CONTENT						
(39) EQILIBRIUM CORE	(%)	7.5	3.2	3.2	2.7	15.0
(71) COOLANT TEMPERATURE (DEG-C)						
(72) AT INLET		286	291			
(73) AT OUTLET		326	326			
(90) FUEL ASSEMBLY						
(92) CONFIGURATION		HEX.	16X16	17X17	-	-*
(91) TOTAL NUMBER OF FUEL ASSEMBLY		511 OR 235	193			
(93) CONSISTED OF						
(94) NO. OF FUEL ROD		199 OR 439	236			
(95) NO. OF ABSORBER		12 OR 24	20			
(96) NO. OF STRUCTURE PIN		6	0			
(97) ROD-TO-ROD SPACING		HN	GR	GR	-	HF
(86) FUEL ROD						
(84) FUEL MATERIAL		MOX	UO-2	UO-2	MOX	MOX
(89) CLADDING MATERIAL		SUS	ZRY-4	ZRY-4	ZRY	SUS
(87) CLADDING DIAMETER	(MM)	9.5	10.75	9.5	14.5	7.6
(88) CLADDING THICKNESS	(MM)	0.40	0.72			
(85) ROD-TO-ROD PITCH	(CM)	1.05	1.43	1.26	-	0.91
(31) AVERAGE LHGR	(W/CM)	175	206	180	220	210
		155(2)				
(51) AVERAGE HEAT FLUX	(W/CM**2)	52	61			
(20) CONTROL ELEMENT						
(93) CONSISTED OF		61X7X9 OR 66X3X21	61X20			
(21) MATERIAL		B-4-C	AG-IN-CD			
(25) REACTIVITY WORTH OF BORON						
(26) (PPM/%-DELTA-K/K)		3250	100			
(27) REACTIVITY VARIATION/ CYCLE	(%)	2	10			
(100) CONVERSION RATIO		0.95	0.55	0.57	0.64	1.20*
(65) AVERAGE BURN UP (MWD/MT(H)M)						
(67) EQILIBRIUM CORE		43000 45000(2)	33000	33000	27000	75000
(997) NOTES		* : INCLUDE CONVERSION IN BLANKETS.				
(998) REMARKS		HEX.: HEXAGONAL. GR : GRID HN : HELICAL FIN. HF : HELICAL FERULE.				
(999) REFERENCES		DATA OF COLUMN (1) AND (3): S. MATSUURA, J. AESJ, 26(6) (1984). (P.470) DATA OF COLUMN (4)-(6): HC-1-5. (P.3)				

<* 100003 *> DATA OF PWR AND HCPWR (APWR) ** 100003 **

		(1)	(2)	(3)	(4)
			HCPWR		
		REFERENCE PWR	HOMOGENEOUS APWR	HETEROGENEOUS APWR SEED/BLANKET	
(10)	THERMOHYDRAULIC DATA				
(11)	CORE THERMAL OUTPUT (MW(T))	3765.	3730.	3705.	
(12)	PLANT NET ELECTRICAL POWER(MW(E))	1300.	1285.	1275.	
(13)	NET				
(14)	PRIMARY CIRCUIT WATER (MW(E))	21.0	23.0	23.6	
(34)	PRIMARY CIRCUIT				
(35)	TOTAL MASS FLOW (KG/S)	18800.	18190.	17410.	
(15)	WATER TEMPERATURE (DEG-C)				
(16)	AT CORE INLET	291.1	290.3	289.6	
(17)	AT CORE OUTLET	326.2	326.2	326.2	
(18)	WATER PRESS. AT CORE OUTLET (BAR)	158.3	158.3	158.3	
(19)	SECONDARY CIRCUIT				
(20)	SATURATED VAPOR PRESSURE (BAR)	64.5	63.9	63.5	
(21)	AVE. NOMINAL ROD LHGR (W/CM)	208.	180.	195.	/ 159.
(22)	AVE. VOLUMETRIC POWER DENS.(W/CC)	94.6*A	145.*A	245.*B/	124.*B
(23)	HOT CHANNEL FACTOR				
(24)	POWER, F-Q	2.1	2.1	2.1	
(25)	WATER ENTHALPY RISE, F-DELTA H	1.6	1.6	1.6	
(26)	MAX. PLANT OVERLOAD FACTOR,F-OP	1.12	1.12	1.12	
(27)	DNBR, RATIO BETWEEN CHF AND MAX.				
(28)	HOT CHANNEL HEAT FLUX.				
(29)	FOR F-OP=1.12	1.77*C	1.31*D	1.46/	1.47*D
(30)	AVE. WATER VELOCITY IN CORE (M/S)	4.47	5.89	6.46/	6.69
(31)	CORE PRESSURE DROP (BAR)	1.25	2.28	3.22	
(32)	TOTAL PRESS. DROP IN				
(33)	WATER PRIMARY CIRCUIT (BAR)	6.54	7.11	7.64	
(40)	GEOMETRICAL DATA				
(41)	EQUIVALENT CORE DIAMETER (M)	3.605	3.86	3.85	
(42)	ACTIVE CORE HEIGHT (M)	3.90	2.206	2.183	
(43)	NUMBER OF FUEL ELEMENT IN CORE	193.	301.	151.	/348.
(45)	DISTANCE BETWEEN THE FLATS OF				
(46)	FUEL ELEMENT (MM)	229.6*F	211.8	164.	
(47)	NUMBER OF CONTROL ROD GUIDE TUBES				
(48)	PER FUEL ELEMENT	20.	12.	12.	/ 0.
(49)	NUMBER OF STRUCTURE RODS				
(50)	PER FUEL ELEMENT	20.	6.	0.	/ 0.
(51)	NUMBER OF FUEL RODS				
(52)	PER FUEL ELEMENT	236.	313.	259.	/169.
(53)	TOTAL NUMBER OF FUEL RODS	45550	94210	97920	
(54)	CLADDING MATERIAL	ZRY-4	SS	SS	
(55)	?		1.4981	1.4981	
(56)	FUEL ROD OUTER DIAMETER (MM)	10.75	9.5	7.4	/ 11.09
(57)	CLADDING THICKNESS (MM)	0.725	0.4	0.37	/ 0.44
(58)	FUEL ROD PITCH (MM)	14.3 *G	11.4	9.59	/ 12.16
(59)	P/D RATIO	1.33*G	1.20	1.30	/ 1.10
(60)	SPACER TYPE	GRID	SPIRAL RIB	GRID	/SPIRAL / RIB
(61)	AXIAL DISTANCE OF SPACER GRID OR				
(62)	AXIAL PITCH OF SPIRAL RIBS (MM)	535.	190.	150.	/243.
(63)	WATER-TO-FUEL VOLUME RATIO -*E	1.67	0.701	1.05	/ 0.372
(64)	WATER-TO-FUEL ROD VOLUME RATIO-*E	1.25	0.588	0.850/	0.326
(70)	NUETRON PHYSICS DATA				
(71)	PLUTONIUM VECTOR (W/O)				
(101)	239-PU	---	57.8,	57.8,	
(102)	240-PU	-	26.6,	26.6,	
(103)	241-PU	-	9.5,	9.5,	
(104)	242-PU	-	6.1,	6.1,	
(73)	URANIUM VECTOR (W/O)				
(201)	235-U	3.2	0.2,	0.2,	
(202)	238-U	96.8	99.8	99.8	
(75)	NUMBER OF RADIAL REGIONS WITH				
(76)	DIFFERENT FUEL COMPOSITION	---	3	3	/ 3
(77)	FISSILE IN EACH RADIAL REGION (%)				
(78)	REGION 1	1.9	6.80	13.8	/ 4.2
(79)	REGION 2	2.5	7.15	14.4	/ 4.4
(80)	REGION 3	3.2	8.25	16.2	/ 5.0
(81)	AVERAGE FISSILE IN THE CORE (%)	2.49	7.40	14.8	/ 4.5
(82)	FISSILE INVENTORY (TON-HM)**				
(83)	(239-PU, 240-PU, 241-PU, 235-PU)	2.57	8.02	8.41	
(84)	TOTAL FUEL INVENTORY (TON-HM)**	103.5	111.	121.	

(85)	CONVERSION RATIO	0.55	0.90*H	0.96*H
(86)	DELTA-K/FPD	-3.E+4?	-1.28E-4	
				-0.95E-4
(87)	NUMBER OF FUEL ELEMENT CYCLES	3	3	3 / 6
(88)	FUEL CYCLE DURATION BY			
(89)	FIRST CORE (FPD)	360.	300.	320.
(90)	AVERAGE DISCHARGE BURNUP (MWD/T	33000.	31000.	41000.
		-35000.		
(91)	AXIAL POWER FACTOR	1.3	1.48	1.54
		TO 1.2		
(92)	RADIAL POWER FACTOR	1.5	1.20	1.20
		TO 1.3		
(93)	DOPPLER COEFFICIENT (BOC, 900K)	-2.1E-5	-3.0E-5	-3.0E-5
(95)	TOTAL VOID REACTIVITY COEFFICIENT			
(96)	AT BOC	---	-1.05E-2	
				-1.34E-2
(97)	WATER DENSITY REACTIVITY			
(98)	COEFFICIENT DELTA-K/DELTA-ROU			
(99)	AT NOMINAL OPERATING CONDITION,			
(100)	EOC (CC/GR)	10E-2	7E-2	3E-2

(997) NOTES

*A : VALUE REFERRED TO TOTAL CORE VOLUME.
*B : VALUE REFERRED TO FUEL ROD UNIT CELL.
*C : CRITICAL HEAT FLUX CALCULATED WITH REF. (47).
*D : CRITICAL HEAT FLUX CALCULATED WITH REF. (27).
*E : REFERRED TO FUEL ROD UNIT CELL.
*F : SQUARE CROSS SECTION.
*G : SQUARE ARRAY.
*H : AT THE END OF THE FIRST FUEL ELEMENT CYCLE (EOC).
** : TONS OF HEAVY METAL.

(998) REMARKS

EOC : END OF CYCLE.
BOC : BEGINNING OF CYCLE.
FPD : FULL POWER DAYS.
HM : HEAVY METAL.

(999) REFERENCES

C. H. M. BROEDERS, M. D. DONNE
NUCL. TECH. 71(OCT. 1985), PP.82-95.

(47) R.W. BOWRING, WSC-2, A SUBCHANNEL DRYOUT CORRELATION FOR WATER-COOLD CLUSTERS OVER THE PRESSURE RANGE 3.4-1.9 MPA, AEEW-R983, UNITED KINGDOM ATOMIC ENERGY AUTHORITY (1979).
(27) M. DALLE DINNE, W. HAME, CRITICAL HEAT FLUX CORRELATION FOR TRIANGULAR ARRAY ROD BUNDLES WITH TIGHT LATTICES, INCLUDING THE SPIRAL SPACER EFFECT, NUCL. TECHNOL. 71, 111 (1985).

<* 100004 *> MAIN CORE CHARACTERISTICS - AVERAGE POWER DENSITY - ** 100004 **

		---(1)-*-	(2)-*-	(3)-*-	(4)-*-	(5)-*-	(6)-*-	(7)-*-	(8)-*
(11)	REACTOR TYPE	GCR	AGR, LWGR	HWR	LWR-BWR	LWR-PWR			
(12)	AVERAGE POWER DENSITY (KW/L)	0.5-2.	1.5-5.	5.-12.	30.-50.	70.-100.			

(998) REMARKS

GCR : GAS COOLED REACTOR, NATURAL U-GRAPHITE.
AGR : ADVANCED GAS COOLED REACTOR, ENRICHED U-GRAPHITE.
HWR : HEAVY WATER REACTOR.

(999) REFERENCES

S.HIRAYAMA, J. AESJ., 21(4),P.318, (1979).

<* 100005 *> SPECIFICATION OF CANDU STANDARD DESIGN ** 100005 **

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                                        ---(1)-*---(2)-*---(3)-*---(4)-*---(5)-*---(6)-*---(7)-*---(8)-*
( 10) PLANT THERMAL OUTPUT,     (MW(T)) 2180.
( 11) PLANT ELECTRIC OUTPUT,    (MW(E))
( 12)   GROSS                            685
( 13)   NET                              638
( 14) THERMAL EFFICIENCY,          (%)
( 12)   GROSS                             31.4
( 13)   NET                               29.3
                                        ----------------------------------------------------------------*
( 20) REACTOR
( 21)   TYPE                            HORIZONTAL PRESSURE TUBE TYPE.
( 22)   MODERATOR                       HEAVY WATER
( 23)   COOLANT                         PRESSURIZED HEAVY WATER
( 24)   FUEL                            NATURAL URANIUM
( 25)   CALANDORIA TANK SIZE,
( 26)     DIAMETER,                (M)    7.60
( 32)     LENGTH,                  (M)    5.94
( 27)   EFFECTIVE CORE SIZE,
( 26)     DIAMETER,                (M)    6.29
( 32)     LENGTH,                  (M)    5.94
( 30)   PRESSURE TUBE
( 31)     MATERIAL                       ZR-2.5%NB
( 32)     LENGTH,                  (M)    6.3
( 33)     INNER DIAMETER,          (CM)   10.3
( 34)     THICKNESS,               (MM)    4.19
( 35)   CALANDORIA
( 31)     MATERIAL                       ZRY-2
( 32)     LENGTH,                  (M)    5.99
( 33)     INNER DIAMETER,          (CM)   12.9
( 34)     THICKNESS,               (MM)    1.4
                                        -------*--------------------------------------------------------*
( 40) FUEL
( 41)   NO. OF FUEL CHANNEL              380.
( 42)   WEIGHT OF LOADING FUEL, (T-UO2)   95.
( 43)   NO. OF FUEL ASSEMBLY            4560
( 44)   LENGTH OF FUEL ASSEMBLY,   (CM)   49.5
( 45)   NO. OF ROD PER ASSEMBLY           37
( 46)   FUEL ROD OUTER DIA.,       (MM)   13.1
( 47)   CLADDING
( 31)     MATERIAL                       ZRY-4
( 34)     THICKNESS,               (MM)    0.4
( 48)   FUEL PELLET
( 49)     DIAMETER,                (MM)   12.2
( 50)     DENSITY,              (GR/CC)   10.6
( 51)   AVERAGE BURNUP,          (MWD/T) 7500.
( 52)   MAXIMUM LHGR,             (KW/M)   54.1
( 53)   MAX. FUEL TEMPERATURE,  (DEG-C) 1900.
( 54)   MAX. CLADDING TEMP.,    (DEG-C)  326.
( 55)   MAX. CHANNEL OUTPUT,        (MW)    6.5
( 56)   SPECIFIC POWER,      (W/GR-UO2)   25.4
( 57)   MAX. CLADDING SURFACE HEAT
( 58)        FLUX,           (W/CM**2)  128.85
                                        ----------------------------------------------------------------
( 60) PRIMARY COOLANT SYSTEM
( 61)   PRESSURE,          (KG/CM**2-A)
( 62)     CORE INLET                     112.7
( 63)     CORE OUTLET                    105.0
( 64)   TEMPERATURE,            (DEG-C)
( 62)     CORE INLET                     267.
( 63)     CORE OUTLET                    312.
( 65)   FLOW RATE,               (KG/S) 7600.
( 66)   INVENTORY                 (TON)  199.1
( 67)   EXIST STEAM QUALITY,        (%)    3.0
( 68)   NO. OF PRIMARY PUMP              4
( 69)   STEAM GENERATOR
( 70)     NUMBER                         4
( 71)     TUBE MATERIAL                INCOLOY-800
                                        ----------------------------------------------------------------
( 80) SECONDARY COOLANT SYSTEM
( 81)   STEAM PRESSURE,    (KG/CM**2-A)
( 82)     AT S.G OUTLET                  47.9
( 83)   STEAM TEMPERATURE,     (DEG-C)
( 82)     AT S.G OUTLET                  260.
( 84)   STEAM FLOW RATE,         (KG/S) 1033.
                                        ----------------------------------------------------------------*
( 90) MODERATOR SYSTEM
( 91)   MAXIMUM TEMPERATURE,   (DEG-C)   71.
( 92)   INVENTORY,               (TON)  263.3
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(100)	REACTOR CONTAINER		
(101)	TYPE		PRE-STRESSED CONCREATE
(102)	INNER DIAMETER,	(M)	41.4
(103)	WALL THICKNESS,	(M)	1.066
(104)	HEIGHT,	(M)	51.2
(105)	DESIGN PRESSURE,	(KG/CM**2-A)	2.26
(998)	REMARKS		CANDU : CAN(ADA) D(EUTERIUM) AND U(RANIUM). CANDU-PHW : CANDU PRESSURIZED HEAVY WATER. CANDU-OCR : CANDU ORGANIC COOLED REACTOR. ZEEP : ZERO ENERGY EXPERIMENTAL PILE, CRITICAL ON SEP. 1945. AECL : ATOMIC ENERGY OF CANADA LTD.
(999)	REFERENCES		MASUHIKO OTSUKA, SHIGEO MITA, 'CANDU SYSTEM'(IN JAP.)', J.AESJ., 23(6) (1981), PP.399-407. (P.404).

<* 110001 *> GENERAL DESCRIPTION OF REACTOR CHARACTERISTICS (1) ** 110001 **

---(1)-*---(2)-*---(3)-*---(4)-*---(5)-*---(6)-*---(7)-*---(8)-*

(1) PLANT NAME		JPDR	JPDR-II	TSURUGA	FUKU-SHIMA 1ST.-1	SHIMANE -1	MILSTONE POINT	BROWNS FERRY-1	MIHAMA-1	
(3) OWNER		JAERI	JAERI	JAPCO	TEPCO	CHUGOKU -EPCO			KANSAI -EPCO	
(2) REACTOR TYPE		BWR	BWR	BWR/2	BWR/3	BWR/3	BWR	BWR/4	PWR(4)	
******** GENERAL **********										
(4) THERMAL OUTPUT	(MW)	45	90	1064	1380	1380	1727	3293	1031	
(5) GROSS ELECTRIC OUTPUT	(MW)	12.5	12.5	357	461	461.6	650	1098	340	
(6) REACTOR SYSTEM PRESS.	(KG/CM2-G)	61.5	61.5	70.3	70.7	70.7	70.3	70.3	157.	
(7) PRIMARY COOLANT FLOW RATE	(T/HR)	1860	3260	17700	21800	22400	31300	45200	23500	
******** CORE CHARACTERISTIC PARAMETERS **********										
(13) CORE EQIVALENT DIAMETER	(M)	1.27	1.27	3.018	3.439	3.44	4.498	4.752	2.47	
(14) CORE HEIGHT	(M)	1.47	1.47	3.658	3.658	3.66	3.658	3.658	3.048	
(15) AVERAGE POWER DENSITY	(KW/L)	22.5	46.5	40.6	40.6	40.6	35.03	50.8	71	
(18) AVE. SPECIFIC HEAT RATE	(KW/KG-UO2)	9.3	18.8	15.5	15.5	17.5	13.3	22.0	25.8	
(53) MAX. HEAT FLUX	(KCAL/HR-M**2)									
(54) AT RATED POWER		823000		1053000	1085000	1056000	905000	1153600		
(55) AT 112 % POWER									1416000	
(56) AT 125 % POWER			1349000							
(51) AVERAGE HEAT FLUX	(KCAL/HR-M**2)	226100	381000	351000	352000	352000	302000	442447	388000	
(57) MINIMUM CHFR (OR DNBR)										
(54) AT RATED POWER				>1.90	>1.90	>1.90		>1.90	>1.83	
(55) AT 112 % POWER									>1.30	
(56) AT 125 % POWER			>1.50				>1.50 ?			
(33) HOT CHANNEL (OR PEAKING) FACTOR		4.55	3.54	3.00	3.00	2.04 AT 100%	3.60	2.60	3.25	
(21) THERMAL N. FLUX (AVE)	(N/CM**2-S)	1.42E13	3.8 E13	3.57E13	3.5 E13	3.5 E13				
(65) AVERAGE BURN UP	(MWD/MT(H)M)									
(66) INITIAL CORE		8000	-	16500	16500	16500	16500	22000	21800	
(67) EQILIBRIUM CORE		-	-	25000	22000	22000	22000	27500	27000	
(41) MODERATOR/FUEL VOLUME RATIO		2.7	2.68	2.38	2.38	2.38	2.38	2.41	3.32 ?	
(37) AVERAGE FUEL ENRICHMENT										
(38) INITIAL CORE	(%)	2.6	2.6	2.04	2.09	2.09	2.07	1.18	2.36	C
								1.64	2.51	M
								2.56	2.81	O
(39) EQILIBRIUM CORE	(%)			2.50	2.31	2.31				
(45) CONTROL ROD (CLUSTER) PITCH	(MM)	273.2	273.2	305	304.8	304.8	304.8			
(35) REACTIVITY WORTH TO BE CONTROLED										
(36) COLD CLEAN, % DELTA-K/K		13.0	29.2	24	24	25	26			
(71) CORE INLET SUBCOOLING										
(72) KCAL/KG		3.06	7.3	11.7	12.9	13.1	11.7	14.2		
(76) CORE EXIT STEAM QUALITY	(%)	4.7	4.4	11.0	11.6	11.5	9.97	-	-*	
******** FUEL PARAMETERS **********										
(81) PELLET										
(82) DIAMETER	(MM)	12.5	10.71	12.4	12.4	12.4	12.4	12.4	10.7	
(83) HEIGHT	(MM)	25.4	15.	18.6 TO 24.8	18.6 TO 24.8	22.23 +-1.275		17.8		
(91) TOTAL NUMBER OF FUEL ASSEMBLY										
(92) CONFIGURATION		6X6	7X7	7X7	7X7	7X7	7X7	7X7	14X14	
(93) NO. OF FUEL ROD PER ASSEMBLY		36	49	49	49	49	49	49	179	
(96) PELLET MAX. TEMP.	(DEG-C)									
(97) AT RATED POWER		1610		2350	2390	2347	1930	2420		
(98) AT 112 % POWER									2230	
(99) AT 125 % POWER			2250							
(101) CLADDING SURFACE MAX. TEMP.	(DEG-C									
(102) AT RATED POWER				295	295	295	292			
(103) AT 112 % POWER									348	
(104) AT 125 % POWER			310							
******** REACTIVITY CONTROL **********										

(106) CONTROL ROD WORTH (% DELTA-K/K)	20	21.9	18	18	18	18	17	4.5
(107) POISSON CURTAIN (% DELTA-K/K)	11	7.3	10	11	11	12	12	
(108) WORTH OF CHEMICAL-SHIM (% DK/K)								24.5
******** REACTOR VESSEL **********								
(110) REACTOR PRESSURE VESSEL								
(111) INNER DIAMETER (M)	2.083	2.083	4.34	4.78	4.78	5.68	-	3.33
(112) TOTAL INNER HEIGHT (M)	8.179	8.179	10.86	18.85	18.848	19.71	-	10.95
******** PRIMARY COOLANT SYSTEM **********								
(121) NUMBER OF LOOP	- NAT. CIRCL.	2	3	2	2	2	?	2
(122) RECIRCULATION PUMP								
(123) FLOW RATE (M**3/HR)			7750.	7250.	7430.	10200.		15900.
(131) (TON/HR)		163.						
(124) BRAKE HOURSE POWER (BHP)			841.	2500.	3000.	4000.		
(125) (KW)		250.						
(126) PIPING OF LOOPS								
(127) MATERIAL		SS	SS	SS304/ SS316	SS	SS		SS
(128) DIAMETER (CM)								
(129) SUCTION SIDE		40.64	66.	61.0	61.0	71.1		70.
(130) DELIVERY SIDE		31.85	66.	61.0	61.0	71.1		70.
(999) REFERENCES	KAZUO KISHIMOTO (CHUGOKU DENRYOKU), PRIVATE COMMUNICATIN, (1972).							

<* 110002 *> GENERAL DESCRIPTION OF REACTOR CHARACTERISTICS (2) ** 110002 **

		BWR 6X6 JPDR	BWR 7X7 JPDR-II	BWR 7X7 INITIAL	BWR 8X8 WR(1)	PWR 11X11 MUTSU	PWR 14X14 STD.	PWR 17X17 STD.
		---(1)-*---(2)-*---(3)-*---(4)-*---(5)-*---(6)-*---(7)-*---(8)-*						
(1) PLANT NAME		JPDR	JPDR-II	TSURUGA	FUKU-SHIMA 1ST.-1	TOKAI-2	MUTSU	MIHAMA -1	OHI-1
(3) OWNER		JAERI	JAERI	JAPCO	TEPCO	JAPCO	JAERI	KANSAI -EPCO	KANSAI -EPCO
		******** GENERAL **********							
(2) REACTOR TYPE		BWR	BWR	BWR/2	BWR/3	BWR/5	PWR(2)	PWR(4)	PWR(NEW)
(4) THERMAL OUTPUT	(MW)	45	90	1064	1380	3293	36	1031	3423
(5) GROSS ELECTRIC OUTPUT	(MW)	12.5	12.5	357	461	1100	-	340	1175
(6) REACTOR SYSTEM PRESS.	(KG/CM2-G)	61.5	61.5	70.3	70.7	70.7	110	157	157
(7) PRIMARY COOLANT FLOW RATE	(T/HR)	1860	3260	17700	21800	48300	1800	23500	60100
		******** MAIN CORE PARAMETERS **********							
		-------- CORE SIZE, AVERAGE POWER DENSITY ----------*							
(13) CORE EQIVALENT DIAMETER	(M)	1.27	1.27	3.018	3.439	4.75	1.146	2.47	3.37
(14) CORE HEIGHT	(M)	1.467	1.467	3.658	3.658	3.66	1.040	3.048	3.66
(15) AVERAGE POWER DENSITY	(KW/L)	22.5	46.5	40.6	40.6	51.2	33.5	71	104.5
(18) AVE. SPECIFIC HEAT RATE	(KW/KG-UO2)	9.3	18.8	15.5	15.5			25.8	39.3
		-------- EXCESS REACTIVITY, CCR OR RCC PITCH ----------							
(45) CONTROL ROD (CLUSTER) PITCH	(MM)	273.2	273.2	305	304.8	304.8	(252)		
(35) REACTIVITY WORTH TO BE CONTROLED									
(36) COLD CLEAN, % DELTA-K/K		13.0	29.2	24	24	25			19.9
		-------- ENRICHMENT, VOLUME RATIO ----------							
(41) MODERATOR/FUEL VOLUME RATIO		2.7	2.68	2.38	2.38		2.3	3.32 ?	3.59 ?
(37) AVERAGE FUEL ENRICHMENT	(%)								
(38) INITIAL CORE		2.6	2.6	2.04	2.09	2.2	3.24 C 4.44 O	2.3 C 3.0 M 3.4 O	2.1 C 2.6 M 3.1 O
(39) EQILIBRIUM CORE				2.54	2.31	2.7			
(40) AVERAGE BURNUP	(MWD/MTM)								
(38) INITIAL CORE		8800.	12000.	16500.	16500.	21000.	5500.	21800.	24100.
(39) EQILIBRIUM CORE				25000.	22000.	27500.		27000.	33000.
(20) THERMAL N. FLUX (AVE)	(N/CM**2-S)	1.42E13	3.8 E13	3.57E13	3.5 E13	4.3 E13			
		******** REACTIVITY CONTROL **********							
(21) CONTROL ROD									
(22) TYPE		CCR	CCR	CCR	CCR	CCR	CCR	RCC	RCC
(25) LATTICE		D	D	D	D	D	K		
(23) WORTH	(DELTA-K/K)	20.	21.9	18.	18.	18.	22.9	4.5	6.
(24) POISSON AND CHEMICAL SHIM	(DT-K/K)	11.	7.3	10.	10.	12.	4.7	24.5	15.
		******** FUEL ASSEMBLY AND ROD **********							
(50) FUEL ASSEMBLY DATA									
(51) TYPE		SB-CN	SB-CN	SB-CN	SB-CN	SB-CN	SB-CN	CL-SB	CL-SB
(53) FUEL ROD ARRAY		6X6	7X7	7X7	7X7	8X8	11X11	14X14	17X17
(52) NUMBER OF ASSEMBLY		72	72	308	400	764	32	121	193
(54) NO. OF FUEL ROD PER ASSEMBLY		36	49	49	49	63	112	179	264
(55) FUEL ROD DATA									
(56) TYPE		UN-P	UN-P	UN-P	UN-P	UN-P	UN-P	UN-P	PRE-P
(64) CLADDING									
(65) MATERIAL		ZRY-2	ZRY-2	ZRY-2	ZRY-2	ZRY-2	SS	ZRY-4	ZRY-4
(57) OUTER DIAMETER	(MM)	14.14	12.23	14.49	14.49	12.5	10.53	10.72	10.72
(58) LENGTH	(MM)								
(60) TOTAL ASSEMBLY LENGTH		1954	1954		4350	4466			
(59) FUEL ROD							1123	3214	3852
(61) FUEL PELLET									
(62) OUTER DIAMETER	(MM)	12.5	10.66	12.4	12.4	10.6	9.6	9.3	8.2
(63) HEIGHT	(MM)	25.4	<15.	18.8 TO 24.8	18.6 TO 24.8	11.	16.	15.24	13.5
		******** THERMAL HYDRAULICS **********							

*** FUEL PERFORMANCE DATA *** DATE = 86-05 **PAGE** (D- 11)

(70)	THERMAL HYDRAULIC DATA								
(71)	LHGR (W/CM)								
(72)	AVERAGE	120.	170.				96.58	154.	178.
(73)	MAXIMUM								
(75)	AT RATED POWER			570.	574.	440.	361.	499.	414.
(74)	HEAT FLUX (KCAL/HR-M**2)								
(72)	AVERAGE	226100	381000	351000	352000	387000	250000	388000	589000
(73)	MAXIMUM								
(75)	AT RATED POWER	823000		1053000	1085000	960000	930000	1416000	
(76)	AT 112 % POWER								1762000
(77)	AT 125 % POWER		1349000						
(81)	MINIMUM CHFR OR DNBR								
(75)	AT RATED POWER			>1.9	>1.9	>1.9		1.83	
(77)	AT 125 % POWER		1.50						
(78)	AT 130 % POWER						>1.3		
(79)	UNDER ABNORMAL TRANSIENT							1.30	1.3
(82)	HOT CHANNEL (OR PEAKING) FACTOR	4.55	3.54	3.00	3.00	2.61	3.72	3.25	
(85)	MAXIMUM FUEL PELLET TEMP. (DEG-C)								
(75)	AT RATED POWER	1610.	1970.	2350.	2390.	2200.	1800.	2185.	2350.
(76)	AT 112 % POWER							2390.	2480.
(77)	AT 125 % POWER	1899.							
(78)	AT 130 % POWER						2100.		
(86)	MAXIMUM CLAD.SURFACE TEMP (DEG-C)								
(75)	AT RATED POWER	298.		295.	295.		321.8	344.	
(76)	AT 112 % POWER							348.	347.
(77)	AT 125 % POWER		310.						
(90)	CORE INLET SUBCOOLING								
(91)	ENTHALPY (KCAL/KG)	3.06		11.7	12.9				
(95)	CORE EXIT STEAM QUALITY (W/O)	4.7	4.4	11.0	11.6	13.	-	-	-*
(96)	COOLANT TEMPERATURE (DEG-C)								
(97)	AT CORE INLET	272.	271.		277.		271. TO 296.4	294.2	289.
(98)	AT CORE OUTLET	277.	277.	285.4	285.4	286.	280.5 TO 344.8	322.	325.
(110)	REACTOR PRESSURE VESSEL								
(111)	INNER DIAMETER (CM)	208.3	208.3	434.	478.	637.5	180.	333.9	440.
(112)	TOTAL INNER HEIGHT (CM)	818.	818.				560.		
(113)	TOTAL OUTER HEIGHT (CM)			1806.	1885.	2300.		1092.	1300.
(115)	NUMBER OF LOOP	NAT. CIRCL.	2	3	2	2	2	2	4

(997) NOTES

CCR : CRUCIFORM CONTROL ROD.
RCC : ROD CLUSTER CONTROL.
D : SQUARE ARRAY.
K : TRIANGLE ARRAY.
SB-CN : SQUARE BOUNDLE CANNED WITH FLOW CHANNEL (CHANNEL BOX).
CL-SB : CANLESS SQUARE BOUNDLE.
UN-P : UNPRESSURIZED FUEL ROD.
PRE-P : PREPRESSURIZED FUEL ROD.
LHGR : LINER HEAT-GENERATEN RATE.

(998) REMARKS

ON THE NEW (IN 1966) BASIS FOR CORE SIZING, THE ALLOWABLE HEAT FLUX VALUE-FOR A GIVEN QUALITY AND MASS FLOW RATE-IS AT LEAST 1.9 TIMES GREATER THAN THE ACTUAL HEAT FLUX AT RATED POWER, UNDER THE STIPULATED CONDITIONS. THE MINIMUM CRITICAL-HEAT-FLUX RATIO (AS THIS VALUE IS CALLED) IS ALSO CALCULATED FOR OFF-STANDARD CONDITIONS OF TRANSIENT AND ABNORMAL OPERATION TO DEMONSTRATE THE ADEQUACY OF THE STEADY-STATE MARGIN (1.9) FOR TRANSIENT CONDITIONS.

THE PREVIOUS BASIS FOR CORE SIZING, IT SHOULD BE NOTED, WAS MCHFR=1.5 AT 120% OF POWER.

- G.M. ROY, SEE FDN-110201. -

<* 110003 *> GENERAL DESCRIPTION OF REACTOR CHARACTERISTICS (3) ** 110003 **

		PWR 15X15 STD.	PWR 17X17 STD.	BWR 7X7 INITIAL	BWR 7X7 REV.	BWR 8X8 WR(1)	BWR 8X8 WR(2)	BWR 9X9 CONCEPT
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
(1) PLANT NAME		*-- OHI-1, 2 --*	*ASEATOM* *BWR-75 *--	FUKUSHIMA-1ST.-1 --*				*CURRENT*	*CONCEPT*
(2) REACTOR TYPE		PWR(*)	PWR(*)	*---------- BWR ----------					
(4) THERMAL OUTPUT	(MW)	3423	3423	3000.	1380			3293	3293
(5) GROSS ELECTRIC OUTPUT	(MW)	1175	1175	1060.	461	461	461	1100	1100
(6) REACTOR SYSTEM PRESS.	(KG/CM2-G)	157	157	70.4	70.7	70.7	70.7	70.7	70.7
(7) PRIMARY COOLANT FLOW RATE	(T/HR)	60100	60100	41000	21800	21800	21800	48300	48300
(8) FULL POWER MONTH	(MONTH)							42	56
(14) CORE HEIGHT	(M)	*	*	3.68	***	***	***	3.71	3.81
(15) AVERAGE POWER DENSITY	(KW/L)	*	*	46.3	***	***	***	50.2	48.7
(16) FUEL INVENTORY	(TON-FUEL)	*		143.3	***	***	***	133	109
(19) HEAT GENERATION IN FUEL ROD	(%)	97.4	97.4						
(20) COOLANT TEMPERATURE	(DEG-C)								
(21) AT INLET OF P. VESSEL		289	289						
(22) AT OUTLET OF P. VESSEL		325	325						
(50) EFFECTIVE HEAT TRANSFER AREA	(M**2)	4850	5550	**	-	-	-	-	-
(51) AVERAGE HEAT FLUX	(KCAL/HR-M**2)	589000	514900	**	352000	-	-	387000	-
(57) MINIMUM CHFR (OR DNBR)									
(55) AT 112 % POWER			>1.30						
(58) UNDER ABNORMAL TRANSIENT		>1.30							
(59) PELLET MAX. TEMP.	(DEG-C)								
(54) AT RATED POWER					2390			2200	
(55) AT 112 % POWER		2360							
(58) UNDER ABNORMAL TRANSIENT			2400						
(32) MAX. LHGR	(KW/M)								
(55) AT 112 % POWER		52.1							
(58) UNDER ABNORMAL TRANSIENT			59.1						
(60) CLADDING SURFACE MAX. TEMP.	(DEG-C)								
(55) AT 112 % POWER		347							
(58) UNDER ABNORMAL TRANSIENT			350						
(70) FUEL ASSEMBLY									
(71) TYPE		CL	CL		FC	FC	FC	FC	FC
(72) CONFIGURATION		15X15	17X17	8X8	7X7	7X7	8X8	8X8	9X9
(73) TOTAL NUMBER OF FUEL ASSEMBLY								764	764
(74) FUEL BUNDLE PITCH	(CM)							15.2	15.2
(80) FUEL ROD									
(82) NO. OF FUEL RODS PER ASSEMBLY								62	77
(87) NO. OF WATER RODS							1	2	4
(83) CLADDING MATERIAL		ZRY-4	ZRY-4	*	ZRY-2, SX	ZRY-2, RX	ZRY-2	ZRY-2	ZRY-2
(84) CLADDING OUTER DIAMETER	(MM)			12.25 11.75				12.3	10.6
(85) CLADDING THICKNESS	(MM)							0.86	0.77
(86) ROD-TO-ROD PITCH	(MM)							16.2	14.3
(90) FUEL PELLET									
(91) PELLET OUTER DIAMETER	(MM)			10.46 9.96				10.3	8.8
(92) PELLET CENTER HOLE DIA.	(MM)							0.	3.0

(999) REFERENCES

DATA OF COLUMN (1) AND (2): - SS59 -
'GENSHIRYOKU ANZENIINKAI ANZEN-SHINSA SHISHIN-SYU', (S.59) (P.564).
DATA OF COLUMN (3): P.3-11, 4-16, 4-23.
DATA OF COLUMN (8):
M.AOYAMA ET AL, NUCL. TECH. 64(1) PP.19-25 (JAN. 1984).

<* 110004 *> MAIN CORE PARAMETERS - MODERATOR/FUEL VOLUME RATIO - ** 110004 **

---(1)-*---(2)-*---(3)-*---(4)-*---(5)-*---(6)-*---(7)-*---(8)-*

(11)	REACTOR TYPE	BWR/2	PWR(4)
(12)	FUEL ASSEMBLY		
(13)	TYPE	7X7	14X14
(14)	NO. OF FUEL RODS PER ASSEMBLY	49	176
(15)	AVE. BURNUP (MWD/MTM)		
(16)	EQUILIBRIUM CORE	22000	27000
(17)	AVE. FUEL ENRICHMENT (W/O)	2.49	3.02
(18)	MODERATOR/FUEL VOLUME RATIO	2.4	1.7
(19)	REACTOR SYSTEM PRESS. (KG/CM2-G)	70.3	157.

(999) REFERENCES S. SUGURI EDS, GENSHIRYOKU HATSUDEN NYUMON. (P.71)

<* 110005 *> NUCLEAR DESIGN PARAMETERS - PWR - ** 110005 **

		PWR 15X15 STD.	PWR 17X17 STD.

---(1)-*---(2)-*---(3)-*---(4)-*---(5)-*---(6)-*---(7)-*---(8)-*

		-- CONDITION -- CHEMICAL* SHIM (K-EFF)	RCC * (PPM)	*-- CONDITION --* CHEMIACL* SHIM (K-EFF)	RCC * (PPM)	
(101)	K-EFF. (INITIAL CORE, AT BOL)					
(102)	COLD	1.199	0. ALL-OUT	0.95	1300.	ALL-IN
(103)	HOT, 0-POWER	1.158	0. ALL-OUT	0.99	1400.	ALL-OUT
(104)	HOT, FULL-POWER					
(105)	NO XE, SM	1.132	0. ALL-OUT	1.00	1200.	ALL-OUT
(106)	XE, SM EQUILIBRIUM	1.091	0. ALL-OUT	1.00	900.	ALL-OUT
(111)	AVERAGE BURN UP (MWD/MTM)					
(122)	INITIAL CORE	24000		24000		
(123)	EQUILIBRIUM CORE	33000		33000		
(131)	POWER CONTROLLING	RCC		RCC		
(132)	NUMBER	53		53		
(143)	ROD NUMBER PER CLUSTER	20		24		
(133)	ONE STUCK ROD MARGIN (DELTA-K/K)	0.06		0.05-.06		
(141)	POWER DISTRIBUTION ADJUSTING CLUST					
(142)	NUMBER	8		8		
(143)	ROD NUMBER PER CLUSTER	20		24		
(151)	BURNABLE POISSON					
(152)	MATERIAL	BOROSILICATE-GLASS CONTAINED IN STAINLESS-STEEL CLAD.		BOROSILICATE-GLASS CONTAINED IN STAINLESS-STEEL CLAD.		
(153)	TOTAL NUMBER	1500				
(154)	INITIAL CORE			1520		
(155)	EQUILIBRIUM CORE			<1520		
(156)	REACTIVITY (DELTA-K/K)	0.09 DELTA-K				
(157)	INITIAL CORE AT BOL			0.550 (COLD) 0.076 (HOT)		
(158)	EQUILIBRIUM CORE AT BOL			<0.055 (COLD) <0.076 (HOT)		
(161)	REACTIVITY COEFF. (DELTA-K/K/C)					
(162)	MODERATOR TEMP. COEFF.	0 TO -5.4E-4		0 TO -7.2E-4		
(163)	DOPPLER COEFF.	-2.2E-5 TO -2.9E-5		<2.2E-5		

(998) REMARKS RCC: ROD CONTROL CLUSTER.

(999) REFERENCES SEE SS59 OF FDN-110003. (P.563)

<* 110006 *> REACTIVITY BALANCE AT BOL - EXAMPLE - ** 110006 **

---(1)-*---(2)-*---(3)-*---(4)-*---(5)-*---(6)-*---(7)-*---(8)-*

		BWR	PWR	BWR/2 TSURUGA
(10)	EXCESS REACTIVITY			
(11)	TEMPERATURE (COLD TO HOT)	3.	5.	
(31)	MODERATOR			0.5
(12)	0-POWER TO RATED POWER	5.	2.	
(32)	DOPPLER			1.0
(33)	VOID			2.5
(13)	XE, SM EQUILIBRIUM	3.	3.	3.7
(14)	BURN-UP	10.	17.	
(34)	1ST CYCLE			15.3
(15)	CONTROL ROD MANEUVERING	0.	0.5	1.0
(16)	TOTAL	21.	27.5	24.0*
(20)	REACTIVITY OF CONTROL ELEMENT			
(21)	CONTROL ROD	17.	6.	
(22)	BURNABLE POISSON	8.	8.	
(23)	CHEMICAL SHIM	-	>21.	
(16)	TOTAL	25	>35.	

UNIT : (% DELTA-K/K)

(998) REMARKS

* : REACTIVITY WORTH TO BE CONTROLLED.

(999) REFERENCES

DATA OF COLUMN (1) AND (3): ?, P.5-23.
DATA OF COLUMN (4):
S. SUGURI EDS, GENSHIRYOKU HATSUDEN NYUMON, P.72.

<* 110007 *> REACTIVITY COEFFICIENT - PWR, MIHAMA - ** 110007 **

---(1)-*---(2)-*---(3)-*---(4)-*---(5)-*---(6)-*---(7)-*---(8)-*

PWR
MIHAMA

(11)	MODERATOR TEMP.COEFF.(DELTA-K/K/C)	+2.	TO -5.E-04
(12)	DOPPLER COEFF. (DELTA-K/K/C)	-2.	TO -3.E-05
(13)	VOID COEFF. (DELTA-K/K/%-VOID)	+1.	TO -3.E-03
(14)	PRESSURE COEFF.(DELTA-K/K/(KG/CM2)	-1.	TO +5.E-05

(999) REFERENCES

S. SUGURI EDS, GENSHIRYOKU HATSUDEN NYUMON, P.73.

<* 110008 *> NUETRON FLUX - TYPICAL EXAMPLE - ** 110008 **

---(1)-*---(2)-*

		BWR	PWR
(1)	REACTOR TYPE		
(11)	THERMAL NUETRON FLUX	4.2	5.
(12)	FAST NUETRON FLUX (>1 MEV)	4.0	9.

UNIT: X 1.0E+13 (N./CM**2-SEC)

(999) REFERENCES

P.5-22.

<* 110009 *> OPERATIONAL REQUIREMENTS FOR LWR FUEL - TYPICAL VALUES - ** 110009 **

			PWR	BWR
(10)	AVERAGE LINER HEAT			
(11)	GENERATION RATE	(W/CM)	155 TO 225	155 TO 230
(20)	RESIDENCE TIME	(YEAR)	3	4
(30)	HOT CHANNEL FACTOR			
(31)	STEADY STATE		1.5 TO 2.1	1.8 TO 2.2
(32)	TRANIENT		2.3 TO 2.5	2.3 TO 2.5
(40)	NUETRON FLUX,	(/CM**-2/SEC)		
(41)	THERMAL		4. TO 6.E+13	3. TO 5.E+13
(42)	FAST		6. TO 9.E+13	4. TO 6.E+13
(50)	BURNUP TARGET			
(51)	(ASSEMBLY AVERAGE)	(GWD/T(U))	28 TO 34	22 TO 28
(60)	COOLANT PRESSURE	(BAR)	145 TO 158	72
(70)	COOLANT TE MPERATURE	(DEG-C)	303 TO 316	287

(999) REFERENCES

F.GARZAROLLI, R. VON JAN, H. STEHLE, 'THE MAIN CAUSES OF FUEL ELEMENT FAILURE IN WATER-COOLED POWER REACTORS', ATOMIC ENERGY REVIER 17(1) (1979), (P.31-128)

<* 110201 *> CORE DESIGNS FOR OPTIMUM PERFORMANCE - HISTORICAL BWR - ** 110201 **

		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
(10)	PLANT NAME	DRESDEN NO.1 INITIAL	DRESDEN NO.1 PRESENT IN 1965	DRESDEN NO.2	BIG ROCK POINT INITIAL	BIG ROCK POINT UPRATED	OYSTER CREEK	CURRENT	CURRENT FUEL DESIGN IN 1966 / IN 1971
(11)	RATED POWER LEVEL, (MW(T))	626	700		157	240	1600		
(12)	NET PLANT ELECTRIC OUTPUT,(MW(E))			755					
(20)	POWER DENSITY-***), (KW/LITER)	29.6	33.2	37.0	45.0	45.0	33.6	51.0	50.0
(21)	CHF RATIO AT OVERPOWER	2.0	1.5		1.5	1.5	1.5		
(22)	MAX. HEAT FLUX,								
(23)	(X1.0E+3,BTU/HR/FT**2)	350	450		510	530	387		
(24)	LINER POWER-**), (KW/FT)	15.2	19.0		15.2	15.8	16.9		
(25)	MASS-FLOW RATE-*),								
(26)	(X1.0E+5/LB/HR/FT**2)	5.8-9.4	5.2-11.5		9.1	4.5-7.0	9.4		
(40)	AVG. EXIT STEAM QUALITY (%)	5.9	6.6	10.	5.3	7.6	9.8	14.	
(27)	INLET SUBCOOLING, (BTU/LB)	50.	50.		20.	20.	26.		
(30)	EXPOSURE, (MWD/TONNE)								
(31)	FIRST CORE	7400		16500				21000	
(32)	EQUILIBRIUM CORE	11000		22000				27500	
(50)	FUEL ROD DIAMETER (IN)	0.567		0.570				0.562	
(60)	FUEL-ASSEMBLY DATA								
(61)	OVERALL LENGTH, (IN)								173.87
(69)	OVERALL CROSS SECTION, (INXIN)								5.438 SQ
(62)	NOMINAL ACTIVE FUEL LENGTH,(IN)								144
(63)	FUEL-ROD PITCH, (IN)								0.738
(64)	NUMBER OF FUEL RODS								49(7X7)
(65)	SPACE BETWEEN FUEL RODS, (IN)								0.175
(66)	FUEL-CHANNEL WALL THICKNESS(IN)								0.080
(67)	FUEL-BUNDLE HEAT-TRANSFER AREA								
(68)	(FT**2)								86.52
(70)	FUEL-ROD DATA								
(71)	OUTSIDE DIAMETER (IN)								0.563
(72)	CLADDING THICKNESS, (IN)								0.032
(73)	PELLET OUTSIDE DIAMETER, (IN)								0.487
(76)	FUEL-PELLET-TO-CLADDING INITIAL								
(77)	DIAMETRAL GAP, (MILS)								12
(74)	FISSION-GAS PLENUM LENGTH, (IN)								16.00
(75)	PELLET IMMERSION DENSITY,(G/CC)								10.42

(997) NOTES

SQ : SQUARE. (VALUE WAS TAKEN FROM FIG.1 (P.69))
*) : ORIFICE ZONES.
**) : AT OVERPOWER.
***): AVERAGE.

(998) REMARKS

A RATIO OF 2 WAS SELECTED TO ACCOUNT FOR THE LACK OF TEST DATA AND POOR UNDERSTANDING OF THE PHENOMENA LEADING TO CHF. SINCE THAT TIME, EXPERIENCE WITH GEOMETRIES AND CONDITIONS TYPICAL OF BOILING WATER REACTORS HAS ENABLED DEGINERS TO REDUCE THE CRITICAL HEAT FLUX RATIO FROM 2.0 TO 1.5. DRESDEN, HUMBOLT BAY AND BIG ROCK POINT HAVE ALL ACCUMULATED A SUBSTANTIAL NUMBER OF OPERATING HOURS AT A RATIO OF 1.5, EVALUATED AT AN OVERPOWER VALUE OF 1.22 TO 1.27.

THE MOST OBVIOUS CHANGE IS THAT SHOWN FOR DRESDEN 1, WHERE REDUCTION IN THE CHF RATIO FROM 2.0 TO 1.5 HAS PERMITED INCREASE OF 25% IN THE LINER SPECIFIC POWER - KW/FT OF FUEL LENGTH - AND 12% IN EXIT STEAM QUALITY.

CHF, THE POINT BEYOND WHICH TEMPERATURE OSCILLATIONS SET IN, HAS ALSO BEEN REFERRED TO AS BOILING CRISIS AND DEPATURE FROM NUCLEATE BOILING (DNB). THE FORMER IS SELECTED FOR USE IN BWR DESIGN (IN GENERAL) BECAUSE IT CAN COVER INSTANCES WHERE EVAPORATION PREVAILS AT AN INTERFACE RATHER THAN BOILING. FURTHER, IT MAKES NO IMPLICATION ABOUT THE CONSEQUENCES OF THE PHENOMENON.

THE CHF RATIO OR 'BURNOUT RATIO' IS THE RATIO OF THE CRITICAL HEAT FLUX (DETERMINED FOR A PARTICULAR REACTOR OPERATING CONDITION) TO THE MAXIMUM OPERATING HEAT FLUX EVALUATED AT A SELECTED OVERPOWER CONDITION. THUS, A RATIO OF 2 INDICATES THE FUEL IS OPERATED AT HALF THE HEAT FLUX THAT WOULD PRODUCE INSTABILITIES IN SURFACE TEMPERATURE AT THIS CONDITION.

CRITICAL HEAT FLUX PREVIOUSLY CALLED 'BURNOUT'.
REFER REMARKS OF FDN-110002.

(901) REMARKS - JET PUMP SYSTEM

THE SYSTEM (JET PUMP) HAS BEEN INCORPORATED IN THE DESIGN OF COMMONWEALTH EDISON'S DRESDEN 2 PLANT AND IN SUBSEQUENT DESIGNS.

IT IS LIKELY THAT JET PUMPS WILL BE USED IN NEW BWRS FOR THE NEXT DECADE FOR SEVERAL RESONS:
* JET PUMP RECIRCULATION SYSTEMS ARE FUNDAMENTAL TO LARGER BWR PLANTS - AND THE INDUSTRY TREND IS TO LARGER PLANTS.
* THE REPLACEABLE JET PUMP ASSEMBLIES ALLOW INCORPORATION OF IMPROVED JET PUMP TECHNOLOGY IN OPERATING PLANTS. THIS AIDS PLANT UPRATING AND IMPROVES EFFICIENCY.
* JET PUMP SYSTEMS ARE COMPATIBLE WITH INCREASED POWER DENSITY, INCREASED CORE EXIT STEAM QUALITY, AND THE INCLUSION OF NUCLEAR SUPERHEAT.

-- DOUGLAS M. GLUNTZ, ROBERT H. MOEN, JOHN L. WRAY, 'JET PUMPS ADVANCE BWR RECIRCULATION FLOW-DESIGN',
- SUBTITLE - JET PUMPS INSTALLED WITHIN BOILING-WATER REACTOR VESSELS REDUCE THE NUMBER OF EXTERNAL RECIRCULATION LOOPS. FURTHER, THEY PROMISE TO LOWER MAINTENANCE COSTS AND INCREASE SAFETY MARGINS.
NUCLEONICS, 23(12), PP.58-61, (DEC. 1965). (P.58)

(999) REFERENCES

(A) GEORGE M. ROY, 'GETTING MORE OUT OF BWR'S', NUCLEONICS, 24(11), PP.41-53. P.41. (NOV. 1966)
(B) T. SORLIE, S. LEVY, M.F. LYONS, J.E. BOYDEN, 'EXPERIENCE WITH BWR FUEL RODS OPERATING ABOVE CRITICAL HEAT FLUX', NUCLEONICS, 23(4), PP.62-65 & 88, (APRIL 1965), (P.63)

DATA OF COLUMN (8):
H.E. WILLIAMSON, D.C. DITMORE, 'CURRENT BWR FUEL DESIGN AND EXPERIENCE', REACT. TECH. 14(1), P.70, (SPRING 1971).

<* 110202 *> PEAK-TO-AVERAGE POWER RATIOS (PEAKING FACTOR) IN BWR CORES ** 110202 **

		(1) PREVIOUS DESIGN BASIS	(2) PRESENT(IN 1966) BASIS
(51)	RADIAL	1.47	1.40
(52)	AXIAL	1.57	1.50
(53)	LOCAL	1.30	1.24
(54)	TOTAL OVERALL	3.0*	2.6*

(997) NOTES

* : PRODUCT OF RADIAL, AXIAL AND LOCAL FACTORS.

(998) REMARKS

THE OVERALL POWER DISTRIBUTION FACTOR IS THE RATIO OF PEAK HEAT FLUX TO THE AVERAGE VALUE AND INCLUDES FACTORS FOR:
* POWER OF THE PEAK FUEL BUNDLE TO AVERAGE FUEL BUNDLE - RADIAL FACTOR - INCLUDING CONTROL ROD EFFECTS.
* PEAK ROD POWER WITHIN A BUNDLE TO AVERAGE ROD POWER IN THE BUNDLE (LOCAL EFFECT).
* PEAK HEAT FLUX ALONG THE ROD TO THE ROD AVERAGE (AXIAL).

THE IMPROVED DISTRIBUTION CAME FROM:
1) THE USE OF THREE FUEL ROD ENRICHMENTS IN EACH FUEL BUNDLE RATHER THAN TWO.
2) THE USE OF AN ONLINE PROCESS COMPUTER.

THE COOLANT FLOW BECOMES A SATURATED LIQUID ANYWHERE FROM ONE-EIGHTH TO ONE-THIRD (1/8 TO 1/3) OF THE DISTANCE BETWEEN UPPER AND LOWER TIE PLATES. BEYOND THIS POINT BULK NUCLEATE BOILING OF THE COOLANT OCCURS. (*B)

(999) REFERENCES

SEE G.M. ROY OF FDN-110201. (P.42,43)
(*B) SEE H.E. WILLIAMSON OF FDN-110201. (P.71)

<* 110203 *> BASIS FOR FUEL DESIGN - DESIGN CRITERIA - ** 110203 **

---(1)-*---(2)-*---(3)-*---(4)-*---(5)-*---(6)-*---(7)-*---(8)-*

(10) BWR DESIGN CRITERIA

THE DESIGN CRITERIA REQUIRE THAT:
1. THE FUEL-ROD-CLADDING EXTERNAL DESIGN PRESSURE SHALL BE EQUAL TO OR GREATER THAN THAT WHICH WOULD OCCUR DURING EITHER ANTICIPATED NORMAL OR TRANSIENT OPERATION.
2. THE INTERNAL DESIGN PRESSURE OF THE FUEL-ROD CLADDING SHALL EXEED THAT RESULTING FROM INITIAL FILL GAS, IMPURITY GASES, AND RELEASED FISSION-PRODUCT GASES THROUTHOUT THE INTENDED FUEL LIFETIME.
3. THE CLADDING STRAIN CAUSED BY RELATIVE EXPANSION BETWEEN FUEL AND CLADDING SHALL BE A SMALL FRACTION OF THAT WHICH WILL CAUSE PERFORATION.

(11) -1% PLASTIC STRAIN LIMITS.

A VALUE OF 1% PLASTIC STRAIN OF ZIRCALOY CLADDING IS DEFINED AS THE LIMIT BELOW WHICH FUEL DAMAGE DUE TO OVERSTRAINING IS NOT EXPECTED TO OCCUR DURING A TRANSIENT. AVAILABLE DATA INDICATE THE THRESHOLD FOR DAMAGE IN IRRADIATED ZIRCALOY CLADDING IS IN EXCESS OF THIS VALUE. THE LHGR REQUIRED TO CAUSE THIS AMOUNT OF CLADDING STRAIN IS APPROXIMATELY 28 KW/FT IN FRESH FUEL OF THE CURRENT DESIGN (IN 1971) AND APPROXIMATELY 22 KW/FT AT A LOCAL EXPOSURE OF 40000 MWD/METRIC-TON.
IN COMPARISON, THE LHGR REQUIRED TO CAUSE INCIPIENT FUEL MELTING IS 21.5 KW/FT (70.54 KW/M), WHEREAS THE ANTICIPATED PEAK LHGR DURING NORMAL MODES OF STEADY-STATE OPERATION IN THE CURRENT GENERATION OF BWRS (IN 1971) IS ONLY 18.5 KW/FT (60.7 KW/M).

(12) -FREESTANDING OR SELF-STANDING.

'FREESTANDING' OR 'SELF-STANDING', I.E., CAPABLE OF WITHSTNDING THE EXTERNAL REACTOR COOLANT PRESSURE WITHOUT COLLAPSING ONTO THE ENCLOSED FUEL PELLETS.
ADEQUATE FREE VOLUME IS PROVIDED WITHIN EACH FUEL ROD TO ACCOMMODATE THE HELIUM BACKFILL PLUS ALL GAS FISSION PRODUCTS RELEASED FROM THE FUEL PELLETS DURING OPERATION WITHOUT EXCESSIVE INTERNAL PRESSURE.

(999) REFERENCES

H.E. WILLIAMSON, D.C. DITMORE, 'CURRENT BWR FUEL DESIGN AND EXPERIENCE', REACT. TECH. 14(1) (SPRING 1971), PP.68-98, P.73.

<* 110204 *> DEFINITION OF FUEL DAMAGE ** 110204 **

---(1)-*---(2)-*---(3)-*---(4)-*---(5)-*---(6)-*---(7)-*---(8)-*

(10) DEFINITION OF FUEL DAMAGE

FUEL DAMAGE IS DEFINED AS PERFORATION OF THE CLADDING THAT PERMITS RELEASE OF FISSION PRODUCTS. TWO PRIMARY MECHANISM MAY CAUSE FUEL DAMAGE DURING REACTOR TRANSIENTS:
1. SEVERE LOCAL OVERHEATING OF THE FUEL CLADDING CAUSED BY INADEQUATE COOLING.
(THE ONSET OF TRANSITION FROM NUCLEATE TO FILM BOILING - MCHFR).
2. FRACTURE OF THE FUEL CLADDING DUE TO EXCESSIVE STRAIN RESULTING FROM RELATIVE PELLET/CLADDING EXPANSION.
(PCMI - PCI - 1% PLASTIC STRAIN LIMIT)

FUEL DAMAGE IS DEFINED AS PENETRATION OF THE FISSION PRODUCT BARRIER (I.E. THE FUEL ROD CLAD). - RESAR 41 (DEC. 1973), (P.4.2-1).

(998) REMARKS

REFER 1% PLASTIC STRAIN LIMITS OF FDN-110203.

(999) REFERENCES

SEE H.E. WILLIAMSON OF FDN-110203. (P.73).

<* 110205 *> FUEL LINEAR HEAT-GENERATION RATES ** 110205 **

USE OF THE DESIGN MODELS PERMITS CALCULATION OF THE LHGR REQUIRED TO CAUSE FUEL DAMAGE (1% PLASTIC STRAIN OF THE CLADDING) DURING AN OVERPOWER TRANSIENT. FOR COMPARISON, THE ANTICIPATED PEAK STEADY-STATE AND TRANSIENT CONDITIONS ARE SHOWN FOR BOTH THE DRESDEN 2 AND THE BF-1 CLASSES OF REACTOR. BOTH THE ANTICIPATED OPERATING CONDITIONS AND THE DAMAGE LIMITS DECREASE MONOTONICALLY WITH BURNUP.

---(1)-*---(2)-*---(3)-*---(4)-*---(5)-*---(6)-*---(7)-*---(8)-*

(10)	EXPOSURE, (MWD/METRIC TON)	0	22000	44000
(20)	PEAK STEADY STATE, (KW/FT)			
(21)	DRESDEN-2	17.5	16.	14.
(22)	BROWNS FERRY-1	18.5	17.	15.
(30)	ANTICIPATED PEAK TRANSIENT(KW/FT)			
(21)	DRESDEN-2	19.9	18.2	15.9
(22)	BROWNS FERRY-1	21.5	19.7	17.4
(40)	CLADDING-STRAIN DAMAGE LIMIT,			
(41)	(KW/FT)	28.	28.	22.
(998)	REMARKS	SEE FDN-110203.		
(999)	REFERENCES	SEE FDN-110203.		

<* 120001 *> SUMMARY OF FUEL ASSEMBLY ** 120001 **

		BWR 7X7 INITIAL	BWR 7X7 REV.	BWR 8X8 WR(1)	BWR 8X8 WR(2)	PWR 14X14 STD.	PWR 15X15 STD.	PWR 17X17 STD.
		---(1)-*---(2)-*---(3)-*---(4)-*---(5)-*---(6)-*---(7)-*---(8)-*						
(10)	FUEL ASSEMBLY							
(11)	TYPE	CN-SB	CN-SB	CN-SB	CN-SB	CL-SB	CL-SB	CL-SB
(12)	FUEL ROD ARRAY	7X7	7X7	8X8	8X8	14X14	15X15	17X17
(13)	FUEL-ROD PITCH (MM)	18.7	18.7	16.2	16.2	14.1	14.3	12.6
(14)	NO. OF FUEL ROD/ASSEMBLY	49	49	63	62	197	204	264
(16)	SPACER OR GRID							
(17)	MATERIAL							
(18)	GRID	*-------- ZRY-4 ----------				*---- INCONEL-718 ----		
(19)	SPRING	*-------- INCONEL X-750 -----				*---- INCONEL-718 ----		
(20)	NUMBER	7	7	7	7	7	7	9 OR 7
(21)	SURPORTING	CR	CR	WR	WR	*-- CONTROL ROD GUIDE *		
						* THIMBLE *		
(30)	WATER ROD OR CONTROL ROD GUIDE							
(31)	THIMBLE							
(32)	MATERIAL	-	-	ZRY-2	ZRY-2	ZRY-4	ZRY-4	ZRY-4
(33)	NUMBER	-	-	1	2	16	20	24
(125)	DIAMETER (MM)							
(126)	UPPER							12.24
(127)	LOWER (DASH POT)							10.90
(25)	THICKNESS (MM)							
(126)	UPPER							0.41
(127)	LOWER (DASH POT)							0.41
(130)	IN-CORE INSTRUMENT GUIDE THIMBLE							
(17)	MATERIAL							ZRY-4
(125)	DIAMETER (MM)							12.24
(25)	THICKNESS (MM)							0.41
(22)	CHANNEL BOX							
(23)	MATERIAL	*---- ZRY-4 ----------						
(24)	DIMENSION (MM)	*---- 138X138 ----------						
(25)	THICKNESS (MM)	2.0	2.0	3.048	-*			
(15)	ASSEMBLY DIMENSION							
(115)	CROSS SECTION (MMXMM)					200X200	214X214	214X214
(116)	TOTAL HEIGHT (MM)							4060
(117)	ASSEMBLY WEIGHT (KG)							670
		----------						
(40)	FUEL ROD							
(41)	TYPE	UN-P	UN-P	UN-P	?	PRE-P	PRE-P	PRE-P
(42)	FUEL PELLET							
(43)	MATERIAL	UO2	*---- UO2+GD2-O3 ----			*--- SINTERED UO2 ----		
(44)	FORM					*-- BOTH END DISH ----		
(45)	DIAMETER (MM)	12.40	12.11	10.56	10.31	9.29	9.26	8.19
(46)	HEIGHT (MM)	22.	12.	11.	11.	15.2	15.2	13.5
(47)	DENSITY (%-TD)	95.	95.	95.	95.	95.	93.	95.
(50)	CLADDING							
(51)	MATERIAL	ZRY-2, SX	ZRY-2, RX	ZRY-2, RX	ZRY-2, RX	ZRY-4	ZRY-4	ZRY-4
(52)	OUTER DIAMETER (MM)	14.5	14.3	12.5	12.3	10.72	10.72	9.50
(53)	THICKNESS (MM)	0.90	0.94	0.86	0.86	0.62	0.617	0.57
(54)	THICKNESS/OUTER-RADIUS	0.11	0.13	0.14	?			
(60)	GAP							
(61)	DIAMETRAL GAP (MM)	0.30	0.31	0.22	0.27	0.19	0.196	0.17
(62)	GAP/CLADDING-OUTER-DIAMETER							
(65)	FUEL ACTIVE LENGTH (MM)	3660.	3660.	3710.	3710.	3660.	3660.	3660.
(66)	GAS PELNUM							
(67)	BONDED GAS	HE	HE	HE	HE	HE + AIR	HE + AIR	HE + AIR
(68)	GAS PRESSURE (ATM)							
(69)	HE	1.	1.	1.	?	20.-30.	20.-30.	20.-30.
(70)	AIR					1.	1.	1.
(71)	PLENUM LENGTH (MM)	406.	406.	356.	?	131.	131.	159.
(72)	PLENUM SPRING							
(73)	MATERIAL	SS	SS	SS	SS	SS	SS	SS
(76)	MOISTURE GETTER	NO	YES	YES	YES			
(75)	TOTAL LENGTH OF FUEL ROD (MM)					3860.	3860.	3860.
		----------						
(80)	NUCLEAR THERMAL-HYDRAULIC CHARAC.							
(81)	MODERATOR/FUEL VOLUME RATIO	2.54	2.38	2.6	?			
(83)	WEIGHT OF U PER ASSEMBLY (KG)	187.- 195.	187.- 195.	184.	?			
(84)	FUEL ENRICHMENT (W/O)							
(85)	AVERAGE ENRICHMENT	2.1-2.5	2.1-2.5	2.62	?			

*** FUEL PERFORMANCE DATA *** DATE = 86-05 **PAGE** (D- 21)

(86)	1ST REGION (CENTER)					2.27	2.04	2.1
(87)	2ND REGION (MEDIUM)					3.03	2.58	2.6
(88)	3RD REGION (OUTER)					3.4	2.20	3.1
(89)	REPLACEMENT FUEL					3.28	3.21	3.2
(90)	MAX. DESIGN BURNUP							
(91)	MWD/ST	40000	40000					
(92)	INITIAL CORE (MWD/MTM)					-	24000	24000
(93)	EQULIBRIUM CORE (MWD/MTM)					-	33000	33000
(94)	GADOLINIUM (BURNABLE POISSON)							
(95)	CONTENT OF GD (W/O)	1.5	1.5	0.5-1.5				
(96)	NO. OF RODS CONTENTED GD/ASSEM.	4	4	4	?			
(97)	LHGR (W/CM)							
(98)	AVERAGE							
(99)	MAXIMUM							
(105)	AT RATED POWER	574.	574. OR 607.	440.	440.	528.		
(106)	AT 112 % POWER						521.	
(107)	UNDER ABNORMAL TRANSIENT							591.
(100)	HOT CHANNEL (OR PEAKING) FACTOR							
(101)	TOTAL	2.85	2.85	2.68	?	<2.32	<2.32	<2.32
(102)	RADIAL	1.4	1.4	1.4				
(103)	AXIAL	1.57	1.57	1.57				
(104)	LOCAL	1.3	1.3	1.22				

(997) NOTES

CN-SB: SQUARE BOUNDLE CANNED WITH FLOW CHANNEL (CHANNEL BOX).
CL-SB: CANLESS SQUARE BOUNDLE.
CR : CENTER FUEL ROD.
WR : WATER ROD.
SX : STRESS RELIEVED.
RX : RECRYSTALLIZED.
UN-P: UNPRESSURIZED.
PRE-P: PRE-PRESSURIZED.

(998) REMARKS

FOR DISHED PELLETS, REFER FDN-120007.

(999) REFERENCES

DATA OF COLUMN (1)-(4):
M. NAGAI ET AL, J. AESJ, 24(6), P.405, (1982)
DATA OF COLUMN (7):
YOSHIAKI KONDO, GENSHIROKU-KOGYO, 28(7), PP.37-43. (P.39)

<* 120002 *> TEST ASSEMBLY DATA - IFA-106 - ** 120002 **

HALDEN
IFA-106

				(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
(10)	PIN NO.										
(11)	UPPER			MA1048	MA1081	SA1043*	MA3236	MA1052*	SA1066	MA1057*	SA1067
(12)	LOWER			MB1049	MB3234	SB1079	MB3321	MB1054	SB1074	SB1080	SB3324
(13)	FUEL WEIGHT,										
(14)	UPPER, ENRICHED PELLET		(KG)	0.6640	0.6552	0.6464	0.6551	0.6485	0.6589	0.6574	0.6569
(15)	LOWER, ENRICHED PELLET		(KG)	0.6642	0.6554	0.6592	0.6554	0.6646	0.6587	0.6588	0.6591
(16)	UPPER, END PELLET		(GR)	11.80	11.70	11.40	11.70	11.80	11.46	11.39	11.43
(17)	LOWER, END PELLET		(GR)	11.80	11.70	11.48	11.70	11.80	11.39	11.42	11.41
(18)	FUEL LENGTH/PIN		(MM)								
(11)	UPPER			720.	720.	722.	720.	720.	720.	720.	720.
(12)	LOWER			720.	720.	721.	720.	720.	720.	720.	721.
(25)	FUEL DIAMETER		(MM)	10.68	10.61	10.68	10.61	10.68	10.68	10.68	10.68
(26)	DIAMETRAL CLEARANCE		(MM)	0.12	0.20	0.12	0.20	0.12	0.12	0.12	0.12
(27)	CLAD. INT. DIAMETER		(MM)	10.80	10.81	10.80	10.81	10.80	10.80	10.80	10.80
(20)	FUEL DENSITY	(GR/CM**3)		ENRICHED FUEL 10.4							
				END PELLET 10.13							
(30)	ENRICHMENT		(W/O)								
(21)	ENRICHED PELLET			10 W/O U-235.							
(22)	END PELLET			4 W/O DY203 IN NAT. UO2, ONE PER PIN NEAR CENTER SPACER.							
(40)	PELLET HEIGHT		(MM)								
(21)	ENRICHED PELLET			M-PELLETS: 18, S-PELLETS: 16.							
(22)	END PELLET			12.7							
(41)	DISHING			NONE							
(50)	CLADDING										
(51)	MATERIAL			ZRY-2							
(52)	STATE			ASTM-B353-64T. BASE ANNEALED (775 DEG-C).							
				AUTOCLAVED (400 DEG-C, STEAM 88ATM., 12 HRS).							
(53)	THICKNESS		(MM)	0.7							
(55)	FILLER GAS			HE							
(56)	PLENUM LENGTH		(MM)	84.2							
(60)	WELDING			END CAPS AR ARC TIG., EVACULATED THROUGH VENT HOLE, HE FILLED,							
				VENT HOLE SPOT WELDING TIG.							
(69)	NO. OF CLUSTER			2							
(70)	NO. PINS/CLUSTER			9							
(71)	PIN ARRAY			SQUARE LATTICE PITCH.							
(72)	PITCH DISTANCE		(MM)	16.60							
(75)	SPACER										
(76)	MATERIAL			ZRY-2							
(77)	NUMBER			1							
(78)	SUPPORTING			CENTRAL SUPPORT, SPACER SCREWED TO THE SHROUD.							
(80)	SHROUD										
(81)	MATERIAL			ZRY-2							
(82)	SHAPE			SQUARE							
(83)	INT. DIMENSION		(MM)	50X50, FIXED SHROUD.							
(997)	NOTES			* : INCLUDING 8.2424 GRAM DY203.							
(999)	REFERENCES			M. UCHIDA, JAERI-MEMO 6159. (P.8)							
				ORIGINAL DATA IS DESCRIBED IN HPR-85.							

<* 120003 *> TEST ASSEMBLY DATA - IFA-106 - (CON'T) ** 120003 **

HALDEN
IFA-106

(10)	PIN NO.		
(11)	UPPER		MA1058
(12)	LOWER		MB1062
(13)	FUEL WEIGHT,		
(14)	UPPER, ENRICHED PELLET	(KG)	0.6553
(15)	LOWER, ENRICHED PELLET	(KG)	0.6553
(113)	TOTAL, ENRICHED PELLET	(KG)	11.8284
(16)	UPPER, END PELLET	(GR)	11.70
(17)	LOWER, END PELLET	(GR)	11.70
(114)	TOTAL, END PELLET	(KG)	0.20878
(115)	TOTAL FUEL WEIGHT	(KG)	12.0372
(18)	FUEL LENGTH/PIN	(MM)	
(11)	UPPER		720.
(12)	LOWER		720
(25)	FUEL DIAMETER	(MM)	10.61
(26)	DIAMETRAL CLEARANCE	(MM)	0.20
(27)	CLAD. INT. DIAMETER	(MM)	10.81

<* 120004 *> CONNECTICUT YANKEE FUEL SUPPLIERS AND DESIGN PARAMETERS ** 120004 **

(1)	BATCH DESIGNATION		1	2	3	4	4N	4A	5 /7A	5G (S004)
(2)	FUEL CONTRACTOR		WESTINGHOUSE (W)				NUMEC		W	GGA
(3)	FUEL PELLET SUPPLIER		WESTINGHOUSE (W)				NUMEC		W	BNFL
(4)	FUEL CLAD SUPPLIER		SUPERIOR TUBE COMPANY				?	?	SUPERIOR	?
(5)	FUEL ASSEMBLY FABRICATOR		WESTINGHOUSE (W)				NUMEC		W	BNFL
(10)	NUMBER OF ASSEMBLIES		53	52	52**)	48	2	2	49/ 1	1
(11)	ENRICHMENT	(W/O)	3.00	3.24	3.67			3.00	4.00	4.00
(12)	FUEL DENSITY	(% TD)	93.0	94.0	94.0	92.8	93.2	92.4	92.9	93.2
(13)	INITIAL PREES.	(PSIA)	14.7							
(14)	FILL GAS		AIR				HE	HE	AIR	HE
(15)	STACK HEIGHT	(IN)	121.8	121.8	121.8	120.0	119.3	118.4	120.0	121.5
(16)		(CM)								
(17)	PELLET DIAMETER	(IN)	0.3835	0.3835	0.3835	0.3835	0.3835	0.3680	0.3835	0.3835
(18)		(MM)								
(19)	PELLET LENGTH	(IN)	0.600							0.450
(20)	CLADDING MAT'L		SS	SS	SS**)	SS	SS	ZRY	SS	SS
(21)	CLAD THICKNESS	(IN)	0.0165					0.024	0.0165	0.0165
(22)	CLAD I.D.	(IN)	0.389					0.374	0.389	0.3905
(23)	GAP DIAMETER	(IN)	0.0055					0.006	0.0055	0.007

(997) NOTES

**) : FOUR ASSEMBLY CONTAIN FOUR ZIRCALOY TEST RODS EACH.

(998) REMARKS

W : WESTINGHOUSE
GGA : GULF GENERAL ATOMIC
BNFL: BRITISH NUCLEAR FUEL LIMITED.
B&W : BABCOCK AND WILCOX.
GUNF: GULF UNITED NUCLEAR FUELS.

(999) REFERENCES

V. PASUPATHI, R. W. KLINGENSMITH, M. T. PITEK
STAINLESS STEEL CLAD FUEL PERFORMANCE IN THE CONNETICUT YANKEE REACTOR,
IAEA, SPECIALIST'S MEETING ON EXAMINATION OF FUEL ASSEMBLY FOR WATER COOLED POWER REACTORS, HELD AT TOKYO, JAPAN, 9-13 NOVEMBER 1981. IWGFPT/12, PAPER NO.196.

<* 120005 *> CONNECTICUT YANKEE FUEL SUPPLIERS AND DESIGN PARAMETERS (CON'T) ** 120005 **

			(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
(1)	BATCH DESIGNATION		5A	6 /6A 7B	7 /7C	8	9			
(2)	FUEL CONTRACTOR		GGA	W	GUNF	GUNF	GUNF			
(3)	FUEL PELLET SUPPLIER		BNFL	W	GUNF	BNFL	B&W			
(4)	FUEL CLAD SUPPLIER		?	SUPERIOR						
(5)	FUEL ASSEMBLY FABRICATOR		BNFL	W	GUNF	B&W	B&W			
(10)	NUMBER OF ASSEMBLIES		2	50/ 2	51/ 2	48	56			
(11)	ENRICHMENT	(W/O)	3.25	4.0 /3.67	4.0 /3.66	4.0	4.0			
(12)	FUEL DENSITY	(% TD)	93.0	92.7 /92.8	94.85 /94.57	95.17	95.27			
(13)	INITIAL PREES.	(PSIA)	-SOME-200.-PSI-		14.7					
(14)	FILL GAS		HE	AIR	HE/AR/AIR					
(15)	STACK HEIGHT	(IN)	121.1	120.0	120.3	120.3	120.3			
(17)	PELLET DIAMETER	(IN)	0.3645	0.3835	0.3835	0.3835	0.3835			
(19)	PELLET LENGTH	(IN)	0.450	0.600	0.420	0.420	0.420			
(20)	CLADDING MAT'L		ZRY	SS	SS	SS	SS			
(21)	CLAD THICKNESS	(IN)	0.025	0.0165	0.0165	0.0165	0.0165			
(22)	CLAD I.D.	(IN)	0.3735	0.389	0.389	0.389	0.389			
(23)	GAP DIAMETER	(IN)	0.009	0.0055	0.0055	0.0055	0.0055			
(997)	NOTES		SEE FDN-120004.							

<* 120006 *> JOYO (FBR) MK-I FUEL ASSEMBLY DESIGN PARAMETERS ** 120006 **

			FBR EXP.
			---(1)-*---(2)-*---(3)-*---(4)-*---(5)-*---(6)-*---(7)-*---(8)-*
(10)	FUEL ASSEMBLY		
(11)	LENGTH	(MM)	2970.
(12)	WEIGHT	(KG)	60.
(13)	NUMBER OF PINS/ASSEMBLY		91
(14)	PIN PITCH	(MM)	7.6
(15)	WRAPPER TUBE		
(16)	MATERIAL		10%CW316
(17)	FLAT-TO-FLAT OUTER		
(18)	OUTER DIMENSION	(MM)	78.5
(19)	INNER DIMENSION	(MM)	74.7
(20)	FUEL PIN		
(21)	PIN LENGTH	(MM)	1910.
(22)	CORE FUEL LENGTH	(MM)	600.
(23)	UPPER BLANKET FUEL LENGTH	(MM)	400.
(24)	LOWER BLANKET FUEL LENGTH	(MM)	400.
(25)	OUTER DIAMETER	(MM)	6.3
(26)	PLENUM VOLUME	(CC)	8.5
(27)	WEIGHT	(KG)	0.465
(28)	WIRE PITCH	(MM)	266.
(30)	CLADDING		
(31)	MATERIAL		10%CW316
(32)	WALL THICKNESS	(MM)	0.35
(40)	SPACER WIRE		
(31)	MATERIAL		SA 316
(41)	DIAMETER	(MM)	1.2
(50)	CORE FUEL		
(31)	MATERIAL		PU-02/(PU-02+17.7W/O-U02) U-235/U: 23W/O
(51)	PELLET DIAMETER	(MM)	5.4
(52)	PELLET LENGTH	(MM)	10.
(53)	PELLET DENSITY	(% TD)	93.5
(60)	AXIAL BLANKET		
(31)	MATERIAL		U-235 0.2 W/O
(51)	PELLET DIAMETER	(MM)	5.4
(53)	PELLET DENSITY	(% TD)	94.

(999) REFERENCES

T. ITAKI ET. AL., 'IRRADIATION PERFORMANCE OF EXPERIMENTAL FAST REACTOR JOYO MK-I DRIVER FUEL ASSEMBLY'(IN JAP.), J.AESJ, 27(5), (MAY, 1985). (P.52)

<* 120007 *> DESCRIPTIONS OF FUEL ASSEMBLY STRUCTURE DESIGN ** 120007 **

---(1)-*---(2)-*---(3)-*---(4)-*---(5)-*---(6)-*---(7)-*---(8)-*

(200)	FUEL ROD	
(201)	- PLENUM	THE ROD DESIGN MUST ACCOUNT FOR THE INTERNAL PRESSURE BUILDUP THAT WILL RESULT FROM THE ACCUMULATION OF RELEASED GASES. THIS MAY BE ACCOMPLISHED BY PROVIDING A FREE VOLUME PLENUM, WITHIN THE FUEL ROD OR USING HEAVIER FUEL CLADDING. AN UNDULY CONSERVATIVE APPROACH IN PLENUM AND/OR CLAD DESIGN WILL RESULT IN AN ECONOMIC PENALTY DUE THROUGH THE INCREASED COST OF CORE COMPONENTS AND A POSSIBLE NEUTRON PENALTY DUE TO INCRESED CLAD THICKNESS. -(REF-4)
(201)	- PLENUM	ADEQUATE FREE VOLUME IS PROVIDED WITHIN EACH FUEL ROD TO ACCOMMODATE THE HELIUM BACKFILL PLUS ALL GAS FISSION PRODUCTS RELEASED FROM THE FUEL PELLETS DURING OPERATION WITHOUT EXCESSIVE INTERNAL PRESSURE. -(REF-2)
(202)	- HOLDDOWN SPRING LOAD	HOLDDOWN SPRING LOAD DESIGN TARGET: TWICE FUEL STACK WEIGHT. -(REF-5)
(300)	FUEL PELLET	
(301)	- PELLET SHAPE	THE EFFECT OF A BAMBOO RIDGE CAN BE MITIGATED, FOR EXAMPLE, BY USING SHORTER OR BARREL-SHAPE PELLETS, CHAMFERED EDGES, DISHED ENDS, DIFFERENT DIAMETRIC CLEARANCES, ETC., BUT ALL THESE DEVICES HAVE A CORRESPONDING PERFORMANCE PENALTY FROM SOME OTHER STANDPOINT, SUCH AS INCREASED MANUFACTORING COSTS, REDUCTION IN URANIUM INVENTORY PER UNIT RUN OF FUEL TUBE, OR LOSS OF HEAT OUTPUT DUE TO IMPAIRMENT OF HEAT TRANSFER. - (REF-1)
(302)	- BWR-DISHED PELLET	BWR-DISHED PELLET : DISHED FUEL PELLETS ARE EMPLOYED IN THE HIGHEST POWER, HIGHEST EXPOSURE FUEL RODS TO ACCOMMODATE LONG-TERM IRRADIATION-INDUCED SWELLING OF THE UO-2. ALL OTHER FUEL RODS EMPLOY A STANDARD RIGHT-CIRCULAR CYLINDRICAL PELLET WITH NO DISH. THE DISH IS A SMALL DEPRESSION IN EACH END OF A DISHED PELLET. - (REF-2)
(303)	- PWR-DISHED PELLET	THE ENDS OF EACH PELLET ARE DISHED SLIGHTLY TO ALLOW GREATER AXIAL EXPANSION AT THE CENTER OF THE PELLETS. - (REF-3)
(400)	FUEL CLADDING	
(401)	- FREESTANDING OR SELF-STANDING	'FREESTANDING' OR 'SELF-STANDING', I.E., CAPABLE OF WITHSTNDING THE EXTERNAL REACTOR COOLANT PRESSURE WITHOUT COLLAPSING ONTO THE ENCLOSED FUEL PELLETS. -(REF-2)

(999) REFERENCES

REF-1: SEE REF-1 OF FDN-300001.

REF-2:
H.E. WILLIAMSON, D.C. DITMORE, 'CURRENT BWR FUEL DESIGN AND EXPERIENCE', REACT. TECH. 14(1) (SPRING 1971), PP.68-98. (P.72), (P.73).

REF-3: RESAR-41, P.4.2-6 (DECEMBER, 1973).

REF-4: HOFFMANN & COPLIN, SEE FDN-900011.

REF-5: STIR-4 (P.4).

<* 120008 *> FUEL ROD ARRAYMENT OF MIXED-OXIDE FUEL ASSEMBLY - BWR - ** 120008 **

THIS DATA LIST SHOES THE ARRANGEMNT OF FUEL RODS.

BWR
8X8
WR(2)

```
---(1)-*---(2)-*---(3)-*---(4)-*---(5)-*---(6)-*---(7)-*---(8)-*
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C*------*-------*-------*-------*-------*-------*-------*-------*
C*      *       *       *       *       *       *       *       *
C*  4   *   3   *   2   *   2   *   2   *   2   *   2   *   3   *
C*      *       *       *       *       *       *       *       *
C*------*-------*-------*-------*-------*-------*-------*-------*
C*      *       *       *       *       *       *       *       *
C*  3   *   1   *   1   *  P3   *  P3   *   1   *   1   *   2   *
C*      *       *       *       *       *       *       *       *
C*------*-------*-------*-------*-------*-------*-------*-------*
C*      *       *       *       *       *       *       *       *
C*  2   *   1   *  P2   *  P2   *  P2   *  P2   *   1   *   1   *
C*      *       *       *       *       *       *       *       *
C*------*-------*-------*-------*-------*-------*-------*-------*
C*      *       *       *       *       *       *       *       *
C*  2   *  P3   *  P2   *  P2   *   W   *  P2   *  P2   *   1   *
C*      *       *       *       *       *       *       *       *
C*------*-------*-------*-------*-------*-------*-------*-------*
C*      *       *       *       *       *       *       *       *
C*  2   *  P3   *  P2   *   W   *  P2   *  P1   *  P2   *   1   *
C*      *       *       *       *       *       *       *       *
C*------*-------*-------*-------*-------*-------*-------*-------*
C*      *       *       *       *       *       *       *       *
C*  2   *   1   *  P2   *  P2   *  P1   *  P1   *  P2   *   1   *
C*      *       *       *       *       *       *       *       *
C*------*-------*-------*-------*-------*-------*-------*-------*
 *      *       *       *       *       *       *       *       *
 *  2   *   1   *   1   *  P2   *  P2   *  P2   *   1   *   1   *
 *      *       *       *       *       *       *       *       *
 *------*-------*-------*-------*-------*-------*-------*-------*
 *      *       *       *       *       *       *       *       *
 *  3   *   2   *   1   *   1   *   1   *   1   *   1   *   2   *
 *      *       *       *       *       *       *       *       *
 *------*-------*-------*-------*-------*-------*-------*-------*
```

(997) NOTES

W : WATER ROD / P : MIXED-OXDE FUEL ROD

CCCCCCC : CONTROL ROD
C
C
C
C

THE NUMBER INDICATES ENRICHMENTS OR CONTENTS OF PU.

UO-2 FUEL ROD	/ MIXED-OXIDE FUEL ROD
NO. ENRICHMENT	NO. CONTENT OF PU.
1 : HIGH ENRICHED	P1 : HIGH CONTENT
2 : MEDIUM (HIGH) ENRICHED	P2 : MEDIUM CONTENT
3 : MEDIUM (LOW) ENRICHED	P3 : LOW CONTENT
4 : LOW ENRICHED	

(998) REMARKS

FOR SPECIFICATIONS OF RODS, REFER FDN-120009.

(999) REFERENCES

YOSHINOBU TAKAHASHI, 'TSURUGA MOX FUEL UTILIZATION PROGRAM' (IN JAP.), J.AESJ, 28(3) PP.203-208 (MAR., 1986). (P.205).

<* 120009 *> SUMMARY OF MIXED-OXIDE FUEL DESIGN PARAMETER - BWR - ** 120009 **

BWR
8X8
WR(2)

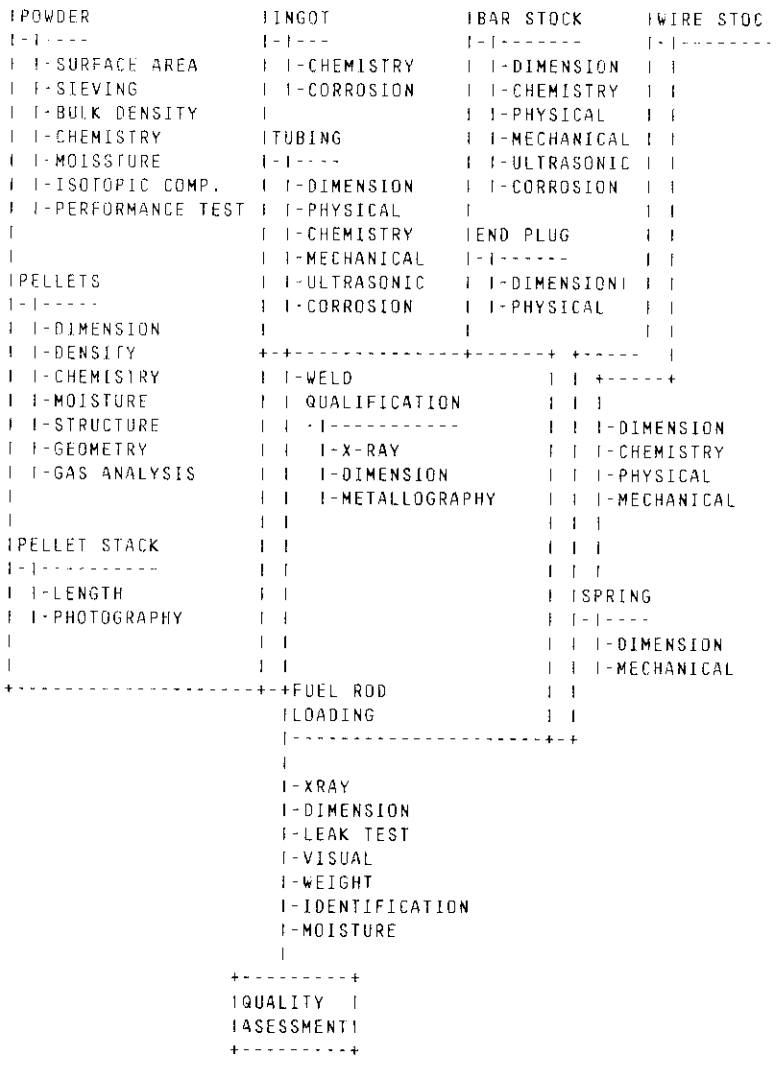
			(1) UO-2 ROD	(2) MOX ROD	(3)	(4)	(5)	(6)	(7)	(8)
(10)	PELLET									
(11)	OUTER DIAMETER,	(CM)	1.03	1.03						
(12)	INNER DIAMETER,	(CM)	0.0	0.36						
(13)	LENGTH,	(CM)	1.0	1.0						
(14)	DENSITY,	(%TD)	95	95						
(15)	MATERIAL		UO-2,UO2-GD2O3	UO2-PUO2						
(20)	CLADDING									
(11)	OUTER DIAMETER,	(CM)	1.23	1.23						
(21)	THICKNESS,	(MM)	0.86	0.86						
(15)	MATERIAL		ZRY-2, RX	ZRY-2, RX						
(30)	FUEL ROD									
(31)	ACTIVE LENGTH,	(M)	3.66	3.66						
(32)	PELLET-CLADDING CLEARANCE,	(MM)	0.24	0.24						
(33)	VOLUME RATIO OF PLENUM		0.1	0.1						
(40)	MAX. LHGR	(KW/M)	44.0	44.0						
(42)	MAX. PELLET TEMPERATURE,	(DEG-C)	1850	1470						
(43)	AT DESIGN LHGR									
(44)	MAX. CLADDING SURFACE TEMP	(DEG-C)	390	390						
(51)	FUEL ASSEMBLY TOTAL LENGTH-*,	(M)	*	4.35						*
(52)	ENRICHMENT-**,	(%)	*	2.9						*
(53)	WATER ROD		*	1.50						*
(997)	NOTES		-* : INCLUDING A LIFTING-HANDLE. -**: ASSEMBLY AVERAGE. (U235 + PU239 +PU241)/(U-TOTAL + PU-TOTAL)							
(999)	REFERENCES		SEE FDN-120008.							

<* 130001 *> FUEL FABRICATION QUALITY CONTROL FLOW CHART -INTER RAMP- ** 130001 **

STUDVIK
INTER-RP
COMMON
DATA

---(1)-*---(2)-*---(3)-*---(4)-*---(5)-*---(6)-*---(7)-*---(8)-*

(1) FUEL FABRICATION FLOW CHART



REMARKS

REFERENCE STIR-53 FIGURE 7.1

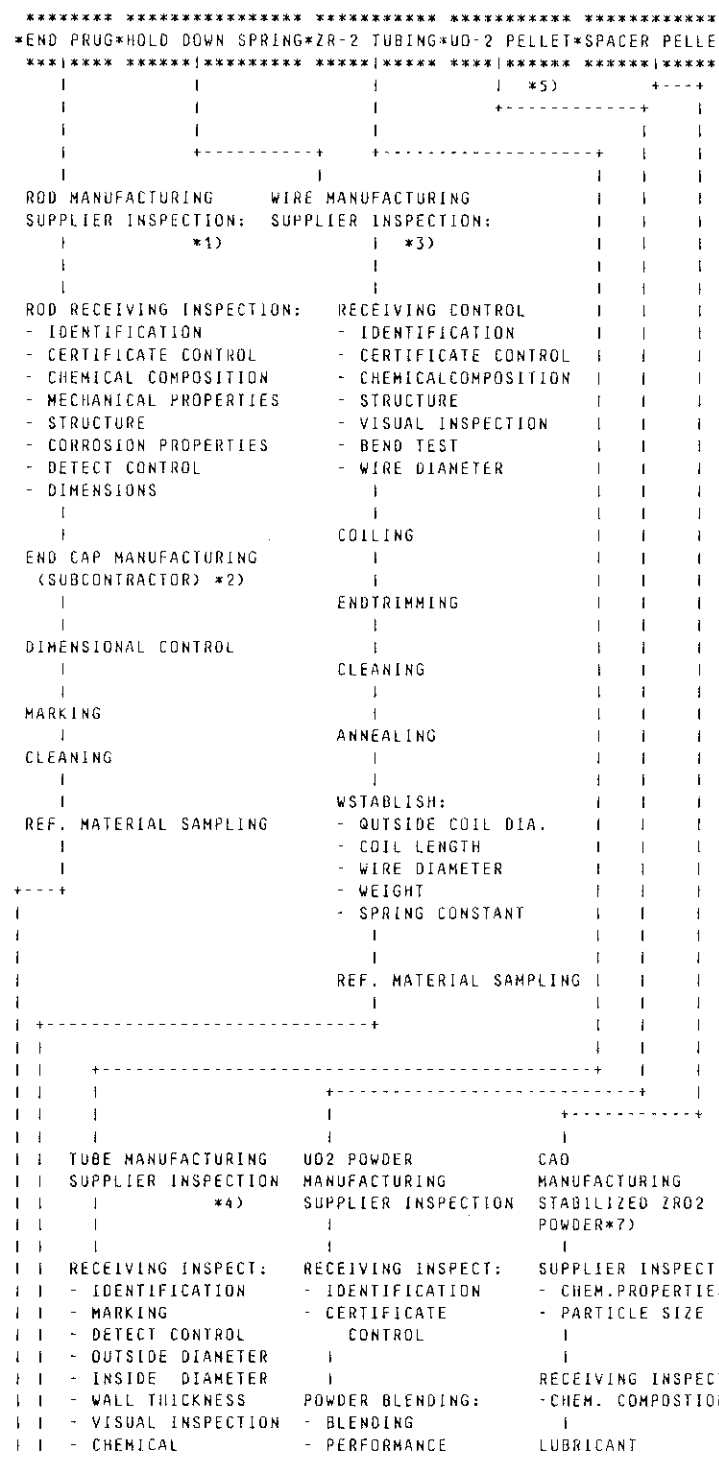
<* 130002 *> OVERALL FLOW SCHEME FOR THE INTER-RAMP EXPERIMENTAL FUEL ** 130002 **

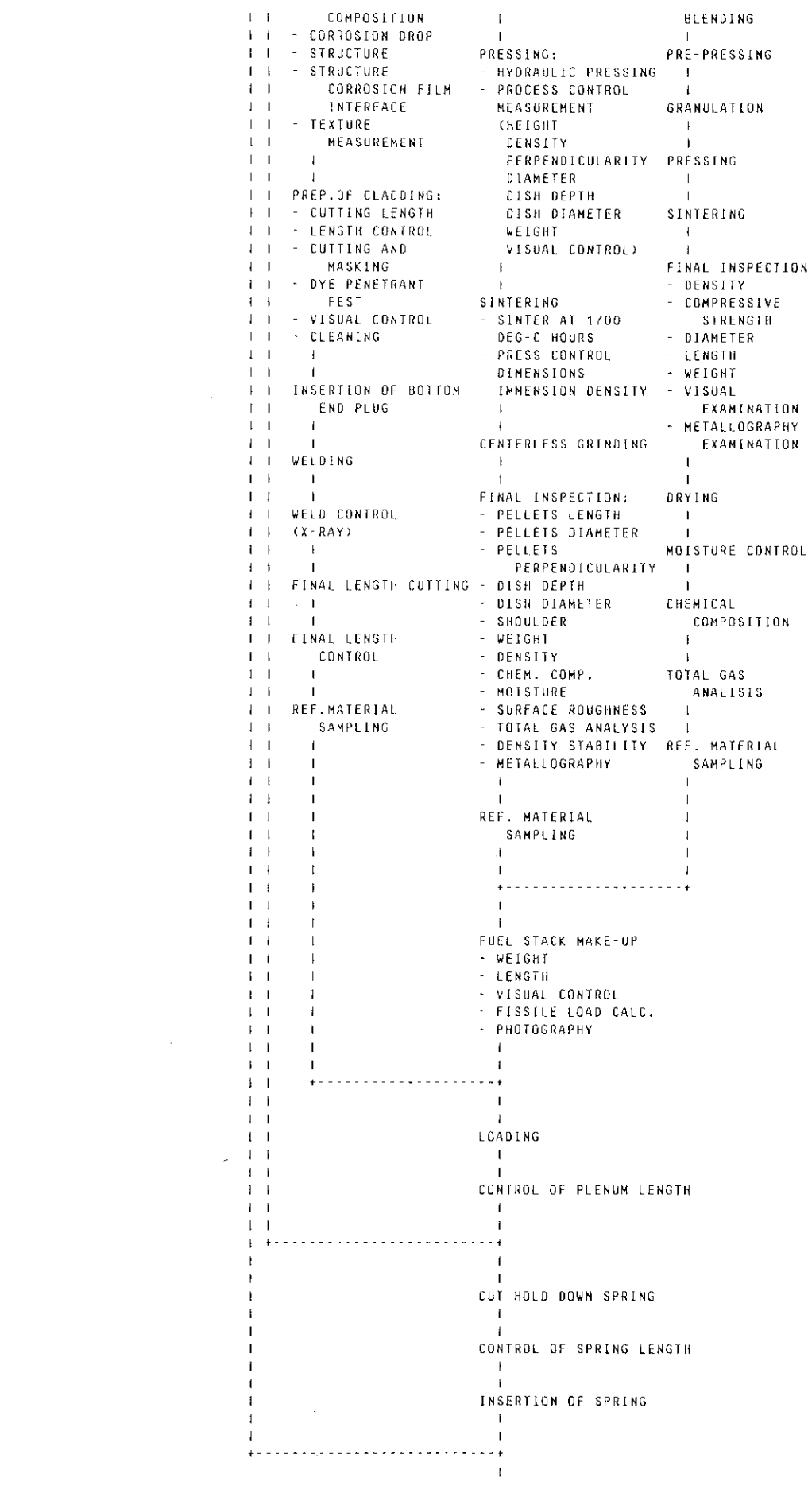
FABRICATION AND FABRICATION CONTROL

STUDVIK
INTER-RP
COMMON
DATA

---(1)-*---(2)-*---(3)-*---(4)-*---(5)-*---(6)-*---(7)-*---(8)-*

FLOW CHERT




COMPOSITION
- CORROSION DROP
- STRUCTURE
- STRUCTURE
CORROSION FILM
INTERFACE
- TEXTURE
MEASUREMENT
PREP.OF CLADDING:
- CUTTING LENGTH
- LENGTH CONTROL
- CUTTING AND
MASKING
- DYE PENETRANT
TEST
- VISUAL CONTROL
- CLEANING
INSERTION OF BOTTOM
END PLUG
WELDING
WELD CONTROL
(X-RAY)
FINAL LENGTH CUTTING
FINAL LENGTH
CONTROL
REF.MATERIAL
SAMPLING
PRESSING:
- HYDRAULIC PRESSING
- PROCESS CONTROL
MEASUREMENT
(HEIGHT
DENSITY
PERPENDICULARITY
DIAMETER
DISH DEPTH
DISH DIAMETER
WEIGHT
VISUAL CONTROL)
SINTERING
- SINTER AT 1700
DEG-C HOURS
- PRESS CONTROL
DIMENSIONS
IMMENSION DENSITY
CENTERLESS GRINDING
FINAL INSPECTION;
- PELLETS LENGTH
- PELLETS DIAMETER
- PELLETS
PERPENDICULARITY
- DISH DEPTH
- DISH DIAMETER
- SHOULDER
- WEIGHT
- DENSITY
- CHEM. COMP.
- MOISTURE
- SURFACE ROUGHNESS
- TOTAL GAS ANALYSIS
- DENSITY STABILITY
- METALLOGRAPHY
REF. MATERIAL
SAMPLING
FUEL STACK MAKE-UP
- WEIGHT
- LENGTH
- VISUAL CONTROL
- FISSILE LOAD CALC.
- PHOTOGRAPHY
LOADING
CONTROL OF PLENUM LENGTH
CUT HOLD DOWN SPRING
CONTROL OF SPRING LENGTH
INSERTION OF SPRING
BLENDING
PRE-PRESSING
PRESSING
SINTERING
FINAL INSPECTION
- DENSITY
- COMPRESSIVE
STRENGTH
- DIAMETER
- LENGTH
- WEIGHT
- VISUAL
EXAMINATION
- METALLOGRAPHY
EXAMINATION
DRYING
MOISTURE CONTROL
CHEMICAL
COMPOSITION
TOTAL GAS
ANALISIS
REF. MATERIAL
SAMPLING

TOP END PLUG INSERTION
|
EB WELDING
|
ROD DRYING(SPECIAL AA PROCEDURE)
|
SEEL WELDING
|
X-RAY WELD CONTROL
|
HE LEAK TESTING
|
MOISTURE ANALYSIS(FINISHED ROD SAMPLE)
|
VISUAL INSPECTION(WELDS,SURFACES)
|
SMEAR TEST
|
FILL GAS ANALYSIS
|
PACKING(RODS,ARCHIVE MATERIAL)
|
DOCUMENTATION
|
RELEASE FOR TRANSPORT TO STUDSVIK

(79) REMARKS

*1) MATERIAL PRODUCER: PECHINEY UGINE KUHLMANN,FRANCE.
*2) SUBCONTRACTOR: WILLO MASKINAKTIEBOLAG,VAXJO,SWEDEN.
*3) SUPPLIER: SANDVIK AB,SWEDEN.
*4) TUBE MANUFACTURER: SANDVIK SPECIAL METALS,KENNEWICK,USA.
*5) PROCESS SCHEME APPLIES ALSO TO UNO2 PELLETS (WITH SOME MINOR DEVIATIONS)

*6) UO2 FUEL POWDER PRODUCE: REAKTORBRENNSTOFFUNON,HANSU,FRG.
*7) POWDER SUPPLIER: HARBINSON AND WALKER,ENGLAND.

(80) REFERENCE

STIR-53 FIGURE 7.3

<* 130003 *> FUEL ROD COMPONENTS AND SPECIFICATIONS -INTER RAMP- ** 130003 **

(EXTRACTED FROM AND SUPERSEEDED BY MANUFACTURING DRAWING)

STUDVIK
INTER-RP
COMMON
DATA

---(1)-*---(2)-*---(3)-*---(4)-*---(5)-*---(6)-*---(7)-*---(8)-*

(1)	FUEL ROD		
(2)	OVERALL LENGTH (MM)	538 +- 1.2	
(3)	DIAMETER (MM)	12.52 +- 0.05	
(4)	FUEL STACK HEIGHT (MM)	425 +- 5	TOTAL STACK
		403 +- 7	ENRICHED PELLETS
(5)	NOMINAL PLENUM CHAMBER L.(MM)	49	
(6)	NUMBER OF PELLETS PER ROD	31 - 35	TOTAL STACK
		29 - 33	ENRICHED PELLETS
			2 NATURAL UO2 PELLETS
(7)	FUEL/CLAD DIAMETRAL GAPS (MM)	0.080, 0.150, AND 0.250 +- 0.015	
(8)	FILL GAS COMPOSITION	> 97 % HE	
(9)	PRESSURE (NOMINAL)	1 ATM	
(10)	PLENUM CHAMBER (DESIGN TARGET)	TO ACCOMODATE ALL RELEASED FISSION GASES AT BURNUP LEVELS UP TO 20000 MWD/TU	
(11)	CLAD		
(12)	MATERIAL	ZIRCALOY 2	
(13)	DIAMETER OUTSIDE (MM)	12.52 +- 0.05	
(14)	INSIDE (MM)	10.795 +- 0.040	
(15)	CLAD WALL THICK. (MM)	0.864 +- 10 %	
(16)	NOMINAL SURFACE ROUGH.(MIC.-M)	0.8	
(17)	OVALITY	NOT SPECIFIED	
(18)	ECCENTRICITY	NOT SPECIFIED	
(19)	GRAIN SIZE	NOT SPECIFIED	
(20)	FUEL		
(21)	MATERIAL	UO2	
(22)	ENRICHMENT	0.7, 2.8, AND 3.5 W/O U-235/U-T	
(23)	PELLET SINTERED DENSITY	95.0 +1 -0.5 % TD 93.0 +1 -0.5 % TD	
(24)	PELLET DIAMETER (MM) :		
(25)	80 MICRON-M GAP ENRICHED UO2	(TUBE ID - 0.080) +- 0.015	
(26)	150 MICRON-M GAP ENRICHED UO2	(TUBE ID - 0.150) +- 0.015	
(27)	250 MICRON-M GAP ENRICHED UO2	(TUBE ID - 0.250) +- 0.015	
(28)	250 MICRON-M GAP NATURAL UO2	(TUBE ID - 0.250) +- 0.015	
(29)	PELLET LENGTH (MM)	13 +- 1	
(30)	DISH DIMENSION DEPTH (MM)	0.26 +- 0.05	
(31)	DIAMETER (NOMINAL) (MM)	8.2	
(32)	SHOULDER WIDTH (MM)	0.75	
(33)	RADIUS OF SPHERE(NOMINAL) MM	31.6	
(34)	NOMINAL SURFACE FINISH	RA 1.5 MICRON-M	
(35)	NON-FUELLED SPACER PELLET		
(36)	MATERIAL	ZRO2 - (4.0 - 5.0) W/O CAO	
(37)	DIAMETER (MM)	10.40 +- 0.15	
(38)	LENGTH (MM)	5 +- 1	
(39)	DENSITY (GM/CM**3)	5.2 +- 0.4	
(40)	FUEL STACK HOLDDOWN SPRING		
(41)	MATERIAL	STAINLESS STEEL SIS-2331	
(42)	LOAD (DESIGN TARGET)	2 X WEIGHT OF FUEL STACK +- 10%	
(43)	END PLUGS		
(44)	MATERIAL	ZIRCALOY 2	
(79)	REMARKS		
(80)	REFERENCE	STIR-53 TABLE 3	

<* 130004 *> ROD DESIGNATION - CHARACTERISTIC SETS OF PARAMETER VALUES ** 130004 **

STUDVIK
INTER-RP
COMMON
DATA

		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
(1)	ROD DESIGNATION	HS	LS	TS	BR	HR	OR	LR	TR
(2)	NUMBER OF RODS	4	5	2	1	5	2	7	2
(3)	NO. OF RODS IN ARCHIVE	1	1	1	1	1	1	2	1
(11)	FUEL/CLAD DIAMETER GAP(MICRON-M)	150.	150.	80.	250.	150.	150.	150.	80.
(12)	GAP TOLERANCE	---- PM 15 (MICRON-M) ----- *							
(14)	CLAD HEAT TREATMENT	SR	SR	SR	RX	RX	RX	RX	RX
(15)	FUEL DENSITY (%TD)	95.	95.	95.	95.	95.	93.	95.	95.
(16)	DENSITY TOLERANCE	---- + 1, - 0.5 (%TD) ----*							
(17)	FUEL ENRICHMENT (% U-235)	3.5	2.8	2.8	3.5	3.5	2.8	2.8	2.8

(79) REMARKS
SR: STRESS RELIEVED CLADDING/ RX: RECRYSTALLIZED CLADDING.
SR: TUBE LOT NO. 7AH11-H / RX: TUBE LOT NO. 7AH11-S.

(80) REFERENCE
STIR-4, P.-5, 12. TABLE 2

<* 130005 *> DRAWINGS REFERENCE - PELLET, FUEL ROD, ASSEMBLY, PARTS -* ** 130005 **

STUDVIK
INTER-RP
COMMON
DATA

(1) PELLET
(11) FUEL ROD
** INTERRAMP PROJECT FUEL ROD DESIGN **
** FIG. 2, STIR-4, P-9 **

<* 130006 *> TEST FUEL ROD DATA -INTER RAMP LR,LS,TR- ** 130006 **

STUDVIK
INTER-RP
COMMON
DATA

		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
(1)	BIRP RIG NO.	1	1	1	1	3	3	3	3
(2)	ROD NO.	1	2	3	4	5	6	7	8
(3)	ROD IDENTIFICATION	LR1	LR2	LR3	LR4	LR5	LS1	LS2	TR1
(4)	CLADDING TYPE	RX	RX	RX	RX	RX	SR	SR	RX
(5)	UO 2 ENRICHMENT (%)	2.82	2.82	2.82	2.82	2.82	2.82	2.82	2.82
(10)	NO. OF ENRICHED PELLETS	31	31	31	31	31	31	31	31
(11)	UO 2 TOT. PELLET COLUMN L. (MM)	426.8	427.2	426.4	426.6	426.8	426.2	425.8	428.0
(12)	UO2 ENRICHED PELLET COLUMN L(MM)	400.8	401.0	400.8	400.9	400.9	400.5	400.0	402.0
(13)	SPACER PELLET LENGTH (MM)	5.2	5.3	5.1	5.1	5.3	5.0	5.2	5.1
(10)	NO. OF ENRICHED PELLETS	42.1	41.6	42.6	42.5	42.0	42.8	43.1	40.9
(15)	CLADDING OUTER DIA. MIN (MM) *1)	12.530	12.515	12.525	12.525	12.530	12.525	12.520	12.535
(16)	CLADDING OUTER DIA. MAX (MM) *1)	12.545	12.520	12.530	12.535	12.535	12.530	12.520	12.545
(17)	CLADDING INNER DIA. MIN (MM) *1)	10.790	10.795	10.780	10.785	10.785	10.775	10.775	10.790
(18)	CLADDING INNER DIA. MAX (MM) *1)	10.800	10.805	10.805	10.800	10.800	10.805	10.805	10.805
(19)	CLADDING WALL THICK. MIN (MM)*2)	0.845	0.835	0.845	0.860	0.845	0.850	0.835	0.845
(20)	CLADDING WALL THICKNESS MAX (MM)	0.885	0.880	0.885	0.880	0.880	0.875	0.875	0.890
(21)	UO 2 PELLET DIAMETER MIN (MM) *3	10.635	10.640	10.641	10.640	10.639	10.633	10.635	10.691
(22)	UO 2 PELLET DIAMETER MAX (MM)	10.650	10.655	10.654	10.654	10.656	10.652	10.650	10.716
(23)	DIAMETRAL PELLET CLADDING GAP MIN (MM) *4)	0.144	0.145	0.138	0.134	0.139	0.132	0.130	0.079
(25)	DIAMETRAL PELLET CLADDING GAP MAX (MM) *4)	0.161	0.159	0.158	0.153	0.154	0.164	0.170	0.114
(27)	UO 2 TOTAL FUEL WEIGHT (GRAM)	389.0	389.9	389.1	388.9	389.4	387.9	388.3	394.3
(28)	UO 2 ENRICHED FUEL WEIGHT (GRAM)	365.6	366.3	365.9	365.9	366.1	364.7	365.2	371.0
(29)	ENRICHED PELLET DENSITY MIN. (G/CM**3) *5)	10.328	10.361	10.337	10.315	10.312	10.296	10.342	10.292
(31)	ENRICHED PELLET DENSITY MAX. (G/CM**3) *5)	10.434	10.423	10.434	10.414	10.430	10.410	10.424	10.419

(79) REMARKS

*1) FROM MEASUREMENTS AT 2 GENERATORS AND 10 AXIAL POSITIONS.
*2) FROM MEASUREMENTS ONLY AT THE TUBING ENDS.
*3) FROM MEASUREMENTS ON ALL ENRICHED PELLETS.
*4) CALCULATED FROM MEASUREMENTS OF PELLET DIAMETERS AND CLADDING TUBE INNER DIAMETER AT 8 AXIAL POSITIONS.
*5) GEOMETRIC DENSITY DETERMINATION.

(80) REFERENCES

STIR-53 TABLE-7

<* 130007 *> TEST FUEL ROD DATA -INTER RAMR LS,TS,DR,HR- ** 130007 **

STUDVIK
INTER-RP
COMMON
DATA

		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
(1)	BIRP RIG NO.	5	5	5	5	2	2	2	2
(2)	ROD NO.	9	10	11	12	13	14	15	16
(3)	ROD IDENTIFICATION	LS3	LS4	TS1	DR1	HR2	HR3	HR4	HR5
(4)	CLADDING TYPE	SR	SR	RX	RX	RX	RX	RX	RX
(5)	UO 2 ENRICHMENT (%)	2.82	2.82	2.82	2.82	3.50	3.50	3.50	3.50
(10)	NO. OF ENRICHED PELLETS	31	31	31	31	31	31	31	31
(11)	UO 2 TOT. PELLET COLUMN L. (MM)	427.1	427.4	428.2	427.3	426.8	426.7	426.8	427.0
(12)	UO2 ENRICHED PELLET COLUMN L(MM)	401.6	401.7	402.0	401.3	400.9	400.8	400.9	400.9
(13)	SPACER PELLET LENGTH (MM)	5.2	5.0	5.2	5.2	5.2	5.3	5.3	5.3
(14)	FISSION GAS PLENUM LENGTH (MM)	41.8	41.7	40.5	41.4	42.2	41.8	42.2	42.0
(15)	CLADDING OUTER DIA. MIN (MM) *1)	12.525	12.525	12.515	12.525	12.520	12.525	12.540	12.530
(16)	CLADDING OUTER DIA. MAX (MM) *1)	12.535	12.535	12.520	12.530	12.530	12.540	12.555	12.540
(17)	CLADDING INNER DIA. MIN (MM) *1)	10.775	10.795	10.790	10.785	10.790	10.785	10.770	10.770
(18)	CLADDING INNER DIA. MAX (MM) *1)	10.800	10.805	10.810	10.800	10.820	10.795	10.800	10.800
(19)	CLADDING WALL THICK. MIN (MM)*2)	0.845	0.840	0.840	0.835	0.830	0.840	0.845	0.845
(20)	CLADDING WALL THICKNESS MAX (MM)	0.875	0.875	0.865	0.880	0.875	0.880	0.895	0.880
(21)	UO 2 PELLET DIAMETER MIN (MM) *3	10.638	10.633	10.703	10.640	10.623	10.639	10.638	10.623
(22)	UO 2 PELLET DIAMETER MAX (MM)	10.652	10.651	10.717	10.651	10.654	10.653	10.655	10.656
(23)	DIAMETRAL PELLET CLADDING GAP MIN (MM) *4)	0.133	0.149	0.085	0.135	0.137	0.136	0.121	0.123
(25)	DIAMETRAL PELLET CLADDING GAP MAX (MM) *4)	0.162	0.160	0.102	0.149	0.175	0.152	0.154	0.157
(27)	UO 2 TOTAL FUEL WEIGHT (GRAM)	388.9	389.3	394.7	381.6	388.2	388.5	388.4	388.6
(28)	UO 2 ENRICHED FUEL WEIGHT (GRAM)	366.0	366.3	371.3	358.3	365.1	365.3	365.4	365.3
(29)	ENRICHED PELLET DENSITY MIN. (G/CM**3) *5)	10.332	10.334	10.306	10.155	10.291	10.328	10.336	10.312
(31)	ENRICHED PELLET DENSITY MAX. (G/CM**3) *5)	10.404	10.411	10.424	10.195	10.377	10.373	10.444	10.384

(79) REMARKS

*1) FROM MEASUREMENTS AT 2 GENERATORS AND 10 AXIAL POSITIONS.
*2) FROM MEASUREMENTS ONLY AT THE TUBING ENDS.
*3) FROM MEASUREMENTS ON ALL ENRICHED PELLETS.
*4) CALCULATED FROM MEASUREMENTS OF PELLET DIAMETERS AND CLADDING TUBE INNER DIAMETER AT 8 AXIAL POSITIONS.
*5) GEOMETRIC DENSITY DETERMINATION.

(80) REFERENCES STIR-53 TABL-7

<* 130008 *> TEST FUEL ROD DATA -INTER RAMP HS,BR- ** 130008 **

STUDVIK
INTER-RP
COMMON
DATA

(1)	BIRP RIG NO.	4	4	4	4
(2)	ROD NO.	17	18	19	20
(3)	ROD IDENTIFICATION	HS1	HS2	HS3	BR1
(4)	CLADDING TYPE	SR	SR	SR	RX
(5)	UO 2 ENRICHMENT (%)	3.50	3.50	3.50	3.50
(10)	NO. OF ENRICHED PELLETS	30	30	31	30
(11)	UO 2 TOT. PELLET COLUMN L. (MM)	425.2	425.0	427.0	423.3
(12)	UO2 ENRICHED PELLET COLUMN L(MM)	399.1	399.0	401.0	397.0
(13)	SPACER PELLET LENGTH (MM)	5.3	5.2	5.3	5.3
(14)	FISSION GAS PLENUM LENGTH (MM)	43.5	44.0	41.8	45.9
(15)	CLADDING OUTER DIA. MIN (MM) *1)	12.530	12.530	12.525	12.540
(16)	CLADDING OUTER DIA. MAX (MM) *1)	12.535	12.535	12.525	12.550
(17)	CLADDING INNER DIA. MIN (MM) *1)	10.780	10.785	10.780	10.780
(18)	CLADDING INNER DIA. MAX (MM) *1)	10.795	10.800	10.795	10.800
(19)	CLADDING WALL THICK. MIN (MM)*2)	0.840	0.840	0.835	0.845
(20)	CLADDING WALL THICKNESS MAX (MM)	0.880	0.885	0.880	0.890
(21)	UO 2 PELLET DIAMETER MIN (MM) *3	10.631	10.633	10.630	10.531
(22)	UO 2 PELLET DIAMETER MAX (MM)	10.651	10.651	10.649	10.551
(23)	DIAMETRAL PELLET CLADDING GAP MIN (MM) *4)	0.136	0.135	0.136	0.229
(25)	DIAMETRAL PELLET CLADDING GAP MAX (MM) *4)	0.154	0.159	0.158	0.253
(27)	UO 2 TOTAL FUEL WEIGHT (GRAM)	386.8	386.5	388.0	377.3
(28)	UO 2 ENRICHED FUEL WEIGHT (GRAM)	363.5	363.3	364.8	354.0
(29)	ENRICHED PELLET DENSITY MIN. (G/CM**3) *5)	10.327	10.309	10.291	10.287
(31)	ENRICHED PELLET DENSITY MAX. (G/CM**3) *5)	10.370	10.364	10.366	10.359

(79) REMARKS

*1) FROM MEASUREMENTS AT 2 GENERATORS AND 10 AXIAL POSITIONS.
*2) FROM MEASUREMENTS ONLY AT THE TUBING ENDS.
*3) FROM MEASUREMENTS ON ALL ENRICHED PELLETS.
*4) CALCULATED FROM MEASUREMENTS OF PELLET DIAMETERS AND CLADDING TUBE INNER DIAMETER AT 8 AXIAL POSITIONS.
*5) GEOMETRIC DENSITY DETERMINATION.

(80) REFERENCES STIR-53 TABLE-7

<* 130009 *> TEST ROD DIMENSIONS AND WEIGHTS -INTER RAMP LR- ** 130009 **

STUDVIK
INTER-RP
COMMON
DATA

---(1)-*---(2)-*---(3)-*---(4)-*---(5)-*---(6)-*---(7)-*---(8)-*

		LR1	LR2	LR3	LR4
(1)	ROD NO.				
(2)	EXTERNAL LENGTH A) (MM)	527.98	528.06	527.97	528.01
(3)	B) (MM)	573.00	573.15	572.87	573.01
(4)	PLENUM CHAMBER LENGTH (MM)	41.9	41.6	42.5	42.3
(5)	TOP NAT PELLET HEIGHT (MM)	12.99	13.28	13.02	12.83
(6)	ENRICHED FUEL STACK HEIGHT (MM)	400.69	400.81	400.45	400.76
(7)	LOWER NAT PELLET HEIGT (MM)	13.21	13.00	12.91	12.93
(8)	WEIGHT OF ROD (GRAM)FS	532.0	531.7	531.9	532.2

(79) REMARKS

EXTERNAL LENGTH.
A) LENGTH OF TEST ROD ONLY BETWEEN THE FLAT END FACES,AT 20 C.
B) LENGHT OF TEST ROD WITH EXTENSIONS, AT 20 C.

(80) REFERENCES

STIR-5 TABLE-1

<* 130010 *> INTER RAMR FUEL RODS SPECIFICATION -LR,LS,TR- ** 130010 **

STUDVIK
INTER-RP
COMMON
DATA

---(1)-*---(2)-*---(3)-*---(4)-*---(5)-*---(6)-*---(7)-*---(8)-*

(1) TEST NAME ** INTER RAMP (BWR) **

		LR1	LR2	LR3	LR4	LR5	LS1	LS2	TR1
(2)	ROD NAME								
(3)	CLADDING OUTER DIA. (MM)	12.52	12.52	12.52	12.52	12.52	12.52	12.52	12.52
(4)	INNER DIA. (MM)	10.80	10.80	10.80	10.80	10.80	10.80	10.80	10.80
(5)	THICKNESS (MM)	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86
(6)	GAP (MM)	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.08
(7)	PELLET OUTER DIA. (MM)	10.6475	10.648	10.654	10.6565	10.6535	10.652	10.65	10.6935
(8)	INNER DIA. (MM)								
(9)	LENGTH (MM)	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0
(10)	L / D (LENGTH / DIA.)	1.22	1.22	1.22	1.22	1.22	1.22	1.22	1.22
(11)	U-235 ENRICHMENT	0.0282	0.0282	0.0282	0.0282	0.0282	0.0282	0.0282	0.0282
(12)	DENSITY/THEORITICAL DENSITY	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
(13)	DISH DIA. (MM)	8.52	8.52	8.52	8.52	8.52	8.52	8.52	8.50
(14)	DISH DEPTH (MM)	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24
(15)	CHAMFER (MM)								
(16)	PLENUM VOLUME(10**2 MM**3)	3.83	3.70	3.79	3.78	3.74	3.81	3.94	3.75
(17)	INITIAL GAS PRESSURE (MPA)	0.101	0.101	0.101	0.101	0.101	0.101	0.101	0.101
(18)	INITIAL GAS CONPOSITION	HE	HE	HE	HE	HE	HE	HE	HE
(19)	PELLET TOTAL WEIGHT (GRAM)	370.83	370.86	371.15	371.46	371.25	371.15	371.01	374.04
(20)	STACK LENGTH (MM)								
(21)	BURNUP (GWD/T)	11.1	9.3	9.8	11.3	9.6	10.0	11.4	11.0

(79) REMARKS

(80) REFERENCE

<** 130011 *> INTER RAMP FUEL RODS SPECIFICATION -LS,TS,DR,HR- ** 130011 **

STUDVIK
INTER-RP
COMMON
DATA

---(1)-*---(2)-*---(3)-*---(4)-*---(5)-*---(6)-*---(7)-*---(8)-*

(1)	TEST NAME		** INTER RAMP (BWR) **						
(2)	ROD NAME		LS3	LS4	TS1	DR1	HR2	HR3	HR4	HR5
(3)	CLADDING OUTER DIA.	(MM)	12.52	12.52	12.52	12.52	12.52	12.52	12.52	12.52
(4)	INNER DIA.	(MM)	10.80	10.80	10.80	10.80	10.80	10.80	10.80	10.80
(5)	THICKNESS	(MM)	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86
(6)	GAP	(MM)	0.15	0.15	0.08	0.15	0.15	0.15	0.15	0.08
(7)	PELLET OUTER DIA.	(MM)	10.6525	10.645	10.6965	10.658	10.634	10.646	10.6525	10.65
(8)	INNER DIA.	(MM)								
(9)	LENGTH	(MM)	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0
(10)	L / D (LENGTH / DIA.)		1.22	1.22	1.22	1.22	1.22	1.22	1.22	1.22
(11)	U-235 ENRICHMENT		0.0282	0.0282	0.0282	0.0282	0.035	0.035	0.035	0.035
(12)	DENSITY/THEORITICAL DENSITY		0.95	0.95	0.95	0.93	0.95	0.95	0.95	0.95
(13)	DISH DIA.	(MM)	8.52	8.52	8.50	8.29	8.56	8.56	8.56	8.56
(14)	DISH DEPTH	(MM)	0.24	0.24	0.25	0.27	0.22	0.22	0.22	0.22
(15)	CHAMFER	(MM)								
(16)	PLENUM VOLUME(10**2 MM**3)		3.81	3.71	3.65	3.80	3.88	3.72	3.86	3.83
(17)	INITIAL GAS PRESSURE	(MPA)	0.101	0.101	0.101	0.101	0.101	0.101	0.101	0.101
(18)	INITIAL GAS CONPOSITION		HE	HE	HE	HE	HE	HE	HE	HE
(19)	PELLET TOTAL WEIGHT	(GRAM)	371.18	370.69	374.25	363.74	369.89	370.73	371.18	371.01
(20)	STACK LENGTH	(MM)								
(21)	BURNUP	(GWD/T)	9.0	11.4	10.8	8.7	18.2	19.2	21.8	21.3
(79)	REMARKS									
(80)	REFERENCE									

*** FUEL PERFORMANCE DATA *** DATE = 86-05 **PAGE** (D- 40)

<* 130012 *> INTER RAMP FUEL RODS SPECIFICATION -HS,BR- ** 130012 **

STUDVIK
INTER-RP
COMMON
DATA

---(1)-*---(2)-*---(3)-*---(4)-*---(5)-*---(6)-*---(7)-*---(8)-*

(1)	TEST NAME		** INTER RAMP (BWR) **			
(2)	ROD NAME		HS1	HS2	HS3	BR1
(3)	CLADDING	OUTER DIA. (MM)	12.52	12.52	12.52	12.52
(4)		INNER DIA. (MM)	10.80	10.80	10.80	10.80
(5)		THICKNESS (MM)	0.86	0.86	0.86	0.86
(6)	GAP	(MM)	0.15	0.15	0.15	0.25
(7)	PELLET	OUTER DIA. (MM)	10.645	10.43	10.643	10.549
(8)		INNER DIA. (MM)				
(9)		LENGTH (MM)	13.0	13.0	13.0	13.0
(10)	L / D (LENGTH / DIA.)		1.22	1.22	1.22	1.23
(11)	U-235 ENRICHMENT		0.035	0.035	0.035	0.035
(12)	DENSITY/THEORITICAL DENSITY		0.95	0.95	0.95	0.95
(13)		DISH DIA. (MM)	8.56	8.56	8.56	8.59
(14)		DISH DEPTH (MM)	0.22	0.22	0.22	0.22
(15)		CHAMFER (MM)				
(16)	PLENUM VOLUME(10**2 MM**3)		3.98	4.02	3.72	4.19
(17)	INITIAL GAS PRESSURE (MPA)		0.101	0.101	0.101	0.101
(18)	INITIAL GAS CONPOSITION		HE	HE	HE	HE
(19)	PELLET TOTAL WEIGHT (GRAM)		370.66	370.52	370.52	364.0
(20)	STACK LENGTH (MM)					
(21)	BURNUP (GWD/T)		21.2	18.2	19.2	21.9
(79)	REMARKS					
(80)	REFERENCE					

<* 130013 *> DEMO RAMP FUEL RODS SPECIFICATION -BWR (1)- ** 130013 **

STUDVIK
DEMO -RP
COMMON
DATA

(1)	TEST NAME		** DEMO RAMP (BWR) **							
(2)	ROD NAME		S30H	S30H	S31H	S35H	S27H	S36H	S29H	S38H
(3)	CLADDING	OUTER DIA. (MM)	12.51	12.51	12.51	12.51	12.51	12.51	12.51	12.51
(4)		INNER DIA. (MM)	10.805	10.805	10.805	10.805	10.805	10.805	10.805	10.80
(5)		THICKNESS (MM)	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86
(6)	GAP	(MM)	0.205	0.205	0.205	0.205	0.205	0.205	0.205	0.20
(7)	PELLET	OUTER DIA. (MM)	10.60		10.60	10.60	10.60	10.60	10.60	10.60
(8)		INNER DIA. (MM)								
(9)		LENGTH (MM)	12.0		12.0	12.0	12.0	12.0	12.0	12.0
(10)	L / D (LENGTH / DIA.)		1.13		1.13	1.13	1.13	1.13	1.13	1.13
(11)	U-235 ENRICHMENT		0.0302		0.0302	0.0302	0.0302	0.0302	0.0302	0.03
(12)	DENSITY/THEORITICAL DENSITY		0.96		0.96	0.96	0.96	0.96	0.96	0.96
(13)		DISH DIA. (MM)	9.3		9.3	9.3	9.3	9.3	9.3	9.3
(14)		DISH DEPTH (MM)	0.25		0.25	0.25	0.25	0.25	0.25	0.25
(15)		CHAMFER (MM)	0.6X0.02		0.6X0.02	"	"	"	"	"
(16)	PLENUM VOLUME(10**2 MM**3)		3.99		3.0	3.0	3.0	3.0	3.0	3.0
(17)	INITIAL GAS PRESSURE (MPA)		0.1		0.1	0.1	0.1	0.1	0.1	0.1
(18)	INITIAL GAS CONPOSITION		HE		HE	HE	HE	HE	HE	HE
(19)	PELLET TOTAL WEIGHT (GRAM)		272.0		271.9	272.5	272.6	272.1	272.4	272.0
(20)	STACK LENGTH	(MM)								
(21)	BURNUP	(GWD/T)	26.9	26.9	25.1	29.1	28.7	28.6	28.1	27.6
(79)	REMARKS									
(80)	REFERENCE									

<* 130014 *> DEMO RAMP FUEL RODS SPECIFICATION -BWR (2)- ** 130014 **

STUDVIK
DEMO -RP
COMMON
DATA

---(1)-*---(2)-*---(3)-*---(4)-*---(5)-*---(6)-*---(7)-*---(8)-*

(1)	TEST NAME		** DEMO RAMP (BWR) **
(2)	ROD NAME		S39H
(3)	CLADDING OUTER DIA.	(MM)	12.51
(4)	INNER DIA.	(MM)	10.805
(5)	THICKNESS	(MM)	0.86
(6)	GAP	(MM)	0.205
(7)	PELLET OUTER DIA.	(MM)	10.60
(8)	INNER DIA.	(MM)	
(9)	LENGTH	(MM)	12.0
(10)	L / D (LENGTH / DIA.)		1.13
(11)	U-235 ENRICHMENT		0.0302
(12)	DENSITY/THEORITICAL DENSITY		0.96
(13)	DISH DIA.	(MM)	9.3
(14)	DISH DEPTH	(MM)	0.2502
(15)	CHAMFER	(MM)	0.6X0.02
(16)	PLENUM VOLUME(10**2 MM**3)		3.0
(17)	INITIAL GAS PRESSURE	(MPA)	0.1
(18)	INITIAL GAS CONPOSITION		HE
(19)	PELLET TOTAL WEIGHT	(GRAM)	272.3
(20)	STACK LENGTH	(MM)	
(21)	BURNUP	(GWD/T)	25.7
(79)	REMARKS		
(80)	REFERENCE		

<* 130015 *> SUPER RAMP FUEL RODS SPECIFICATION -PWR (1)- ** 130015 **

STUDVIK
SUPER-RP
COMMON
DATA

			---(1)-*---(2)-*---(3)-*---(4)-*---(5)-*---(6)-*---(7)-*---(8)-*							
(1)	TEST NAME		** SUPER RAMP (PWR) **							
(2)	ROD NAME		PK4/1	PK4/2	PK4/3	PK4/S	PK6/1	PK6/2	PK6/3	PK6/4
(3)	CLADDING	OUTER DIA. (MM)	10.75	10.75	10.75	10.75	10.75	10.75	10.75	10.75
(4)		INNER DIA. (MM)								
(5)		THICKNESS (MM)								
(6)	GAP	(MM)	0.17	0.17	0.17	0.17	0.14	0.14	0.14	0.14
(7)	PELLET	OUTER DIA. (MM)			9.113	9.113	9.144	9.144	9.144	9.144
(8)		INNER DIA. (MM)								
(9)		LENGTH (MM)			10.799	10.799	11.1	11.1	11.1	11.1
(10)	L / D (LENGTH / DIA.)				1.19	1.19	1.21	1.21	1.21	1.21
(11)	U-235 ENRICHMENT				0.02985	0.02985	0.02985	0.02985	0.02985	"
(12)	DENSITY/THEORITICAL DENSITY				0.9393	0.9393	0.9510	0.9510	0.9510	"
(13)		DISH DIA. (MM)			7.9	7.9	6.544	0.6544	0.6544	"
(14)		DISH DEPTH (MM)			0.25	0.25	0.58	0.58	0.58	"
(15)		CHAMFER (MM)			0.6X0.02	"	0.56X0.18	"	"	"
(16)	PLENUM VOLUME(10**2 MM**3)				2.2	2.2	1.5	1.5	1.5	1.5
(17)	INITIAL GAS PRESSURE (MPA)				2.3	2.3	2.3	2.3	2.3	2.3
(18)	INITIAL GAS CONPOSITION				HE	HE	HE	HE	HE	HE
(19)	PELLET TOTAL WEIGHT (GRAM)				205.0	205.0	208.0	208.0	207.0	207.0
(20)	STACK LENGTH (MM)									
(21)	BURNUP (GWD/T)		33.7	33.8	33.6	32.5	36.7	36.8	36.5	33.6
(79)	REMARKS									
(80)	REFERENCE									

<* 130016 *> SUPER RAMP FUEL RODS SPECIFICATION -PWR (2)- ** 130016 **

STUDVIK
SUPER-RP
COMMON
DATA

			** SUPER RAMP (PWR) **							
(1)	TEST NAME									
(2)	ROD NAME		PK6/S	PW3/1	PW3/2	PW3/3	PW3/4	PW5/1	PW5/2	PW5/3
(3)	CLADDING	OUTER DIA. (MM)	10.75	9.5	9.5	9.5	9.5	9.5	9.5	9.5
(4)		INNER DIA. (MM)								
(5)		THICKNESS (MM)								
(6)	GAP	(MM)	0.14	0.165	0.165	0.165	0.165	0.165	0.165	0.165
(7)	PELLET	OUTER DIA. (MM)	9.144	8.19	8.19	8.19	8.19	8.19	8.19	8.19
(8)		INNER DIA. (MM)						2.17	2.17	2.17
(9)		LENGTH (MM)	11.1	13.36	13.36	13.36	13.36	13.56	13.56	13.56
(10)	L / D (LENGTH / DIA.)		1.21	1.63	1.63	1.63	1.63	1.66	1.66	1.66
(11)	U-235 ENRICHMENT		0.02985	0.0826	0.0826	0.0826	0.0826	0.0574	0.0574	0.057
(12)	DENSITY/THEORITICAL DENSITY		0.9510	0.949	0.949	0.949	0.949	0.949	0.949	0.949
(13)		DISH DIA. (MM)	6.544	5.97	5.97	5.97	5.97			
(14)		DISH DEPTH (MM)	0.58	0.305	0.305	0.305	0.305			
(15)		CHAMFER (MM)	0.56X0.18							
(16)	PLENUM VOLUME(10**2 MM**3)		1.5	6.47	6.55	6.57	5.76	6.64	6.66	6.67
(17)	INITIAL GAS PRESSURE (MPA)		2.3	1.38	1.38	1.38	1.38	1.38	1.38	1.38
(18)	INITIAL GAS CONPOSITION		HE	HE	HE	HE	HE	HE	HE	HE
(19)	PELLET TOTAL WEIGHT	(GRAM)	207.0	529.0	528.0	529.0	535.0	493.0	493.0	493.0
(20)	STACK LENGTH	(MM)	S14.9	979.8	979	979.0	990.1	977.2	976.2	977.S
(21)	BURNUP	(GWD/T)	39.6	30.7	29.1	29.2	31.1	32.7	32.2	33.4
(79)	REMARKS									
(80)	REFERENCE									

<* 130017 *> SUPER RAMP FUEL RODS SPECIFICATION -PWR (3)- ** 130017 **

STUDVIK
SUPER-RP
COMMON
DATA

---(1)-*---(2)-*---(3)-*---(4)-*---(5)-*---(6)-*---(7)-*---(8)-*

(1)	TEST NAME		** SUPER RAMP (PWR) **						
(2)	ROD NAME		PW5/4	PK1/1	PK1/2	PK1/3	PK1/4	PK1/S	PK2/1	PK2/2
(3)	CLADDING OUTER DIA.	(MM)	9.5	10.75	10.75	10.75	10.75	10.75	10.75	10.75
(4)	INNER DIA.	(MM)								
(5)	THICKNESS	(MM)								
(6)	GAP	(MM)	0.165	0.190	0.190	0.190	0.190	0.190	0.140	0.140
(7)	PELLET OUTER DIA.	(MM)	8.19	9.110	9.110	9.11	9.11	9.11	9.138	9.138
(8)	INNER DIA.	(MM)	2.17							
(9)	LENGTH	(MM)	13.56	11.135	11.35	11.35	11.35	11.35	11.34	11.34
(10)	L / D (LENGTH / DIA.)		1.66	1.22	1.22	1.22	1.25	1.22	1.24	1.24
(11)	U-235 ENRICHMENT		0.0574	0.032	0.032	0.032	0.032	0.032	0.0321	0.0321
(12)	DENSITY/THEORITICAL DENSITY		0.949	0.9452	0.9452	0.9452	0.9452	0.9452	0.9434	0.9434
(13)	DISH DIA.	(MM)		7.9	7.9	7.9	7.9	7.9	7.9	7.9
(14)	DISH DEPTH	(MM)		0.25	0.25	0.25	0.25	0.25	0.25	0.25
(15)	CHAMFER	(MM)		0.6X0.02	"	"	"	"	"	"
(16)	PLENUM VOLUME(10**2 MM**3)		6.69	2.2	2.2	2.2	2.2	2.2	2.2	2.2
(17)	INITIAL GAS PRESSURE	(MPA)	1.38	2.25	2.25	2.25	2.25	2.25	2.25	2.25
(18)	INITIAL GAS CONPOSITION		HE	HE	HE	HE	HE	HE	HE	HE
(19)	PELLET TOTAL WEIGHT	(GRAM)	493.0	206.0	206.0	205.0	206.0	206.0	210.0	210.0
(20)	STACK LENGTH	(MM)	976.5	311.1	311.5	310.0	311.4	311.4	317.4	317.8
(21)	BURNUP	(GWD/T)	31.6	35.4	35.6	35.2	33.1	34.0	45.2	45.1
(79)	REMARKS									
(80)	REFERENCE									

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<* 130018 *> SUPER RAMP FUEL RODS SPECIFICATION -PWR (4)- ** 130018 **

STUDVIK
SUPER-RP
COMMON
DATA

---(1)-*---(2)-*---(3)-*---(4)-*---(5)-*---(6)-*---(7)-*---(8)-*

			** SUPER RAMP (PWR) **		
(1)	TEST NAME				
(2)	ROD NAME		PK2/3	PK2/4	PK2/5
(3)	CLADDING OUTER DIA.	(MM)	10.75	10.75	10.75
(4)	INNER DIA.	(MM)			
(5)	THICKNESS	(MM)			
(6)	GAP	(MM)	0.140	0.140	0.140
(7)	PELLET OUTER DIA.	(MM)	9.138	9.138	9.138
(8)	INNER DIA.	(MM)			
(9)	LENGTH	(MM)	11.34	11.34	11.34
(10)	L / D (LENGTH / DIA.)		1.24	1.24	1.24
(11)	U-235 ENRICHMENT		0.0321	0.0321	0.0321
(12)	DENSITY/THEORITICAL DENSITY		0.9434	0.9434	0.9434
(13)	DISH DIA.	(MM)	7.9	7.9	7.9
(14)	DISH DEPTH	(MM)	0.25	0.25	0.25
(15)	CHAMFER	(MM)	0.6X0.02	"	"
(16)	PLENUM VOLUME(10**2 MM**3)		2.2	2.2	2.2
(17)	INITIAL GAS PRESSURE	(MPA)	2.25	2.25	2.25
(18)	INITIAL GAS CONPOSITION		HE	HE	HE
(19)	PELLET TOTAL WEIGHT	(GRAM)	210.0	209.0	206.0
(20)	STACK LENGTH	(MM)	319.0	317.2	311.4
(21)	BURNUP	(GWD/T)	44.6	41.4	43.4
(79)	REMARKS				
(80)	REFERENCE				

<* 130019 *> SUPER RAMP FUEL RODS SPECIFICATION -BWR (1)- ** 130019 **

STUDVIK
SUPER-RP
COMMON
DATA

			(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
(1)	TEST NAME		** SUPER RAMP (BWR) **							
(2)	ROD NAME		BK7/1	BK7/2	BK7/3	BK7/4	BK7/5	BK7/5	BK7/6	BK7/6
(3)	CLADDING OUTER DIA.	(MM)	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5
(4)	INNER DIA.	(MM)								
(5)	THICKNESS	(MM)								
(6)	GAP	(MM)	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20
(7)	PELLET OUTER DIA.	(MM)								
(8)	INNER DIA.	(MM)								
(9)	LENGTH	(MM)								
(10)	L / D (LENGTH / DIA.)									
(11)	U-235 ENRICHMENT									
(12)	DENSITY/THEORITICAL DENSITY									
(13)	DISH DIA.	(MM)								
(14)	DISH DEPTH	(MM)								
(15)	CHAMFER	(MM)								
(16)	PLENUM VOLUME(10**2 MM**3)									
(17)	INITIAL GAS PRESSURE	(MPA)								
(18)	INITIAL GAS CONPOSITION									
(19)	PELLET TOTAL WEIGHT	(GRAM)								
(20)	STACK LENGTH	(MM)								
(21)	BURNUP	(GWD/T)	37.7	36.5	34.8	31.8	38.4	38.4	37.2	37.2
(79)	REMARKS									
(80)	REFERENCE									

<* 130020 *> SUPER RAMP FUEL RODS SPECIFICATION -BWR (2)- ** 130020 **

STUDVIK
SUPER-RP
COMMON
DATA

(1)	TEST NAME		** SUPER RAMP (BWR) **						
(2)	ROD NAME		BK7/7	BK7/8	BG8/1	BG8/2	BG8/3	BG8/3	BG8/4	BG9/1
(3)	CLADDING	OUTER DIA. (MM)	12.5	12.5	12.5	12.5	12.5	12.5	*	12.5
(4)		INNER DIA. (MM)								
(5)		THICKNESS (MM)								
(6)	GAP	(MM)	0.20	0.20	0.10	0.10	0.10	0.10	*	0.23
(7)	PELLET	OUTER DIA. (MM)								
(8)		INNER DIA. (MM)								
(9)		LENGTH (MM)								
(10)	L / D (LENGTH / DIA.)									
(11)	U-235 ENRICHMENT									
(12)	DENSITY/THEORITICAL DENSITY									
(13)		DISH DIA. (MM)								
(14)		DISH DEPTH (MM)								
(15)		CHAMFER (MM)								
(16)	PLENUM VOLUME(10**2 MM**3)									
(17)	INITIAL GAS PRESSURE (MPA)									
(18)	INITIAL GAS CONPOSITION									
(19)	PELLET TOTAL WEIGHT (GRAM)									
(20)	STACK LENGTH (MM)									
(21)	BURNUP	(GWD/T)	35.4	32.6	30.3	*	27.2	*	*	28.4
(79)	REMARKS									
(80)	REFERENCE									

<* 130021 *> SUPER RAMP FUEL RODS SPECIFICATION -BWR (3)- ** 130021 **

STUDVIK
SUPER-RP
COMMON
DATA

(1)	TEST NAME		** SUPER RAMP (BWR) **		
(2)	ROD NAME		BG9/2	BG9/3	BG9/4
(3)	CLADDING OUTER DIA.	(MM)	12.5	12.5	12.5
(4)	INNER DIA.	(MM)			
(5)	THICKNESS	(MM)			
(6)	GAP	(MM)	0.23	0.23	0.23
(7)	PELLET OUTER DIA.	(MM)			
(8)	INNER DIA.	(MM)			
(9)	LENGTH	(MM)			
(10)	L / D (LENGTH / DIA.)				
(11)	U-235 ENRICHMENT				
(12)	DENSITY/THEORITICAL DENSITY				
(13)	DISH DIA.	(MM)			
(14)	DISH DEPTH	(MM)			
(15)	CHAMFER	(MM)			
(16)	PLENUM VOLUME(10**2 MM**3)				
(17)	INITIAL GAS PRESSURE	(MPA)			
(18)	INITIAL GAS CONPOSITION				
(19)	PELLET TOTAL WEIGHT	(GRAM)			
(20)	STACK LENGTH	(MM)			
(21)	BURNUP	(GWD/T)	31.1	28.5	31.0
(79)	REMARKS				
(80)	REFERENCE				

<* 130022 *> OVER RAMP FUEL RODS SPECIFICATION -PWR (1)- ** 130022 **

STUDVIK
OVER -RP
COMMON
DATA

				(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
(1)	TEST NAME			** OVER RAMP (PWR) **							
(2)	ROD NAME			A10/1	A10/2	A10/3	A10/4	E10/1	E10/2	E10/3	E10/4
(3)	CLADDING	OUTER DIA.	(MM)	10.75	10.75	10.75	10.75	10.75	10.75	10.75	10.75
(4)		INNER DIA.	(MM)	9.30	9.30	9.30	9.30	9.30	9.30	9.30	9.30
(5)		THICKNESS	(MM)	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72
(6)	GAP		(MM)	0.135	0.138	0.137	0.138	0.140	0.139	0.142	0.142
(7)	PELLET	OUTER DIA.	(MM)	9.158	9.158	9.158	9.15	9.158	9.158	9.158	9.158
(8)		INNER DIA.	(MM)								
(9)		LENGTH	(MM)	11.0	11.0	11.0	11.0	11.0	11.0	11.0	11.0
(10)	L / D (LENGTH / DIA.)			1.20	1.20	1.20	1.20	1.20	1.20	1.20	1.20
(11)	U-235 ENRICHMENT			0.031	0.031	0.031	0.031	0.031	0.031	0.031	0.031
(12)	DENSITY/THEORITICAL DENSITY			0.937	0.937	0.937	0.937	0.0937	0.0937	0.0937	0.0937
(13)		DISH DIA.	(MM)	7.958	7.958	7.958	7.958	7.958	7.958	7.958	7.958
(14)		DISH DEPTH	(MM)	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
(15)		CHAMFER	(MM)	0.6X0.02	"	"	"	"	"	"	"
(16)	PLENUM VOLUME(10**2 MM**3)			2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2
(17)	INITIAL GAS PRESSURE		(MPA)	2.25	2.25	2.25	2.25	2.25	2.25	2.25	2.25
(18)	INITIAL GAS CONPOSITION			HE	HE	HE	HE	HE	HE	HE	HE
(19)	PELLET TOTAL WEIGHT		(GRAM)	210.0	209.0	209.0	210.0	210.0	209.0	209.0	209.0
(20)	STACK LENGTH		(MM)	320.0	330.0	320.0	320.0	320.0	320.0	320.0	320.0
(21)	BURNUP		(GWD/T)	13.1	13.0	12.7	12.0	12.6	12.6	12.3	11.8
(79)	REMARKS										
(80)	REFERENCE										

<** 130023 *> OVER RAMP FUEL RODS SPECIFICATION -PWR (2)- ** 130023 **

STUDVIK
OVER -RP
COMMON
DATA

---(1)-*---(2)-*---(3)-*---(4)-*---(5)-*---(6)-*---(7)-*---(8)-*

(1)	TEST NAME		** OVER RAMP (PWR) **						
(2)	ROD NAME		A20/1	A20/2	A20/3	A20/4	F20/1	F20/2	F20/3	F20/4
(3)	CLADDING	OUTER DIA. (MM)	10.75	10.75	10.75	10.75	10.75	10.75	10.75	10.75
(4)		INNER DIA. (MM)	9.29	9.29	9.29	9.29	9.29	9.29	9.29	9.29
(5)		THICKNESS (MM)	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70
(6)	GAP	(MM)	0.134	0.134	0.134	0.134	0.166	0.166	0.165	0.164
(7)	PELLET	OUTER DIA. (MM)	9.158	9.158	9.158	9.158	9.115	9.115	9.115	9.115
(8)		INNER DIA. (MM)								
(9)		LENGTH (MM)	11.0	11.0	11.0	11.0	11.1	11.1	11.1	11.1
(10)	L / D (LENGTH / DIA.)		1.20	1.20	1.20	1.20	1.22	1.22	1.22	1.22
(11)	U-235 ENRICHMENT		0.031	0.031	0.031	0.031	0.0298	0.0298	0.0298	0.029
(12)	DENSITY/THEORITICAL DENSITY		0.937	0.937	0.937	0.937	0.9498	0.9498	0.9498	0.949
(13)		DISH DIA. (MM)	7.958	7.958	7.958	7.958	6.515	6.515	6.515	6.515
(14)		DISH DEPTH (MM)	0.25	0.25	0.25	0.25	0.58	0.58	0.58	0.58
(15)		CHAMFER (MM)	0.6X0.02	"	"	"	0.56X0.18	"	"	"
(16)	PLENUM VOLUME(10**2 MM**3)		2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2
(17)	INITIAL GAS PRESSURE (MPA)		2.25	2.25	2.25	2.25	2.25	2.25	2.25	2.25
(18)	INITIAL GAS CONPOSITION		HE	HE	HE	HE	HE	HE	HE	HE
(19)	PELLET TOTAL WEIGHT	(GRAM)	210.0	211.0	211.0	211.0	209.0	208.5	209.0	211.0
(20)	STACK LENGTH	(MM)	320.0	320.0	320.0	320.0	320.0	320.0	320.0	320.0
(21)	BURNUP	(GWD/T)	24.8	25.2	24.7	23.4	25.1	25.3	25.1	23.9
(79)	REMARKS									
(80)	REFERENCE									

<* 130024 *> OVER RAMP FUEL RODS SPECIFICATION -PWR (3)- ** 130024 **

STUDVIK
OVER -RP
COMMON
DATA

---(1)-*---(2)-*---(3)-*---(4)-*---(5)-*---(6)-*---(7)-*---(8)-*

(1)	TEST NAME		** OVER RAMP (PWR) **						
(2)	ROD NAME		G20/1	G20/2	G20/3	G20/4	F30/S	F30/1	F30/2	F30/4
(3)	CLADDING OUTER DIA.	(MM)	10.74	10.74	10.74	10.74	10.74	10.74	10.74	10.74
(4)	INNER DIA.	(MM)	9.29	9.29	9.29	9.29	9.29	9.29	9.29	9.29
(5)	THICKNESS	(MM)	0.73	0.73	0.73	0.32	0.70	0.70	0.70	0.70
(6)	GAP	(MM)	0.143	0.146	0.144	0.144	0.170	0.171	0.172	0.172
(7)	PELLET OUTER DIA.	(MM)		9.114	9.114	9.114	9.115	9.115	9.115	9.115
(8)	INNER DIA.	(MM)								
(9)	LENGTH	(MM)		11.0	11.1	11.1	11.1	11.1	11.1	11.1
(10)	L / D (LENGTH / DIA.)			1.21	1.22	1.22	1.22	1.22	1.22	1.22
(11)	U-235 ENRICHMENT			0.0299	0.0299	0.0299	0.0298	0.0298	0.0298	"
(12)	DENSITY/THEORITICAL DENSITY			0.951	0.951	0.951	0.9498	0.9498	0.9498	"
(13)	DISH DIA.	(MM)		6.544	6.544	6.544	6.515	6.515	6.515	"
(14)	DISH DEPTH	(MM)		0.58	0.58	0.58	0.58	0.58	0.58	0.58
(15)	CHAMFER	(MM)		0.56X0.18	"	"	"	"	"	"
(16)	PLENUM VOLUME(10**2 MM**3)			2.2	2.2	2.2	2.1	2.2	2.2	2.2
(17)	INITIAL GAS PRESSURE	(MPA)		2.25	2.25	2.25	2.25	2.25	2.25	2.25
(18)	INITIAL GAS CONPOSITION			HE	HE	HE	HE	HE	HE	HE
(19)	PELLET TOTAL WEIGHT	(GRAM)		206.3	207.0	206.0	209.0	208.5	209.0	208.5
(20)	STACK LENGTH	(MM)		319.5	319.5	319.5	320.0	320.0	320.0	320.0
(21)	BURNUP	(GWD/T)	24.6	24.2	24.3	22.6	30.7	31.3	30.9	29.1
(79)	REMARKS									
(80)	REFERENCE									

<* 130025 *> OVER RAMP FUEL RODS SPECIFICATION -PWR (4)- ** 130025 **

STUDVIK
OVER -RP
COMMON
DATA

(1)	TEST NAME		** OVER RAMP (PWR) **							
(2)	ROD NAME		W5/1	W5/2	W5/3	W5/4	W5/5	W5/6	W4/1	W4/2
(3)	CLADDING	OUTER DIA. (MM)	9.51	9.51	9.51	9.51	9.51	9.51	9.51	9.51
(4)		INNER DIA. (MM)	8.36	8.36	8.36	8.36	8.36	8.36	8.36	8.36
(5)		THICKNESS (MM)	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58
(6)	GAP	(MM)	0.165	0.165	0.165	0.165	0.165	0.165	0.165	0.165
(7)	PELLET	OUTER DIA. (MM)	8.19	8.19	8.19	8.19	8.19	8.198.19	8.19	
(8)		INNER DIA. (MM)								
(9)		LENGTH (MM)	13.44	13.44	13.44	13.44	13.44	13.44	13.44	13.44
(10)	L / D (LENGTH / DIA.)		1.64	1.64	1.64	1.64	1.64	1.64	1.64	1.64
(11)	U-235 ENRICHMENT		0.0826	0.0826	0.0826	0.0826	0.0826	0.0826	0.0826	"
(12)	DENSITY/THEORITICAL DENSITY		0.9516	0.9516	0.9516	0.9516	0.9516	0.9516	0.9498	"
(13)		DISH DIA. (MM)	5.95	5.95	5.95	5.95	5.95	5.95	5.95	5.95
(14)		DISH DEPTH (MM)	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
(15)		CHAMFER (MM)								
(16)	PLENUM VOLUME(10**2 MM**3)		5.2	5.2	4.7	4.9	5.2	5.4	5.3	4.7
(17)	INITIAL GAS PRESSURE	(MPA)	1.38	1.38	1.38	1.38	1.38	1.38	2.48	2.48
(18)	INITIAL GAS CONPOSITION		HE	HE	HE	HE	HE	HE	HE	HE
(19)	PELLET TOTAL WEIGHT	(GRAM)	531.2	528.5	535.1	534.0	531.1	527.7	534.7	532.8
(20)	STACK LENGTH	(MM)	982.8	979.0	989.1	990.1	982.8	977.8	990.9	992.1
(21)	BURNUP	(GWD/T)	21.6	21.9	21.3	18.1	23.8	24.2	22.8	23.1
(79)	REMARKS									
(80)	REFERENCE									

<* 130026 *> OVER RAMP FUEL RODS SPECIFICATION -PWR (5)- ** 130026 **

STUDVIK
OVER -RP
COMMON
DATA

(1)	TEST NAME		** OVER RAMP (PWR) **						
(2)	ROD NAME		W4/3	W4/4	W4/5	W4/6	W8/1	W8/2	W8/3
(3)	CLADDING OUTER DIA.	(MM)	9.51	9.51	9.51	9.51	9.51	9.51	9.51
(4)	INNER DIA.	(MM)	8.36	8.36	8.36	8.36	8.36	8.36	8.36
(5)	THICKNESS	(MM)	0.58	0.58	0.58	0.58	0.58	0.58	0.58
(6)	GAP	(MM)	0.165	0.165	0.165	0.165	0.165	0.165	0.165
(7)	PELLET OUTER DIA.	(MM)	8.19	8.19	8.19	8.19	8.19	8.19	8.19
(8)	INNER DIA.	(MM)							
(9)	LENGTH	(MM)	13.44	13.44	13.44	13.44	13.44	13.44	13.44
(10)	L / D (LENGTH / DIA.)		1.64	1.64	1.64	1.64	1.64	1.64	1.64
(11)	U-235 ENRICHMENT		0.0826	0.0826	0.0826	0.0826	0.0826	0.0826	0.0826
(12)	DENSITY/THEORITICAL DENSITY		0.9498	0.9498	0.9498	0.9498	0.9489	0.9489	0.9489
(13)	DISH DIA.	(MM)	5.95	5.95	5.95	5.95	7.94	7.94	7.94
(14)	DISH DEPTH	(MM)	0.3	0.3	0.3	0.3	0.3	0.3	0.3
(15)	CHAMFER	(MM)					0.125X0.76	"	"
(16)	PLENUM VOLUME(10**2 MM**3)		5.3	4.6	5.3	5.3	5.0	5.1	4.9
(17)	INITIAL GAS PRESSURE	(MPA)	2.48	2.48	2.48	2.48	1.38	1.38	1.38
(18)	INITIAL GAS CONPOSITION		HE	HE	HE	HE	HE	HE	HE
(19)	PELLET TOTAL WEIGHT	(GRAM)	533.5	532.8	533.5	533.5	529.5	527.7	530.1
(20)	STACK LENGTH	(MM)	980.0	992.0	993.3	993.0	986.0	984.0	987.5
(21)	BURNUP	(GWD/T)	22.6	16.5	16.7	16.4	20.3	20.7	20.2
(79)	REMARKS								
(80)	REFERENCE								

<* 140001 *> PELLET TYPE DESIGNATION - INTER RAMP - ** 140001 **

STUDVIK
INTER-RP
COMMON
DATA

(1)	PELLET TYPE		E*	T	L	D**	H	B
(11)	ENRICHMENT	(% U-235)	NAT.	2.82	2.82	2.82	3.5	3.5
(12)	DENSITY,	(% TD)	95	95	95	93	95	95
(13)	DIAMETER, (CLEARANCE, MICRON-M)		-	80	150	150	150	250
(14)	USASE		*	4 RODS	12 RODS	2 RODS	9 RODS	2 RODS
(79)	REMARKS		* : END PELLET IN ALL RODS.					
			**: POREFORMER ADDED.					
(80)	REFERENCES		STIR-4, P-44.					

<* 140002 *> PELLET - CHEMICAL IMPURITIES - ** 140002 **

STUDVIK
INTER-RP
LR-1(E)
PELLET

---(1)-*---(2)-*---(3)-*---(4)-*---(5)-*---(6)-*---(7)-*---(8)-*

(100)	ELEMENT,	(PPM)	
(102)	AL		2.
(106)	C		9.
(107)	CA		
(109)	CL		
(111)	CR		7.
(116)	F		<2.
(117)	FE		73.
(126)	N		
(128)	NI		1.
(133)	SI		5.
(150)	O/U RATIO	(FRAC.)	2.003

---*

<* 140003 *> PELLETIZING PARAMETERS - INTER RAMP - ** 140003 **

STUDVIK
INTER-RP
COMMON
DATA

---(1)-*---(2)-*---(3)-*---(4)-*---(5)-*---(6)-*---(7)-*---(8)-*

(1)	PELLET ENRICHMENT	(% U-235)	0.72	2.82	2.82	3.5
(11)	U3O8 ADD.	(%)	-	5	5	5
(12)	DEXTRIN ADD.	(%)	-	-	0.6	-
(15)	PRESSING PRESS.	(TON/CM**2)	3.8	3.0	2.5	3.0
(21)	GREEN DENSITY	(GR/CC)	5.68	5.45	5.32	5.47
(31)	SINTERING TEMP.	(DEG-C)	1700	1750	1750	1750
(32)	SINTERING TIME	(HRS)	8	4	4	4.5

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(80) REFERENCES STIR-4, P-48.

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<* 140004 *> MOISTURE CONTENT OF PELLETS - INTER RAMP - ** 140004 **

STUDVIK
INTER-RP
COMMON
DATA

---(1)-*---(2)-*---(3)-*---(4)-*---(5)-*---(6)-*---(7)-*---(8)-*

(1)	PELLET TYPE	E	T,L	D	B,M
(2)	ENRICHMENT(%)	0.72	2.82	2.82	3.5
(11)	MOISTURE PRIOR TO LOADING (PPM/PELLET)	0.7	2.2-4.2	1.9-2.2	-*
(13)	MOISTURE FINISHED ROD (PPM/PELLET)	0.4-1.0	0.4-1.2	0.5-1.6	1.0-2.0
(15)	(AVERAGE)	0.8	0.6	0.9	1.3

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(79) REMARKS SEE FDN-140001 FOR PELLET TYPE.

---*

(80) REFERENCES STIR-4, P-56.

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<* 140005 *> MIXED OXIDE PELLET - CHEMICAL COMPOSITION AND IMPURITIES - ** 140005 **

THIS IS DATA OF IFA-514.

			---(1)-*---(2)-*---(3)-*---(4)-*---(5)-*---(6)-*---(7)-*---(8)-* (SPEC)
(10)	FABRICATION		MECHANICAL BLENDING, COLD-PRESSING, SINTERED
(11)	FUEL COMPOSITION		94.2 W/O UO2 + 5.8 W/O PU-O2
(12)	PU FISSILE CONTENT -*1),	(W/O)	4.64 +- 0.14
(13)	URANIUM ENRICHMENT,	(W/O)	NATURAL-U
(20)	ABUNDANCE OF PU-ISOTOPES	(W/O)	ANALIZED ON 21 SEP, 1976.
(21)	PU-238		0.10
(22)	PU-239		77.14
(23)	PU-240		19.42
(24)	PU-241		2.78
(25)	PU-242		0.56
(26)	AM		2420 PPM, ANALIZED ON 10 NOV. 1976.
(30)	PU-O2 PARTICLE SIZE,	(MICRON-M)	<500.
(31)	HEAVY METAL (U + PU) CONTENT	(W/O)	> 87.7
(32)	O/M RATIO		1.98 TO 2.01
(40)	IMPURITIES,	(PPM)	
(41)	AG		< 10.
(42)	AL		<300.
(43)	B		< 1.0
(44)	CA		<200.
(45)	CD		< 1.0
(46)	CR		<200.
(47)	CU		< 50.
(48)	FE		<400.
(49)	MG		<100.
(50)	MN		<200.
(51)	MO		<300.
(52)	NI		<300.
(53)	PB		<100.
(54)	SI		<300.
(55)	SN		<100.
(56)	C		<200.
(57)	F		< 15.
(58)	CL		< 25.
(59)	N		<100.
(60)	ZN		<400.
(61)	DY + EU + GD + SM		< 2.0
(70)	MOISTURE CONTENT,	(MICRO-L/GR-MO2)	< 10.
(71)	TEST CONDITION		>400 DEG-C
(75)	VAPOURIZE IMPURITIES,		
(76)		(MICRO-L/GR-MO2)	< 50.
(71)	TEST CONDITION		AT 1700 DEG-C, > 30 MINUTES.
(77)	PELLET DENSITY,	(%TD)	94.0 +-1.5
(78)	PELLET FORM		CHANFERED
(80)	PELLET DIMENSION,	(MM)	
(81)	OUTER DIAMETER		10.55 +0.03, -0.05
(82)	HEIGHT		10.0 +-0.5
(83)	INNER DIAMETER		3.5 +-0.2 (FOR HOLLOW PELLETS)
			1.8 +-0.1 (FOR TE PELLETS)
(86)	HEIGHT OF CHANFER		0.32 +-0.20
(87)	LENGTH OF CHANFER		0.22 +-0.10
(997)	NOTES		*1) : PU FISSILE CONTENT (W/O) = (WEIGHT OF PU-239 AND PU-241)/ (WEIGHT OF TOTAL PU AND TOTAL U) * 100.

<* 140006 *> SPACER PELLET - CHEMICAL COMPOSITION AND IMPURITIES, INTER-RP.- ** 140006 **

STUDVIK
INTER-RP
LR-1(E)
PELLET

			(SPEC)
(20) ELEMENT,		(PPM)	--- CHEMICAL IMPURITIES ---
(21)	AL		500. 530.
(22)	B		20. 8.
(23)	CA		21000. 2.1(W/O)
(24)	CD		1. 2.
(25)	CO		13. 50.
(26)	CU		50. 10.
(27)	FE		400. 280.
(28)	K		<400. 10.
(29)	MG		600. 600.
(30)	MN		50. 9.
(31)	MO		<60. 20.
(32)	NA		<50. 20.
(33)	PB		50. 40.
(34)	SN		50. 5.
(35)	SI		1000. 1320.
(36)	TI		60. 265.
(37)	V		50. 20.

<* 140007 *> UO-2 POWDER CHARACTERISTICS - INTER RAMP - ** 140007 **

STUDVIK
INTER-RP
COMMON
DATA

(1)	DESIGNATION	U-N-O-2 2.82 % 3.5 %	
		SP	LS,TS, HS,BR, DR,LR,TR HR
(11)	ENRICHMENT (%)	0.714	2.805 3.468 PM0.020 PM0.044 2.844*
(13)	O/U RATIO	2.123	2.11 2.185**
(12)	U CONTENT (FRAC.)	-**	0.8737 0.8813
(14)	MOISTURE (PPM)	2410.	2200. -**
(21)	BEQ VALUE (PPM)	2.95	2.04 2.94
(22)	BET SURFACE AREA (M**2/GR)	2.9	6.26 -**
(23)	PARTICLE SIZE(MICRON-M)	<100.	<100. <100.
		--- IMPURITIES ---	
(31)	FLUORINE (PPM)	3(<2)	44(6) 25(12)
(32)	CARBON (PPM)	25(9)	150(12) 147(4)
(33)	NITROGEN (PPM)	5	12 6(2)
(39)	OTHER IMPURITIES (PPM)	<25	<100 <100
(79)	REMARKS	* : AFTER MIXING WITH 5% U3O8.	
		** : VALUE NOT AVAILABLE.	
		( ): PELLET VALUE.	
		SP : USE SPACER PELLETS.	
(80)	REFERENCES	STIR-4, P.47, 5	

<* 140008 *> JPDR-II FUEL PELLET DENSITY MEASUREMENT (1) ** 140008 **

BWR
7X7
JPDR-II

---(1)-*---(2)-*---(3)-*--(4)-*---(5)-*---(6)-*---(7)-*---(8)-*

---- GEOMETRICAL ----------*---- IMMERSION ----------*

			(NO. OF SAMPLE)	*---- PERCENT ----*---- 1----*----2	(NO. OF SAMPLE)	*---- PERCENT ----*---- 1----*----2
(20)	RANGE OF DENSITY,	(%TD)				
(21)	0.00 - 93.40		0		0	
(22)	93.40 - 93.60		0		0	
(23)	93.60 - 93.80		0		0	
(24)	93.80 - 94.00		1		1	*
(25)	94.00 - 94.20		2	*	1	*
(26)	94.20 - 94.40		9	***	2	*
(27)	94.40 - 94.60		23	*********	3	***
(28)	94.60 - 94.80		41	****************	12	******
(29)	94.80 - 95.00		64	*************************	13	*******
(30)	95.00 - 95.20		53	*********************	32	*****************
(31)	95.20 - 95.40		28	***********	41	**********************
(32)	95.40 - 95.60		17	******	37	********************
(33)	95.60 - 95.80		17	******	29	***************
(34)	95.80 - 96.00		6	**	13	*******
(35)	96.00 - 96.20		4	**	3	**
(36)	96.20 - 96.40		0		0	
(37)	96.40 - 96.60		0		0	
(38)	96.60 -100.00		0		0	
				----*----1----*----2		----*----1----*----2
(40)	TOTAL NUMBER OF SAMPLES		265		187	
(50)	AVERAGE,	(%TD)	95.020		95.322	
(51)	STANDARD DEVIATION(1 SIGMA)	(%TD)	0.395		0.379	

(999) REFERENCES

Y. HARAYAMA, PRIVATE COMMUNICATION (DEC. 1971).

<* 140009 *> JPDR-II FUEL PELLET DENSITY MEASUREMENT (2) ** 140009 **

BWR
7X7
JPDR-II

---(1)-*---(2)-*---(3)-*--(4)-*---(5)-*---(6)-*---(7)-*---(8)-*

(10) MANUFACTURE — MAIN CONTRUCTOR - TOTAL -

			GEOMETRICAL (NO. OF SAMPLE)	PERCENT ----*----1----*----2	IMMERSION (NO. OF SAMPLE)	PERCENT ----*----1----*----2
(20)	RANGE OF DENSITY,	(%TD)				
(21)	0.00 - 93.40		0		0	
(22)	93.40 - 93.60		0		0	
(23)	93.60 - 93.80		0		0	
(24)	93.80 - 94.00		0		1	*
(25)	94.00 - 94.20		1		0	
(26)	94.20 - 94.40		7	***	1	*
(27)	94.40 - 94.60		19	*********	2	**
(28)	94.60 - 94.80		27	************	10	********
(29)	94.80 - 95.00		48	************************	7	******
(30)	95.00 - 95.20		38	********************	20	******************
(31)	95.20 - 95.40		24	************	23	********************
(32)	95.40 - 95.60		15	*******	27	************************
(33)	95.60 - 95.80		15	*******	21	******************
(34)	95.80 - 96.00		6	***	11	**********
(35)	96.00 - 96.20		4	**	3	**
(36)	96.20 - 96.40		0		0	
				----*----1----*----2----*----*		----*----1----*----2---S
(40)	TOTAL NUMBER OF SAMPLES		204		126	
(50)	AVERAGE,	(%TD)	95.055		95.349	
(51)	STANDARD DEVIATION(1 SIGMA)	(%TD)	0.407		0.392	

(999) REFERENCES — SEE FDN-140008.

<* 140010 *> JPDR-II FUEL PELLET DENSITY MEASUREMENT (3) ** 140010 **

BWR
7X7
JPDR-II

---(1)-*---(2)-*---(3)-*--(4)-*---(5)-*---(6)-*---(7)-*---(8)-*

(10) MANUFACTURE — SUB-CONTRUCTOR - TOTAL -

---- GEOMETRICAL ----------*---- IMMERSION ----------*

		(%TD)	(NO. OF SAMPLE)	GEOMETRICAL PERCENT ----*----1----*----2	(NO. OF SAMPLE)	IMMERSION PERCENT ----*----1----*----2
(20)	RANGE OF DENSITY,					
(21)	0.00 - 93.40		0		0	
(22)	93.40 - 93.60		0		0	
(23)	93.60 - 93.80		0		0	
(24)	93.80 - 94.00		1	**	0	
(25)	94.00 - 94.20		1	**	1	**
(26)	94.20 - 94.40		2	***	1	**
(27)	94.40 - 94.60		4	*******	1	**
(28)	94.60 - 94.80		14	**********	2	***
(29)	94.80 - 95.00		16	**********	6	**********
(30)	95.00 - 95.20		15	**********	12	**********
(31)	95.20 - 95.40		4	*******	18	**********C
(32)	95.40 - 95.60		2	***	10	**********
(33)	95.60 - 95.80		2	***	8	**********
(34)	95.80 - 96.00		0		2	***
(35)	96.00 - 96.20		0		0	
(36)	96.20 - 96.40		0		0	
				----*----1----*----2----*		----*----1----*----2---S
(40)	TOTAL NUMBER OF SAMPLES		61		61	
(50)	AVERAGE,	(%TD)		94.903		95.267
(51)	STANDARD DEVIATION(1 SIGMA)	(%TD)		0.338		0.348

(999) REFERENCES — SEE FDN-140008.

<* 140011 *> JPDR-II FUEL PELLET DENSITY MEASUREMENT (4) ** 140011 **

BWR
7X7
JPDR-II

---(1)-*---(2)-*---(3)-*--(4)-*---(5)-*---(6)-*---(7)-*---(8)-*

(10) MANUFACTURE — MAIN CONTRUCTOR - 2.7 W/O ENRICHED PELLET -

---- GEOMETRICAL ----------*---- IMMERSION ----------*

		(%TD)	(NO. OF SAMPLE)	GEOMETRICAL PERCENT ----*----1----*----2	(NO. OF SAMPLE)	IMMERSION PERCENT ----*----1----*----2
(20)	RANGE OF DENSITY,					
(23)	93.60 - 93.80		0		0	
(24)	93.80 - 94.00		0		1	*
(25)	94.00 - 94.20		1	*	0	
(26)	94.20 - 94.40		1	*	1	*
(27)	94.40 - 94.60		16	**********	2	**
(28)	94.60 - 94.80		21	**********	7	*******
(29)	94.80 - 95.00		43	**********	7	*******
(30)	95.00 - 95.20		35	**********	15	**********
(31)	95.20 - 95.40		22	**********	23	**********
(32)	95.40 - 95.60		14	**********	26	**********
(33)	95.60 - 95.80		11	**********	19	**********
(34)	95.80 - 96.00		6	***	10	**********
(35)	96.00 - 96.20		4	**	2	**
(36)	96.20 - 96.40		0		0	
				----*----1----*----2----*		----*----1----*----2---S
(40)	TOTAL NUMBER OF SAMPLES		174		113	
(50)	AVERAGE,	(%TD)		95.088		95.359
(51)	STANDARD DEVIATION(1 SIGMA)	(%TD)		0.389		0.385

(999) REFERENCES — SEE FDN-140008.

<* 140012 *> JPDR-II FUEL PELLET DENSITY MEASUREMENT (5) ** 140012 **

BWR
7X7
JPDR-II

---(1)-*---(2)-*---(3)-*--(4)-*---(5)-*---(6)-*---(7)-*---(8)-*

(10) MANUFACTURE — SUB-CONTRUCTOR - 2.7 W/O ENRICHED PELLET -

---- GEOMETRICAL ----------*---- IMMERSION ----------*

			(NO. OF SAMPLE)	PERCENT ----*----1----*----2	(NO. OF SAMPLE)	PERCENT ----*----1----*----2
(20)	RANGE OF DENSITY,	(%TD)				
(23)	93.60 - 93.80		0		0	
(24)	93.80 - 94.00		1	**	0	
(25)	94.00 - 94.20		0		0	
(26)	94.20 - 94.40		0		1	**
(27)	94.40 - 94.60		3	******	0	
(28)	94.60 - 94.80		11	**********	0	
(29)	94.80 - 95.00		15	**********C	3	******
(30)	95.00 - 95.20		15	**********C	11	**********C
(31)	95.20 - 95.40		4	********	18	**********C
(32)	95.40 - 95.60		1	**	10	**********
(33)	95.60 - 95.80		2	****	7	**********
(34)	95.80 - 96.00		0		2	****
(36)	96.20 - 96.40		0		0	
				----*----1----*----2----*		----*----1----*----2---S
(40)	TOTAL NUMBER OF SAMPLES		52		52	
(50)	AVERAGE,	(%TD)		94.952		95.341
(51)	STANDARD DEVIATION(1 SIGMA)	(%TD)		0.303		0.271
(999)	REFERENCES		SEE FDN-140008.			

<* 140013 *> JPDR-II FUEL PELLET DENSITY MEASUREMENT (6) ** 140013 **

BWR
7X7
JPDR-II

---(1)-*---(2)-*---(3)-*--(4)-*---(5)-*---(6)-*---(7)-*---(8)-*

(10) MANUFACTURE — MAIN CONTRUCTOR - 2.0 W/O ENRICHED PELLET -

---- GEOMETRICAL ----------*---- IMMERSION ----------*

			(NO. OF SAMPLE)	PERCENT ----*----1----*----2	(NO. OF SAMPLE)	PERCENT ----*----1----*----2
(20)	RANGE OF DENSITY,	(%TD)				
(25)	94.00 - 94.20		0		0	
(26)	94.20 - 94.40		6	**********	0	
(27)	94.40 - 94.60		3	*****	0	
(28)	94.60 - 94.80		6	**********	3	**********
(29)	94.80 - 95.00		5	*********	0	
(30)	95.00 - 95.20		3	*****	5	**********C
(31)	95.20 - 95.40		2	*******	0	
(32)	95.40 - 95.60		1	***	1	********
(33)	95.60 - 95.80		4	**********	2	**********
(34)	95.80 - 96.00		0		1	********
(35)	96.00 - 96.20		0		1	********
(36)	96.20 - 96.40		0		0	
				----*----1----*----2----*		----*----1----*----2---S
(40)	TOTAL NUMBER OF SAMPLES		30		13	
(50)	AVERAGE,	(%TD)		94.862		95.269
(51)	STANDARD DEVIATION(1 SIGMA)	(%TD)		0.463		0.460
(999)	REFERENCES		SEE FDN-140008.			

<* 140014 *> JPDR-II FUEL PELLET DENSITY MEASUREMENT (7) ** 140014 **

BWR
7X7
JPDR-II

---(1)-*---(2)-*---(3)-*--(4)-*---(5)-*---(6)-*---(7)-*---(8)-*

(10) MANUFACTURE — SUB-CONTRUCTOR - 2.0 W/O ENRICHED PELLET -

			GEOMETRICAL (NO. OF SAMPLE)	GEOMETRICAL PERCENT	IMMERSION (NO. OF SAMPLE)	IMMERSION PERCENT
(20)	RANGE OF DENSITY,	(%TD)				
(23)	93.75 - 94.00		0		0	
(24)	94.00 - 94.25		1	**********	1	**********
(25)	94.25 - 94.50		3	**********C	1	**********
(26)	94.50 - 94.75		3	**********C	2	**********
(27)	94.75 - 95.00		1	**********	3	**********C
(28)	95.00 - 95.25		0		1	**********
(29)	95.25 - 95.50		0		0	
(30)	95.50 - 95.75		1	**********	1	**********
(31)	95.75 - 96.00		0		0	
			----*----1----*----2----*		----*----1----*----2---S	
(40)	TOTAL NUMBER OF SAMPLES		9		9	
(50)	AVERAGE,	(%TD)	94.616		94.836	
(51)	STANDARD DEVIATION(1 SIGMA)	(%TD)	0.403		0.442	

(999) REFERENCES — SEE FDN-140008.

<* 140015 *> THERMAL SINTERING TEST CONDITION FOR PELLET DENSIFICATION ** 140015 **

---(1)-*---(2)-*---(3)-*--(4)-*---(5)-*---(6)-*---(7)-*---(8)-*

(10)	TEST TEMPERATURE,	(DEG-C)	1600.	1700.
(20)	SINTERING TIME,	(HR)	6.	24.
(30)	REFERENCE NO.		--- REF-1) ----*	

(999) REFERENCES

REF-1) : V.PASUPATHI, R.W. KINGENSMITH, 'INVESTIGATION OF STAINLESS STEEL CLAD FUEL ROD FAILURES AND FUEL PERFORMANCE IN THE CONNECTICUT YANKEE REACTOR', EPRI NP-2119 (NOV. 1981),P.2-3

<* 140016 *> COMPARATIVE MANPOWER COSTS FOR FUEL FABRICATION PROCESSES ** 140016 **

---(1)-*---(2)-*---(3)-*--(4)-*---(5)-*---(6)-*---(7)-*---(8)-*

(10) PROCESS	COST RATIO (NORMALIZED)
(11) STANDARD PELLET PROCESS	1.00 : GROUND PELLETS WITH 4-9-MIL DIAMETRAL GAP.
(14) SWAGED PELLET PROCESS	1.06 : GROUND PELLETS WITH GAP REDUCES BY LIGHT SWAGE PASS.
(14) SWAGED PELLET PROCESS	0.886 : UNGROUND PELLETS WITH GAP REDUCED BY LIGHT SWAGE PASS.
(15) TWO-PASS COLD-SWAGED POWDER	0.886
(16) THREE-PASS COLD-SWAGED POWDER	0.771
(17) THREE-PASS HOT-SWAGED POWDER	0.771
(18) VIBRATORY-COMPACTED POWDER	0.928
(19) TANDEM-ROLLED POWDER	0.623

(997) NOTES

COSTS OF MATERIALS ARE NOT CONSIDERED IN THIS ANALYSIS.

IN THE TWO-PASS SWAGED POWDER PROCESS, THREE PARTICLE-SIZE FABRICATIONS OF POWDER MUST BE USED TO ACHIVE A HIGH-DENSITY END PRODUCT: POWDER IS LOADED INTO TUBES, VIBRATORY COMPACTED, AND RUN ONCE THROUGH A ROTARY SWAGING MACHINE USING DOUBLE REDUCTION DIES. THE END RESULT IN A FUEL ROD AT 90-93% OF THEORETICAL UO-2 DENSITY (REF-3).

THE TREE-PASS SWAGED POWDER PROCESS, WHICH REQUIRES ONLY ONE PARTICLE-SIZE MATERIAL, CONSISTS OF A DOUBLE REDUCTION PASS AND A SINGLE REDUCTION PASS AND YIELDS A FUEL ROD WITH 91-94% OF THEORETICAL UO-2 DENSITY (REF-4).

THE HOT SWAGING PROCESS INTRODUCES AN ANNEALING STEP BETWEEN THE SECOND AND THIRD PASSES OF THE THREE-PASS PROCESS. THE END RESULT IS A ROD WITH UO-2 DENSITIES >=95% OF THEORETICAL (APPROACHING THAT OF SINTERED PELLETS) WITH A CLADDING MATERIAL IN A ALMOST THE DEAD-ANNEALED CONDITION (REF-4).

THE TANDEM ROLL PROCESS SUBSTITUTES A SERIES OF GROOVED TANDEM ROLLS FOR THE SWAGING MACHINE. POWDER PREPARATION IS MORE COMPLEX THAN FOR ANY OF THE FABRICATION PROCESSES AND REQUIRES -10 SCREEN-SIZE FRACTIONS BLENDED IN PROPER PROPORTIONS PRIOR TO LOADING INTO RODS. THE PROCESS REQUIRES VIBRATORY COMPACTION PRIOR TO ROLLING AND RESULTS IN A UO-2 DENSITY OF 88-89% OF THEORETICAL (REF-5).

THE VIBRATORY COMPACTION PROCESS UTILIZES NO OTHER METHOD FOR ACHIEVING HIGH DENSITY THAN SELECTIVE BLENDING OF SPECIFIC SCREEN SIZES (REF-6). THE DESIRED FINAL DENSITY DETERMINES THE NUMBER OF SCREEN SIZES REQUIRED (I.E., HIGHER DENSITY, MORE FRACTIONS)

(999) REFERENCES

R.N. DUNCAN ET. AL., NUCLEONICS 23(4), P.51 (APR. 1965).
SEE FDN-700216.

REF-3) C.M. RYER, 'POWDER FUEL PROCESSING BY TWO-PASS SWAGING', GEAP-3891 (APRIL 10, 1962).
REF-4) E.A. LEES, 'FABRICATION OF FUEL ELEMENTS BY SWAGING', GEAP-3918 (MAY 21, 1962).
REF-5) J.W. LINGAFELTER, 'FABRICATION OF FUEL RODS BY TANDEM ROLLING', GEAP-3775 (JULY, 1961).
REF-6) W.R. DEHOLLANDER, 'VIBRATIONAL COMPACTION OF URANIUM DIOXIDE', GEAP-4032 (MARCH 1, 1962).

<* 140017 *> EQUIVALENT BORON CONTENT - EBC - ** 140017 **

THE TOTAL IMPURITY CONTENT FOR NUCLEAR GRADE URANIUM DIOXIDE, SINTERABLE, SHALL NOT EXCEED THE 'EQUIVALENT BORON CONTENT' (EBC) OF 4 PARTS PER MILLION ON A WEIGHT BASIS.

THE FOLLOWING LISTED ELEMENTS ARE TO BE INCLUDED IN THE CALCULATION OF THE EBC BUT ARE NOT NECESSARILY ALL THE ELEMENTS TO BE CONSIDERED IN THE TOTAL IMPURITY VALUES FOR THE ELEMENTS LISTED: B, CD, CR, CO, CU, FE, PB, MN, MO, NI, SI, AG, SN, DY, EU, GD, SM.

---(1)-*---(2)-*---(3)-*---(4)-*---(5)-*---(6)-*---(7)-*---(8)-*

BORON EQUIVALENTS FOR IMPURITIES IN URANIUM

		SIGMA(A) (BARNS)	ATOMIC WEIGHT	EBC PART PER MILLION
(10)	IMPURITY			
(11)	ALUMINIUM	0.230	26.98	0.000122
(12)	BARIUM	1.170	137.34	0.000122
(13)	BERYLLIUM	0.010	9.01	0.000015
(14)	BORON	755	10.81	0.999999
(15)	CALCIUM	0.43	40.08	0.000153
(16)	CADMIUM	2550	112.40	0.325097
(17)	CARBON	0.00373	12.01	0.000004
(18)	CHROMIUM	2.90	52.00	0.000799
(19)	COBALT	38.00	58.93	0.009239
(20)	COPPER	3.85	63.54	0.000868
(21)	IRON	2.62	55.85	0.000672
(22)	LEAD	0.170	207.19	0.000011
(23)	MAGNESIUM	0.069	24.32	0.000040
(24)	MANGANESE	13.20	54.93	0.003443
(25)	MOLYBDENUM	2.70	95.94	0.000403
(26)	NICKEL	4.60	58.71	0.001122
(27)	NITROGEN	1.88	14.00	0.001924
(28)	OXYGEN	0.0002	16.00	-
(29)	PHOSPHORUS	0.19	30.97	0.000087
(30)	SILICON	0.13	28.09	0.000066
(31)	SILVER	62.0	107.87	0.008236
(32)	TIN	0.60	118.7	0.000072
(33)	TUNGSTEN	19.20	183.85	0.001496
(34)	VANADIUM	5.00	50.94	0.001406
(35)	ZINC	1.10	65.37	0.000241
(36)	ZIRCONIUM	0.185	91.22	0.000029
(37)	SAMARIUM	5500	150.35	0.524575
(38)	EUROPIUM	4600	152.00	0.433973
(39)	GADOLINIUM	46000	157.26	4.19458
(40)	DYSPROSIUM	1100	162.51	0.097064

(997) NOTES

EBC IS TO BE CALCULATED BY THE FOLLOWING FORMULA.

EBC=((ATOMIC WEIGHT BORON)*(SIGMA(A) IMPURITY))/
((ATOMIC WEIGHT IMPURITY)*(SIGMA(A) BORON))
*(PPM IMPURITY)

WHERE

SIGMA(A)=2200 METERS PER SECOND THERMAL NUETRON ABSORPTION CROSS SECTION.

(999) REFERENCES

PROPOSED AMERICAN STANDARD, A.S.A. SPECIFICATIONS FOR NUCLEAR FUELS.

<* 140018 *> METHOD OF MEASUREMENT FOR PELLET GEOMETRICAL DENSITY ** 140018 **

THE GEOMETRICAL DENSITY OF THE FIRED PELLETS, AND THE GREEN DENSITY OF THE UNFIRED PELLETS SHALL BE DETERMINED AS FOLLOWS:

---(1)-*---(2)-*---(3)-*---(4)-*---(5)-*---(6)-*---(7)-*---(8)-*

(10) DIAMETER — RECORD THE AVERAGE OF 5 READINGS TAKEN UNIFORMLY FROM LACATION BETWEEN 1/16 INCH FROM EACH END OF THE PELLET.

(20) LENGTH — RECORD THE AVERAGE OF 3 READINGS ACROSS A DIAGONAL.
- DIAMETER AND LENGTH ARE TO BE MEASURED WITH A STANDARD FLAT-NOSED MICROMETER AND RECORDED TO THE NEAREST 0.0002 INCH -

(30) WEIGHT — WEIGHT ON A METTLER (OR EQUIVALENT) BALANCE TO THE NEAREST 0.001 GRAM.

(40) DENSITY — CALCULATE THE DENSITY OF EACH PELLET TO THE NEAREST 0.01 GRAM PER CUBIC CENTIMETER.

(997) NOTES — TD (THEORETICAL DENSITY) OF UO-2 SINTERED PELLET IS 10.965 GR/CC

(999) REFERENCES — SEE FDN-140017.

<* 150001 *> ZIRCALOY TUBE CHEMICAL REQUIREMENTS - ASTM DESIGNATION - ** 150001 **

		---(1)-*---(2)-*---(3)-*---(4)-*---(5)-*---(6)-*---(7)-*---(8)-*					
(1)	ASTM DESIGNATION: ASTM B 353-	60T	62T	*----- 64T -----*----- 69 ------*			
(2)	GRADE	RA-1	RA-1	RA-1	RA-2	RA-1	RA-2
		-------- ALLOYING ELEMENTS, UNIT IS WEIGHT PERCENT ----------					
(10)	CHEMICAL COMPOSITION						
(11)	TIN	1.20 TO 1.70			1.20 TO 1.70	THE SAME AS (1).	1.20 TO 1.70
(12)	IRON	0.07 TO 0.20			0.18 TO 0.24	COLOUM	0.18 TO 0.28
(13)	CHRONIUM	0.05 TO 0.15	THE SAME AS VALUES IN COLOUM (1).		0.07 TO 0.13		0.07 TO 0.13
(14)	NICKEL	0.03 TO 0.08			----		----
(15)	TOTAL:						
(16)	IRON+CHRONIUM+NICKEL	0.18 TO 0.38			0.28 TO 0.37		0.28 TO 0.37
		-------- IMPURITES, MAXIMUM ----------*					
		--- PPM ---------- WEIGHT PERCENT ------*					
(20)	CHEMICAL IMPURITIES						
(21)	ALUMINUM	75.	75.	0.0075	0.0075	0.0075	0.0075
(22)	BORON	0.5	0.5	0.00005	0.00005	0.00005	0.00005
(23)	CADMIUM	0.5	0.5	0.00005	0.00005	0.00005	0.00005
(24)	CARBON	500.	500.	0.027	0.027	0.027	0.027
(25)	CHLORINE		20.				
(27)	COBALT	20.	20.	0.0020	0.0020	0.0020	0.0020
(28)	COPPER	50.	50.	0.0050	0.0050	0.0050	0.0050
(29)	HAFNIUM	200.	100.	0.020	0.020	0.020	0.020
(30)	HYDROGEN	25.	25.	0.0025	0.0025	0.0025	0.0025
(32)	LEAD	130.	130.				
(33)	MAGNESIUM *A)		20.				
(34)	MANGANESE	50.	50.	0.0050	0.0050	0.0050	0.0050
(35)	NICKEL				0.0070		0.0070
(36)	NITROGEN	80	80	0.0080	0.0080	0.0080	0.0080
(37)	OXYGEN	*B	*B	*C	*C	*C	*C
(38)	SILICON	120.	120.	0.020	0.0120	0.020	0.0120
(39)	SODIUM *A)		20.				
(40)	TITANIUM	50.	50.	0.0050	0.0050	0.0050	0.0050
(41)	TUNGSTEN	100.	100.	0.010	0.010	0.010	0.010
(42)	URANIUM (TOTAL)	3.5	3.5	0.00035	0.00035	0.00035	0.00035

(997) NOTES

*A) : ANALYZE FOR MAGNESIUM OR SODIUM ACCORDING TO THE PROCESS USED IN REDUCING THE SPONGE.

*B : AT THE OPTION OF THE PURCHASER AND THE LIMITS MUTUALLY AGREED UPON.

*C : WHEN SPECIFIED ON THE PURCHASE ORDER, OXYGEN SHALL BE DETERMINED AND REPORTED MAXIMUM PERMISSIBLE VALUES SHALL BE AS SPECIFIED.

(998) REMARKS

1) RA-2 HAS BEEN REGISTERED ASTM STANDARD SINCE 1964.
2) RA-1 CORRESPONDS TO ZIRCALOY-2.
3) RA-2 CORRESPONDS TO ZIRCALOY-4.
ZIRCALOY-4 WAS LATER DEVELOPED FOR REDUCING ABSORPTION OF HYDROGEN DURING SERVICE LIFE. IN ZIRCALOY-4, NICKEL (CONTAINED IN ZIRCALOY-2) IS REDUCED AND IRON CONTENT IS ABOUT 50 % HIGHER THAN IN ZIRCALOY-2, SO THAT IT IS ALSO CALLED NICKEL FREE ZIRCALOY-2.
IT IS USED IN HYDROGEN-RICH WATER OR FOR FUEL PARTS REQUIRING LONG SERVICE LIFE.

4) THE CONTRIBUTION TO THE LOW-TEMPERATURE TENSILE STRENGTH OF ZIRCONIUM ALLOYS MADE BY THE COMMON IMPURITY OXYGEN IS IMPORTANT. OXYGEN EXISTS IN THE ZIRCONIUM LATTICE AS AN INTERSTITIAL IMPURITY, AND OXEGEN ATOMS INCREASE THE LATTICE FRICTION STRESS BY INTERACTING WITH THE CORE OF MOVING DISLOCATIONS. THIS EFFECT IS STRONGLY TEMPERATURE DEPENDENT, AND OXYGEN (AND NITROGEN ALIKE) CONTRIBUTES A MUCH SMALLER FACTOR TO THE TENSILE STRENGTH OF ZIRCONIUM ALLOYS AT 300 DEG-C OR HIGHER TEMPERATURES.
-C.D. WILLIAMS- DEVELOPMENT POTENTIAL OF ZIRCONIUM ALLOYS FOR HIGH-TEMPERATURE APPLICATIONS- REACTOR TECHNOLOGY, VOL-13(2), (SPRING 1970), P.P.149-150-

<* 150002 *> CLADDING MATERIAL - ZIRCALOY CHEMICAL COMPOSITION & IMPURITIES - ** 150002 **

STUDVIK
INTER-RP
COMMON
DATA

---(1)-*---(2)-*---(3)-*---(4)-*---(5)-*---(6)-*---(7)-*---(8)-*
(SPEC) (TOP) (MIDDLE)(BOTTOM)

(1)	MATERIAL		ZIRCALOY-2				
(2)	INGOT NO.		395481 Q				
			--- CHEMICAL COMPOSITION ---				
(100)	CHEMICAL COMPOSITION						
(3)	SN	(W/O)	1.20-1.70	1.56	1.54	1.41	
(4)	FE	(W/O)	0.07-0.20	0.14	0.14	0.14	
(5)	CR	(W/O)	0.05-0.15	0.12	0.12	0.11	
(6)	NI	(W/O)	0.03-0.08	0.05	0.05	0.05	
(7)	FE + CR + NI	(W/O)	0.18-0.38	0.31	0.31	0.3	
(8)	ZR	(W/O)	B	B	B	B	
			--- CHEMICAL IMPURITIES ---				
(110)	CHEMICAL IMPURITIES,	(PPM)					
(11)	AL		75.	45.	46.	41.	
(12)	B		0.5	0.3	0.2	0.2	
(13)	CD		0.5	< 0.2	< 0.2	< 0.2	
(14)	CA		30.	<10.	<10.	<10.	
(15)	C		270.	120.	110.	100.	
(16)	CL		20.	< 5.	< 5.	< 5.	
(17)	CO		20.	<10.	<10.	<10.	
(18)	CU		50.	12.	16.	14.	
(19)	HF		100.	73.	74.	74.	
(20)	H		25.	7.	6.	7.	
(21)	PB		130.	<25.	<25.	<25.	
(22)	MG		20.	<10.	<10.	<10.	
(23)	MN		50.	<25.	<25.	<25.	
(24)	N		80.	39.	14.	22.	
(25)	SI		200.	<50.	<50.	<50.	
(26)	TI		50.	<25.	<25.	<25.	
(27)	W		100.	<25.	<25.	<25.	
(28)	U		3.5	< 0.5	< 0.5	< 0.5	
(29)	O		900-1400	1160.	1160.	1160.	(0.9-1.4 W/O SPEC)
(30)	CB		120.	<50.	<50.	<50.	
(31)	MO		50.	<10.	<10.	<10.	
(32)	TA		200.	<100.	<100.	<100.	
(33)	V		50.	<25.	<25.	<25.	
(34)	NA		20.	<10.	<10.	<10.	
(997)	NOTES		B: BALANCE				
(999)	REFERENCES		STIR-4, P. 10, 11.				

<* 150003 *> ANALYSIS OF THE CONTENT OF GASEOUS CONSTITUENTS IN TUBES ** 150003 **

STUDVIK
INTER-RP
COMMON
DATA

---(1)-*---(2)-*---(3)-*---(4)-*---(5)-*---(6)-*---(7)-*---(8)-*

(1)	LOT NO. OR NAME		(SPEC)	*--------- 7AH11-H ----------*			
(2)	SAMPLE NAME			SSM1	SSM2	AA/H4-1	AA/H4-2
(11)	H2	(PPM)	<25	13	13	13	12
(12)	N2	(PPM)	<80	32	34	35	41
(13)	O2	(PPM)	1000-1600	1240	1220	1235	1248
(1)	LOT NO. OR NAME		(SPEC)	*--------- 7AH11-S ----------*			
(2)	SAMPLE NAME			SSM3	SSM4	AA/S4-1	AA/S4-2
(11)	H2	(PPM)	<25	14	14	12	12
(12)	N2	(PPM)	<80	34	32	35	36
(13)	O2	(PPM)	1000-1600	1180	1200	1195	1200
(80)	REFERENCE			STIR-4, P-32, TABLE 14.			

<* 150004 *> WALL THICKNESS OF TUBES - MEASUREMENT, INTER RAMP - ** 150004 **

STUDVIK
INTER-RP
COMMON
DATA

---(1)-*---(2)-*---(3)-*---(4)-*---(5)-*---(6)-*---(7)-*---(8)-*

(1)	TUBE LOT NO.		*------ 7AH11-S ---------*			
(2)	SAMPLE NO.		/1	/2	/3	/4
(3)	FUEL ROD NO.		TR1	TR2	HR3.2	LR1
(11)	MIN. AT MARKED END	(MICRON-M)	-14	-19	-14	-19
(12)	MAX. AT MARKED END	(MICRON-M)	16	16	11	21
(21)	MIN. AT UNMARKED END	(MICRON-M)	-19	-14	-24	-19
(22)	MAX. AT UNMARKED END	(MICRON-M)	26	16	16	16
(31)	T(MAX)-T(MIN)	(MICRON-M)	45	35	40	40
(997)	NOTES		MEASUREMENT VALUES ARE DEVIATIONS FROM THE NOMINAL VALUE OF 864 (MICRON-M).			
(999)	REFERENCES		STIR-4, P-42. TABLE 19.			

<* 150005 *> MECHANICAL PROPERTIES OF ZIRCALOY TUBE TESTED AT ROOM TEMP.-ASTM ** 150005 **

			(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
(1)	ASTM DESIGNATION : ASTM B 353-		60T		62T		64T		69	
(2)	GRADE		R-1	RA-1	R-1	RA-1	R-1	RA-1 RA-2	R-1	RA-1 RA-2
(11)	ANNEALED									
(21)	TENSILE STRENGTH, MIN	(PSI)	42000.	60000.	42000.	60000.	42000.	60000.	42000.	60000.
(26)		(KGF/MM**2)							30.	42.
(22)	*YIELD STRENGTH, MIN	(PSI)	20000.	35000.	20000.	35000.	20000.	35000.	20000.	35000.
(26)		(KGF/MM**2)							14.	25.
(24)	ELONGATION IN 2 INCH, MIN,	(%)	18.	14.	25.	20.	25.	20.	25.	20.
(12)	QUATER HARD									
(21)	TENSILE STRENGTH, MIN	(PSI)	60000.	75000.						
(22)	*YIELD STRENGTH, MIN	(PSI)	45000.	65000.						
(24)	ELONGATION IN 2 INCH, MIN,	(%)	8.	8.						
(13)	HALF-HARD									
(21)	TENSILE STRENGTH, MIN	(PSI)	80000.	95000.						
(22)	*YIELD STRENGTH, MIN	(PSI)	70000.	90000.						
(24)	ELONGATION IN 2 INCH, MIN,	(%)	5.	3.						
(14)	TEMPER H-12									
(21)	TENSILE STRENGTH, MIN	(PSI)			60000.	75000.	60000.	75000.		
(22)	*YIELD STRENGTH, MIN	(PSI)			45000.	65000.	45000.	65000.		
(24)	ELONGATION IN 2 INCH, MIN,	(%)			14.	12.	14.	12.		
(15)	TEMPER H-14									
(21)	TENSILE STRENGTH, MIN	(PSI)			80000.	95000.	80000.	95000.		
(22)	*YIELD STRENGTH, MIN	(PSI)			70000.	90000.	70000.	90000.		
(24)	ELONGATION IN 2 INCH, MIN,	(%)			8.	5.	8.	5.		
(25)	COLD-WORKED AND STRESS RILIEVED									
(21)	TENSILE STRENGTH, MIN	(PSI)							*B	*B
(22)	*YIELD STRENGTH, MIN	(PSI)							*B	*B
(24)	ELONGATION IN 2 INCH, MIN,	(%)							*B	*B

(997) NOTES

* : 0.2 PERCENT OFFSET.
*B: TO BE AGREED UPON BETWEEN THE MANUFACTURE AND THE PURCHASER.

FOR CHEMICAL REQUIREMENTS, REFER FDN-150001.

(998) REMARKS

THIS TEST IS TENSILE TEST, DIRECTION IS LONGITUDINAL.

<* 150006 *> MECHANICAL PROPERTIES OF CLADDING TUBES - INTER RAMP - ** 150006 **

STUDVIK
INTER-RP
COMMON
DATA

		(UNIT)	(SPEC)				
(2)	LOT NO. OR NAME			*--- 7AH11-H ---*		*--- 7AH11-S ---*	
(3)	SAMPLE NAME			QC1	QC2	QC5	QC6
(11)	TEST TEMPERATURE		------ ROOM TEMPERATURE -----*				
(12)	0.2% YIELD ST.	(MPA)	330-434			353.	348.2
(12)	0.2% YIELD ST.	(MPA)	>413.7	598.5	503.3		
(13)	ULTIMATE ST.	(MPA)	496-600			521.9	519.2
(13)	ULTIMATE ST.	(MPA)	>482.6	670.2	684.		
(14)	ELONGATION	(%)	> 30.			37.	37.
(14)	ELONGATION	(%)	> 16.	26.	25.		

		(UNIT)	(SPEC)				
(2)	LOT NO. OR NAME			*--- 7AH11-H ---*		*--- 7AH11-S ---*	
(3)	SAMPLE NAME			QC3	QC4	QC7	QC8
(11)	TEST TEMPERATURE	(DEG-C)	343.	-------- 343 DEG-C ----------*			
(12)	0.2% YIELD ST.	(MPA)	110-165			131.7	133.8
(12)	0.2% YIELD ST.	(MPA)	>275.8	292.3	310.3		
(13)	ULTIMATE ST.	(MPA)	248-310			258.6	259.2
(13)	ULTIMATE ST.	(MPA)	>344.7	414.4	427.5		
(14)	ELONGATION	(%)	> 30.			49.	49.
(14)	ELONGATION	(%)	> 27.	27.	27.		

		(UNIT)	(SPEC)			
(2)	LOT NO. OR NAME			*------- 7AH11-H -------*		
(3)	SAMPLE NAME			AA1	AA2	AA3
(11)	TEST TEMPERATURE		------ ROOM TEMPERATURE -----*			
(12)	0.2% YIELD ST.	(MPA)		520.	512.	510.
(13)	ULTIMATE ST.	(MPA)		712.	699.	695.
(14)	ELONGATION	(%)		22.	22.	22.

		(UNIT)	(SPEC)			
(2)	LOT NO. OR NAME			*------ 7AH11-S --------*		
(3)	SAMPLE NAME			AA7	AA8	AA9
(11)	TEST TEMPERATURE		------ ROOM TEMPERATURE -----*			
(12)	0.2% YIELD ST.	(MPA)		378.	378.	377.
(13)	ULTIMATE ST.	(MPA)		534.	534.	534.
(14)	ELONGATION	(%)		32.	32.	32.

		(UNIT)	(SPEC)			
(2)	LOT NO. OR NAME			*------- 7AH11-H -------*		
(3)	SAMPLE NAME			AA4	AA5	AA6
(11)	TEST TEMPERATURE	(DEG-C)	------ 300 DEG-C ------------*			
(12)	0.2% YIELD ST.	(MPA)		361.	369.	343.
(13)	ULTIMATE ST.	(MPA)		464.	461.	458.
(14)	ELONGATION	(%)		23.	19.	26.

		(UNIT)	(SPEC)			
(2)	LOT NO. OR NAME			*------- 7AH11-S -------*		
(3)	SAMPLE NAME			AA10	AA11	AA12
(11)	TEST TEMPERATURE	(DEG-C)	------ 300 DEG-C ------------*			
(12)	0.2% YIELD ST.	(MPA)		157.	155.	168.
(13)	ULTIMATE ST.	(MPA)		288.	286.	293.
(14)	ELONGATION	(%)		40.	44.	44.

(79) REMARKS

RT = ROOM TEMPERATURE,
QC = QUALITY CERTIFICATE SAMPLE,
AA = ASEA-ATOM RECIEVING INSPECTION SAMPLE.

THE FINAL TUBE ANNEALING TEMPERATURE AND TIME ARE SELECTED TO YIELD THE SPECIFIED MECHANICAL PROPERTIES. HELIUM ADDITIONS ARE USED FOR HEATING AND COOLING, BUT ANNEALING IS DONE IN A VACUUM BETTER THAN 1.E-05 TORR. INTERMEDIATE HOLLOWS ARE ANNEALED AT 677 DEG-C (1250 F) FOR 45 MINITES. ACCORDINGLY, 'SOFT' TUBE PROPERTIES WERE OBTAINED BY VACUUM ANNEALING AT 565 DEG-C (1050 F) FOR 2 HOURS ('RECRYSTALLIZED' TUBE LOT NO. 7A11-S). 'HARD' TUBE PROPERTIES WERE, ON THE OTHER HAND, REACHED

BY ANNEALING AT 495 DEG-C (923 F) DURING 4 HOURS ('STRESS RELIEVED' TUBE LOT NO. 7AH11-H).
(FROM STIR-4, P-12.)

(80) REFERENCE — STIR-4, P-15, 12. TABLE 8.

<* 150007 *> BURST PROPERTIES FOR CLADDING TUBES ** 150007 **

STUDVIK
INTER-RP
COMMON
DATA

			TEMP. (DEG.-C)	7AH11-H 1	7AH11-H 2	7AH11-H 3	7AH11-S 4	7AH11-S 5	7AH11-S 6
(12)	BURST PRE SSURE	(MPA)	RT	820.	796.	826.	674.	668.	674.
(15)	DUCTILITY*	(%)	RT	26.	31.	22.	49.	52.	49.
(12)	BURST PRE SSURE	(MPA)	300.	499.	499.	492.	317.	317.	320.
(15)	DUCTILITY*	(%)	300.	28.	28.	29.	70.	79.	82.

(79) REMARKS
* : (STUDVIK INTER-RAMP) THE DUCTILITY WAS CALCULATED AS THE PERCENTAGE CIRCUMFERENTIAL INCREASE.
RT : ROOM TEMPERATURE.

(80) REFERENCE — STIR-4, P-16, TABLE 9.

<* 150009 *> CORROSION PROPERTIES FOR ZIRCALOY CLADDING TUBES ** 150009 **

STUDVIK
INTER-RP
COMMON
DATA

			REQ'S	STANDARD C241(T)	STANDARD C246(C)	STANDARD C247(B)
(12)	TEST TIME	(DAYS)	3	14	3	?	?
(13)	WEIGHT GAIN	(MGR/DM**2)	<22	<38	13.7	11.6	13.7

(79) REMARKS
(T): TOP OF AUTOCLAV
(C): CENTER OF AUTOCLAV
(B): BOTTOM OF AUTOCLAV
REQ'S : REQUIREMENTS AS OF ASTM B 353.

			7AH11-H SSM1	SSM2	SSM3	SSM4	AE1	AE2	AE3	AE4
(12)	TEST TIME	(DAYS)					14	14	14	14
(13)	WEIGHT GAIN	(MGR/DM**2)	14.2	13.2	13.3	14.1	34.4	32.6	33.9	33.6
(78)	NOTES		L	L	N	N				

			7AH11-S SSM5	SSM6	SSM7	SSM8	AE5	AE6	AE7	AE8
(12)	TEST TIME	(DAYS)					14	14	14	14
(13)	WEIGHT GAIN	(MGR/DM**2)	13.7	12.7	14.1	14.6	34.8	34.0	34.2	33.3
(78)	NOTES		L	L	N	N				

(79) REMARKS — L = LAB ETCHED. N = NOT LAB ETCHED.

(80) REFERENCE — STIR-4, P-17.

<* 150010 *> HYDRIDE ORIENTATION METHOD AND RESULTS FOR CLADDING TUBES ** 150010 **

STUDVIK
INTER-RP
COMMON
DATA

		SPECIFICATION AE-PS-0002	RESULT	
(1)	SAMPLE IDENTIFICATION		SSM	AA
(2)	SAMPLE NUMBER	>2	>2	>2
(11)	HYDRIDING METHOD			
(12)	MEDIUM	0.25 M LIOH	1 M LIOH	H2
(13)	TEMP. (DEG-C), (DEG-F)	360.	316.	400.
(14)	TIME (HRS)	36.	18.	2.
(20)	AFTER-TREATMENT			
(21)	TEMP. (DEG-C), (DEG-F)	(NOT SPECIFIED)	399.	-
(22)	TIME (HRS)		5PM1	-
(24)	COOLING RATE (DEG-F/MIN)		<25.	
(23)	COOLING RATE (DEG-C/MIN)			< 1.
(25)	HYDROGEN CONCENTRATION, (PPM)	100-150	100.	200.
(30)	METALLOGRAPHY			
(31)	ETCHING	ACC. TO AGREEMENT	HNO3-HF-H2O (ANODIZING)	HNO3-HF
(32)	NO. OF HYDRIDES/ZONE	>100.	>100.	>100.
(33)	NO. OF WALL ZONES	3.	1.	3.
(34)	ANGULAR INTERVAL*FOR COUNTING	45-90	50-90	45-90

UNIT OF ABOVE VALUES IS DEG..

(79) REMARKS
* : RELATIVE THE TUBE TANGENTIAL PLANE.

(80) REFERENCE
STIR-4, P-18. TABLE-11.

<* 150011 *> HYDRIDE ORIENTATION FACTOR (FN) FOR CLADDING TUBES - INTER-RP. - ** 150011 **

STUDVIK
INTER-RP
COMMON
DATA

		(SPEC)	SSM3	SSM4	AA1/OZ	7AH11-S AA2/OZ	AA3/MZ	AA1-3/MZ	AA1-3/IZ
(1)	TUBE LOT NO. OR NAME								
(2)	SAMPLE IDENTIFICATION	SPEC/AZ							
(11)	FN VALUE	<0.30	0.20	0.14	0.51	0.53	0.54	0.14-.24	0.14-.24

		(SPEC)	7AH11-H	
(1)	TUBE LOT NO. OR NAME			
(2)	SAMPLE IDENTIFICATION	SPEC/AZ	SSM1	SSM2
(11)	FN VALUE	<0.30	0.02	0.01

(997) NOTES
OZ: OUTER ZONE, MZ: MIDDLE ZONE, IZ: INNER ZONE, AZ: ANY ZONE.

(999) REFERENCES
STIR-4, P-20, TABLE 12.

<* 150012 *> GRAIN SIZE IN ZIRCALOY TUBES - INTER RAMP ** 150012 **

STUDVIK
INTER-RP
COMMON
DATA

		---(1)-*---(2)-*---(3)-*---(4)-*---(5)-*---(6)-*---(7)-*---(8)-*							
(1)	LOT NO.	*--------- 7AH11-H ----------*---------- 7AH11-S ----------*							
(2)	SAMPLE NAME	SSM1	SSM2	SSM3	SSM4	SSM5	SSM6	SSM7	SSM8
(11)	GRAIN SIZE (ASTM NUMBER)	11.5	11.5	12.0	11.5	11.5	11.5	11.5	11.5
(21)	CROSSECTION	L	L	T	T	L	L	T	T
(997)	NOTES	L = LONGITUDINAL CROSSECTION/ T = TRANSVERSE CROSSECTION.							
(999)	REFERENCES	STIR-4, P-23.							

<* 150013 *> CLADDING MATERIAL - STAINLESS STEEL CHEMICAL COMPOSITION & IMP.- ** 150013 **

PWR
11X11
MUTSU

		---(1)-*---(2)-*---(3)-*---(4)-*---(5)-*---(6)-*---(7)-*---(8)-*
(1)	MATERIAL	SUS-27 LOW COBALT
		(SPEC) -- W/O-*
(10)	CHEMICAL COMPOSITION	
(11)	NICKEL	8.00 TO 11.00
(12)	CHRONIUM	18.00 TO 20.00
(13)	IRON	B
(20)	IMPURITIES, MAX.	
(21)	CARBON	0.08
(22)	SILICON	1.00
(23)	MANGANESE	2.00
(24)	PHOSHATE	0.04
(25)	SULPHER	0.03
(26)	COBALT	0.05
(997)	NOTES	B : BALANCE.
(999)	REFERENCES	JNS-09, P.10 (MAY 1972)

<* 150014 *> JPDR TEST ASSEMBLY NO.1 ZRY-2 TUBES AND BARS TEST DATA (1/3) ** 150014 **

BWR
6X6
JPDR

---(1)-*---(2)-*---(3)-*---(4)-*---(5)-*---(6)-*---(7)-*---(8)-*

(1)	MAKER			-- A INGOT NO (TUBU TT2-1627) -- (BAR TT2-1586)				
(2)	CONDITION			--------- QUARTER HARD ----------				
(3)	LOT NO.			A-1	A-2	B-1	B-2	B-3
(4)	TUBE NO.			#1-18	#20-54	#56-72 #256-265	#73-80	#86-96
(5)	NO.OF PCS.							
(11)	MECHANICAL PROPERTIES							
(12)	Y.S 0.2 %	1/4H > 45	KG/SQMM	50.1	55.0	54.1	53.5	53.7
				52.0	54.6	52.6	54.3	53.8
(13)		0 > 24	KG/SQMM	50.4	50.3	52.2	51.5	
(14)	U.T.S	1/4H > 52	KG/SQMM	53.0	55.7	55.7	55.6	55.4
				54.0	54.8	54.8	56.1	55.5
(15)		0 > 42	KG/SQMM	53.3	54.2	55.3	55.0	
(16)	ELONGATION	1/4H > 8	%	13.5	11.8	11.8	12.0	13.6
				12.0	11.4	10.4	13.0	13.2
(17)		0 > 14	%	12	11	14	13	
(18)	FLARE	> 15	%	43	50	43	48	45
				GOOD	GOOD	GOOD	GOOD	GOOD
				NO CRACK			42% CRACK	
(19)	BURST YIELD		KG/SQCM	605	615	600	605	565
				615	600	580	610	565
(20)	BURST	1/4H >600	KG/SQCM	750	710	630	705	720
				760	720	(580) 710	720	720
(21)	GRAIN SIZE (ASTM)	> #7		9.0	9.0	7.5,7.5	7.5,7.5	7.5
(22)	CORROSION	< 22 MG/DM**2 3DAYS		13.69	15.09	14.96	17.12	18.58
(23)		< 38 MG/DM**2 14DAYS						
(24)	FINISH PRODUCT	H < 25	PPM	12	22	23	24	21
(25)		N < 80	PPM	10	32	31	16	36
(26)		O	PPM	620		1080	623	
(79)	REMARKS							
(80)	REFERENCE			C-94				

<* 150015 *> JPDR TEST ASSEMBLY NO.1 ZRY-2 TUBES AND BARS TEST DATA ** 150015 **

BWR
6X6
JPDR

---(1)-*---(2)-*---(3)-*---(4)-*---(5)-*---(6)-*---(7)-*---(8)-*

(1)	MAKER		-- B INGOT NO (TUBU V-1045) ---- (BAR V-1044)				
(2)	CONDITION		--------- QUARTER HARD ----------				
(3)	LOT NO.		1	2	3	4	5
			JPFD483	JPFD484	JPFD485	JPFD486	JPFD487
(4)	TUBE NO.		101-105	106-130	131-157	158-173	174-191
(5)	NO.OF PCS.						
(11)	MECHANICAL PROPERTIES						
(12)	Y.S 0.2 %	1/4H > 45 KG/SQMM	52.7	49.1	51.6	55.2	52.0
			51.9	49.7	53.2	54.1	54.0
(13)		0 > 24 KG/SQMM	48.7	51.6	37.6	53.1	54.5
					40.3		
					52.1		
					50.8		
(14)	U.T.S	1/4H > 52 KG/SQMM	53.4	53.4	54.2	56.5	57.2
			53.8	55.1	55.5	55.8	55.8
(15)		0 > 42 KG/SQMM	53.1	56.8	54.8	56.7	58.4
					50.2		
					53.3		
					53.0		
(16)	ELONGATION	1/4H > 8 %	13,12	14,14	13,13	10,9	9,9
(17)		0 > 14 %	10	12	15,16	12	10
					12,12		
(18)	FLARE	> 15 %	45	48	45	50	50
			GOOD	GOOD			
			24 %	23 %			
			STOPPED	STOPPED	56 %	41 %	45 %
(19)	BURST YIELD	KG/SQCM	660	700	700	710	750
			650	655			
(20)	BURST	1/4H >600 KG/SQCM	730	740	760	730	770
			720	740			
(21)	GRAIN SIZE (ASTM)	> #7	7.8	8.2	8.0	8.5	8.5
(22)	CORROSION	< 22 MG/DM**2 3DAYS	22,21	19,21	21,25	20,27	25,20
(23)		< 38 MG/DM**2 14DAYS	29	27	29.2	27.1	30.5
			29	28	27.6	31.3	27.0
(24)	FINISH PRODUCT	H < 25 PPM	22	20	20	20	24
(25)		N < 80 PPM	26	14	18	20	27
(26)		0 PPM					

(79) REMARKS

(80) REFERENCE C-94

<** 150016 *> JPDR TEST ASSEMBLY NO.1 ZRY-2 TUBES AND BARS TEST DATA ** 150016 **

BWR
6X6
JPDR

---(1)-*---(2)-*---(3)-*---(4)-*---(5)-*---(6)-*---(7)-*---(8)-*

(1)	MAKER			C	
(2)	CONDITION			-QUARTER HARD-	-FULL ANNEALED-
(3)	LOT NO.			INGOT NO 34295	INGOT NO 34315
				LOT NO 2667	LOT NO 2576
(4)	TUBE NO.			501 - 899	901 -999
(5)	NO.OF PCS.			280	100
(11)	MECHANICAL PROPERTIES				
(12)	Y.S 0.2 %	1/4H > 45	KG/SQMM	59.1	37.2
				55.6	38.9
(13)		0 > 24	KG/SQMM	47.7	
(14)	U.T.S	1/4H > 52	KG/SQMM	67.5	53.4
				67.6	53.2
(15)		0 > 42	KG/SQMM	62.5	
(16)	ELONGATION	1/4H > 8	%	14.0	28.0
				17.0	25.0
(17)		0 > 14	%	22.8	
(18)	FLARE	> 15	%		
				19.8	20.0
				20.2	20.0
(19)	BURST YIELD		KG/SQCM	685.5	492.2
				773.4	509.7
(20)	BURST	1/4H >600	KG/SQCM	738.3	650.4
				791.0	650.4
(21)	GRAIN SIZE (ASTM)	> #7		LONG #8	
				TRAN #8	
(22)	CORROSION	< 22 MG/DM**2 3DAYS		15.4	18.7
				15.5	22.7
(23)		< 38 MG/DM**2 14DAYS			
(24)	FINISH PRODUCT	H < 25	PPM	13	15
				12	15
(25)		N < 80	PPM	32	26
				32	26
(26)		0	PPM		
(79)	REMARKS				
(80)	REFERENCE			C-94	

<* 150017 *> JPDR TEST ASSEMBLY NO.1 ZRY-2 TUBES AND BARS TEST DATA (1/6) ** 150017 **

***** CHEMICAL ANALYSIS *****
BWR
6X6
JPDR

						(1) TT2 -1627 (TUBE) TOP VENDER	(2) TT2 -1627 (TUBE) TOP JAERI	(3) TT2 -1627 (TUBE) MIDDLE VENDER	(4) TT2 -1627 (TUBE) MIDDLE JAERI	(5) TT2 -1627 (TUBE) BOTTOM VENDER	(6) TT2 -1627 (TUBE) BOTTOM JAERI
(1)	INGOT NO.										
(2)	POSITION					TOP	TOP	MIDDLE	MIDDLE	BOTTOM	BOTTOM
(11)	ALLOYS	SN	1.20 - 1.70	%		1.55	1.57	1.57	1.55	1.49	1.54
(12)		FE	0.07 - 0.20	%		.135	.130	.132	.135	.130	.132
(13)		CR	0.05 - 0.15	%		.111	.105	.112	.106	.109	.108
(14)		NI	0.03 - 0.08	%		.051	.051	.053	.051	.051	.042
(15)		FE+CR+NI	0.18 - 0.38	%		.297		.297		.290	
(16)	OTHERS	AL	< 75	PPM		41		30		35	
(17)		B	< 0.5	PPM			.39		.36		.32
(18)		C	< 500	PPM		60		60		60	
(19)		CA	< 30	PPM			< 30		< 30		< 30
(20)		CD	< 0.5	PPM			< .2		< .2		< .2
(21)		CL	< 20	PPM		< 20		< 20		< 20	
(22)		CO	< 20	PPM		< 10	< 6	< 10	< 6	< 10	< 6
(23)		CU	< 50	PPM		14	5	10	7	13	7
(24)		HF	<100	PPM		89		90		84	
(25)		MG	< 20	PPM		< 20	< 1	< 20	< 1	< 20	< .9
(26)		MN	< 50	PPM		< 50	6	< 50	8	< 50	16
(27)		MO		PPM		< 30	12<<24	< 30	= 6	< 30	< 6
(28)		NA		PPM							
(29)		PB	<130	PPM		< 40	< 15	< 40	3	< 40	3
(30)		SI	<120	PPM		50		40		50	
(31)		TI	< 50	PPM		45	< 30	40	< 30	42	< 30
(32)		V		PPM		< 20		< 20		< 20	
(33)		W	<100	PPM		< 40		< 40		< 40	
(34)		U	< 3.5	PPM					.19		
(35)		H	< 25	PPM		5	(5)	5	5.7	10	16.8
(36)		N	< 80	PPM		14		19		29	
(37)		O	900-1500	PPM		775		872	640	775	630
(38)	SIZE (TUBE)					I.D= 12.62 +- 0.04 MM T= 0.76 +- 0.075 MM L= 912 +0.5 -0 MM					
(79)	REMARKS										
(80)	REFERENCE					C-94					

<* 150018 *> JPDR TEST ASSEMBLY NO.1 ZRY-2 TUBES AND BARS TEST DATA (2/6) ** 150018 **

***** CHEMICAL ANALYSIS *****
BWR
6X6
JPDR

---(1)-*---(2)-*---(3)-*---(4)-*---(5)-*---(6)-*---(7)-*---(8)-*

					TT2 -1856 (BAR)			
(1)	INGOT NO.							
(2)	POSITION				--- TOP ---		-- MIDDLE --	
					VENDER	JAERI	VENDER	JAERI
(11)	ALLOYS	SN	1.20 - 1.70	%	1.40		1.40	
(12)		FE	0.07 - 0.20	%	.135		.143	
(13)		CR	0.05 - 0.15	%	.095		.099	
(14)		NI	0.03 - 0.08	%	.049		.051	
(15)		FE+CR+NI	0.18 - 0.38	%	.279		.293	
(16)	OTHERS	AL	< 75	PPM	25		25	
(17)		B	< 0.5	PPM				
(18)		C	< 500	PPM	60		60	
(19)		CA	< 30	PPM				
(20)		CD	< 0.5	PPM				
(21)		CL	< 20	PPM	< 20		< 20	
(22)		CO	< 20	PPM	< 2		< 2	
(23)		CU	< 50	PPM	32		15	
(24)		HF	<100	PPM	87		91	
(25)		MG	< 20	PPM	< 20		< 20	
(26)		MN	< 50	PPM	15		14	
(27)		MO		PPM	< 20		< 20	
(28)		NA		PPM				
(29)		PB	<130	PPM	< 40		< 40	
(30)		SI	<120	PPM	13		14	
(31)		TI	< 50	PPM	16		34	
(32)		V		PPM				
(33)		W	<100	PPM	< 40		< 40	
(34)		U	< 3.5	PPM				
(35)		H	< 25	PPM	7		9	
(36)		N	< 80	PPM	25		32	
(37)		O	900-1500	PPM	840		990	

(38)	SIZE (TUBE)		I.D= 12.62 +- 0.04 MM T= 0.76 +- 0.075 MM L= 912 +0.5 -0 MM
(79)	REMARKS		
(80)	REFERENCE		C-94

					TT2 -1856 (BAR)		
					-- BOTTOM--		
					VENDER	JAERI	
(11)	ALLOYS	SN	1.20 - 1.70	%	1.41		
(12)		FE	0.07 - 0.20	%	.143		
(13)		CR	0.05 - 0.15	%	.094		
(14)		NI	0.03 - 0.08	%	.050		
(15)		FE+CR+NI	0.18 - 0.38	%	.287		
(16)	OTHERS	AL	< 75	PPM	25		
(17)		B	< 0.5	PPM			
(18)		C	< 500	PPM	60		
(19)		CA	< 30	PPM			
(20)		CD	< 0.5	PPM			
(21)		CL	< 20	PPM	< 20		
(22)		CO	< 20	PPM	< 2		
(23)		CU	< 50	PPM	20		
(24)		HF	<100	PPM	96		
(25)		MG	< 20	PPM	< 20		
(26)		MN	< 50	PPM	6		
(27)		MO		PPM	< 200		
(28)		NA		PPM			
(29)		PB	<130	PPM	< 40		
(30)		SI	<120	PPM	15		
(31)		TI	< 50	PPM	30		
(32)		V		PPM			
(33)		W	<100	PPM	< 40		
(34)		U	< 3.5	PPM			
(35)		H	< 25	PPM	8		
(36)		N	< 80	PPM	29		
(37)		O	900-1500	PPM	1210		

<* 150019 *> JPDR TEST ASSEMBLY NO.1 ZRY-2 TUBES AND BARS TEST DATA (3/6) ** 150019 **

***** CHEMICAL ANALYSIS *****
BWR
6X6
JPDR

					(1)	(2)	(3)	(4)	(5)	(6)
(1)	INGOT NO.				V - 1045 (TUBE)					
(2)	POSITION				--- TOP ---		-- MIDDLE --		-- BOTTOM--	
					VENDER	JAERI	VENDER	JAERI	VENDER	JAERI
(11)	ALLOYS	SN	1.20 - 1.70	%	1.59	1.74	1.64	1.65	1.66	1.67
(12)		FE	0.07 - 0.20	%	.164	.190	.177	.175	.164	.174
(13)		CR	0.05 - 0.15	%	.076	.110	.080	.098	.075	.074
(14)		NI	0.03 - 0.08	%	.058	.055	.059	.049	.054	.050
(15)		FE+CR+NI	0.18 - 0.38	%	.298	.355	.316	.321	.293	.297
(16)	OTHERS	AL	< 75	PPM	60		35		40	
(17)		B	< 0.5	PPM	< .5	.43	< .5	< .43	< .5	.42
(18)		C	< 500	PPM	60		70		100	
(19)		CA	< 30	PPM		< 30		< 30		< 30
(20)		CD	< 0.5	PPM	< .5	< .2	< .5	< .2	< .5	< .2
(21)		CL	< 20	PPM	ND		ND		ND	
(22)		CO	< 20	PPM	1	< 6	1	< 6	1	< 6
(23)		CU	< 50	PPM	6	10	7	6	8	23
(24)		HF	<100	PPM	< 100		< 100		< 100	
(25)		MG	< 20	PPM	ND	.8	ND	.6	ND	.8
(26)		MN	< 50	PPM	40	25	30	30	20	14
(27)		MO		PPM		< 6		< 6		< 6
(28)		NA		PPM						
(29)		PB	<130	PPM	6	5	4	4	5	4
(30)		SI	<120	PPM	30		55		50	
(31)		TI	< 50	PPM	18	< 30	26	< 30	24	< 30
(32)		V		PPM						
(33)		W	<100	PPM	1		3		5	
(34)		U	< 3.5	PPM				.13		
(35)		H	< 25	PPM	13	7.4	18	3.9	10	5.5
(36)		N	< 80	PPM	20		22		40	
(37)		O	900-1500	PPM	600	520	600	820	600	800
(38)	SIZE (TUBE)				I.D= 12.62 +- 0.04 MM T= 0.76 +- 0.075 MM L= 912 +0.5 -0 MM					
(79)	REMARKS									
(80)	REFERENCE				C-94					

<* 150020 *> JPDR TEST ASSEMBLY NO.1 ZRY-2 TUBES AND BARS TEST DATA (4/6) ** 150020 **

***** CHEMICAL ANALYSIS *****
BWR
6X6
JPDR

---(1)-*---(2)-*---(3)-*---(4)-*---(5)-*---(6)-*---(7)-*---(8)-*

						V - 1044 (BAR)			
(1)	INGOT NO.								
(2)	POSITION					--- TOP ---		-- MIDDLE --	
						VENDER	JAERI	VENDER	JAERI
(11)	ALLOYS	SN	1.20 - 1.70	%		1.63		1.59	
(12)		FE	0.07 - 0.20	%		.14		.15	
(13)		CR	0.05 - 0.15	%		.089		.065	
(14)		NI	0.03 - 0.08	%		.060		.059	
(15)		FE+CR+NI	0.18 - 0.38	%		.289		.274	
(16)	OTHERS	AL	< 75	PPM		60		70	
(17)		B	< 0.5	PPM		< .5		< .5	
(18)		C	< 500	PPM		70		100	
(19)		CA	< 30	PPM					
(20)		CD	< 0.5	PPM		< .5		< .5	
(21)		CL	< 20	PPM		ND		ND	
(22)		CO	< 20	PPM		ND		ND	
(23)		CU	< 50	PPM		9		15	
(24)		HF	<100	PPM		< 100		< 100	
(25)		MG	< 20	PPM		ND		ND	
(26)		MN	< 50	PPM		20		10	
(27)		MO		PPM					
(28)		NA		PPM					
(29)		PB	<130	PPM		4		2	
(30)		SI	<120	PPM		40		50	
(31)		TI	< 50	PPM		29		35	
(32)		V		PPM					
(33)		W	<100	PPM		6		5	
(34)		U	< 3.5	PPM					
(35)		H	< 25	PPM		8		6	
(36)		N	< 80	PPM		14		14	
(37)		O	900-1500	PPM					
(38)	SIZE (TUBE)					I.D= 12.62 +- 0.04 MM T= 0.76 +- 0.075 MM L= 912 +0.5 -0 MM			
(79)	REMARKS								
(80)	REFERENCE					C-94			

						BOTTOM--	
						VENDER	JAERI
(11)	ALLOYS	SN	1.20 - 1.70	%		1.69	
(12)		FE	0.07 - 0.20	%		.14	
(13)		CR	0.05 - 0.15	%		.070	
(14)		NI	0.03 - 0.08	%		.066	
(15)		FE+CR+NI	0.18 - 0.38	%		.276	
(16)	OTHERS	AL	< 75	PPM		40	
(17)		B	< 0.5	PPM		< .5	
(18)		C	< 500	PPM		60	
(19)		CA	< 30	PPM			
(20)		CD	< 0.5	PPM		< .5	
(21)		CL	< 20	PPM		ND	
(22)		CO	< 20	PPM		ND	
(23)		CU	< 50	PPM		43	
(24)		HF	<100	PPM		< 100	
(25)		MG	< 20	PPM		ND	
(26)		MN	< 50	PPM		10	
(27)		MO		PPM			
(28)		NA		PPM			
(29)		PB	<130	PPM		2	
(30)		SI	<120	PPM		60	
(31)		TI	< 50	PPM		38	
(32)		V		PPM			
(33)		W	<100	PPM		19	
(34)		U	< 3.5	PPM			
(35)		H	< 25	PPM		10	
(36)		N	< 80	PPM		42	
(37)		O	900-1500	PPM			

<* 150021 *> JPDR TEST ASSEMBLY NO.1 ZRY-2 TUBES AND BARS TEST DATA (5/6) ** 150021 **

***** CHEMICAL ANALYSIS *****
BWR
6X6
JPDR

(1)	INGOT NO.					34295				
(2)	POSITION					--- TOP ---		-- MIDDLE --		-- BOTTOM--
						VENDER	JAERI	VENDER	JAERI	VENDER JAERI
(11)	ALLOYS	SN	1.20 - 1.70	%		1.58		1.55		1.53
(12)		FE	0.07 - 0.20	%		.159		.163		.154
(13)		CR	0.05 - 0.15	%		.108		.104		.095
(14)		NI	0.03 - 0.08	%		.059		.060		.060
(15)		FE+CR+NI	0.18 - 0.38	%		.326		.327		.309
(16)	OTHERS	AL	< 75	PPM		29		35		37
(17)		B	< 0.5	PPM		.35		.4		.35
(18)		C	< 500	PPM		166		182		190
(19)		CA	< 30	PPM		< 20		< 20		< 20
(20)		CD	< 0.5	PPM		< .25		< .25		< .25
(21)		CL	< 20	PPM		< 20		< 20		< 20
(22)		CO	< 20	PPM		< 10		< 10		< 10
(23)		CU	< 50	PPM		< 20		< 20		< 20
(24)		HF	<100	PPM		77		67		68
(25)		MG	< 20	PPM		< 10		< 10		< 10
(26)		MN	< 50	PPM		< 20		< 20		< 20
(27)		MO		PPM		< 20		< 20		< 20
(28)		NA		PPM		< 10		< 10		< 10
(29)		PB	<130	PPM		< 20		< 20		< 20
(30)		SI	<120	PPM		37		39		37
(31)		TI	< 50	PPM		22		32		< 20
(32)		V		PPM		< 20		< 20		< 20
(33)		W	<100	PPM		< 20		< 20		< 20
(34)		U	< 3.5	PPM		< .2		< .2		< .2
(35)		H	< 25	PPM		8		8		10
(36)		N	< 80	PPM		32		32		36
(37)		O	900-1500	PPM		1160		1230		1460
(38)	SIZE (TUBE)					I.D= 0.495 +0.0035 -0 MM T= 0.030 +-0.0031 MM L= 36 +0.3 -0 MM				
(79)	REMARKS									
(80)	REFERENCE					C-94				

<* 150022 *> JPDR TEST ASSEMBLY NO.1 ZRY-2 TUBES AND BARS TEST DATA (6/6) ** 150022 **

***** CHEMICAL ANALYSIS *****
BWR
6X6
JPDR

---(1)-*---(2)-*---(3)-*---(4)-*---(5)-*---(6)-*---(7)-*---(8)-*

(1)	INGOT NO.					34315		
(2)	POSITION				--- TOP ---		-- MIDDLE --		-- BOTTOM--	
					VENDER	JAERI	VENDER	JAERI	VENDER	JAERI
(11)	ALLOYS	SN	1.20 - 1.70	%	1.53		1.54		1.55	
(12)		FE	0.07 - 0.20	%	.169		.169		.160	
(13)		CR	0.05 - 0.15	%	.106		.139		.095	
(14)		NI	0.03 - 0.08	%	.061		.063		.058	
(15)		FE+CR+NI	0.18 - 0.38	%	.336		.371		.313	
(16)	OTHERS	AL	< 75	PPM	32		34		29	
(17)		B	< 0.5	PPM	.36		.40		.34	
(18)		C	< 500	PPM	160		168		.188	
(19)		CA	< 30	PPM	< 20		< 20		< 20	
(20)		CD	< 0.5	PPM	< .25		< .25		< .25	
(21)		CL	< 20	PPM						
(22)		CO	< 20	PPM	< 10		< 10		< 10	
(23)		CU	< 50	PPM	< 20		< 20		< 20	
(24)		HF	<100	PPM	90		84		90	
(25)		MG	< 20	PPM	< 10		< 10		< 10	
(26)		MN	< 50	PPM	< 20		< 20		< 20	
(27)		MO		PPM	< 20		< 20		< 20	
(28)		NA		PPM	< 10		< 10		< 10	
(29)		PB	<130	PPM	< 20		< 20		< 20	
(30)		SI	<120	PPM	38		38		37	
(31)		TI	< 50	PPM	33		33		30	
(32)		V		PPM	< 20		< 20		< 20	
(33)		W	<100	PPM	< 20		< 20		< 20	
(34)		U	< 3.5	PPM	< .2		< .2		< .2	
(35)		H	< 25	PPM	9		8		17	
(36)		N	< 80	PPM	32		40		41	
(37)		O	900-1500	PPM	1290		1300		1390	
(38)	SIZE (TUBE)				I.D= 0.495 +0.0035 -0 MM T= 0.030 +-0.0031 MM L= 36 +0.3 -0 MM					
(79)	REMARKS									
(80)	REFERENCE				C-94					

<* 150023 *> JPDR TEST ASSEMBLY NO.1 BARS TEST DATA (1/2) ** 150023 **

***** MECHANICAL PROPERTIES *****
BWR
6X6
JPDR

---(1)-*---(2)-*---(3)-*---(4)-*---(5)-*---(6)-*---(7)-*---(8)-*

(1)	SIZE			15 +- 0.25 MM DIA. X 1000 MM
(2)	Y.S	> 24	KG/SQMM	34.8 ,28.1
(3)	U.T.S	> 42	KG/SQMM	50.1 ,46.4
(4)	ELONGATION	> 14	%	22 ,22
(5)	GRAIN SIZE (ASTM)	#7		
(6)	CORROSION	< 38	MG/DM**2-14DAYS	
(7)	H , N		PPM	H= 23 ,O= 700 ,N=?
(8)	HARDNESS HR(B)	< 92		85.0 ,86.0 ,86.7 (85.9 MEAN)

(79)	REMARKS	JPFD-481
(80)	REFERENCE	C-94

<* 150024 *> JPDR TEST ASSEMBLY NO.1 BARS TEST DATA (2/2) ** 150024 **

***** MECHANICAL PROPERTIES *****
BWR
6X6
JPDR

---(1)-*---(2)-*---(3)-*---(4)-*---(5)-*---(6)-*---(7)-*---(8)-*

(1)	SIZE			15 +- 0.25 MM DIA. X 2000 MM
(2)	Y.S	> 24	KG/SQMM	39.2 ,38.9
(3)	U.T.S	> 42	KG/SQMM	44.1 ,46.3
(4)	ELONGATION	> 14	%	26 ,30
(5)	GRAIN SIZE (ASTM)	#7		# 7
(6)	CORROSION	< 38	MG/DM**2-14DAYS	20 ,19(3 DAYS) 28.6 ,30.2(14 DAYS)
(7)	H , N		PPM	H= 9 ,N=25
(8)	HARDNESS HR(B)	< 92		85.0

(79)	REMARKS	JPFD-482
(80)	REFERENCE	C-94

<* 150025 *> JPDR TEST ASSEMBLY NO.1 TUBE TEST DATA ** 150025 **

***** MECHANICAL PROPERTIES *****
BWR
6X6
JPDR

---(1)-*---(2)-*---(3)-*---(4)-*---(5)-*---(6)-*---(7)-*---(8)-*

(1)	SIZE			0.495 +0.0035 -0 I.D X 0.030 +-0.0036 T X 36 +0.2 -0 L(MM)					
(2)	ROOM TEMPERATURE	DEG-C		R.N	------ 300 ------			--- 360 ---			---420 ---
(3)	Y.S	> 24	KG/SQMM	47.7	30.3		29.9	27.4	27.7	26.8	25.1
(4)	U.T.S	> 42	KG/SQMM	62.5	36.8	37.7	36.0	33.9	33.6	31.2	29.8
(5)	ELONGATION	> 14	%	22.8	18.6	19.4	18.4	13.6	15.0	13.2	17.0

(79)	REMARKS	
(80)	REFERENCE	C-94

<* 150501 *> TYPICAL ZIRCALOY CLADDING TUBE SPECIFICATION DATA ** 150501 **

				PWR	BWR	
(10) PROPERTIES SPECIFIED						
(11) SURFACE:						
(12) SURFACE TREATMENT			GROUND/SAND-BLASTED	GROUND/SAND-BLASTED PICKLED/SAND-BLASTED PICKLED/PICKLED	
(13) SURFACE ROUGHNESS, MAX.		(RA)	0.7 TO 1.0	1.2	
(20) DIMENSION:					
(21) INNER DIAMETER,		(MM)	+-0.04	+-0.04 TO 0.05	
(22) OUTER DIAMETER,		(MM)	+-0.04 TO 0.05, NS	+-0.05 TO 0.06, NS	
(23) WALL THICKNESS,		(MM)	+-0.05, MIN.	+-0.04 TO 0.08, MIN.	
(24) OVALITY, I.D.,		(MM)	+-0.025, NS	+-0.03 TO 0.05 NS	
(25) ECCENTRICITY			(0.10 TO 0.16), NS	(0.10 TO 0.16), NS	
(26) STRAIGHTNESS, MAX.			0.25/300 TO 0.6/600	0.4/500 TO 0.6/600	
(30) STRUCTURE:					
(31) GRAIN SIZE,		ASTM NO.	6 TO 7 (FULLY ANNEALED)	7 TO 13	
(32) HYDRIDE ORIENTATION,		FN NUMBER	< 0.3 TO 0.4	0.1<FN<0.45, <0.3	
(33) TEXTURE			NS	YES, NS	
(40) CORROSION:					
(41) CORROSION WEIGHT GAIN,					
(42) MAX.		(MG/DM**2)	22	7 TO 13	
(50) MECHANICAL:					
(51) TENSILE TEST			RT ET	RT ET	
(52) UTS,	MIN.	(KP/MM**2)	49-60 22-38	46-53 23-29	NS
(53) YP ,	MIN.	(KP/MM**2)	35-46 20-32	29-44,5 12-22.5	NS
(54) ELONGATION,	MIN.	(%)	12-18 10-18	15-30 20-30	NS
(55) UNIFORM,	MIN.	(%)	NS NS	NS	NS
(60) BURST TEST					
(61) BURST PRESSURE, MIN.		(%)	YES NS NS	YES NS NS	NS
(62) TOTAL ELONGATION, MIN.		(%)	12 NS NS	16-24 NS	NS
(63) UNIFORM ELONGATION, MIN.		(%)	NS 2.5	NS NS	NS
(64) CREEP ELONGATION, MAX.		(%)	NS 1	NS NS	NS
(70) DEFECT:					
(71) CRACKS,FLAWS,INCLUSIONS			5 % MIN.WALL	5-10 % WALL	

(997) NOTES

NS : NOT SPECIFIED.

OVALITY : THE OVALITY IS DEFINED AS DELTA ID (INNER DIA.(MAX) - INNER DIA.(MIN))

ECCENTRICITY : THE ECCENTRICITY IS DEFINED AS
E= (W(MAX)-W(MIN))/(W(MAX)+W(MIN)),
WHERE W IS WALL THICKNESS.

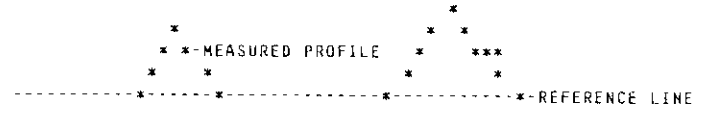
RA IS AN ABBREVATION OF THE GERMAN WORD 'RAUHEIT' OR 'RAUIGKEIT' , WHICH MEANS ROUGHNESS.

RA IS GIVEN IN MICRON-M AND IS THE ARITHMETICAL MEAN OF THE PEAKS IN THE MEASURED PROFILE (SEE ATTACHED FIGURE) ABOVE THE REFERENCE LINE. THE REFERENCE LINE IS USUALLY PLACED SUCH THAT THE AREA BETWEEN THE MEASURED PROFILE AND THE REFERENCE LINE BELOW THE REFERENCE LINE IS EQUAL TO THE AREA BETWEEN THE MEASURED PROFILE AND THE REFERENCE LINE ABOVE THE REFERENCE LINE.

R(MAX) IS THE DISTANCE BETWEEN THE BOTTOM LINE AND TOP LINE.

THE MEASUREMENT IS DONE WITH A STANDARDIZED NEEDLE AND THE EQUIPMENT IS CALIBRATED BY USING STANDARDS OF THE VARIOUS ROUGHNESS NUMBERS.
- STEINAR AAS, PRIVATE COMMUNICATION (APRIL 4, 1986). -

- ATTACHED FIGURE -



-------- BOTTOM LINE ----------

(998) REMARKS (981) -HYDRIDE ORIENTATION	THE HYDRIDE ORIENTATION IS NORMALLY QUOTED AS THE PERCENTAGE OF HYDRIDES, OBSERVED IN A PLANE, WHOSE ANGLES WITH A REFERENCE DIRECTION ARE IN THE RANGE X-90 DEGREES. TYPICALLY THIS QUANTITY HAS BEEN QUOTED AS F(X), WHERE X IS THE REFERENCE ANGLE CHOSEN. WHEN DIFINED IN THIS WAY, A HIGH F(X) VALUE LEADS TO LOW TENSILE DUCTILITY WHEN THE STRESS AXIS IS THE REFERENCE DIRECTION. IN TUBES, THE CIRCUMFERENTIAL DIRECTION WAS CHOSEN BY MARSHALL (REF-28) AS THE REFERENCE, SINCE UNDER INTERNAL PRESSURIZATION THIS IS THE DIRECTION OF MAXIMUM STRESS. - C.E. ELLS, 'HYDRIDE PRECIPITATES IN ZIRCONIUM ALLOYS (A REVIEW)', J. NUCL. MAT. 28(1968) PP.129-151. (P.136). -
(999) REFERENCES	R. ROSE, K. LUNDE, S. AAS, 'ZIRCALOY CLADDING: MANUFACTURING TECHNIQUES AND ACHIEVABLE QUALITY - A TUBE MANUFACTURER'S VIEW', NUCL. ENG. DES. 33(2) (SEP. 1975), PP.219-229. (P.220). REF-28): R.P. MARSHALL, J. NUCL. MAT. 24(1967) 34.

<* 150502 *> SUMMARY OF STRESS-INTENSITY LIMITS ** 150502 **

---(1)-*---(2)-*---(3)-*---(4)-*---(5)-*---(6)-*---(7)-*---(8)-*

	BWR YIELD STRENGTH (SY)	ULTIMATE TENSILE STRENGTH (SU)
(10) CATEGORIES		
(20) GENERAL PRIMARY-MEMBRANE		
(21) STRESS INTENSITY	2/3*SY	1/2*SU
(30) LOCAL PRIMARY-MEMBRANE		
(21) STRESS INTENSITY	SY	1/2 TO 3/4*SU
(40) PRIMARY-MEMBRANE-PLUS-BENDING		
(21) STRESS INTENSITY	SY	1/2 TO 3/4*SU
(50) PRIMARY-PLUS-SECONDARY		
(21) STRESS INTENSITY	2*SY	1 TO 3/2*SU
(999) REFERENCES	H.E. WILLIAMSON, D.C.DITMORE, 'CURRENT BWR FUEL DESIGN & EXPERIENCE', REACTOR TECH. 14(1) (SPRING 1971), PP.68-98. P.73.	

<* 150503 *> BASIC STRESS INTENSITY LIMITS - ASME VESSEL CODE SECTION III - ** 150503 **

---(1)-*---(2)-*---(3)-*---(4)-*---(5)-*---(6)-*---(7)-*---(8)-*

(10) CATEGORIES	STRESS INTENSITY LIMITS IN TERMS OF:			
	TABULATED SM VALUE	YIELD STRENGTH (SY)		ULTIMATE STRENGTH (SU)
(20) GENERAL PRIMARY-MEMBRANE				
(21) STRESS INTENSITY, (PM)	SM	<=(2/3)*SY		<=(1/3)*SU
(30) LOCAL PRIMARY-MEMBRANE				
(31) STRESS INTENSITY, (PL)	1.5*SM	<=	SY	<=(1/2)*SU
(40) PRIMARY-MEMBRANE-PLUS-BENDING				
(41) STRESS INTENSITY,				
(42) (PM (OR PL) + PB)	1.5*SM	<=	SY	<=(1/2)*SU
(50) PRIMARY-PLUS-SECONDARY				
(51) STRESS INTENSITY,				
(52) (PM (OR PL) + PB + Q)	3.0*SM	<= 2.0*SY		<= SU

(997) NOTES

SM : DESIGN STRESS INTENSITY VALUE (SEE TABLE 421 AND 422 DESCRIBED IN ASME CODE SECTION III).

THE STRESS INTENSITY IS DEFINED AS TWICE THE MAXIUM SHEAR STRESS AND IS EQUAL TO THE LARGEST ALGEBRAIC DIFFERENCE BETWEEN ANY TWO OF THE THREE PRINCIPAL STRESSES. THUS THE STRESS INTENSITY IS DIRECTLY COMPARABLE TO STRENGTH VALUES FOUND FROM TENSILE TESTS. (P.3)

(998) REMARKS

SPECIFICALLY EXCLUDED FROM CONSIDERATION IN THIS SECTION OF THE CODE ARE TUBES OR OTHER FORMS OF SHEATHING USED ONLY FOR CLADDING NUCLEAR FUEL, AND ALSO INSTRUMENT CONNECTIONS 1/2 INCH PIPE SIZE OR LESS.
-- FOOTNOTE OF N-130 OF ASME CODE SECTION III -,
ASME BOILER & PRESSURE VESSEL CODE SECTION III ('63 EDITION).

(999) REFERENCES

ASME, 'CRITERIA OF SECTION III OF THE ASME BOILER AND PRESSURE VESSEL CODE FOR NUCLEAR VESSELS', (1963).

<* 160001 *> CHEMICAL ANALYSIS OF ZIRCALOY BAR FOR FUEL ROD END PLUGS ** 160001 **

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---(1)-*---(2)-*---(3)-*---(4)-*---(5)-*---(6)-*---(7)-*---(8)-*

(9) SAMPLE NO.		(SPEC)	SM1	SM2	SS3
(1) MATERIAL		ZIRCALOY-2			
(10) CHEMICAL COMPOSITION,	(W/O)				
(11) SN		1.20-1.70	1.57	1.58	1.61
			1.51	1.53	1.54
(12) FE		0.07-0.20	0.170	0.181	0.179
			0.132	0.141	0.145
(13) CR		0.05-0.15	0.103	0.106	0.106
			0.077	0.082	0.087
(14) NI		0.03-0.08	0.059	0.054	0.059
			0.056	0.057	0.055
(110) CHEMICAL IMPURITIES,	(PPM)	--- CHEMICAL		IMPURITIES	---
(115) C		<270.	260.	286.	270.
			100.	174.	131.
(120) H		< 25.	5.	7.	6.
			6.	5.	5.
(124) N		< 80.	41.	49.	41.
			67.	59.	56.

(999) REFERENCES

STIR-4, P-62.

<* 160002 *> MECHANICAL PROPERTIES OF MATERIAL FOR FUEL ROD END PLUGS ** 160002 **

STUDVIK
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COMMON
DATA

(3)	TEST METHOD		ASTM E8-71T					
(4)	SAMPLING		2 LOTS A AND B					
(1)	MATERIAL		ZIRCALOY-2					
(2)	SAMPLE		A1	A2	A3	B1	B2	B3
(11)	CROSS SECTION,	(MM**2)	31.9	31.5	32.0	31.6	31.5	31.3
(13)	0.2 % TENSILE ST.,	(N/MM**2)	376	413	400	396	378	411
(15)	ULTIMATE TENSILE ST.,	(N/MM**2)	517	527	522	508	527	546
(17)	ELONGATION,	(%)	32	32	34	29	28	25
(999)	REFERENCES		STIR-4, P-62.					

<* 160003 *> CHEMICAL ANALYSIS RESULTS OF FUEL HOLDDOWN SPRING MATERIAL ** 160003 **

STUDVIK
INTER-RP
COMMON
DATA

(1)	MATERIAL		(SIS - 2331)		
(10)	SAMPLE NO.		(1)	(2)	(3)
(11)	C	(%)	0.097	0.097	0.099
(12)	CO	(%)	0.040	0.040	0.040
(13)	CR	(%)	18.2	18.3	18.2
(14)	MN	(%)	1.18	1.20	1.19
(15)	MO	(%)	0.20	0.20	0.20
(16)	NI	(%)	8.8	9.0	8.9
(17)	P	(%)	0.020	0.020	0.020
(18)	S	(%)	0.004	0.004	0.005
(19)	SI	(%)	0.79	0.81	0.81
(999)	REFERENCES		STIR-4, P-64.		

<* 160004 *> MECHANICAL PROPERTIES OF HOLDDOWN SPRING MATERIAL ** 160004 **

STUDVIK
INTER-RP
COMMON
DATA

(1)	MATERIAL		(SIS - 2331)
(10)	0.2 % TENSILE ST.,	(N/MM**2)	1976 (17 SAMPLES)
(11)	ULTIMATE TENSILE ST.,	(N/MM**2)	1949 (16 SAMPLES)
(997)	NOTES		THESE VALUES INDICATE AN AVERAGE VALUE FROM TENSILE TESTS (1.20 MM DIA.).
(999)	REFERENCES		STIR-4, P-64.

<* 300001 *> IRRADIATION BEHAVIORS OF REACTOR FUELS ** 300001 **

---(1)-*---(2)-*---(3)-*---(4)-*---(5)-*---(6)-*---(7)-*---(8)-*

(100) FUEL PELLET

(102) - FISSION PRODUCT GAS

SOME OF THE FISSION GAS WILL BE RETAINED IN THE CRYSTAL LATTICE, GRAIN BOUNDARRIES, OR OCCLUDED POROSITY OF THE UO-2.
HOWEVER, IT IS TO BE EXPECTED THAT A PORTION OF THE GAS WILL MIGRATE TO THE EXTERNAL SURFACE OF THE SOLID AND ESCAPE TO THE FREE VOLUME OF A FUEL ROD. -(REF-2)

(200) FUEL CLADDING

DURING THE NUETRON IRRADIATION IN THE CORE, SEVERAL MATERIAL PROPERTIES OF ZIRCALOY CHANGE. THE MOST PRONOUNCED EFFECTS ARE THE CHANGE IN STRENGTH, FRACTURE BEHAVIOUR AND CREEP.
THE PHYSICAL REASON FOR THESE CHANGES ARE THOUGHT TO BE THE PRODUCTION OF VACANCIES, INTERESTIALS, DEFECT CLUSTERS AND DISLOCATION LOOPS. NO EVIDENCE IS SO FAR FOUND AT FLUENCES OF INTEREST IN THERMAL REACTORS FOR THE FORMATION OF THREE-DIMENSIONAL VOIDS OF THE TYPE REPORTED IN STEELS SUBJECTED TO HIGH NUETRON FLUENCES AT TEMPERATURE ABOVE ABOUT 400 DEG-C.(REF-3)

(201) - IRRADIATION GROWTH

IRRADIATION GROWTH IN ZIRCALOY IS DEFINED AS A SHAPE CHANGE DURING IRRADIATION IN ABSENCE OF EXTERNAL STRESS.
THE EXISTENCE OF IRRADIATION GROWTH WAS FIRST REPORTED BY BUCKLEY (16),(17). HE ALSO PROPOSED A MECHANISN TO EXPLAIN THE PHENOMENON. THE GROWTH WAS THOUGHT TO BE DUE TO THE FORMATION OF VACANCY LOOPS ON THE BASAL PLANES AND INTERSTITIAL LOOPS ON THE PRISM PLANES. THE DIFFERENTIAL CONDENSATION OF POINT DEFECTS WAS THOUGHT TO BE CAUSED BY THE ANISOTROPIC THERMAL EXPANSION COEFFICIENTS STTING UP CORRESPONDING THERMAL STRESSES.
HESKETH (18) ADOPTED THE MODEL AND FOUND IT CONSISTENT WITH HIS RESULTS ON IRRADIATION GROWTH. HESKETH ALSO FOUND THAT THE GROWTH PROCESS WAS ACCOMPANIED BY NO, OR AT LEAST NEGLIGIBLE, VOLUME CHANGES.
SOME RESULTS HAVE BEEN PUBLISHED RECENTLY THAT DO NOT FULLY AGREE WITH THE BUCKLEY MODEL (19),(20). (REF-3)

(300) PELLET-CLAD INTERACTION

(301) - BAMBOO-LIKE APPEARANCE

IN A POWER REACTOR, DIFFERENTIAL THERMAL EXPANSION BETWEEN THE UO-2 FUEL PELLETS AND THE METAL CLADDING ARISES BECAUSE OF THE STEEP TEMPERATURE GRADIENT THROUTH THE PELLET AND THE TEMPERATURE DIFFERENCE BETWEEN PELLET AND CLADDING. THE RESULTING MOVEMENTS ARE BOTH RADIAL AND LONGITUDINAL AND DISTORT AND STRAIN THE FUEL TUBE GIVING IT A BAMBOO-LIKE APPEARANCE. -(REF-1)

(302) - PCI FAILURE

THE FIRST OBSERVATION OF PCI FAILURE DATES BACK TO 1964 (352), BUT IT WAS NOT BEFORE ABOUT 1970 THAT PCI WAS RECOGNIZED AS A PERFORMANCE-LIMITING EFFECT. AT THAT TIME FAILURES WERE OBSERVED IN HBWR TEST RODS (353), CANDU FUEL (354) AND BWR FUEL (352) AND WERE ATTRIBUTED TO SEVERE LOCAL POWER RAMPS DEFINED AS A FIRST AND FAST POWER INCREASE AFTER EXTENDED EXPOSURE ACCUMULATED AT LOW POWER. IN FACT, POWER CYCLING ON A DAILY OR WEEKLY BASIS NEVER DID LEAD TO PCI FAILURES. EARLY PWR FUEL WAS NOT AFFECTED BY PCI FAILURES, WHICH WAS PARTLY DUE TO THE LOWER EFFECTIVE POWER RAMPS AS COMPARED WITH HWR(S) AND BWR(S), PARTLY DUE TO THE EARLY USE OF PREPRESSURIZED FUEL RODS. HOWEVER, SEVERAL POWER RAMP INCIDENCES IN PWR(S) SINCE 1973 HAVE CONFIRMED THAT THE PROPENSITY TO PCI FAILURE IS A GENERIC FEATURE OF ALL ZIRCALOY-CLAD FUEL. -(REF-4)

(303) - 'X' MARKS

THE BRITTLE NATURE OF THE PCI FAILURES WAS RECOGNIZED AND THE MECHANISM WAS ATTRIBUTED TO STRESS CORROSION CRACKING ATARTING FORM THE INNER CLAD SURFACE. POST-IRRADIATION EXAMINATION OF PCI DEFECTS FORM POWER REACTORS AND POWER RAMP EXPERIMENTS ALWAYS SHOWED THE SANE FAILURE CHARACTERISTICS, I.E. FINE CRACKS OFTEN ASSOCIATED WITH 'X'-MARKS ON THE CLAD OUTER SURFACE. THE AXIAL POSITION IS PREDOMINANTLY AT PELLET/PELLET INTERFACES OR AT TRANSVERSE PELLET CRACKS. THE RIDGE HEIGHT AT THE POSITION OF A DEFECT IS GENERALLY VERY SMALL. METALLOGRAPHIC EXAMINATION REVEALED TINY BRITTLE CRACKS STARTING FROM THE INNER CALD SURFACE, MOSTLY OPPOSITE RADIAL PELLET CRACKS BUT SOMETIMES OPPOSITE OTHER PELLET IMPERFECTIONS LIKE MISSING CHIPS OR CHIPS WEDGED
INTO THE PELLET-CLAD GAP. THE NATURE OF THE FRACTURE FREQUENTLY CHANGES OVER THE LENGTH OF THE CRACK, BEING BRITTLE AND BRANCHED ON THE OUTER SIDE OF THE CLADDING. DETAILED EXAMINATION OF THESE CRACKS BY SEM SHOWED TRANSCRYSTALLINE FACETS (CLEAVAGE FRACTURE) LINKED BY FLUTINGS (DUCTILE FRACTURE), AS WELL AS INTERCRYSTALLINE FRACTURE NODES, DEPENDING ON THE CRACK PROPAGATION RATE. -(REF-4, P.77)

(999) REFERENCES

REF-1: J.F. WHATHAM, 'INFLUENCE OF PELLET LENGTH ON INTERACTION BETWEEN FUEL AND CLADDING IN SIMULATED REACTOR FUEL PINS', NUCL. ENG. DES. 26(1974) PP.423-431. (P.423)

REF-2: HOFFMANN & COPLIN, SEE FDN-900011.

REF-3: K. HANNERZ, G. VESTERLUND, 'ZIRCALOY CLADDING MECHANICAL PROPERTIES', NUCL. ENGRG. DES. 33(1975), PP.205-218. (P.207, P.208).
(59) H. STEHLE, F. GARZAROLLI, H. KNAB, R. MANZEL, 'DIMENSION-STABIHTAT VON LWR-BRENNSTABEN, PAPER PRESENTED AT THE REACTOR-TAGUNG, BERLIN, 2-5 APR. 1974.
(16) S.N.BUCKLEY, PROPERTIES OF REACTOR MATERIALS AND EFFECTS OF RADIATION DAMAGE, ED. W.J.LITTLER, BUTTERWORTHS, LONDON (1962) 413.
(17) S.N.BUCKLEY, UK17EA REPORT, AERE-R5944, VOL.II, (1968) 547.
(18) R.V.HESKETH, J.E.HARBOTTLE, N.A.WATEMANN, R.C.LOBB, 'RADIATION DAMAGE IN REACTOR MATERIALS', VOL.I, INT. ATOMIC ENERGY AGENCY, VIENNA (1969) 365.
(19) E.F.IBRAHIM, J.E.WINEGAR, 'DIMENSIONAL CHANGES OF UNSTRESS-ED ZIRCALOY-2 AND ZR-2.5%NB SPECIMENS IN A FAST NUETRON FLUX', J.NUCL.MATER. 45(1973) 335.
(20) V.FIDLERIS, 'THE EFFECT OF COLD-WORK AND STRESS RELIEVING ON THE IRRADIATION GROWTH BEHAVIOUR OF ZIRCONIUM ALLOYS', J.NUCL.MATER. 46(1973).

REF-4: SEE REFERENCES OF FDN-110009.
(352) DAVIES, J.H., ET. AL., AM. NUCL. SOC. TOPICAL MEETING WATER REACTOR FUEL PERFORMANCE, ST. CHARLES (1977) 230.
(353) MOGARD, H., ASS, S., JUNKRANS, S., PEACEFUL USES OF ATOMIC ENERGY (PROC. CONF. GENEVA, 1971) 10, UN, NEW YORK, AND IAEA, VIENNA (1971) 273.
(354) ROBERTSON, J. A. L., ENG. J. (MONTREAL), (NOV/DEC 1972) 9.

<* 300002 *> CLASSIFICATION OF OBSERVED FUEL FAILURES - ZIRCALOY CLAD - ** 300002 **

		(1) MAIN CAUSES	(2) ORIGIN	(3) TIME OF OCCURENCE	(4) CONSEQUENCES	(5) REACTOR TYPE
(10)	PHENOMENON					
(100)	HYDRIDING	MOISTURE IN PELLETS/ RODS	MANUFACTURE +SPECIFICATION	EARLY	PERFORATION LOCAL ATTACK	ALL TYPE
		COMTAMINATION, END PLUG STRINGERS, WELD DEFICIENCIES	MANUFACTURE	EARLY	PERFORATION	ALL TYPE
(200)	PELLET CLAD INTERACTION (PCI)	POWER RAMP	OPERATION	MID TO LATE	PERFORATION INCIPIENT CRACK	ALL TYPE
		LOCAL HYDRIDING + POWER RAMP	MANUFACTURE + OPERATION	MID TO	PERFORATION	BWR
(300)	CORROSION (BURNOUT)	WELD CONTAMINATION	MANUFACTURE	EARLY	PERFORATION	ALL TYPE
		CRUD DEPOSITS	EXTERNAL	EARLY TO LATE	PERFORATION	BWR, SGHWR
		COOLANT BLOCKAGE	EXTERNAL OR DESIGN	EARLY	PERFORATION	ONE BWR
		HIGH HEAT FLUX/ CLAD TEMPERATURE	OPERATION OR DESIGN	LATE	PERFORATION	EXPERIMENTAL RODS ONLY
(400)	CLAD COLLAPSING	AXIAL GAPS BY FUEL DENSIFICATION	SPECIFICATION	EARLY	DEFORMATION (SOME PERFORATION)	PWR
(500)	ZIRCALOY GROWTH	IRRADIATION-INDUCED GROWTH AND PELLET/CLAD INTERACTION	DESIGN	EARLY TO LATE	STRUCTUAL MISFIT ROD BOWING	BWR,PWR, SGHWR, PWR
(600)	ROD BOWING	RELAXATION OF CLADDING TUBE	SPECIFICATION	EARLY	DEFORMATION + BURNOUT	ONE BWR
		ROD GROWTH + INTERACTION ENDPLATE	DESIGN	CONTINUOUS	DEFORMATION	PWR
		INTERACTION WITH ASSEMBLY STRUCTURE	DESIGN	CONTINUOUS	DEFORMATION	PWR
(700)	FRETTING WEAR	FOREIGN PARTICLES	EXTERNAL	EARLY	PERFORATION WEAR MARKS	ALL TYPE
		VIBRATION ROD/ SPACER GRID	MANUFACTURE OR REPAIR	EARLY	PERFORATION	PWR
		VIBRATION OF ASSEMBLY	EXTERNAL OR DESIGN	EARLY	PERFORATION WEAR MARKS	PWR
		VIBRATION OF INCORE COMPOMENTS	EXTERNAL	EARLY	CHANNEL WEAR	BWR
(997)	NOTES	SGHWR : STEAM GENERATING HEAVY WATER REACTOR.				
(999)	REFERENCES	SEE F. GARZAROLLI OF REFERENCES OF FON-110009.				

<* 700001 *> TEST MATRIX OF THE INTER RAMP PROJECT (1) -LR,LS,TR- ** 700001 **

STUDVIK
INTER-RP
COMMON
DATA

			(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
(1)	BIRP NO.		1	1	1	1	3	3	3	3
(2)	TEST ROD NO.		1	2	3	4	5	6	7	8
(3)	TEST ROD LABEL		LR1	LR2	LR3	LR4	LR5	LS1	LS2	TR1
(4)	GAP 0.08	(MM)								*
(5)	GAP 0.15	(MM)	*	*	*	*	*	*	*	
(6)	GAP 0.25	(MM)								
(7)	CLAD HT: RX		*	*	*	*	*			*
(8)	CLAD HT: SR							*	*	
(9)	UO-2 DENSITY	(%)	---------- 95 ----------				---------- 95 ----------			
(10)	BURNUP *1)	(MWD/KG-U)	---------- 10 ----------				---------- 10 ----------			
(11)	U-235 ENRICHMENT	(%)	--------- 2.8 ----------				--------- 2.8 ----------			

(79) REMARKS

*1) NOMINAL VALUES

NOTATION: GAP = FUEL-CLAD DIAMETRAL GAP
CLAD HEAT TREATMENT: RX= RECRYSTALLIZED ,
SR = COLD-WORKED + STRESS RELIEVED MATERIAL

(80) REFERENCE

STIR-53 TABLE-2

A. KIKUCHI, M. ICHIKAWA,
'INVESTIGATION RESULTS IN INTER RAMP PROJECTS'(IN JAP.),
J.AESJ 23(7) (1981), PP.507-516. P.508.

<* 700002 *> TEST MATRIX OF THE INTER RAMP PROJECT (2) -LS,TS,DR,HR- ** 700002 **

STUDVIK
INTER-RP
COMMON
DATA

---(1)-*---(2)-*---(3)-*---(4)-*---(5)-*---(6)-*---(7)-*---(8)-*

(1)	BIRP NO.		5	5	5	5	2	2	2	2
(2)	TEST ROD NO.		9	10	11	12	13	14	15	16
(3)	TEST ROD LABEL		LS3	LS4	TS1	DR1	HR2	HR3	HR4	HR5
(4)	GAP 0.08	(MM)				*				
(5)	GAP 0.15	(MM)	*	*	*		*	*	*	*
(6)	GAP 0.25	(MM)								*
(7)	CLAD HT: RX					*	*	*	*	*
(8)	CLAD HT: SR		*	*	*					
(9)	UO-2 DENSITY	(%)	95	95	95	93	---------- 95 ----------			
(10)	BURNUP *1)	(MWD/KG-U)	---------- 10 ----------				---------- 20 ----------			
(11)	U-235 ENRICHMENT	(%)	--------- 2.8 ----------				--------- 3.5 ----------			

(79) REMARKS

*1) NOMINAL VALUES

NOTATION: GAP = FUEL-CLAD DIAMETRAL GAP
CLAD HEAT TREATMENT: RX= RECRYSTALLIZED ,
SR = COLD-WORKED + STRESS RELIEVED MATERIAL

(80) REFERENCE

STIR-53 TABLE-2

<* 700003 *> TEST MATRIX OF THE INTER RAMP PROJECT (3) -HS,BR- ** 700003 **

STUDVIK
INTER-RP
COMMON
DATA

			(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
(1)	BIRP NO.		4	4	4	4				
(2)	TEST ROD NO.		17	18	19	20				
(3)	TEST ROD LABEL		HS1	HS2	HS3	BR1				
(4)	GAP 0.08	(MM)								
(5)	GAP 0.15	(MM)	*	*	*					
(6)	GAP 0.25	(MM)				*				
(7)	CLAD HT: RX					*				
(8)	CLAD HT: SR		*	*	*					
(9)	UO-2 DENSITY	(%)	---------- 95 ----------							
(10)	BURNUP *1)	(MWD/KG-U)	---------- 20 ----------							
(11)	U-235 ENRICHMENT	(%)	--------- 3.5 ----------							

(79) REMARKS

*1) NOMINAL VALUES

NOTATION: GAP = FUEL-CLAD DIAMETRAL GAP
CLAD HEAT TREATMENT: RX= RECRYSTALLIZED ,
SR = COLD-WORKED + STRESS RELIEVED MATERIAL

(80) REFERENCE

STIR-53 TABLE-2

<* 700004 *> INTER RAMP IRRADIATION DATA (1) -LR,LS,TR- ** 700004 **

STUDVIK
INTER-RP
COMMON
DATA

			(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
(1)	BIRP NO.		1	1	1	1	3	3	3	3
(2)	ROD NO.		1	2	3	4	5	6	7	8
(3)	ROD LABEL		LR1	LR2	LR3	LR4	LR5	LS1	LS2	TR1
(4)	F , FS	*1)	NF	F	F	F	F	F	NF	NF
(5)	CONDITIONING									
(6)	LHR	(KW/M) *2)	29.8	24.5	35.0	35.3	25.1	26.9	31.8	30.7
(7)	TIME	(HOURS)	24	24	24	24	24	24	24	24
(8)	RAMP TESTING									
(9)	RAMP RATE	(W/M.S)	80 *4)	70	65	65	85	90	65	70
(10)	TERMINAL LHR	(KW/M)	43.8	45.7	50.1	65.4	42.7	48.2	43.8	42.2
(11)	HOLD TIME AT RTL	(MIN)	1440	84	103	5	1440 *6)	35	1440	1440
(12)	TFPD *3)	(MIN)		46/91 *5)	11	0.5	162/194/212	17/26		

(79) REMARKS

*1) F = FAILURE NF = NON FAILURE
*2) LHR = LINEAR HEAT RATING AT AXIAL PEAK POWER POSITION.
*3) TFPD = TIME TO FISSION PRODUCT DETECTION.
*4) PAUSE 2 MIN AT 32.0 KW/M .
*5) SMALL ACTIVITY INCREASE AFTER 46 MIN,LARGER ACTIVITY INCREASE AFTER 61 MIN .

*6) THE IRRADIATION CONTINUED 24 HOURS, IN SPITE OF THE ROD FAILURE, OWING TO THE FACT THAT THE VERY SMALL FISSION PRODUCT ACTIVITY INCREASE WAS NOT CONSIDERED EVIDENCE OF FAILURE DURING THE RAMP PERFORMANCE .
*7) FROM 29.6 KW/M WITH A RATE OF 0.28 KW/M.S TO 40.8 KW/M .
*8) THE VALUE SHOULD HAVE BEEN 40.1 (SAME AS THE LAST REACTOR CYCLE DURING THE PRE-RAMP IRRADIATION)
*9) INCIPIENT CRACKS HAVE BEEN FOUND AT THE HOT CELL POST IRRADIATION EXAMINATION .
*10) THE HOLD TIME WAS INTENTIONALLY INTERRUPTED AFTER 26 MIN .

*11) NO FISSION PRODUCT ACTIVITY WAS DETECTED DURING THE HOLD TIME .
SUBSEQUENT EXAMINATIONS SHOWED THE ROD TO BE A FAILURE .

(80) REFERENCE STIR-53 TABLE-10

<* 700005 *> INTER RAMP IRRADIATION DATA (2) -LS,TS,DR,HR- ** 700005 **

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STUDVIK
INTER-RP
COMMON
DATA

---(1)-*---(2)-*---(3)-*---(4)-*---(5)-*---(6)-*---(7)-*---(8)-*

(1)	BIRP NO.		5	5	5	5	2	2	2	2
(2)	ROD NO.		9	10	11	12	13	14	15	16
(3)	ROD LABEL		LS3	LS4	TS1	DR1	HR2	HR3	HR4	HR5
(4)	F , FS	*1)	NF	F	F	NF	NF	F	NF	NF *9
(5)	CONDITIONING									
(6)	LHR (KW/M)	*2)	25.0	40.8*7)	29.7*8)	22.9	23.0	25.2	29.0	29.0
(7)	TIME (HOURS)		24	24	24	24	24	24	24	24
(8)	RAMP TESTING									
(9)	RAMP RATE	(W/M.S)	65	70	70	75	75	65	70	70
(10)	TERMINAL LHR	(KW/M)	41.8	50.7	47.3	43.2	38.0	43.2	46.1	47.9
(11)	HOLD TIME AT RTL	(MIN)	1440	92	319	1440	1440	316	1440	1440
(12)	TFPD *3)	(MIN)		72	296			260		

(79) REMARKS

*1) F = FAILURE NF = NON FAILURE
*2) LHR = LINEAR HEAT RATING AT AXIAL PEAK POWER POSITION.
*3) TFPD = TIME TO FISSION PRODUCT DETECTION.
*4) PAUSE 2 MIN AT 32.0 KW/M .
*5) SMALL ACTIVITY INCREASE AFTER 46 MIN,LARGER ACTIVITY INCREASE AFTER 61 MIN .

*6) THE IRRADIATION CONTINUED 24 HOURS, IN SPITE OF THE ROD FAILURE, OWING TO THE FACT THAT THE VERY SMALL FISSION PRODUCT ACTIVITY INCREASE WAS NOT CONSIDERED EVIDENCE OF FAILURE DURING THE RAMP PERFORMANCE .
*7) FROM 29.6 KW/M WITH A RATE OF 0.28 KW/M.S TO 40.8 KW/M .
*8) THE VALUE SHOULD HAVE BEEN 40.1 (SAME AS THE LAST REACTOR CYCLE DURING THE PRE-RAMP IRRADIATION)
*9) INCIPIENT CRACKS HAVE BEEN FOUND AT THE HOT CELL POST IRRADIATION EXAMINATION .
*10) THE HOLD TIME WAS INTENTIONALLY INTERRUPTED AFTER 26 MIN .

*11) NO FISSION PRODUCT ACTIVITY WAS DETECTED DURING THE HOLD TIME .
SUBSEQUENT EXAMINATIONS SHOWED THE ROD TO BE A FAILURE .

(80) REFERENCE STIR-53 TABLE-10

<* 700006 *> INTER RAMP IRRADIATION DATA (3) -HS,BR- ** 700006 **

STUDVIK
INTER-RP
COMMON
DATA

			---(1)-*---(2)-*---(3)-*---(4)-*---(5)-*---(6)-*---(7)-*---(8)-*			
(1)	BIRP NO.		4	4	4	4
(2)	ROD NO.		17	18	19	20
(3)	ROD LABEL		HS1	HS2	HS3	BR1
(4)	F , FS	*1)	F	NF *9)	F	F
(5)	CONDITIONING					
(6)	LHR (KW/M)	*2)	30.3	24.8	26.6	31.1
(7)	TIME (HOURS)		24	24	24	24
(8)	RAMP TESTING					
(9)	RAMP RATE	(W/M.S)	65	65	70	65
(10)	TERMINAL LHR	(KW/M)	47.8	41.0	44.9	51.0
(11)	HOLD TIME AT RTL	(MIN)	26*10)	1440	59	1440
(12)	TFPD *3)	(MIN)	*11)		42	*11)

(79) REMARKS

*1) F = FAILURE NF = NON FAILURE
*2) LHR = LINEAR HEAT RATING AT AXIAL PEAK POWER POSITION.
*3) TFPD = TIME TO FISSION PRODUCT DETECTION.
*4) PAUSE 2 MIN AT 32.0 KW/M .
*5) SMALL ACTIVITY INCREASE AFTER 46 MIN,LARGER ACTIVITY INCREASE AFTER 61 MIN .

*6) THE IRRADIATION CONTINUED 24 HOURS, IN SPITE OF THE ROD FAILURE, OWING TO THE FACT THAT THE VERY SMALL FISSION PRODUCT ACTIVITY INCREASE WAS NOT CONSIDERED EVIDENCE OF FAILURE DURING THE RAMP PERFORMANCE .
*7) FROM 29.6 KW/M WITH A RATE OF 0.28 KW/M.S TO 40.8 KW/M .
*8) THE VALUE SHOULD HAVE BEEN 40.1 (SAME AS THE LAST REACTOR CYCLE DURING THE PRE-RAMP IRRADIATION)
*9) INCIPIENT CRACKS HAVE BEEN FOUND AT THE HOT CELL POST IRRADIATION EXAMINATION .
*10) THE HOLD TIME WAS INTENTIONALLY INTERRUPTED AFTER 26 MIN .

*11) NO FISSION PRODUCT ACTIVITY WAS DETECTED DURING THE HOLD TIME .
SUBSEQUENT EXAMINATIONS SHOWED THE ROD TO BE A FAILURE .

(80) REFERENCE STIR-53 TABLE-10

<* 700007 *> INTER RAMP (PRE-RAMP IRRADIATION DATA AT AXIAL PEAK POWER (1)) ** 700007 **

STUDVIK
INTER-RP
COMMON
DATA

		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
(1)	BIRP NO.	1	1	1	1	3	3	3	3
(2)	ROD NO.	1	2	3	4	5	6	7	8
(3)	ROD LABEL	LR1	LR2	LR3	LR4	LR5	LS1	LS2	TR1
(4)	HIGH POWER PERIODS								
(5)	APH1 (KW/M) *3)	36.3	32.1	33.6	36.7	32.2	32.8	36.3	35.5
(6)	APH2 (KW/M)	37.7	34.7	35.1	38.4	34.1	34.4	37.8	37.1
(7)	APH3 (KW/M)								
(8)	APH4 (KW/M)								
(9)	LOWER POWER PERIODS								
(10)	APL1 (KW/M)	25.4	19.7	21.4	26.2	20.9	22.7	27.9	26.9
(11)	APL2 (KW/M)	27.3	21.3	23.1	28.2	22.4	24.3	29.8	28.8
(12)	APL3 (KW/M)								
(13)	APL4 (KW/M)								
(14)	HPP, PEAK VALUES *1)								
(15)	PH1 (KW/M) *4)	37.2	32.8	34.3	37.6	34.7	35.2	39.0	38.2
(16)	PH2 (KW/M)	38.8	35.7	36.1	39.7	35.7	36.1	39.6	38.8
(17)	PH3 (KW/M)								
(18)	PH4 (KW/M)								
(19)	LAST RC *2)								
(20)	PLLRC *5)	28.6	22.3	24.2	29.7	22.3	24.2	29.6	28.6
(21)	TOTAL IRRADIATION								
(22)	APTOT (KW/M)	31.3	26.4	27.9	32.1	27.9	28.9	33.2	32.3
(23)	BURNUP (MWD/KG/U)	11.1	9.3	9.8	11.3	9.6	10.0	11.4	11.0
(24)	FAST NEWTRON FLUENCE	18.1	12.9	14.3	18.9	12.6	13.6	18.2	17.2
(25)	E > 1 MEV X10XX24 MXX-2								

(79) REMARKS

*1) HPP = HIGH POWER PERIOD .
*2) RC = REACTOR CYCLE
*3) APH1 = AVERAGE LINEAR HEAT RATING DURING THE FIRST HIGHT POWER PERIOD .
*4) PH1 = MAX. LINEAR HEAT RATING DURING THE FIRST HIGHT POWER PERIOD . (AVERAGE DURING ONE REACTOR CYCLE)
*5) PLLRC = LINEAR HEAE RATING DURING THE LAST LOW POWER REACTOR CYCLE . FOR LS4 AND TS1 THE LAST REACTOR CYCLE WAS A HIGHT POWER CYCLE OF 38.9 RESP 38.3 KW/M .

(80) REFERENCE STIR-53 TABLE-8

<* 700008 *> INTER RAMP (PRE-RAMP IRRADIATION DATA AT AXIAL PEAK POWER (2)) ** 700008 **

STUDVIK
INTER-RP
COMMON
DATA

---(1)-*---(2)-*---(3)-*---(4)-*---(5)-*---(6)-*---(7)-*---(8)-*

(1)	BIRP NO.		5	5	5	5	2	2	2	2
(2)	ROD NO.		9	10	11	12	13	14	15	16
(3)	ROD LABEL		LS3	LS4	TS1	DR1	HR2	HR3	HR4	HR5
(4)	HIGH POWER PERIODS									
(5)	APH1 (KW/M)	*3)	34.2	37.8	37.0	33.8	31.2	33.0	41.0	38.5
(6)	APH2 (KW/M)		34.4	37.9	37.1	34.1	33.3	34.6	37.4	37.1
(7)	APH3 (KW/M)						33.7	35.0	37.5	37.2
(8)	APH4 (KW/M)						32.2	33.3	35.5	35.3
(9)	LOWER POWER PERIODS									
(10)	APL1 (KW/M)		23.6	28.9	28.0	28.3	20.7	22.4	26.3	25.7
(11)	APL2 (KW/M)		24.7	30.1	29.1	22.7	21.8	23.6	27.5	26.9
(12)	APL3 (KW/M)						22.4	24.1	27.9	27.3
(13)	APL4 (KW/M)						22.9	24.6	28.1	27.6
(14)	HPP, PEAK VALUES	*1)								
(15)	PH1 (KW/M)	*4)	36.3	40.3	39.4	35.8	34.5	35.9	44.3	40.8
(16)	PH2 (KW/M)		35.5	39.0	38.3	35.1	33.7	35.0	37.7	37.4
(17)	PH3 (KW/M)						35.2	36.4	39.1	38.8
(18)	PH4 (KW/M)						33.4	34.5	36.7	36.5
(19)	LAST RC	*2)								
(20)	PLLRC	*5)	23.8	28.9 (38.9)*5)	28.0 (38.3)*5)	21.8	22.4	24.0	27.5	26.9
(21)	TOTAL IRRADIATION									
(22)	APTOT (KW/M)		29.8	34.4	33.6	28.7	27.3	28.8	32.7	32.0
(23)	BURNUP (MWD/KG/U)		9.0	11.4	10.8	8.7	18.2	19.2	21.8	21.3
(24)	FAST NEWTRON FLUENCE		10.5	14.9	14.1	9.8	20.8	23.6	30.4	29.3
(25)	E > 1 MEV X10XX24 MXX-2									

(79) REMARKS

*1) HPP = HIGH POWER PERIOD .
*2) RC = REACTOR CYCLE
*3) APH1 = AVERAGE LINEAR HEAT RATING DURING THE FIRST HIGHT POWER PERIOD .
*4) PH1 = MAX. LINEAR HEAT RATING DURING THE FIRST HIGHT POWER PERIOD . (AVERAGE DURING ONE REACTOR CYCLE)
*5) PLLRC = LINEAR HEAE RATING DURING THE LAST LOW POWER REACTOR CYCLE . FOR LS4 AND TS1 THE LAST REACTOR CYCLE WAS A HIGHT POWER CYCLE OF 38.9 RESP 38.3 KW/M .

(80) REFERENCE STIR-53 TABLE-8

<* 700009 *> INTER RAMP (PRE-RAMP IRRADIATION DATA AT AXIAL PEAK POWER (3)) ** 700009 **

STUDVIK
INTER-RP
COMMON
DATA

---(1)-*---(2)-*---(3)-*---(4)-*---(5)-*---(6)-*---(7)-*---(8)-*

(1)	BIRP NO.	4	4	4	4
(2)	ROD NO.	17	18	19	20
(3)	ROD LABEL	HS1	HS2	HS3	BR1
(4)	HIGH POWER PERIODS				
(5)	APH1 (KW/M) *3)	37.0	32.7	34.2	37.4
(6)	APH2 (KW/M)	36.3	32.4	33.8	36.6
(7)	APH3 (KW/M)	36.3	32.6	33.9	36.4
(8)	APH4 (KW/M)	35.2	32.2	33.3	35.3
(9)	LOWER POWER PERIODS				
(10)	APL1 (KW/M)	26.6	21.4	23.2	27.2
(11)	APL2 (KW/M)	28.1	22.8	24.7	28.8
(12)	APL3 (KW/M)	28.4	22.7	24.5	29.2
(13)	APL4 (KW/M)	29.2	23.5	25.2	30.0
(14)	HPP, PEAK VALUES *1)				
(15)	PH1 (KW/M) *4)	38.6	34.2	35.7	39.0
(16)	PH2 (KW/M)	37.5	33.5	34.9	37.9
(17)	PH3 (KW/M)	38.0	34.3	35.6	38.2
(18)	PH4 (KW/M)	36.1	33.0	34.1	36.2
(19)	LAST RC *2)				
(20)	PLLRC *5)	29.4	23.7	25.4	30.1
(21)	TOTAL IRRADIATION				
(22)	APTOT (KW/M)	32.2	27.7	29.2	32.7
(23)	BURNUP (MWD/KG/U)	21.2	18.2	19.2	21.9
(24)	FAST NEWTRON FLUENCE	26.7	18.7	21.4	27.6
(25)	E > 1 MEV X10XX24 MXX-2				

(79) REMARKS

*1) HPP = HIGH POWER PERIOD .
*2) RC = REACTOR CYCLE
*3) APH1 = AVERAGE LINEAR HEAT RATING DURING THE FIRST HIGHT POWER PERIOD .
*4) PH1 = MAX. LINEAR HEAT RATING DURING THE FIRST HIGHT POWER PERIOD . (AVERAGE DURING ONE REACTOR CYCLE)
*5) PLLRC = LINEAR HEAE RATING DURING THE LAST LOW POWER REACTOR CYCLE . FOR LS4 AND TS1 THE LAST REACTOR CYCLE WAS A HIGHT POWER CYCLE OF 38.9 RESP 38.3 KW/M .

(80) REFERENCE STIR-53 TABLE-8

<* 700010 *> INTER RAMP DIAMETER MEASUREMENT DATA (1) -LR,LS.TR- ** 700010 **

STUDVIK
INTER-RP
COMMON
DATA

---(1)-*---(2)-*---(3)-*---(4)-*---(5)-*---(6)-*---(7)-*---(8)-*

(1)	BIRP NO.	1	1	1	1	3	3	3	3
(2)	ROD NO.	1	2	3	4	5	6	7	8
(3)	ROD LABEL	LR1	LR2	LR3	LR4	LR5	LS1	LS2	TR1
(4)	F , FN	NF	F	F	F	F	F	NF	NF
(5)	OVALITY								
(6)	AVERAGE (7 POSITIONS) *1)								
(7)	ATI (MICRON M) *5)	14	6	7	9	8	9	8	12
(8)	PTR (MICROM M) *6)	21	10	7	18	9	13	20	20
(9)	AR (MICRON M) *7)	21	11	-	-	13	-	19	22
(10)	MAX (SPIRAL PROF)								
(11)	PTR (MICRON M)	27	18	27	34	12	35	-	49
(12)	AR	33	18	33	54	25	35	-	33
(13)	DIAMETER DECREASE *2)								
(14)	PTI - PTR								
(15)	MIDPELLET AVERAGE (MICRON M)	26.8	24.0	24.7	29.3	17.8	25.0	34.5	21.5
(16)	INTERFACE AVERAGE (MICRON M)	21.3	21.8	22.7	27.2	16.7	23.0	29.6	14.6
(17)	DIAMETER INCREASE *2)								
(18)	AR - PTR								
(19)	MIDPELLET								
(20)	MAX. (MICRON M)	5	10	16	12	10	8	5	3
(21)	AVERAGE (MICRON M)	2.7	4.0	6.6	7.0	3.1	1.6	0.7	-0.7
(22)	INTERFACE								
(23)	MAX. (MICRON M)	11	9	20	50	26	18	8	7
(24)	AVERAGE (MICRON M)	5.0	6.3	12.2	20.6	7.2	7.6	3.8	0.9
(25)	RIDGE HEIGHT								
(26)	PR MAX. (MICRON M)	4	4	6	2	0	5	2	5
(27)	AR MAX. (MICRON M)	21	12	19	54	21	22	19	19

(79) REMARKS

*1) AVERAGE OF THE MEASUREMENTS AT THE AXIAL POSITIONS 92, 144,196,248,300,352 AND 404 MM FROM THE BOTTOM OF THE RODS .

*2) THE DIAMETER CHANGE HAS BEEN MEASURED FROM PROFILOMETRY RECORDINGS FOR TWO GENERATORS (0 - 180 AN 90 -270 DEGREE) AT 13 CONSEQUTIVE POSITIONS (PELLET NO 10 TO 22 OR INTERFACE 10/11 TO 22/23 FROM BOTTOM END EMBRACING 95 - 100 % OF THE MAXIMUM POWER LEVEL AT RAMPING .

*3) A LARGE OVALITY OF 50 MICRON-M OVER THE 2ND PELLET NOT INCLUDED .

*4) A LARGE OVALITY OF 32 MICRON-M OVER THE 3ND PELLET NOT INCLUDED .

*5) PTI = PRIOR TO IRRADIATION .

*6) PTR = PRIOR TO RAMPING

*7) AR = AFTER RAMPING .

(80) REFERENCE

STIR-53 TABLE-16

<* 700011 *> INTER RAMP DIAMETER MEASUREMENT DATA (2) -LS,TS,DR,HR- ** 700011 **

STUDVIK
INTER-RP
COMMON
DATA

		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
(1)	BIRP NO.	5	5	5	5	2	2	2	2
(2)	ROD NO.	9	10	11	12	13	14	15	16
(3)	ROD LABEL	LS3	LS4	TS1	DR1	HR2	HR3	HR4	HR5
(4)	F , FN	NF	F	F	NF	NF	F	NF	NF
(5)	OVALITY								
(6)	AVERAGE (7 POSITIONS) *1)								
(7)	ATI (MICRON M) *5)	7	5	5	8	6	6	16	8
(8)	PTR (MICROM M) *6)	11	11	9	13	11	11	22	12
(9)	AR (MICRON M) *7)	10	9	9	10	14	-	23	12
(10)	MAX (SPIRAL PROF)								
(11)	PTR (MICRON M)	-	30	22	-	22	22	40	34
(12)	AR	-	36	35	-	20	25	40	33
(13)	DIAMETER DECREASE *2)								
(14)	PTI - PTR								
(15)	MIDPELLET AVERAGE (MICRON M)	25.2	24.8	26.4	18.0	26.2	25.4	32.2	33.1
(16)	INTERFACE AVERAGE (MICRON M)	23.7	21.7	20.3	16.7	22.5	22.5	23.1	23.2
(17)	DIAMETER INCREASE *2)								
(18)	AR - PTR								
(19)	MIDPELLET								
(20)	MAX. (MICRON M)	1	4	18	4	2	13	11	14
(21)	AVERAGE (MICRON M)	-2.5	0.8	5.3	1.1	-0.3	6.8	3.7	7.1
(22)	INTERFACE								
(23)	MAX. (MICRON M)	7	10	17	8	6	22	14	18
(24)	AVERAGE (MICRON M)	1.7	3.8	7.2	4.7	2.4	13.6	6.8	10.7
(25)	RIDGE HEIGHT								
(26)	PR MAX. (MICRON M)	0	4	4	0	7	5	6	8
(27)	AR MAX. (MICRON M)	15	22	28	10	12	19	35	26

(79) REMARKS

*1) AVERAGE OF THE MEASUREMENTS AT THE AXIAL POSITIONS 92, 144,196,248,300,352 AND 404 MM FROM THE BOTTOM OF THE RODS .

*2) THE DIAMETER CHANGE HAS BEEN MEASURED FROM PROFILOMETRY RECORDINGS FOR TWO GENERATORS (0 - 180 AN 90 -270 DEGREE) AT 13 CONSEQUTIVE POSITIONS (PELLET NO 10 TO 22 OR INTERFACE 10/11 TO 22/23 FROM BOTTOM END EMBRACING 95 - 100 % OF THE MAXIMUM POWER LEVEL AT RAMPING .

*3) A LARGE OVALITY OF 50 MICRON-M OVER THE 2ND PELLET NOT INCLUDED .

*4) A LARGE OVALITY OF 32 MICRON-M OVER THE 3ND PELLET NOT INCLUDED .

*5) PTI = PRIOR TO IRRADIATION .

*6) PTR = PRIOR TO RAMPING

*7) AR = AFTER RAMPING .

(80) REFERENCE

STIR-53 TABLE-16

<* 700012 *> INTER RAMP DIAMETER MEASUREMENT DATA (3) -HS,BR- ** 700012 **

STUDVIK
INTER-RP
COMMON
DATA

		(1)	(2)	(3)	(4)
(1)	BIRP NO.	4	4	4	4
(2)	ROD NO.	17	18	19	20
(3)	ROD LABEL	HS1	HS2	HS3	BR1
(4)	F , FN	F	NF	F	F
(5)	OVALITY				
(6)	AVERAGE (7 POSITIONS) *1)				
(7)	ATI (MICRON M) *5)	7	7	7	12
(8)	PTR (MICROM M) *6)	16	9	9	14
(9)	AR (MICRON M) *7)	17	9	8	19
(10)	MAX (SPIRAL PROF)				
(11)	PTR (MICRON M)	24	27 *3)	20 *4)	39
(12)	AR	28	26 *3)	25 *4)	115
(13)	DIAMETER DECREASE *2)				
(14)	PTI - PTR				
(15)	MIDPELLET AVERAGE (MICRON M)	43.6	35.3	36.8	26.6
(16)	INTERFACE AVERAGE (MICRON M)	35.5	32.8	33.7	24.2
(17)	DIAMETER INCREASE *2)				
(18)	AR - PTR				
(19)	MIDPELLET				
(20)	MAX. (MICRON M)	3	7	9	11
(21)	AVERAGE (MICRON M)	1.0	2.3	0.9	1.3
(22)	INTERFACE				
(23)	MAX. (MICRON M)	10	14	16	92
(24)	AVERAGE (MICRON M)	5.4	8.0	7.6	13.2
(25)	RIDGE HEIGHT				
(26)	PR MAX. (MICRON M)	6	6	6	6
(27)	AR MAX. (MICRON M)	26	16	15	100

(79) REMARKS

*1) AVERAGE OF THE MEASUREMENTS AT THE AXIAL POSITIONS 92, 144,196,248,300,352 AND 404 MM FROM THE BOTTOM OF THE RODS .

*2) THE DIAMETER CHANGE HAS BEEN MEASURED FROM PROFILOMETRY RECORDINGS FOR TWO GENERATORS (0 - 180 AN 90 -270 DEGREE) AT 13 CONSEQUTIVE POSITIONS (PELLET NO 10 TO 22 OR INTERFACE 10/11 TO 22/23 FROM BOTTOM END EMBRACING 95 - 100 % OF THE MAXIMUM POWER LEVEL AT RAMPING .

*3) A LARGE OVALITY OF 50 MICRON-M OVER THE 2ND PELLET NOT INCLUDED .

*4) A LARGE OVALITY OF 32 MICRON-M OVER THE 3ND PELLET NOT INCLUDED .

*5) PTI = PRIOR TO IRRADIATION .
*6) PTR = PRIOR TO RAMPING
*7) AR = AFTER RAMPING .

(80) REFERENCE STIR-53 TABLE-16

<* 700013 *> INTER RAMP MEASUREMENTS DATA (1) FOR B1RP-2 AND BIRP-4 ** 700013 **

STUDVIK
INTER-RP
COMMON
DATA

(1)	EXAMINATION	-------BIRP-4--------			----------BIRP-2---------- (1)			
(2)	R2 CYCLE NO. PRECEDING MEASURE.	-------76-12A--------			----------76-09----------			
(3)	R2 CORE NO. PRECEDING MEASURE.	--------554---------			----------554----------			
(4)	ROD NO.	HS1	HS2	HS3	HR2	HR3	HR4	HR5
(5)	FN FLUENCE X10XX24 (ACC) *1)	7.00	4.90	5.63	5.66	6.24	8.07	7.64
(6)	BURNUP (MWD/KG) *1)	5.29	4.51	4.78	4.42	4.72	5.73	5.47
(7)	HPP *2)							
(8)	R2 CYCLE NO.	------76-07--09B-----			----------76-03--06----------			
(9)	PEAK POWER (KW/M)	38.6	34.2	35.7	34.5	35.9	44.3	40.8
(10)	AVERAGE POWER (KW/M)	37.0	32.7	34.2	31.2	33.0	41.0	38.5
(11)	ROD ELONGATION (MM)	0.38	0.29	0.30	0.42	0.45	0.47	0.44
(12)	DIAMETER CREEP-DWON (MICRON M)	18.4	15.5	15.3	13.3	13.2	17.1	14.4
(13)	MAX. OVALITY *3) (MICRON M)	----NOT MEASURED-----			18	14	23	10
(14)	DIAM. RIDGE H.(MAX) (MICRON M)	0	0	0	2	3	10	4
(15)	PELLET INTERFACE NO.				11/12	12/13	5/6	6/7

(79) REMARKS

*1) REPOTED VALUES ARE MAXIMUM VALUES. TO GET AVERAGE VALUES OVER THE SEVEN PRESCRIBED AXIAL POSITIONS FOR DIAMETER CREEP-DOWEN AND OVALITY MEASUREMENTS MULTIPLY WITH 0.91 FOR FN FLUENCE AND BURNUP .

*2) HPP = HIGH POWER PERIOD

*3) MAX OVALITY PRE-IRRADIATION VALUES : HR2 7,HR3 7,HR4 17, HR5 10 MICRON M .

(80) REFERENCE

STIR-53 TABLE-14

<* 700014 *> INTER RAMP MEASUREMENTS DATA (2) FOR BIRP-2 AND BIRP-4 ** 700014 **

STUDVIK
INTER-RP
COMMON
DATA

			(2)				(3)			
(2)	R2 CYCLE NO. PRECEDING MEASURE.		76-10				77-02			
(3)	R2 CORE NO. PRECEDING MEASURE.		547				566			
(4)	ROD NO.		HR2	HR3	HR4	HR5	HR2	HR3	HR4	HR5
(5)	FN FLUENCE X10XX24 (ACC)	*1)	6.37	7.07	9.15	8.69	10.9	12.3	15.8	15.1
(6)	BURNUP (MWD/KG)	*1)	5.08	5.41	6.49	6.22	8.92	9.7	11.04	10.70
(7)	HPP	*2)								
(8)	R2 CYCLE NO.		76-10				76-10--12A			
(9)	PEAK POWER (KW/M)		32.8	34.2	37.0	36.7	33.7	35.0	37.7	37.4
(10)	AVERAGE POWER (KW/M)		32.7	34.1	36.8	36.5	33.3	34.6	37.4	37.1
(11)	ROD ELONGATION (MM)		0.43	0.45	0.50	0.44	0.55	0.54	0.66	0.66
(12)	DIAMETER CREEP-DWON (MICRON M)						20.0	20.0	23.9	23.3
(13)	MAX. OVALITY *3) (MICRON M)						16	12	22	14
(14)	DIAM. RIDGE H.(MAX) (MICRON M)		2	3	11	4	4	3	14	12
(15)	PELLET INTERFACE NO.		11/12	12/13	5/6	6/7	11/12	11/12	5/6	12/13

(79) REMARKS

*1) REPOTED VALUES ARE MAXIMUM VALUES. TO GET AVERAGE VALUES OVER THE SEVEN PRESCRIBED AXIAL POSITIONS FOR DIAMETER CREEP-DOWEN AND OVALITY MEASUREMENTS MULTIPLY WITH 0.91 FOR FN FLUENCE AND BURNUP .

*2) HPP = HIGH POWER PERIOD

*3) MAX OVALITY PRE-IRRADIATION VALUES : HR2 7,HR3 7,HR4 17, HR5 10 MICRON M .

(80) REFERENCE

STIR-53 TABLE-14

<* 700015 *> INTER RAMP MEASUREMENTS DATA (3) FOR BIRP-2 AND BIRP-4 ** 700015 **

STUDVIK
INTER-RP
COMMON
DATA

(1) EXAMINATION	BIRP-2 (4)				(5)			
(2) R2 CYCLE NO. PRECEDING MEASURE.	77-03				77-11			
(3) R2 CORE NO. PRECEDING MEASURE.	568				579			
(4) ROD NO.	HR2	HR3	HR4	HR5	HR2	HR3	HR4	HR5
(5) FN FLUENCE X10XX24 (ACC) *1)	11.7	13.2	17.0	16.3	16.2	18.4	23.6	22.7
(6) BURNUP (MWD/KG) *1)	9.59	10.16	11.78	11.44	13.24	14.02	16.08	15.68
(7) HPP *2)								
(8) R2 CYCLE NO.	78-03				77-03--06			
(9) PEAK POWER (KW/M)	34.3	35.7	38.4	38.1	35.2	36.4	39.1	38.8
(10) AVERAGE POWER (KW/M)	34.2	35.5	38.2	37.9	33.7	35.0	37.5	37.2
(11) ROD ELONGATION (MM)	0.57	0.55	0.71	0.69	0.63	0.61	0.95	0.90
(12) DIAMETER CREEP-DWON (MICRON M)					19.7	20.1	27.1	27.1
(13) MAX. OVALITY *3) (MICRON M)					13	11	24	15
(14) DIAM. RIDGE H.(MAX) (MICRON M)	5	4	17	13	5	3	20	12
(15) PELLET INTERFACE NO.	10/11	11/12	13/14	12/13	11/12	12/13	5/6	12/13

(79) REMARKS

*1) REPOTED VALUES ARE MAXIMUM VALUES. TO GET AVERAGE VALUES OVER THE SEVEN PRESCRIBED AXIAL POSITIONS FOR DIAMETER CREEP-DOWEN AND OVALITY MEASUREMENTS MULTIPLY WITH 0.91 FOR FN FLUENCE AND BURNUP .

*2) HPP = HIGH POWER PERIOD

*3) MAX OVALITY PRE-IRRADIATION VALUES : HR2 7,HR3 7,HR4 17, HR5 10 MICRON M .

(80) REFERENCE

STIR-53 TABLE-14

<* 700016 *> INTER RAMP MEASUREMENTS DATA (4) FOR BIRP-2 AND BIRP-4 ** 700016 **

STUDVIK
INTER-RP
COMMON
DATA

---(1)-*---(2)-*---(3)-*---(4)-*---(5)-*---(6)-*---(7)-*---(8)-*

(1) EXAMINATION

				(6)			PRIOR TO RAMP		
(2)	R2 CYCLE NO. PRECEDING MEASURE.		----------77-12----------			----------78 03----------			
(3)	R2 CORE NO. PRECEDING MEASURE.		----------581----------			----------595----------			
(4)	ROD NO.		HR2	HR3	HR4	HR5	HR2	HR3	HR4	HR5
(5)	FN FLUENCE X10XX24 (ACC)	*1)	16.7	18.9	24.4	23.4	20.8	23.6	30.4	29.3
(6)	BURNUP (MWD/KG)	*1)	13.91	14.71	16.81	16.41	18.18	19.19	21.27	21.29
(7)	HPP	*2)								
(8)	R2 CYCLE NO.		----------77-12----------				----------77-12--16----------			
(9)	PEAK POWER (KW/M)		33.4	34.5	36.7	36.5	33.4	34.5	36.7	36.5
(10)	AVERAGE POWER (KW/M)		33.4	34.5	36.7	36.5	32.2	33.3	35.5	35.3
(11)	ROD ELONGATION (MM)		0.67	0.63	1.00	0.96	0.73	0.69	1.09	1.06
(12)	DIAMETER CREEP-DWON (MICRON M)						23.6	23.6	31.9	30.2
(13)	MAX. OVALITY *3) (MICRON M)						16	14	26	18
(14)	DIAM. RIDGE H.(MAX) (MICRON M)		8	6	23	17	12	6	23	19
(15)	PELLET INTERFACE NO.		11/12	12/13	6/7	12/13	8/9	12/13	6/7	13/14

(79) REMARKS

*1) REPOTED VALUES ARE MAXIMUM VALUES. TO GET AVERAGE VALUES OVER THE SEVEN PRESCRIBED AXIAL POSITIONS FOR DIAMETER CREEP-DOWEN AND OVALITY MEASUREMENTS MULTIPLY WITH 0.91 FOR FN FLUENCE AND BURNUP .

*2) HPP = HIGH POWER PERIOD

*3) MAX OVALITY PRE-IRRADIATION VALUES : HR2 7,HR3 7,HR4 17, HR5 10 MICRON M .

(80) REFERENCE

STIR-53 TABLE-14

<* 700017 *> INTER RAMP HOT CELL PIE DATA (1) -LR,LS,TR- ** 700017 **

STUDVIK
INTER-RP
COMMON
DATA

			(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
(1)	BIRP NO.		1	1	1	1	3	3	3	3
(2)	ROD NO.		1	2	3	4	5	6	7	8
(3)	ROD LABEL		LR1	LR2	LR3	LR4	LR5	LS1	LS2	TR1
(4)	F , NF		NF	F	F	F	F	F	NF	NF
(5)	WEIGHT									
(6)	PTI	(G) *4)	532.0	531.7	531.9	532.2	532.3	530.5	530.2	537.5
(7)	AR	(G) *5)	532.2	532.8	533.2	533.1	533.1	531.7	530.3	537.8
(8)	AR -PTI	(G)	0.2	1.1	1.3	0.9	0.8	1.8	0.1	0.3
(9)	GAMMA - SCANNING	AR								
(10)	NUCLIDE		CS-137	-	LA-140	LA-140	CS-137	CS-137	CS-137	CS-137 ZR/ NB-95
(11)	AXIAL FROM FACTOR		1.12	-	1.11	1.12	1.13	1.14	1.13	1.14 1.14
(12)	POSITION OF PEAK *3)	(MM)	220	-	240	230	210	200	200	200 210
(13)	BURNUP ANALYSIS									
(14)	ND-148	(MWD/KG-U)								11.2
(15)	U/PU	(MWD/KG-U)								11.05
(16)	FISSION GAS RELEASE									
(17)	KR	(%)	4.6						4.7	1.7
(18)	XE	(%)	4.8						5.0	1.6
(19)	TENSILE TESTING (AVERAGE)									
(20)	STRESS AT 0.2 % STRAIN	(MPA)							531	573
(21)	MAX STRESS	(MPA)							562	590
(22)	HOMOGENOUS STRAIN	(%)							1.2	0.52
(23)	TOTAL STRAIN								8.9	4.7

(79) REMARKS

*1) UNCERTAIN VALUE (+0.4 - 0.3) DUE TO TOP AND/OR BOTTOM EXTENSION PIECES MEASURED TOGETHER WITH THE ROD PTI BUT NOT AR .

*2) VALUE SUBTRACTED BY 2.8 GRAMS DUE TO A BROKEN END PEG , WHICH WAS LEFT IN THE BOTTOM PLUG HOLE .

*3) MEASURED FROM THE BOTTOM OF THE FUEL ROD .

*4) PTI = PRIOR TO IRRADIATION .

*5) AR = AFTER RAMPING .

(80) REFERENCE

STIR-53 TABLE-17

<* 700018 *> INTER RAMP HOT CELL PIE DATA (2) -LS,TS,DR,HR- ** 700018 **

STUDVIK
INTER-RP
COMMON
DATA

		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
(1)	BIRP NO.	5	5	5	5	2	2	2	2
(2)	ROD NO.	9	10	11	12	13	14	15	16
(3)	ROD LABEL	LS3	LS4	TS1	DR1	HR2	HR3	HR4	HR5
(4)	F , NF	NF	F	F	NF	NF	F	NF	NF
(5)	WEIGHT								
(6)	PTI (G) *4)	531.6	531.6	536.2	524.2	559.4	560.4	561.2	-
(7)	AR (G) *5)	531.6*2)	532.4	536.6	524.0*2)	559.8*1)	561.4*1)	561.3*1)	560.8
(8)	AR -PTI (G)	0	0.8	0.4	-0.2	0.1-0.8	0.7-1.4	-0.1-+0.4	-
(9)	GAMMA - SCANNING AR								
(10)	NUCLIDE	CS-137 ZR/ NB-95	CS-137	CS-137	CS-137	CS-137 ZR/ NB-95	CS-137	CS-137 ZR/ NB-95	LA-140
(11)	AXIAL FROM FACTOR	1.13 1.11	1.09	1.12	1.12	1.18 1.08	1.10	1.11 1.08	1.13
(12)	POSITION OF PEAK *3) (MM)	210 220	180	200	200	200 220	210	210 210	230
(13)	BURNUP ANALYSIS								
(14)	ND-148 (MWD/KG-U)	8.5				18.0			21.0
(15)	U/PU (MWD/KG-U)	8.71				18.2			21.0
(16)	FISSION GAS RELEASE								
(17)	KR (%)	2.3			5.5	3.4		9.6	13.9
(18)	XE (%)	2.2			5.8	3.7		10.4	16.0
(19)	TENSILE TESTING (AVERAGE)								
(20)	STRESS AT 0.2 % STRAIN (MPA)							532	
(21)	MAX STRESS (MPA)							550	
(22)	HOMOGENOUS STRAIN (%)							0.58	
(23)	TOTAL STRAIN							4.5	

(79) REMARKS

*1) UNCERTAIN VALUE (+0.4 - 0.3) DUE TO TOP AND/OR BOTTOM EXTENSION PIECES MEASURED TOGETHER WITH THE ROD PTI BUT NOT AR .

*2) VALUE SUBTRACTED BY 2.8 GRAMS DUE TO A BROKEN END PEG , WHICH WAS LEFT IN THE BOTTOM PLUG HOLE .

*3) MEASURED FROM THE BOTTOM OF THE FUEL ROD .

*4) PTI = PRIOR TO IRRADIATION .

*5) AR = AFTER RAMPING .

(80) REFERENCE

STIR-53 TABLE-17

<* 700019 *> INTER RAMP HOT CELL PIE DATA (3) -HS,BR- ** 700019 **

STUDVIK
INTER-RP
COMMON
DATA

---(1)-*---(2)-*---(3)-*---(4)-*---(5)-*---(6)-*---(7)-*---(8)-*

(1)	BIRP NO.		4	4	4	4
(2)	ROD NO.		17	18	19	20
(3)	ROD LABEL		HS1	HS2	HS3	BR1
(4)	F , NF		F	NF	F	F
(5)	WEIGHT					
(6)	PTI	(G) *4)	558.8	558.8	559.2	549.9
(7)	AR	(G) *5)	559.8*1)	559.1*1)	560.2	550.0*1)
(8)	AR -PTI	(G)	0.1-0.8	0.3-1.0	1.0	0.2-0.4
(9)	GAMMA - SCANNING AR					
(10)	NUCLIDE		CS-137	CS-137 ZR/ NB-95	LA-140	LA-140
(11)	AXIAL FROM FACTOR		1.12	1.11 1.08	1.11	1.11
(12)	POSITION OF PEAK *3) (MM)		240	200 200	200	200
(13)	BURNUP ANALYSIS					
(14)	ND-148 (MWD/KG-U)			17.1		
(15)	U/PU (MWD/KG-U)			18.1		
(16)	FISSION GAS RELEASE					
(17)	KR (%)		6.2	3.4	24.2	
(18)	XE (%)		6.6	3.5	29.6	
(19)	TENSILE TESTING (AVERAGE)					
(20)	STRESS AT 0.2 % STRAIN (MPA)					
(21)	MAX STRESS (MPA)					
(22)	HOMOGENOUS STRAIN (%)					
(23)	TOTAL STRAIN					

(79) REMARKS

*1) UNCERTAIN VALUE (+0.4 - 0.3) DUE TO TOP AND/OR BOTTOM EXTENSION PIECES MEASURED TOGETHER WITH THE ROD PTI BUT NOT AR .

*2) VALUE SUBTRACTED DY 2.8 GRAMS DUE TO A BROKEN END PEG , WHICH WAS LEFT IN THE BOTTOM PLUG HOLE .

*3) MEASURED FROM THE BOTTOM OF THE FUEL ROD .

*4) PTI = PRIOR TO IRRADIATION .

*5) AR = AFTER RAMPING .

(80) REFERENCE

STIR-53 TABLE-17

<* 700020 *> RESULTS OF SCC TESTING OF INTER RAMP MATERIAL *1) ** 700020 **

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STUDVIK
INTER-RP
COMMON
DATA

---(1)-*---(2)-*---(3)-*---(4)-*---(5)-*---(6)-*---(7)-*---(8)-*

(1)	SAMPLE		HR4T *2)	HR4B *3)	1S	6S	LS3T *3)	LS3B *3)	5H	7H
(2)	ANNEL STATE		RECRYST	:	:	:	STRESS REL	:	:	:
(3)	FAST NEUTRON DOSE	(N/CM**2)	3*10**21	:	0	0	1**10**21	:	0	0
(4)	BURNUP	(MWD/KG-U)	21.8	21.8	0	0	9.0	9.0	0	0
(5)	IODINE *3)	(MG/CM**3)	1	1	1	1	1	1	5	2.5
(6)	STRESS	(MPA)	332	359	285	340	322 STEPS-	492	485	495
			359		330		WISE TO 545			
(7)	TIME	(HOURS)	1	0.4	3.7	0.17	8 STEPS	0.6	1.25	1
			0.7		1		1 HR			
(8)	ELONG	(%)				10.7	1.12	0.64	2.2	4
			0.24	0.24	14.7					
(9)	FRACTURE									
(10)	MICROSCOPIC		*4)	*5)	*6)	*5)	*7)	*7)	*7)	*7)
(11)	SCC CRACK									
(12)	LENGTH	(MM)	10	10	5	1.1	20	LONG	25	20
(13)	DEPTH	(MM)	0.53	0.48	0.15	0.45	0.16	0.31	0.5	0.1

(79) REMARKS

*1) TESTING TEMPERATURE 320 DEG-C (MORE RESULTS ON UNIRRADIATED MATERIAL IS GIVEN IN REF 144 - 145)
*2) T = TOP
*3) B = BOTTOM
*4) INTERCRYSTALLINE ALL THROUGH .
*5) INTERCRYSTALLINE AND CLEAVAGE .

*6) INTERCRYSTALLINE .
*7) MAINLY INTERCRYSTALLINE .
CRACKS ALONG ELONGATED GRAINS TYPICAL FOR STRESS RELIEVED MATERIAL .

(80) REFERENCE

STIR-53 TABLE-18

<* 700021 *> INTER RAMP ROD LENGTH MEASUREMENT DATA (1) -LR,LS,TR- ** 700021 **

STUDVIK
INTER-RP
COMMON
DATA

---(1)-*---(2)-*---(3)-*---(4)-*---(5)-*---(6)-*---(7)-*---(8)-*

(1)	BIRP NO.		1	1	1	1	3	3	3	3
(2)	ROD NO.		1	2	3	4	5	6	7	8
(3)	ROD LABEL		LR1	LR2	LR3	LR4	LR5	LS1	LS2	TR1
(4)	F , FS		NF	F	F	F	F	F	NF	NF
(5)	EXTERNAL ROD LENGTH									
(6)	MECH PTI	(MM)	573.00	573.15	572.87	573.01	572.90	574.34	572.98	573.03
(7)	MECH PTR	(MM)	573.67	573.93	573.30	573.70	572.43	574.90	-	573.73
(8)	MECH PTR - PTI	(MM)	0.67	0.78	0.43	0.69	0.53	0.56	-	0.70
(9)	MECH AR		573.70	574.06	-	-	573.51	-	-	573.76
(10)	MECH AR - PTR	(MM)	0.03	0.13	-	-	0.08	-	-	0.03
(11)	ROD LENGTH BETWEEN FLAT ENDS									
(12)	MECH PTI	(MM)	527.98	528.06	527.97	528.01	527.87	527.94	528.00	528.03
(13)	N-RAD PTR	(MM)	528.57	528.57	528.57	528.71	528.41	528.39	528.62	528.71
(14)	PTR - PTI	(MM)	0.69	0.51	0.60	0.70	0.54	0.45	0.62	0.68
(15)	N-RAD AR	(MM)	528.63	528.55	528.55	528.85	528.67	528.51	528.71	528.73
					528.73*1)	528.94*1)	528.58*1)			
(16)	AR - PTR	(MM)	-0.04	-0.02	-0.02	-0.14	0.26	0.12	0.09	0.02
					(0.16)	(0.23)	(0.19)			
(17)	UO-2 TOTAL STACK LENGTH									
(18)	MECH F	(MM)	427.0	427.4	426.7	426.7	426.9	426.4	425.8	428.1
(19)	N-RAD PTI	(MM)	426.89	427.09	426.38	426.52	426.69	426.16	425.73	428.04
(20)	N-RAD PTR	(MM)	425.19	426.47	425.35	425.06	425.97	425.37	424.60	426.95
(21)	PTR - PTI	(MM)	-1.70	-0.62	-1.03	-1.46	-0.72	-0.79	-1.13	-1.09
(22)	N-RAD AR	(MM)	424.95	426.63	426.21	425.46	426.11	425.44	424.65	426.75
(23)	AR - PTR	(MM)	-0.24	0.16	0.86	0.40	0.14	0.07	0.05	-0.20
(24)	ENRICHED UO-2 STACK LENGTH									
(25)	MECH F	(MM)	400.8	401.0	400.8	400.9	400.9	400.5	400.0	402.0
(26)	N-RAD PTI	(MM)	400.69	400.81	400.45	400.76	400.65	400.37	399.92	401.84
(27)	N-RAD PTR	(MM)	399.04	400.09	399.49	399.34	399.95	399.54	398.73	400.78
(28)	PTR - PTI	(MM)	-1.65	-0.72	-0.96	-1.42	-0.70	-0.83	-1.19	-1.06
(29)	N-RAD AR	(MM)	398.87	400.25	400.24	399.59	400.06	399.58	398.78	400.67
(30)	AR - PTR	(MM)	-0.17	0.16	0.75	0.25	0.11	0.04	0.05	-0.11
(31)	PLENUM CHAMBER LENGTH									
(32)	MECH F	(MM)	42.1	41.6	42.6	42.5	42.0	42.8	43.1	40.9
(33)	N-RAD PTI	(MM)	41.9	41.6	42.5	42.3	42.1	42.54	43.06	40.91
(34)	N-RAD PTR	(MM)	44.2	42.8	44.1	44.5	43.06	43.86	44.85	42.49
(35)	PTR - PTI	(MM)	2.3	1.2	1.6	2.2	0.96	1.32	1.79	1.58
(36)	N-RAD AR	(MM)	44.2	42.8	43.15	44.33	43.24	43.91	45.07	42.83
(37)	AR - PTR	(MM)	0	0	-0.95	-0.17	0.18	0.05	0.22	0.34

(79) REMARKS

NOTATION :
- MECH = MECHANICAL MEASUREMENT CORRECTED TO 20 DEG-C .
- N-RAD= MEASUREMENT FROM N-RADIOGRAPHY NOT CORRECTED TEMP. .
- PTI = PRIOR TO IRRADIATION .
- PTR = PRIOR TO RAMP .
- AR = AFTER RAMP .
- F = FABRICATION MEASUREMENT .

*1) HOT CELL MECHANICAL MEASUREMENT CORRECTED TO 20 DEG-C .
*2) FUEL STACK DISTURBED .

(80) REFERENCE

STIR-53 TABLE-15

<* 700022 *> INTER RAMP ROD LENGTH MEASUREMENT DATA (2) -LS,TS,DR,HR- ** 700022 **

STUDVIK
INTER-RP
COMMON
DATA

(1)	BIRP NO.		5	5	5	5	2	2	2	2
(2)	ROD NO.		9	10	11	12	13	14	15	16
(3)	ROD LABEL		LS3	LS4	TS1	DR1	HR2	HR3	HR4	HR5
(4)	F , FS		NF	F	F	NF	NF	F	NF	NF
(5)	EXTERNAL ROD LENGTH									
(6)	MECH PTI	(MM)	572.87	573.01	572.85	573.05	573.23	573.39	573.17	573.34
(7)	MECH PTR	(MM)	-	573.63	573.71	-	573.96	574.08	574.26	574.40
(8)	MECH PTR - PTI	(MM)	-	0.62	0.86	-	0.73	0.69	1.09	1.06
(9)	MECH AR		-	573.71	573.77	-	573.99	-	574.31	574.47
(10)	MECH AR - PTR	(MM)	-	0.08	0.06	-	0.03	-	0.05	0.07
(11)	ROD LENGTH BETWEEN FLAT ENDS									
(12)	MECH PTI	(MM)	527.96	527.98	527.86	527.98	-	-	-	-
(13)	N-RAD PTR	(MM)	528.39	528.50	528.69	528.37	528.92	528.89	529.13	529.07
(14)	PTR - PTI	(MM)	0.43	0.52	0.83	0.39				
(15)	N-RAD AR	(MM)	528.38 528.97*1)	528.60	528.60	528.34 528.71*1)	528.90	529.00	529.08	529.39
(16)	AR - PTR	(MM)	-0.01 (0.58)	0.10	-0.09	-0.03 (0.34)	-0.02	0.11	-0.05	0.32
(17)	UO-2 TOTAL STACK LENGTH									
(18)	MECH F	(MM)	427.2	427.4	428.2	427.4	426.7	426.7	426.7	427.0
(19)	N-RAD PTI	(MM)	426.99	427.27	428.17	427.24	426.77	426.61	426.70	-
(20)	N-RAD PTR	(MM)	426.57	426.60	427.10	427.31	426.25	426.33	424.94	425.4
(21)	PTR - PTI	(MM)	-0.42	-0.67	-1.07	0.07	-0.52	-0.28	-1.76	-1.8
(22)	N-RAD AR	(MM)	426.10	426.36	427.33	427.15	426.23	426.99*2)	425.08	425.29
(23)	AR - PTR	(MM)	-0.47	-0.24	0.23	-0.16	-0.02	0.66*2)	0.14	0.05
(24)	ENRICHED UO-2 STACK LENGTH									
(25)	MECH F	(MM)	406.6	401.7	402.0	401.3	400.9	400.8	400.9	400.9
(26)	N-RAD PTI	(MM)	400.36	401.56	402.01	401.17	400.94	400.70	400.88	-
(27)	N-RAD PTR	(MM)	400.90	400.91	400.93	401.13	400.38	400.45	399.36	399.37
(28)	PTR - PTI	(MM)	-0.46	-0.65	-1.08	-0.04	-0.56	-0.25	-1.52	(-1.5)
(29)	N-RAD AR	(MM)	400.52	400.70	401.26	401.09	400.42	400.60	399.52	399.73
(30)	AR - PTR	(MM)	-0.38	-0.21	-0.33	-0.04	0.04	0.15	0.16	0.36
(31)	PLENUM CHAMBER LENGTH									
(32)	MECH F	(MM)	41.8	41.7	40.5	41.4	42.2	41.8	42.2	42.0
(33)	N-RAD PTI	(MM)	41.7	41.5	40.5	41.5	42.3	42.1	42.2	41.9
(34)	N-RAD PTR	(MM)	42.68	42.85	42.47	41.92	43.53	42.86	44.89	44.58
(35)	PTR - PTI	(MM)	0.98	1.4	2.0	0.4	1.2	0.8	2.7	2.7
(36)	N-RAD AR	(MM)	43.16	43.29	42.21	42.14	43.39	42.72	44.88	44.66
(37)	AR - PTR	(MM)	0.48	0.44	-0.26	0.22	-0.14	-0.14	-0.01	0.08

(79) REMARKS

NOTATION :
MECH = MECHANICAL MEASUREMENT CORRECTED TO 20 DEG-C .
N-RAD= MEASUREMENT FROM N-RADIOGRAPHY NOT CORRECTED TEMP. .
PTI = PRIOR TO IRRADIATION .
PTR = PRIOR TO RAMP .
AR = AFTER RAMP .
F = FABRICATION MEASUREMENT .

*1) HOT CELL MECHANICAL MEASUREMENT CORRECTED TO 20 DEG-C .
*2) FUEL STACK DISTURBED .

(80) REFERENCE

STIR-53 TABLE-15

<* 700023 *> INTER RAMP ROD LENGTH MEASUREMENT DATA (3) -HS,BR- ** 700023 **

STUDVIK
INTER-RP
COMMON
DATA

---(1)-*---(2)-*---(3)-*---(4)-*---(5)-*---(6)-*---(7)-*---(8)-*

(1)	BIRP NO.	4	4	4	4
(2)	ROD NO.	17	18	19	20
(3)	ROD LABEL	HS1	HS2	HS3	BR1
(4)	F , FS	F	NF	F	F
(5)	EXTERNAL ROD LENGTH				
(6)	MECH PTI (MM)	573.37	573.27	573.30	573.25
(7)	MECH PTR (MM)	574.53	574.04	574.13	574.13
(8)	MECH PTR - PTI (MM)	1.16	0.77	0.83	0.88
(9)	MECH AR	574.59	574.06	574.19	574.20
(10)	MECH AR - PTR (MM)	0.06	0.02	0.06	0.07
(11)	ROD LENGTH BETWEEN FLAT ENDS				
(12)	MECH PTI (MM)	-	-	-	-
(13)	N-RAD PTR (MM)	529.26	528.89	529.09	529.09
(14)	PTR - PTI (MM)				
(15)	N-RAD AR (MM)	529.40	529.03	529.25	529.16
(16)	AR - PTR (MM)	0.14	0.14	0.16	0.07
(17)	UO-2 TOTAL STACK LENGTH				
(18)	MECH F (MM)	425.2	425.0	427.0	423.1
(19)	N-RAD PTI (MM)	425.29	424.89	427.03	423.03
(20)	N-RAD PTR (MM)	424.32	424.93	426.52	421.64
(21)	PTR - PTI (MM)	-0.97	0.04	-0.51	-1.39
(22)	N-RAD AR (MM)	424.36	424.76	426.65	421.95
(23)	AR - PTR (MM)	0.04	-0.17	0.13	0.31
(24)	ENRICHED UO-2 STACK LENGTH				
(25)	MECH F (MM)	399.1	399.0	401.0	397.0
(26)	N-RAD PTI (MM)	399.17	398.95	401.07	397.02
(27)	N-RAD PTR (MM)	398.35	398.96	400.63	395.79
(28)	PTR - PTI (MM)	-0.82	0.01	-0.44	-1.23
(29)	N-RAD AR (MM)	398.32	398.84	400.77	395.73
(30)	AR - PTR (MM)	-0.03	-0.12	0.14	-0.06
(31)	PLENUM CHAMBER LENGTH				
(32)	MECH F (MM)	43.5	44.0	41.8	45.9
(33)	N-RAD PTI (MM)	43.5	43.9	42.5	45.8
(34)	N-RAD PTR (MM)	45.66	44.58	43.25	48.03
(35)	PTR - PTI (MM)	2.16	0.68	0.75	2.23
(36)	N-RAD AR (MM)	45.84	45.05	43.30	47.60
(37)	AR - PTR (MM)	0.18	0.47	0.05	-0.43

(79) REMARKS

NOTATION :
MECH = MECHANICAL MEASUREMENT CORRECTED TO 20 DEG-C .
N-RAD= MEASUREMENT FROM N-RADIOGRAPHY NOT CORRECTED TEMP. .
PTI = PRIOR TO IRRADIATION .
PTR = PRIOR TO RAMP .
AR = AFTER RAMP .
F = FABRICATION MEASUREMENT .

*1) HOT CELL MECHANICAL MEASUREMENT CORRECTED TO 20 DEG-C .
*2) FUEL STACK DISTURBED .

(80) REFERENCE

STIR-53 TABLE-15

<* 700024 *> INTER RAMP,PRE-RAMP IRRADIATION DATA AND RAMP IRRADIATION DATA 1 ** 700024 **

STUDVIK
INTER-RP
COMMON
DATA

---(1)-*---(2)-*---(3)-*---(4)-*---(5)-*---(6)-*---(7)-*---(8)-*

(1) BIRP NO.	1	1	1	1	3	3	3	3
(2) ROD NO.	LR1	LR2	LR3	LR4	LR5	LS1	LS2	TR1
(3) F , FS *1)	NF	F	F	F	F	F	NF	NF
(4) PRE-RAMP IRRADIATION								
(5) LAST RC PL (KW/M) *2)	30.0	23.4	25.4	31.1	23.4	25.4	31.0	30.0
(6) LAST LPP AVPL (KW/M) *3)	28.6	22.3	24.2	29.6	23.5	25.5	31.2	30.2
(7) LAST HPP PH (KW/M) *4)	40.7	37.4	37.8	41.6	37.4	37.8	41.5	40.7
(8) BURNUP (MWD/KG)	11.6	9.8	10.3	11.9	10.0	10.5	12.0	11.6
(9) TEST FLUENCE	18.1	12.9	14.3	18.9	12.6	13.6	18.2	17.2
E > 1 MEV 10**24 .M**-2								
(11) CONDITIONING								
(12) CPL PC (KW/M) *5)	29.8	24.5	35.0	35.3	25.1	26.9	31.8	30.7
(13) TIME (HOURS)	24	24	24	24	24	24	24	24
(14) RAMP IRRADIATION								
(15) PRR DPR (W/M.S) *6)	80*8)	70	65	65	85	90	65	70
(16) PTL PEAK PR (W/M.S) *7)	43.8	45.7	50.1	65.4	42.7	48.2	43.8	42.2
(17) TFPD (MIN) *13)	>1440	46/61*9)	11	0.5	162/194 /212	17/26	>1440	>1440
(18) HOLD TIME AT PTL (MIN)	1440	84	103	5	1440	35	1440	1440
(19) POWER INCREASE ABOVE								
(20) DELTA PL (KW/M)	13.8	22.3	24.7	34.3	19.3	22.8	12.8	12.2
(21) DELTA AVPL (KW/M)	15.2	23.4	25.9	35.8	19.2	22.7	12.6	12.0
(22) DELTA PH (KW/M)	3.1	8.3	12.3	23.8	5.3	10.4	2.3	1.5
(23) DELTA PC (KW/M)	14.0	21.2	15.1	30.1	17.6	21.3	12.0	11.5

(79) REMARKS

*1) F = FAILURE , NF = NON FAILURE
*2) RC = REACTOR CYCLE
*3) LPP = LOW POWER PERIOD
*4) HPP = HIGH POER PERIOD
*5) CPL = CONDITIONING POWER LEVEL

*6) PRR = POWER RAMP RATE
*7) PTL = RAMP TERMINAL LEVEL
*8) PAUSE 2 MIN AT 32.0 KW/M
*9) SMALL ACTIVITY INCREASE AFTER 46 MIN
LARGER ACTIVITY INCREASE AFTER 61 MIN
*10) THE LAST RC WAS A HIGH POWER CYCLE AT 40.8 KW/M

*11) FROM 29.6 KW/M WITH A RATE OF 0.28 KW/M.S TO 40.8 KW/M
*12) THE LAST RC WAS A HIGH POWER CYCLE AT 40.1 KW/M
*13) TFPD = TIME TO FISSION PRODUCT DETECTION (NOT INCLUDING DELAY TIME OF MEASUREMENT SYSTEM)

(80) REFERENCE

STIR-51 TABLE-1

<* 700025 *> INTER RAMP,PRE RAMP IRRADIATION DATA AND RAMP IRRADIATION DATA 2 ** 700025 **

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STUDVIK
INTER-RP
COMMON
DATA

---(1)-*---(2)-*---(3)-*---(4)-*---(5)-*---(6)-*---(7)-*---(8)-*

(1) BIRP NO.	5	5	5	5	2	2	2	2
(2) ROD NO.	LS3	LS4	TS1	DR1	HR2	HR3	HR4	HR5
(3) F , FS *1)	NF	F	F	NF	NF	F	NF	NF
(4) PRE-RAMP IRRADIATION								
(5) LAST RC PL (KW/M) *2)	24.9*	30.3*10)	29.4*12)	22.9	23.5	25.2	28.8	28.2
(6) LAST LPP AVPL (KW/M) *3)	25.9	31.5	30.5	23.8	24.0	25.7	29.5	28.9
(7) LAST HPP PH (KW/M) *4)	37.2	40.9	40.1	36.8	35.0	36.2	38.5	38.3
(8) BURNUP (MWD/KG)	9.4	11.9	11.3	9.1	19.1	20.1	22.8	22.3
(9) TEST FLUENCE E > 1 MEV 10**24 .M**-2	10.5	14.9	14.1	9.8	20.8	23.6	30.4	29.3
(11) CONDITIONING								
(12) CPL PC (KW/M) *5)	25.0	40.8*11)	29.7	22.9	23.0	25.2	29.0	29.0
(13) TIME (HOURS)	24	24	24	24	24	24	24	24
(14) RAMP IRRADIATION								
(15) PRR DPR (W/M.S) *6)	65	70	70	75	75	65	70	70
(16) PTL PEAK PR (W/M.S) *7)	41.8	50.7	47.3	43.2	38.0	43.2	46.1	47.9
(17) TFPD (MIN) *13)	>1440	72	296	>1440	>1440	260	>1440	>1440
(18) HOLD TIME AT PTL (MIN)	1440	92	319	1440	1440	316	1440	1440
(19) POWER INCREASE ABOVE								
(20) DELTA PL (KW/M)	16.9	20.4	17.9	20.3	14.5	18.0	17.3	19.7
(21) DELTA AVPL (KW/M)	15.9	19.2	16.8	19.4	14.0	17.5	16.6	19.0
(22) DELTA PH (KW/M)	4.6	9.8	7.2	6.4	3.0	7.0	7.6	9.6
(23) DELTA PC (KW/M)	16.8	9.9	17.6	20.3	15.0	18.0	17.1	18.9

(79) REMARKS

*1) F = FAILURE , NF = NON FAILURE
*2) RC = REACTOR CYCLE
*3) LPP = LOW POWER PERIOD
*4) HPP = HIGH POER PERIOD
*5) CPL = CONDITIONING POWER LEVEL

*6) PRR = POWER RAMP RATE
*7) PTL = RAMP TERMINAL LEVEL
*8) PAUSE 2 MIN AT 32.0 KW/M
*9) SMALL ACTIVITY INCREASE AFTER 46 MIN
LARGER ACTIVITY INCREASE AFTER 61 MIN
*10) THE LAST RC WAS A HIGH POWER CYCLE AT 40.8 KW/M

*11) FROM 29.6 KW/M WITH A RATE OF 0.28 KW/M.S TO 40.8 KW/M
*12) THE LAST RC WAS A HIGH POWER CYCLE AT 40.1 KW/M
*13) TFPD = TIME TO FISSION PRODUCT DETECTION (NOT INCLUDING DELAY TIME OF MEASUREMENT SYSTEM)

(80) REFERENCE

STIR-51 TABLE-1

<* 700026 *> INTER RAMP,PRE RAMP IRRADIATION DATA AND RAMP IRRADIATION DATA 3 ** 700026 **

STUDVIK
INTER-RP
COMMON
DATA

(1)	BIRP NO.	4	4	4	4
(2)	ROD NO.	HS1	HS2	HS3	BR1
(3)	F , FS *1)	F	NF	F	F
(4)	PRE-RAMP IRRADIATION				
(5)	LAST RC PL (KW/M) *2)	30.8	24.8	26.6	31.5
(6)	LAST LPP AVPL (KW/M) *3)	30.6	24.6	26.4	31.4
(7)	LAST HPP PH (KW/M) *4)	37.8	34.6	35.7	37.9
(8)	BURNUP (MWD/KG)	22.2	19.1	20.1	23.0
(9)	TEST FLUENCE E > 1 MEV 10**24 .M**-2	26.7	18.7	21.4	27.6
(11)	CONDITIONING				
(12)	CPL PC (KW/M) *5)	30.3	24.8	26.6	31.1
(13)	TIME (HOURS)	24	24	24	24
(14)	RAMP IRRADIATION				
(15)	PRR DPR (W/M.S) *6)	65	65	70	65
(16)	PTL PEAK PR (W/M.S) *7)	47.8	41.0	44.9	51.0
(17)	TFPD (MIN) *13)	26	1440	42	1440
(18)	HOLD TIME AT PTL (MIN)	26	1440	59	1440
(19)	POWER INCREASE ABOVE				
(20)	DELTA PL (KW/M)	17.0	16.2	18.3	19.5
(21)	DELTA AVPL (KW/M)	17.2	16.4	18.5	19.6
(22)	DELTA PH (KW/M)	10.0	6.4	9.2	13.1
(23)	DELTA PC (KW/M)	17.5	16.2	18.3	19.9

(79) REMARKS

*1) F = FAILURE , NF = NON FAILURE
*2) RC = REACTOR CYCLE
*3) LPP = LOW POWER PERIOD
*4) HPP = HIGH POER PERIOD
*5) CPL = CONDITIONING POWER LEVEL

*6) PRR = POWER RAMP RATE
*7) PTL = RAMP TERMINAL LEVEL
*8) PAUSE 2 MIN AT 32.0 KW/M
*9) SMALL ACTIVITY INCREASE AFTER 46 MIN
LARGER ACTIVITY INCREASE AFTER 61 MIN
*10) THE LAST RC WAS A HIGH POWER CYCLE AT 40.8 KW/M

*11) FROM 29.6 KW/M WITH A RATE OF 0.28 KW/M.S TO 40.8 KW/M
*12) THE LAST RC WAS A HIGH POWER CYCLE AT 40.1 KW/M
*13) TFPD = TIME TO FISSION PRODUCT DETECTION (NOT INCLUDING DELAY TIME OF MEASUREMENT SYSTEM)

(80) REFERENCE

STIR-51 TABLE-1

<* 700027 *> INTER RAMP FUEL RODS WEIGHT INCREASES (1) -LR,LS,TR- ** 700027 **

STUDVIK
INTER-RP
COMMON
DATA

---(1)-*---(2)-*---(3)-*---(4)-*---(5)-*---(6)-*---(7)-*---(8)-*

(1)	BIRP NO.		1	1	1	1	2	2	2	2
(2)	ROD NO.		LR1	LR2	LR3	LR4	HR2	HR3	HR4	HR5
(3)	WEIGHT BEFORE IRRADIATION	(G)	532.0	431.7	531.9	532.2	559.4	560.4	561.2	-
(4)	AFTER RAMP	(G)	532.2	532.8	533.2	533.1	559.8 +0.4 -0.3 *1)	561.4 +0.4 -0.3 *1)	561.3 +0.3 -0.2 *1)	560.8
(5)	INCREASE	(G)	+0.2	+1.1	+1.3	+0.9	0.1-0.8	0.7-1.4	-0.1-+0.4	?
(6)	FAILED , NONFAILED		NF	F	F	F	NF	F	NF	NF

(79) REMARKS

*1) THE VALUE AFTER RAMP IS UNCERTAIN WITHIN THE GIVEN LIMITS AS IT CONTAINS THE AVERAGE WEIGHTS OF TOP AND / OR BOTTOM EXTENSIONS WHICH WERE MOUNTED ON THE ROD WHEN WEIGHED BEFORE IRRADIATION BUT NOT WHEN WEIGHED AFTER RAMP .

*2) VALUE SUBTRACTED BY 2.8 GRAMS WHICH IS THE CALCULATED WEIGHT OF A BROKEN END PEG WHICH WAS LEFT IN THE BOTTOM PLUG HOLE .

(80) REFERENCE

STIR-51 TABLE-4

<* 700028 *> INTER RAMP FUEL RODS WEIGHT INCREASES (2) -LS,TS,DR,HR- ** 700028 **

STUDVIK
INTER-RP
COMMON
DATA

---(1)-*---(2)-*---(3)-*---(4)-*---(5)-*---(6)-*---(7)-*---(8)-*

(1)	BIRP NO.		3	3	3	3	4	4	4	4
(2)	ROD NO.		LR5	LS1	LS2	TR1	BR1	HS1	HS2	HS3
(3)	WEIGHT BEFORE IRRADIATION	(G)	532.3	530.5	530.2	537.5	549.9	558.8	558.8	559.2
(4)	AFTER RAMP	(G)	533.1	531.7	530.3	537.8	550.2 +-0.1 -0.3 *1)	559.4 +0.4 -0.3 *1)	559.1 +0.4 *1)	560.2
(5)	INCREASE	(G)	+0.8	+1.8	+0.1	+0.3	0.2-0.4	0.3-1.0	0.3-1.0	1.0
(6)	FAILED , NONFAILED		F	F	NF	NF	F	F	NF	F

(79) REMARKS

*1) THE VALUE AFTER RAMP IS UNCERTAIN WITHIN THE GIVEN LIMITS AS IT CONTAINS THE AVERAGE WEIGHTS OF TOP AND / OR BOTTOM EXTENSIONS WHICH WERE MOUNTED ON THE ROD WHEN WEIGHED BEFORE IRRADIATION BUT NOT WHEN WEIGHED AFTER RAMP .

*2) VALUE SUBTRACTED BY 2.8 GRAMS WHICH IS THE CALCULATED WEIGHT OF A BROKEN END PEG WHICH WAS LEFT IN THE BOTTOM PLUG HOLE .

(80) REFERENCE

STIR-51 TABLE-4

<* 700029 *> INTER RAMP FUEL RODS WEIGHT INCREASES (3) -HS,BR- ** 700029 **

STUDVIK
INTER-RP
COMMON
DATA

---(1)-*---(2)-*---(3)-*---(4)-*---(5)-*---(6)-*---(7)-*---(8)-*

(1)	BIRP NO.	5	5	5	5
(2)	ROD NO.	DR1	LS3	LS4	TS1
(3)	WEIGHT BEFORE IRRADIATION (G)	524.2	531.6	531.6	536.2
(4)	AFTER RAMP (G)	524.0*2)	531.6*2)	532.4	536.6
(5)	INCREASE (G)	-0.2	0	0.8	0.4
(6)	FAILED , NONFAILED	NF	NF	F	F

(79) REMARKS

*1) THE VALUE AFTER RAMP IS UNCERTAIN WITHIN THE GIVEN LIMITS AS IT CONTAINS THE AVERAGE WEIGHTS OF TOP AND / OR BOTTOM EXTENSIONS WHICH WERE MOUNTED ON THE ROD WHEN WEIGHED BEFORE IRRADIATION BUT NOT WHEN WEIGHED AFTER RAMP .

*2) VALUE SUBTRACTED BY 2.8 GRAMS WHICH IS THE CALCULATED WEIGHT OF A BROKEN END PEG WHICH WAS LEFT IN THE BOTTOM PLUG HOLE .

(80) REFERENCE

STIR-51 TABLE-4

<* 700030 *> INTER RAMP FISSION GAS REREASE DATA (1) ** 700030 **

STUDVIK
INTER-RP
COMMON
DATA

---(1)-*---(2)-*---(3)-*---(4)-*---(5)-*---(6)-*---(7)-*---(8)-*

(1)	BIRP NO.	1	2	2	2	3	3
(2)	ROD NO.	LR1	HR2	HR4	HR5	LS2	TR1
(3)	MEASURED ROD VOL.						
(4)	ROD VOL. (CM**3)	6.16	5.94	6.00	6.05	5.91	5.48
(5)	GAS CONTENT 10**-4 (MOLES)	4.09	4.89	11.3	15.5	4.24	2.65
(6)	MASS SPECTROMETRY KR/HE	0.11	0.12	0.32	0.46	0.12	0.049
(7)	XE/HE	0.79	0.91	2.4	3.5	0.90	0.32
(8)	MEASURED KR 10**-5 (MOLES)	2.4	2.9	9.9	14.0	2.6	0.92
(9)	XE 10**-5 (MOLES)	1.7	2.2	7.3	11.0	1.9	0.59
(10)	HE 10**-4 (MOLES)	2.2	2.4	3.1	3.1	2.1	1.9
(11)	ROD PRESSURE AT 0 DEG-C (ATM)	1.5	1.8	4.2	5.7	1.6	1.0
(12)	FIMA VALUE 10**-2	1.02	1.70	2.03	1.98	1.09	1.05
(13)	PRODUCED KR 10**-4 (MOLES)	5.18	8.63	10.3	10.1	5.54	5.41
(14)	XE 10**-3 (MOLES)	3.54	5.90	7.05	6.8	3.78	3.70
(15)	RELEASED KR (%)	4.6	3.4	9.6	13.9	4.7	1.7
(16)	XE (%)	4.8	3.7	10.4	16.0	5.0	1.6

(79) REMARKS

(80) REFERENCE

STIR-51 TABLE-7

<* 700031 *> INTER RAMP FISSION GAS REREASE DATA (2) ** 700031 **

STUDVIK
INTER-RP
COMMON
DATA

(1)	BIRP NO.	4	4	4	5	5
(2)	ROD NO.	BR1	HS1	HS2	DR1	LS3
(3)	MEASURED ROD VOL.					
(4)	ROD VOL. (CM**3)	6.88	5.96	6.07	6.22	5.82
(5)	GAS CONTENT 10**-4 (MOLES)	26.7	7.76	4.49	4.13	2.70
(6)	MASS SPECTROMETRY KR/HE	0.62	0.22	0.13	0.088	0.045
(7)	XE/HE	5.2	1.6	0.93	0.63	0.31
(8)	MEASURED KR 10**-5 (MOLES)	24.0	6.1	2.9	2.1	0.91
(9)	XE 10**-5 (MOLES)	20.0	4.4	2.0	1.5	0.61
(10)	HE 10**-4 (MOLES)	3.9	2.8	2.2	2.4	2.0
(11)	ROD PRESSURE AT 0 DEG-C (ATM)	8.7	2.9	1.7	1.5	1.0
(12)	FIMA VALUE 10**-2	2.01	1.94	1.67	0.76	0.79
(13)	PRODUCED KR 10**-4 (MOLES)	9.9	9.8	8.43	3.79	4.02
(14)	XE 10**-3 (MOLES)	6.76	6.69	5.75	2.59	2.75
(15)	RELEASED KR (%)	24.2	6.2	3.4	5.5	2.3
(16)	XE (%)	29.6	6.6	3.5	5.8	2.2

(79) REMARKS

(80) REFERENCE STIR-51 TABLE-7

<* 700032 *> INTER RAMP CLAD TENSILE TESTING RESULT (1) -LS- ** 700032 **

STUDVIK
INTER-RP
COMMON
DATA

(1)	ROD NO.	LS2	LS2	LS2	LS2	AVERAGE
(2)	SPECIMEN	1	2	3	4	
(3)	SIGMA 0.2 (KP/MM**2)	52.4	54.1	55.1	54.6	54.1
(4)	SIGMA U.T.S (KP/MM**2)	55.9	57.9	55.9	59.4	57.3
(5)	EPSILON HOMOGENOUS (%)	1.11	1.38	0.9	1.4	1.2
(6)	EPSILON TOTAL (%)	9.1	8.91	7.71	9.7	8.9

(79) REMARKS

*1) SPECIMEN SLIPPED IN THE JAWS .

(80) REFERENCE STIR-51 TABLE-9

<* 700033 *> INTER RAMP CLAD TENSILE TESTING RESULT (2) -LS- ** 700033 **

STUDVIK
INTER-RP
COMMON
DATA

---(1)-*---(2)-*---(3)-*---(4)-*---(5)-*---(6)-*---(7)-*---(8)-*

		LS3	LS3	LS3	LS3	AVERAGE
(2) SPECIMEN		1	2	3	4	
(3) SIGMA 0.2	(KP/MM**2)	58.0	54.3	58.8	53.4	56.1
(4) SIGMA U.T.S	(KP/MM**2)	58.9	58.3	59.4	57.6	58.6
(5) EPSILON HOMOGENOUS	(%)	0.70	1.38	0.54	1.43	1.0
(6) EPSILON TOTAL	(%)	7.37	9.20	11.2	9.14	9.2

(79) REMARKS

*1) SPECIMEN SLIPPED IN THE JAWS .

(80) REFERENCE STIR-51 TABLE-9

<* 700034 *> INTER RAMP CLAD TENSILE TESTING RESULT (3) -HR- ** 700034 **

STUDVIK
INTER-RP
COMMON
DATA

---(1)-*---(2)-*---(3)-*---(4)-*---(5)-*---(6)-*---(7)-*---(8)-*

		HR4	HR4	HR4	HR4	AVERAGE
(2) SPECIMEN		1	2	3	4	
(3) SIGMA 0.2	(KP/MM**2)	55.4	55.4	53.6	52.8	54.3
(4) SIGMA U.T.S	(KP/MM**2)	56.8	56.6	57.0	54.1	56.1
(5) EPSILON HOMOGENOUS	(%)	0.50	0.53	0.73	0.55	0.58
(6) EPSILON TOTAL	(%)	3.98	5.75	3.74	5.12	4.5

(79) REMARKS

*1) SPECIMEN SLIPPED IN THE JAWS .

(80) REFERENCE STIR-51 TABLE-9

<** 700035 *> INTER RAMP CLAD TENSILE TESTING RESULT (4) -TR- ** 700035 **

STUDVIK
INTER-RP
COMMON
DATA

---(1)-*---(2)-*---(3)-*---(4)-*---(5)-*---(6)-*---(7)-*---(8)-*

(1)	ROD NO.		TR1	TR1	TR1	TR1	AVERAGE
(2)	SPECIMEN		1	2	3	4	
(3)	SIGMA 0.2	(KP/MM**2)	58.1	*1)	58.9	57.6	58.4
(4)	SIGMA U.T.S	(KP/MM**2)	61.6	58.4	59.6	61.4	60.2
(5)	EPSILON HOMOGENOUS	(%)	0.47	*1)	0.40	0.68	0.52
(6)	EPSILON TOTAL	(%)	5.70	*1)	4.51	3.79	4.7

(79) REMARKS

*1) SPECIMEN SLIPPED IN THE JAWS .

(80) REFERENCE

STIR-51 TABLE-9

<** 700036 *> POWER RAMP TEST PARAMETER (PETTEN PWR (1)) ** 700036 **

STUDVIK
INTER-RP
COMMON
DATA

---(1)-*---(2)-*---(3)-*---(4)-*---(5)-*---(6)-*---(7)-*---(8)-*

(1)	ROD NO.		SU-1	SU-1	SU-2	SU-2	SU-3	SU-3	SU-4	SU-4
(2)	BASE CONDITION									
(3)	MAX.	KW/M *1)								
(4)	LATEST	KW/M *2)	20.8	20.8	20.7	20.7	20.7	20.7	19.5	19.5
(5)	CONDITIONING									
(6)	TERM. LEVEL	KW/M								
(7)	HOLD TIME	HRS								
(8)	POWER RAMP COMDITION									
(9)	TERM. LEVEL	KW/M	30.3	53.7	31.2	55.7	32.4	57.4	29.3	54.8
(10)	RATE	KW/M*MIN	0.227	0.027	0.133	0.037	0.198	1.335	0.190	0.9
(11)	F / NF /HF	*7)	NF	NF	NF	NF	NF	NF	NF	NF
(12)	HOLD TIME	MIN								
(13)	TFPD	MIN *3)								
(14)	DELTA POWER									
(15)	PC	KW/M *4)								
(16)	PL	KW/M *5)	9.5	32.9	10.5	35.0	11.7	36.7	9.8	35.3
(17)	PH	KW/M *6)								

(79) REMARKS

*1) MAX :L.H.R. DURING THE HIGH POWER PERIOD OF BASE IRRA..
*2) LATEST:L.H.R. DURING THE LAST POWER PERIOD OF BASE IRRA..
*3) TFPD :TIME TO FISSION PRODUCT DETECTION.
*4) PC :RAMP TERMINAL LEVEL - CONDITIONING TERMINAL LEVEL
*5) PL :RAMP TERMINAL LEVEL - LATEST

*6) PH :RAMP TERMINAL LEVEL - MAX.
*7) F :FAILURE
NF :NO FAILURE
HF :INCIPIENT NON-THROUGHGOING CLADDING CRACKS FUOND AT PIE .

(80) REFERENCE

<* 700037 *> POWER RAMP TEST PARAMETER (PETTEN PWR (2)) ** 700037 **

STUDVIK
INTER-RP
COMMON
DATA

				(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
(1)	ROD NO.			SU-5	SU-5	IS-1	IS-2	IS-3	IS-4	IS-5	IS-6
(2)	BASE CONDITION										
(3)	MAX.	KW/M	*1)								
(4)	LATEST	KW/M	*2)	22.0	22.0	13.5	12.4	21.3	21.9	21.7	21.2
(5)	CONDITIONING										
(6)	TERM. LEVEL	KW/M				30.0	30.7	30.3	30.6	30.6	31.1
(7)	HOLD TIME	HRS									
(8)	POWER RAMP COMDITION										
(9)	TERM. LEVEL	KW/M		31.2	56.4	46.6	59.5	61.6	47.3	53.2	52.2
(10)	RATE	KW/M*MIN		0.202	9.8	9.8	9.9	9.7	10.5	9.3	11.5
(11)	F / NF /HF		*7)	NF	F	NF	NF	NF	F	F	NF
(12)	HOLD TIME	MIN				2880.0	2880.0	2880.0			2880.0
(13)	TFPD	MIN	*3)		3.0					4.0	
(14)	DELTA POWER										
(15)	PC	KW/M	*4)			16.6	28.8	31.3	16.7	22.6	21.1
(16)	PL	KW/M	*5)	9.2	34.4	33.1	47.1	40.3	25.4	31.5	31.0
(17)	PH	KW/M	*6)								

(79) REMARKS

*1) MAX :L.H.R. DURING THE HIGH POWER PERIOD OF BASE IRRA..
*2) LATEST:L.H.R. DURING THE LAST POWER PERIOD OF BASE IRRA..
*3) TFPD :TIME TO FISSION PRODUCT DETECTION.
*4) PC :RAMP TERMINAL LEVEL - CONDITIONING TERMINAL LEVEL
*5) PL :RAMP TERMINAL LEVEL - LATEST

*6) PH :RAMP TERMINAL LEVEL - MAX.
*7) F :FAILURE
NF :NO FAILURE
HF :INCIPIENT NON-THROUGHGOING CLADDING CRACKS FUOND AT PIE .

(80) REFERENCE

<* 700038 *> POWER RAMP TEST PARAMETER (PEFTEN PWR (3)) ** 700038 **

STUDVIK
INTER-RP
COMMON
DATA

(1)	ROD NO.			IS-7
(2)	BASE CONDITION			
(3)	MAX.	KW/M	*1)	
(4)	LATEST	KW/M	*2)	22.0
(5)	CONDITIONING			
(6)	TERM. LEVEL	KW/M		30.7
(7)	HOLD TIME	HRS		
(8)	POWER RAMP CONDITION			
(9)	TERM. LEVEL	KW/M		58.2
(10)	RATE	KW/M*MIN		11.8
(11)	F / NF /HF		*7)	F
(12)	HOLD TIME	MIN		
(13)	TFPD	MIN	*3)	1.5
(14)	DELTA POWER			
(15)	PC	KW/M	*4)	27.5
(16)	PL	KW/M	*5)	36.2
(17)	PH	KW/M	*6)	

(79) REMARKS

*1) MAX :L.H.R. DURING THE HIGH POWER PERIOD OF BASE IRRA..
*2) LATEST:L.H.R. DURING THE LAST POWER PERIOD OF BASE IRRA..
*3) TFPD :TIME TO FISSION PRODUCT DETECTION.
*4) PC :RAMP TERMINAL LEVEL - CONDITIONING TERMINAL LEVEL
*5) PL :RAMP TERMINAL LEVEL - LATEST

*6) PH :RAMP TERMINAL LEVEL - MAX.
*7) F :FAILURE
NF :NO FAILURE
HF :INCIPIENT NON-THROUGHGOING CLADDING CRACKS FUOND AT PIE .

(80) REFERENCE

<* 700042 *> POWER RAMP TEST PARAMETER (GE R2 *BWR* (1)) ** 700042 **

STUDVIK
INTER-RP
COMMON
DATA

				(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
(1)	ROD NO.			SRP2/12	SRP2/15	SRP2/21	SRP2/22	SRP2/24	SRP3/7	SRP2/35	SRP2/36
(2)	BASE CONDITION										
(3)	MAX.	KW/M	*1)								
(4)	LATEST	KW/M	*2)								
(5)	CONDITIONING										
(6)	TERM. LEVEL	KW/M		26.2	26.2	26.2	26.2	26.2	26.2	26.2	26.2
(7)	HOLD TIME	HRS									
(8)	POWER RAMP COMDITION										
(9)	TERM. LEVEL	KW/M		53.2	50.5	53.2	52.1	52.1	59.1	44.5	44.9
(10)	RATE	KW/M*MIN		18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0
(11)	F / NF /HF		*7)	F	F	F	F	F	NF	NF	F
(12)	HOLD TIME	MIN						260.0	240.0		
(13)	TFPD	MIN	*3)	50.0	23.0	2.5	40.0	4.5		36.0	
(14)	DELTA POWER										
(15)	PC	KW/M	*4)	27.0	24.3	27.0	25.9	25.9	32.9	18.3	18.7
(16)	PL	KW/M	*5)								
(17)	PH	KW/M	*6)								

(79) REMARKS

*1) MAX :L.H.R. DURING THE HIGH POWER PERIOD OF BASE IRRA..
*2) LATEST:L.H.R. DURING THE LAST POWER PERIOD OF BASE IRRA..
*3) TFPD :TIME TO FISSION PRODUCT DETECTION.
*4) PC :RAMP TERMINAL LEVEL - CONDITIONING TERMINAL LEVEL
*5) PL :RAMP TERMINAL LEVEL - LATEST

*6) PH :RAMP TERMINAL LEVEL - MAX.
*7) F :FAILURE
NF :NO FAILURE
HF :INCIPIENT NON-THROUGHGOING CLADDING CRACKS FUOND AT PIE .

(80) REFERENCE

<* 700043 *> POWER RAMP TEST PARAMETER (GE R2 *BWR* (2)) ** 700043 **

STUDVIK
INTER-RP
COMMON
DATA

(1)	ROD NO.			SRP2/47	SRP2/48	SRP2/51	SRP2/53	SRP2/55	SRP3/48	SRP3/49
(2)	BASE CONDITION									
(3)	MAX.	KW/M	*1)							
(4)	LATEST	KW/M	*2)							
(5)	CONDITIONING									
(6)	TERM. LEVEL	KW/M		26.2	26.2	26.2	26.2	26.2	26.2	26.2
(7)	HOLD TIME	HRS								
(8)	POWER RAMP COMDITION									
(9)	TERM. LEVEL	KW/M		32.8	39.8	52.2	39.4	45.2	45.9	52.5
(10)	RATE	KW/M*MIN		18.0	18.0	18.0	18.0	18.0	18.0	18.0
(11)	F / NF /HF		*7)	NF	F	NF	F	F	NF	F
(12)	HOLD TIME	MIN				240.0			240.0	
(13)	TFPD	MIN	*3)		90.0		180.0	90.0		18.0
(14)	DELTA POWER									
(15)	PC	KW/M	*4)	6.6	13.6	26.0	13.2	19.0	19.7	26.3
(16)	PL	KW/M	*5)							
(17)	PH	KW/M	*6)							

(79) REMARKS

*1) MAX :L.H.R. DURING THE HIGH POWER PERIOD OF BASE IRRA..
*2) LATEST:L.H.R. DURING THE LAST POWER PERIOD OF BASE IRRA..
*3) TFPD :TIME TO FISSION PRODUCT DETECTION.
*4) PC :RAMP TERMINAL LEVEL - CONDITIONING TERMINAL LEVEL
*5) PL :RAMP TERMINAL LEVEL - LATEST

*6) PH :RAMP TERMINAL LEVEL - MAX.
*7) F :FAILURE
NF :NO FAILURE
HF :INCIPIENT NON-THROUGHGOING CLADDING CRACKS FUOND AT PIE .

(80) REFERENCE

<* 700044 *> POWER RAMP TEST PARAMETER (INTER RAMP *BWR* (1)) ** 700044 **

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STUDVIK
INTER-RP
COMMON
DATA

---(1)-*---(2)-*---(3)-*---(4)-*---(5)-*---(6)-*---(7)-*---(8)-*

(1)	ROD NO.			LR1	LR2	LR3	LR4	LR5	LS1	LS2	TR1
(2)	BASE CONDITION										
(3)	MAX.	KW/M	*1)	38.8	35.7	36.1	39.7	35.7	36.1	39.6	38.8
(4)	LATEST	KW/M	*2)	28.6	22.3	24.2	29.7	22.3	24.2	29.6	28.6
(5)	CONDITIONING										
(6)	TERM. LEVEL	KW/M		29.8	24.5	35.0	35.3	25.1	26.9	31.8	30.7
(7)	HOLD TIME	HRS		24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0
(8)	POWER RAMP COMDITION										
(9)	TERM. LEVEL	KW/M		43.8	45.7	50.1	65.4	42.7	48.2	43.8	42.2
(10)	RATE	KW/M*MIN		4.8	4.2	3.9	3.9	5.1	5.4	3.9	4.2
(11)	F / NF /HF		*7)	NF	F	F	F	F	F	NF	NF
(12)	HOLD TIME	MIN		1440.0						1440.0	1440.0
(13)	TFPD	MIN	*3)		46.0	11.0	0.5	162.0	17.0		
(14)	DELTA POWER										
(15)	PC	KW/M	*4)	14.0	21.2	15.1	30.1	17.6	21.3	12.0	11.5
(16)	PL	KW/M	*5)	15.2	23.4	25.9	35.7	20.4	24.0	14.2	13.6
(17)	PH	KW/M	*6)	5.0	10.0	14.0	25.7	7.0	12.1	4.2	3.4

(79) REMARKS

*1) MAX :L.H.R. DURING THE HIGH POWER PERIOD OF BASE IRRA..
*2) LATEST:L.H.R. DURING THE LAST POWER PERIOD OF BASE IRRA..
*3) TFPD :TIME TO FISSION PRODUCT DETECTION.
*4) PC :RAMP TERMINAL LEVEL - CONDITIONING TERMINAL LEVEL
*5) PL :RAMP TERMINAL LEVEL - LATEST

*6) PH :RAMP TERMINAL LEVEL - MAX.
*7) F :FAILURE
NF :NO FAILURE
HF :INCIPIENT NON-THROUGHGOING CLADDING CRACKS FUOND AT PIE .

(80) REFERENCE

<* 700045 *> POWER RAMP TEST PARAMETER (INTER RAMP *BWR* (2)) ** 700045 **

STUDVIK
INTER-RP
COMMON
DATA

				(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
(1)	ROD NO.			LS3	LS4	TS1	DR1	HR2	HR3	HR4	HR5
(2)	BASE CONDITION										
(3)	MAX.	KW/M	*1)	35.5	39.0	38.3	35.1	35.2	36.4	44.3	40.8
(4)	LATEST	KW/M	*2)	23.8	28.9	28.0	21.8	22.4	24.0	27.5	29.0
(5)	CONDITIONING										
(6)	TERM. LEVEL	KW/M		25.0	40.8	29.7	22.9	23.0	35.2	29.0	29.0
(7)	HOLD TIME	HRS		24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0
(8)	POWER RAMP CONDITION										
(9)	TERM. LEVEL	KW/M		41.8	50.7	47.3	43.2	38.0	43.2	46.1	47.9
(10)	RATE	KW/M*MIN		3.9	4.2	4.2	4.5	4.5	3.9	4.2	4.2
(11)	F / NF /HF		*7)	NF	F	F	HF	NF	F	NF	HF
(12)	HOLD TIME	MIN		1440.0			1440.0	1440.0		1440.0	1440.0
(13)	TFPD	MIN	*3)		72.0	296.0			260.0		
(14)	DELTA POWER										
(15)	PC	KW/M	*4)	16.8	9.9	17.6	20.3	15.0	18.0	17.1	18.9
(16)	PL	KW/M	*5)	18.0	21.8	19.3	21.4	15.6	19.2	18.6	18.0
(17)	PH	KW/M	*6)	6.3	11.7	9.0	8.1	2.8	6.8	1.8	7.1

(79) REMARKS

*1) MAX :L.H.R. DURING THE HIGH POWER PERIOD OF BASE IRRA..
*2) LATEST:L.H.R. DURING THE LAST POWER PERIOD OF BASE IRRA..
*3) TFPD :TIME TO FISSION PRODUCT DETECTION.
*4) PC :RAMP TERMINAL LEVEL - CONDITIONING TERMINAL LEVEL
*5) PL :RAMP TERMINAL LEVEL - LATEST

*6) PH :RAMP TERMINAL LEVEL - MAX.
*7) F :FAILURE
NF :NO FAILURE
HF :INCIPIENT NON-THROUGHGOING CLADDING CRACKS FUOND AT PIE .

(80) REFERENCE

<* 700046 *> POWER RAMP TEST PARAMETER (INTER RAMP *BWR* (3)) ** 700046 **

STUDVIK
INTER-RP
COMMON
DATA

---(1)-*---(2)-*---(3)-*---(4)-*---(5)-*---(6)-*---(7)-*---(8)-*

(1)	ROD NO.			HS1	HS2	HS3	BR1
(2)	BASE CONDITION						
(3)	MAX.	KW/M	*1)	38.6	34.3	35.7	39.0
(4)	LATEST	KW/M	*2)	29.4	23.7	25.4	30.1
(5)	CONDITIONING						
(6)	TERM. LEVEL	KW/M		30.3	24.8	26.6	31.1
(7)	HOLD TIME	HRS		24.0	24.0	24.0	24.0
(8)	POWER RAMP COMDITION						
(9)	TERM. LEVEL	KW/M		47.8	41.0	44.9	51.0
(10)	RATE	KW/M*MIN		3.9	3.9	4.2	3.9
(11)	F / NF /HF		*7)	F	HF	F	F
(12)	HOLD TIME	MIN			1440.0		
(13)	TFPD	MIN	*3)			4.2	
(14)	DELTA POWER						
(15)	PC	KW/M	*4)	17.5	16.2	18.3	19.9
(16)	PL	KW/M	*5)	18.4	17.3	19.5	20.9
(17)	PH	KW/M	*6)	9.2	6.7	9.2	12.0

(79) REMARKS

*1) MAX :L.H.R. DURING THE HIGH POWER PERIOD OF BASE IRRA..
*2) LATEST:L.H.R. DURING THE LAST POWER PERIOD OF BASE IRRA..
*3) TFPD :TIME TO FISSION PRODUCT DETECTION.
*4) PC :RAMP TERMINAL LEVEL - CONDITIONING TERMINAL LEVEL
*5) PL :RAMP TERMINAL LEVEL - LATEST

*6) PH :RAMP TERMINAL LEVEL - MAX.
*7) F :FAILURE
NF :NO FAILURE
HF :INCIPIENT NON-THROUGHGOING CLADDING CRACKS FUOND AT PIE .

(80) REFERENCE

<* 700047 *> POWER RAMP TEST PARAMETER (DEMO RAMP *8WR* (1)) ** 700047 **

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STUDVIK
DEMO -RP
COMMON
DATA

				(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
(1)	ROD NO.			S30H	S30H	S31H	S35H	S27H	S36H	S29H	S38H
(2)	BASE CONDITION										
(3)	MAX.	KW/M	*1)	26.1	26.1	27.1	28.2	29.6	26.2	27.3	25.8
(4)	LATEST	KW/M	*2)	17.8	17.8	16.2	19.8	19.0	19.4	18.6	18.5
(5)	CONDITIONING										
(6)	TERM. LEVEL	KW/M		30.1	38.0	30.0	30.0	30.0	30.0	30.0	30.0
(7)	HOLD TIME	HRS		24	24	24	24	24	24	24	24
(8)	POWER RAMP COMDITION										
(9)	TERM. LEVEL	KW/M		38.0	43.5	41.3	48.0	48.5	45.0	42.0	41.8
(10)	RATE	KW/M*MIN		4.0	3.9	4.2	17.0	22.0	17.0	17.5	3.8
(11)	F / NF /HF		*7)	NF	NF	F	HF	HF	HF	NF	HF
(12)	HOLD TIME	MIN		1440	60.0		0.6	0.16	0.25	0.18	4.5
(13)	TFPD	MIN	*3)			66.0					
(14)	DELTA POWER										
(15)	PC	KW/M	*4)	8.0	5.5	11.3	18.0	18.5	15.0	12.0	11.8
(16)	PL	KW/M	*5)	20.2	25.7	25.1	28.2	29.5	25.6	23.4	23.3
(17)	PH	KW/M	*6)	11.9	17.4	14.2	19.8	18.9	18.8	14.7	16.0

(79) REMARKS

*1) MAX :L.H.R. DURING THE HIGH POWER PERIOD OF BASE IRRA..
*2) LATEST:L.H.R. DURING THE LAST POWER PERIOD OF BASE IRRA..
*3) TFPD :TIME TO FISSION PRODUCT DETECTION.
*4) PC :RAMP TERMINAL LEVEL - CONDITIONING TERMINAL LEVEL
*5) PL :RAMP TERMINAL LEVEL - LATEST

*6) PH :RAMP TERMINAL LEVEL - MAX.
*7) F :FAILURE
NF :NO FAILURE
HF :INCIPIENT NON-THROUGHGOING CLADDING CRACKS FUOND AT PIE .

(80) REFERENCE

<* 700048 *> POWER RAMP TEST PARAMETER (DEMO RAMP *BWR* (2)) ** 700048 **

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                                  **********************************************************************
                                                        STUDVIK
                                                        DEMO -RP
                                                        COMMON
                                                        DATA

                                  ---(1)-*---(2)-*---(3)-*---(4)-*---(5)-*---(6)-*---(7)-*---(8)-*

                                  ----------------------------------------------------------------------*
(1)  ROD NO.                        S29H
                                  ----------------------------------------------------------------------*
(2)  BASE CONDITION
(3)    MAX.          KW/M    *1)    26.6
(4)    LATEST        KW/M    *2)    16.9
                                  ----------------------------------------------------------------------*
(5)  CONDITIONING
(6)    TERM. LEVEL   KW/M           30.0
(7)    HOLD  TIME    HRS            24
                                  ----------------------------------------------------------------------*
(8)  POWER RAMP COMDITION
(9)    TERM. LEVEL   KW/M           43.0
(10)   RATE          KW/M*MIN       4.2
(11)   F / NF /HF             *7)    HF
(12)   HOLD TIME     MIN            1.1
(13)   TFPD          MIN     *3)
                                  ----------------------------------------------------------------------*
(14)  DELTA POWER
(15)   PC            KW/M    *4)    13.0
(16)   PL            KW/M    *5)    26.1
(17)   PH            KW/M    *6)    16.4


                                  ----------------------------------------------------------------------*
(79)  REMARKS
                                    *1) MAX   :L.H.R. DURING THE HIGH POWER PERIOD OF BASE IRRA..
                                    *2) LATEST:L.H.R. DURING THE LAST POWER PERIOD OF BASE IRRA..
                                    *3) TFPD  :TIME TO FISSION PRODUCT DETECTION.
                                    *4) PC    :RAMP TERMINAL LEVEL - CONDITIONING TERMINAL LEVEL
                                    *5) PL    :RAMP TERMINAL LEVEL - LATEST

                                    *6) PH    :RAMP TERMINAL LEVEL - MAX.
                                    *7) F     :FAILURE
                                        NF    :NO FAILURE
                                        HF    :INCIPIENT NON-THROUGHGOING CLADDING CRACKS FUOND
                                               AT PIE .
                                  ----------------------------------------------------------------------*
(80)  REFERENCE
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<* 700049 *> POWER RAMP TEST PARAMETER (SUPER RAMP *PWR* (1)) ** 700049 **

STUDVIK
SUPER-RP
COMMON
DATA

---(1)-*---(2)-*---(3)-*---(4)-*---(5)-*---(6)-*---(7)-*---(8)-*

				PK4/1	PK4/2	PK4/3	PK4/S	PK6/1	PK6/2	PK6/3	PK6/4
(1)	ROD NO.										
(2)	BASE CONDITION										
(3)	MAX.	KW/M	*1)	25.1	26.2	27.1	24.7	27.4	27.4	27.0	24.5
(4)	LATEST	KW/M	*2)	20.3	20.5	20.5	20.1	20.8	21.0	21.0	20.0
(5)	CONDITIONING										
(6)	TERM. LEVEL	KW/M		25.0	25.0	25.5	25.0	25.0	25.5	25.0	25.5
(7)	HOLD TIME	HRS		24	24	24	24	24	24	24	24
(8)	POWER RAMP COMDITION										
(9)	TERM. LEVEL	KW/M		39.0	44.5	50.5	43.0	45.0	40.0	43.0	44.0
(10)	RATE	KW/M*MIN		8.0	8.5	11.0	10.0	9.0	9.0	9.0	10.0
(11)	F / NF /HF		*7)	NF	NF	NF	NF	F	NF	NF	F
(12)	HOLD TIME	MIN		720.0	720.0	720.0	720.0		720.0	720.0	
(13)	TFPD	MIN	*3)					24.0			30.0
(14)	DELTA POWER										
(15)	PC	KW/M	*4)	14.0	19.5	25.0	18.0	20.0	14.5	18.0	18.5
(16)	PL	KW/M	*5)	18.7	24.0	30.0	22.9	24.2	19.0	22.0	24.0
(17)	PH	KW/M	*6)	13.9	18.3	23.4	18.3	17.6	12.6	16.0	19.5

(79) REMARKS

*1) MAX :L.H.R. DURING THE HIGH POWER PERIOD OF BASE IRRA..
*2) LATEST:L.H.R. DURING THE LAST POWER PERIOD OF BASE IRRA..
*3) TFPD :TIME TO FISSION PRODUCT DETECTION.
*4) PC :RAMP TERMINAL LEVEL - CONDITIONING TERMINAL LEVEL
*5) PL :RAMP TERMINAL LEVEL - LATEST

*6) PH :RAMP TERMINAL LEVEL - MAX.
*7) F :FAILURE
NF :NO FAILURE
HF :INCIPIENT NON-THROUGHGOING CLADDING CRACKS FUOND AT PIE .

(80) REFERENCE

<* 700050 *> POWER RAMP TEST PARAMETER (SUPER RAMP *PWR* (2)) ** 700050 **

STUDVIK
SUPER-RP
COMMON
DATA

(1)	ROD NO.			PK6/S	PW3/1	PW3/2	PW3/3	PW3/4	PW5/1	PW5/2	PW5/3
(2)	BASE CONDITION										
(3)	MAX.	KW/M	*1)	25.4	20.3	18.8	19.1	21.8	22.9	22.6	23.9
(4)	LATEST	KW/M	*2)	21.1	17.7	16.7	17.0	19.4	19.6	19.2	20.5
(5)	CONDITIONING										
(6)	TERM. LEVEL	KW/M		25.0	25.5	25.5	25.0	25.0	25.0	25.0	25.0
(7)	HOLD TIME	HRS		24	24	24	24	24	24	24	24
(8)	POWER RAMP COMDITION										
(9)	TERM. LEVEL	KW/M		42.0	40.0	35.3	37.2	37.7	42.7	40.3	38.2
(10)	RATE	KW/M*MIN		10.0	10.0	10.0	10.0	9.5	9.0	9.0	9.0
(11)	F / NF /HF		*7)	NF	F	NF	NF	F	F	F	F
(12)	HOLD TIME	MIN		720.0		720.0	720.0				
(13)	TFPD	MIN	*3)		8.0			7.0	15.0	17.0	19.0
(14)	DELTA POWER										
(15)	PC	KW/M	*4)	17.0	14.5	9.8	12.2	12.7	17.7	15.3	13.2
(16)	PL	KW/M	*5)	20.9	22.3	18.6	20.2	18.3	23.1	21.1	17.7
(17)	PH	KW/M	*6)	16.6	19.7	16.5	18.1	15.9	19.8	17.7	14.3

(79) REMARKS

*1) MAX :L.H.R. DURING THE HIGH POWER PERIOD OF BASE IRRA..
*2) LATEST:L.H.R. DURING THE LAST POWER PERIOD OF BASE IRRA..
*3) TFPD :TIME TO FISSION PRODUCT DETECTION.
*4) PC :RAMP TERMINAL LEVEL - CONDITIONING TERMINAL LEVEL
*5) PL :RAMP TERMINAL LEVEL - LATEST

*6) PH :RAMP TERMINAL LEVEL - MAX.
*7) F :FAILURE
NF :NO FAILURE
HF :INCIPIENT NON-THROUGHGOING CLADDING CRACKS FUOND AT PIE .

(80) REFERENCE

<* 700051 *> POWER RAMP TEST PARAMETER (SUPER RAMP *PWR* (3)) ** 700051 **

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STUDVIK
SUPER-RP
COMMON
DATA

---(1)-*---(2)-*---(3)-*---(4)-*---(5)-*---(6)-*---(7)-*---(8)-*

(1)	ROD NO.			PW5/4	PK1/1	PK1/2	PK1/3	PK1/4	PK1/5	PK2/1	PK2/2
(2)	BASE CONDITION										
(3)	MAX.	KW/M	*1)	20.2	26.1	27.0	26.8	24.3	24.8	25.5	26.2
(4)	LATEST	KW/M	*2)	9.4	21.4	21.1	20.7	19.3	20.9	19.2	18.9
(5)	CONDITIONING										
(6)	TERM. LEVEL	KW/M		25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0
(7)	HOLD TIME	HRS		24	24	24	24	24	24	24	24
(8)	POWER RAMP COMDITION										
(9)	TERM. LEVEL	KW/M		38.0	41.5	44.0	47.5	47.5	42.0	41.0	46.0
(10)	RATE	KW/M*MIN		9.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
(11)	F / NF /HF		*7)	F	NF	NF	NF	NF	NF	NF	NF
(12)	HOLD TIME	MIN			720.0	720.0	720.0	720.0	720.0	720.0	720.0
(13)	TFPD	MIN	*3)								
(14)	DELTA POWER										
(15)	PC	KW/M	*4)	13.0	16.5	19.0	22.5	22.5	17.0	16.0	21.0
(16)	PL	KW/M	*5)	28.6	20.1	22.9	26.8	28.2	21.1	21.8	27.1
(17)	PH	KW/M	*6)	17.8	15.4	17.0	20.7	23.2	17.2	15.5	19.8

(79) REMARKS

*1) MAX :L.H.R. DURING THE HIGH POWER PERIOD OF BASE IRRA..
*2) LATEST:L.H.R. DURING THE LAST POWER PERIOD OF BASE IRRA..
*3) TFPD :TIME TO FISSION PRODUCT DETECTION.
*4) PC :RAMP TERMINAL LEVEL - CONDITIONING TERMINAL LEVEL
*5) PL :RAMP TERMINAL LEVEL - LATEST

*6) PH :RAMP TERMINAL LEVEL - MAX.
*7) F :FAILURE
NF :NO FAILURE
HF :INCIPIENT NON-THROUGHGOING CLADDING CRACKS FUOND AT PIE .

(80) REFERENCE

<* 700052 *> POWER RAMP TEST PARAMETER (SUPER RAMP *PWR* (4)) ** 700052 **

STUDVIK
SUPER-RP
COMMON
DATA

---(1)-*---(2)-*---(3)-*---(4)-*---(5)-*---(6)-*---(7)-*---(8)-*

(1)	ROD NO.			PK2/3	PK2/4	PK2/5
(2)	BASE CONDITION					
(3)	MAX.	KW/M	*1)	25.9	23.4	24.6
(4)	LATEST	KW/M	*2)	18.5	17.3	18.8
(5)	CONDITIONING					
(6)	TERM. LEVEL	KW/M		25.0	25.0	25.0
(7)	HOLD TIME	HRS		24	24	24
(8)	POWER RAMP COMDITION					
(9)	TERM. LEVEL	KW/M		49.0	44.0	44.0
(10)	RATE	KW/M*MIN		10.0	10.0	10.0
(11)	F / NF /HF		*7)	NF	NF	NF
(12)	HOLD TIME	MIN		720.0	1.0	720.0
(13)	TFPD	MIN	*3)			
(14)	DELTA POWER					
(15)	PC	KW/M	*4)	24.0	19.0	19.0
(16)	PL	KW/M	*5)	30.5	26.7	25.2
(17)	PH	KW/M	*6)	23.1	20.6	19.4

(79) REMARKS

*1) MAX :L.H.R. DURING THE HIGH POWER PERIOD OF BASE IRRA..
*2) LATEST:L.H.R. DURING THE LAST POWER PERIOD OF BASE IRRA..
*3) TFPD :TIME TO FISSION PRODUCT DETECTION.
*4) PC :RAMP TERMINAL LEVEL - CONDITIONING TERMINAL LEVEL
*5) PL :RAMP TERMINAL LEVEL - LATEST
*6) PH :RAMP TERMINAL LEVEL - MAX.
*7) F :FAILURE
NF :NO FAILURE
HF :INCIPIENT NON-THROUGHGOING CLADDING CRACKS FUOND AT PIE .

(80) REFERENCE

<* 700053 *> POWER RAMP TEST PARAMETER (SUPER RAMP *BWR* (5)) ** 700053 **

STUDVIK
SUPER-RP
COMMON
DATA

(1)	ROD NO.			BK7/1	BK7/2	BK7/3	BK7/4	BK7/5	BK7/5	BK7/6	BK7/6
(2)	BASE CONDITION										
(3)	MAX.	KW/M	*1)	29.6	27.3	26.1	27.1	28.2	28.2	26.2	26.2
(4)	LATEST	KW/M	*2)	15.8	14.7	13.3	11.8	16.2	16.2	15.0	15.0
(5)	CONDITIONING										
(6)	TERM. LEVEL	KW/M		25.5	25.0	25.0	25.0	25.0	25.0	25.0	25.0
(7)	HOLD TIME	HRS		24	24	24	24	24	24	24	24
(8)	POWER RAMP CONDITION										
(9)	TERM. LEVEL	KW/M		37.5	36.0	32.5	30.0	32.0	37.5	32.5	40.5
(10)	RATE	KW/M*MIN		10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
(11)	F / NF /HF		*7)	F	F	NF	NF	NF	NF	NF	NF
(12)	HOLD TIME	MIN				720.0	720.0	1440.0	720.0	1440.0	720.0
(13)	TFPD	MIN	*3)	144.0	420.0						
(14)	DELTA POWER										
(15)	PC	KW/M	*4)	12.0	11.0	7.5	5.0	7.0	5.5	7.5	15.5
(16)	PL	KW/M	*5)	21.0	21.3	19.2	18.2	15.8	21.3	17.5	25.5
(17)	PH	KW/M	*6)	7.9	8.7	6.4	2.9	3.8	9.3	6.3	14.3

(79) REMARKS

*1) MAX :L.H.R. DURING THE HIGH POWER PERIOD OF BASE IRRA..
*2) LATEST:L.H.R. DURING THE LAST POWER PERIOD OF BASE IRRA..
*3) TFPD :TIME TO FISSION PRODUCT DETECTION.
*4) PC :RAMP TERMINAL LEVEL - CONDITIONING TERMINAL LEVEL
*5) PL :RAMP TERMINAL LEVEL - LATEST

*6) PH :RAMP TERMINAL LEVEL - MAX.
*7) F :FAILURE
NF :NO FAILURE
HF :INCIPIENT NON-THROUGHGOING CLADDING CRACKS FUOND AT PIE .

(80) REFERENCE

<* 700054 *> POWER RAMP TEST PARAMETER (SUPER RAMP *BWR* (6)) ** 700054 **

STUDVIK
SUPER-RP
COMMON
DATA

				(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
(1)	ROD NO.			BK7/7	BK7/7	BK7/8	BK8/1	BK9/1	BK9/2	BK9/3	BK9/4
(2)	BASE CONDITION										
(3)	MAX.	KW/M	*1)	25.8	25.8	26.6	15.7	15.9	17.7	15.7	17.7
(4)	LATEST	KW/M	*2)	13.7	13.7	12.0	11.9	11.7	12.0	11.8	12.0
(5)	CONDITIONING										
(6)	TERM. LEVEL	KW/M		25.0	32.5	18.0	21.5	27.5	27.5	21.5	21.5
(7)	HOLD TIME	HRS						1	1		
(8)	POWER RAMP COMDITION										
(9)	TERM. LEVEL	KW/M		32.5	40.0	33.0	34.0	44.0	42.0	41.8	43.3
(10)	RATE	KW/M*MIN		10.0	10.0	10.0	0.0044	0.0056	0.0053	0.0055	0.005
(11)	F / NF /HF		*7)	NF	F	F	F	NF	F	F	F
(12)	HOLD TIME	MIN						720.0			
(13)	TFPD	MIN	*3)							160.0	
(14)	DELTA POWER										
(15)	PC	KW/M	*4)	7.5	7.5	15.0	12.5	16.5	14.5	20.3	21.8
(16)	PL	KW/M	*5)	18.8	26.3	21.0	22.1	32.3	30.0	30.0	31.3
(17)	PH	KW/M	*6)	6.7	14.2	6.4	18.3	28.1	24.3	26.1	25.6

(79) REMARKS

*1) MAX :L.H.R. DURING THE HIGH POWER PERIOD OF BASE IRRA..
*2) LATEST:L.H.R. DURING THE LAST POWER PERIOD OF BASE IRRA..
*3) TFPD :TIME TO FISSION PRODUCT DETECTION.
*4) PC :RAMP TERMINAL LEVEL - CONDITIONING TERMINAL LEVEL
*5) PL :RAMP TERMINAL LEVEL - LATEST

*6) PH :RAMP TERMINAL LEVEL - MAX.
*7) F :FAILURE
NF :NO FAILURE
HF :INCIPIENT NON-THROUGHGOING CLADDING CRACKS FUOND AT PIE .

(80) REFERENCE

<* 700055 *> POWER RAMP TEST PARAMETER (OVER RAMP *PWR* (1)) ** 700055 **

STUDVIK
OVER -RP
COMMON
DATA

(1)	ROD NO.			A10/1	A10/2	A10/3	A10/4	E10/1	E10/2	E10/3	E10/4
(2)	BASE CONDITION										
(3)	MAX. *1)	KW/M	*1)	26.1	26.9	26.0	23.3	25.1	25.9	25.1	22.8
(4)	LATEST *2)	KW/M	*2)	24.7	24.1	23.9	23.3	23.7	23.2	23.1	22.8
(5)	CONDITIONING										
(6)	TERM. LEVEL	KW/M		30.0	30.0	30.5	30.0	30.0	30.0	30.0	30.0
(7)	HOLD TIME	HRS		72.0	72.0	68.0	72.0	72.0	72.0	72.0	72.0
(8)	POWER RAMP COMDITION										
(9)	TERM. LEVEL	KW/M		49.0	44.5	53.0	52.5	44.5	47.5	52.5	52.5
(10)	RATE	KW/M*MIN		10.2	9.3	0.460	10.2	9.9	8.4	0.049	0.470
(11)	F / NF /HF *7)		*7)	NF	NF	NF	NF	NF	F	NF	NF
(12)	HOLD TIME	MIN		1440.0	1440.0	1900.0	1440.0	1440.0		1440.0	1440.0
(13)	TFPD *3)	MIN	*3)						46.0		
(14)	DELTA POWER										
(15)	PC *4)	KW/M	*4)	19.0	14.5	22.5	22.5	14.5	17.5	22.5	22.5
(16)	PL *5)	KW/M	*5)	24.3	20.4	29.1	29.2	20.8	24.3	29.4	29.7
(17)	PH *6)	KW/M	*6)	22.9	17.6	27.0	29.2	19.4	21.6	27.4	29.7

(79) REMARKS

*1) MAX :L.H.R. DURING THE HIGH POWER PERIOD OF BASE IRRA..
*2) LATEST:L.H.R. DURING THE LAST POWER PERIOD OF BASE IRRA..
*3) TFPD :TIME TO FISSION PRODUCT DETECTION.
*4) PC :RAMP TERMINAL LEVEL - CONDITIONING TERMINAL LEVEL
*5) PL :RAMP TERMINAL LEVEL - LATEST

*6) PH :RAMP TERMINAL LEVEL - MAX.
*7) F :FAILURE
NF :NO FAILURE
HF :INCIPIENT NON-THROUGHGOING CLADDING CRACKS FUOND AT PIE .

(80) REFERENCE

<* 700056 *> POWER RAMP TEST PARAMETER (OVER RAMP *PWR* (2)) ** 700056 **

STUDVIK
OVER -RP
COMMON
DATA

				(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
(1)	ROD NO.			A20/1	A20/2	A20/3	A20/4	F20/1	F20/2	F20/3	F20/4
(2)	BASE CONDITION										
(3)	MAX.	KW/M	*1)	26.4	27.5	27.0	24.4	27.0	27.6	27.8	25.5
(4)	LATEST	KW/M	*2)	22.7	23.5	23.4	23.1	23.3	24.1	24.1	23.7
(5)	CONDITIONING										
(6)	TERM. LEVEL	KW/M		30.0	30.0	30.0	30.0	30.0	30.0	30.0	29.5
(7)	HOLD TIME	HRS		72.0	72.0	72.0	72.0	72.0	72.0	72.0	72.0
(8)	POWER RAMP CONDITION										
(9)	TERM. LEVEL	KW/M		44.0	51.5	48.8	48.7	50.8	46.6	43.2	39.4
(10)	RATE	KW/M*MIN		10.2	10.8	10.2	10.2	9.6	9.6	9.6	9.5
(11)	F / NF /HF		*7)	NF	F	NF	NF	F	F	F	HF
(12)	HOLD TIME	MIN		1440.0		1440.0	1440.0				1440.0
(13)	TFPD	MIN	*3)		128.0			2.0	2.0	2.0	
(14)	DELTA POWER										
(15)	PC	KW/M	*4)	14.0	21.5	18.8	18.7	20.8	16.6	13.2	9.9
(16)	PL	KW/M	*5)	21.3	28.0	25.4	25.6	27.5	22.5	19.1	15.7
(17)	PH	KW/M	*6)	17.6	24.0	21.8	24.3	23.8	19.0	15.4	13.9

(79) REMARKS

*1) MAX :L.H.R. DURING THE HIGH POWER PERIOD OF BASE IRRA..
*2) LATEST:L.H.R. DURING THE LAST POWER PERIOD OF BASE IRRA..
*3) TFPD :TIME TO FISSION PRODUCT DETECTION.
*4) PC :RAMP TERMINAL LEVEL - CONDITIONING TERMINAL LEVEL
*5) PL :RAMP TERMINAL LEVEL - LATEST

*6) PH :RAMP TERMINAL LEVEL - MAX.
*7) F :FAILURE
NF :NO FAILURE
HF :INCIPIENT NON-THROUGHGOING CLADDING CRACKS FUOND AT PIE .

(80) REFERENCE

<* 700057 *> POWER RAMP TEST PARAMETER (OVER RAMP *PWR* (3)) ** 700057 **

STUDVIK
OVER -RP
COMMON
DATA

				(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
(1)	ROD NO.			G20/1	G20/2	G20/3	G20/4	F30/S	F30/1	F30/2	F30/4
(2)	BASE CONDITION										
(3)	MAX.	KW/M	*1)	25.3	26.2	27.6	25.5	23.3	24.1	23.7	21.1
(4)	LATEST	KW/M	*2)	24.7	21.6	22.0	21.5	18.6	18.4	16.3	16.2
(5)	CONDITIONING										
(6)	TERM. LEVEL	KW/M		30.0	30.0	29.0	30.0	29.5	30.0	30.0	30.0
(7)	HOLD TIME	HRS		72.0	80.0	72.0	72.0	72.0	72.0	73.0	72.0
(8)	POWER RAMP COMDITION										
(9)	TERM. LEVEL	KW/M		42.0	44.5	48.2	43.5	48.5	37.8	41.1	44.5
(10)	RATE	KW/M*MIN		5.5	8.5	9.5	8.5	9.0	8.5	11.5	9.0
(11)	F / NF /HF		*7)	NF	NF	F	NF	F	NF	NF	NF
(12)	HOLD TIME	MIN			10.5		10.5		1440.0	683.0	1174.0
(13)	TFPD	MIN	*3)			5.0		3.5			
(14)	DELTA POWER										
(15)	PC	KW/M	*4)	12.0	14.5	19.2	13.5	19.0	7.8	11.1	14.5
(16)	PL	KW/M	*5)	17.3	22.9	26.2	22.0	29.9	19.4	24.8	28.3
(17)	PH	KW/M	*6)	16.7	18.3	20.6	18.0	25.2	13.7	17.4	23.4

(79) REMARKS

*1) MAX :L.H.R. DURING THE HIGH POWER PERIOD OF BASE IRRA..
*2) LATEST:L.H.R. DURING THE LAST POWER PERIOD OF BASE IRRA..
*3) TFPD :TIME TO FISSION PRODUCT DETECTION.
*4) PC :RAMP TERMINAL LEVEL - CONDITIONING TERMINAL LEVEL
*5) PL :RAMP TERMINAL LEVEL - LATEST

*6) PH :RAMP TERMINAL LEVEL - MAX.
*7) F :FAILURE
NF :NO FAILURE
HF :INCIPIENT NON-THROUGHGOING CLADDING CRACKS FUOND AT PIE .

(80) REFERENCE

<* 700058 *> POWER RAMP TEST PARAMETER (OVER RAMP *PWR* (4)) ** 700058 **

****

STUDVIK
OVER -RP
COMMON
DATA

				(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
(1)	ROD NO.			W5/1	W5/2	W5/3	W5/4	W5/5	W5/6	W4/1	W4/2
(2)	BASE CONDITION										
(3)	MAX.	KW/M	*1)	19.5	19.5	19.5	16.9	21.7	21.7	21.2	21.2
(4)	LATEST	KW/M	*2)	13.6	13.6	13.6	11.5	14.8	14.8	14.6	14.6
(5)	CONDITIONING										
(6)	TERM. LEVEL	KW/M		30.5	30.5	30.0	30.0	30.0	30.0	30.0	30.0
(7)	HOLD TIME	HRS		72.0	72.0	72.0	72.0	72.0	72.0	72.0	72.0
(8)	POWER RAMP COMDITION										
(9)	TERM. LEVEL	KW/M		44.5	37.0	39.0	43.0	41.5	42.5	43.5	39.5
(10)	RATE	KW/M*MIN		10.0	10.5	10.5	11.5	10.0	11.0	10.0	10.5
(11)	F / NF /HF		*7)	F	NF	NF	NF	NF	F	F	NF
(12)	HOLD TIME	MIN			1440.0	1440.0	1440.0	1440.0			1440.0
(13)	TFPD	MIN	*3)	11.0					15.0	9.5	
(14)	DELTA POWER										
(15)	PC	KW/M	*4)	14.0	6.7	9.0	13.0	11.5	12.5	13.5	9.5
(16)	PL	KW/M	*5)	30.9	23.4	25.4	31.5	26.7	27.7	28.9	24.9
(17)	PH	KW/M	*6)	25.0	17.5	19.5	26.1	19.8	20.8	22.3	18.3

(79) REMARKS

*1) MAX :L.H.R. DURING THE HIGH POWER PERIOD OF BASE IRRA..
*2) LATEST:L.H.R. DURING THE LAST POWER PERIOD OF BASE IRRA..
*3) TFPD :TIME TO FISSION PRODUCT DETECTION.
*4) PC :RAMP TERMINAL LEVEL - CONDITIONING TERMINAL LEVEL
*5) PL :RAMP TERMINAL LEVEL - LATEST

*6) PH :RAMP TERMINAL LEVEL - MAX.
*7) F :FAILURE
NF :NO FAILURE
HF :INCIPIENT NON-THROUGHGOING CLADDING CRACKS FUOND AT PIE .

(80) REFERENCE

<* 700059 *> POWER RAMP TEST PARAMETER (OVER RAMP *PWR* (5)) ** 700059 **

STUDVIK
OVER -RP
COMMON
DATA

---(1)-*---(2)-*---(3)-*---(4)-*---(5)-*---(6)-*---(7)-*---(8)-*

(1)	ROD NO.			W4/4	W4/5	W4/6	W8/1	W8/2	W8/3
(2)	BASE CONDITION								
(3)	MAX.	KW/M	*1)	15.7	15.7	15.7	18.8	18.8	18.8
(4)	LATEST	KW/M	*2)	11.5	11.5	11.5	12.8	12.8	12.8
(5)	CONDITIONING								
(6)	TERM. LEVEL	KW/M		23.0	23.0	23.0	30.0	30.0	30.0
(7)	HOLD TIME	HRS		72.0	87.0	72.0	72.0	72.0	72.0
(8)	POWER RAMP COMDITION								
(9)	TERM. LEVEL	KW/M		41.2	37.5	39.5	42.0	42.5	40.0
(10)	RATE	KW/M*MIN		9.0	10.0	9.5	10.0	0.0109	11.0
(11)	F / NF /HF		*7)	F	NF	NF	F	F	NF
(12)	HOLD TIME	MIN			1440.0	910.0			1440.0
(13)	TFPD	MIN	*3)	57.0			6.5	16.0	
(14)	DELTA POWER								
(15)	PC	KW/M	*4)	18.2	14.5	16.5	12.0	12.5	10.0
(16)	PL	KW/M	*5)	29.7	26.0	28.0	29.2	29.7	27.2
(17)	PH	KW/M	*6)	25.5	21.8	23.8	23.2	23.7	21.2

(79) REMARKS

*1) MAX :L.H.R. DURING THE HIGH POWER PERIOD OF BASE IRRA..
*2) LATEST:L.H.R. DURING THE LAST POWER PERIOD OF BASE IRRA..
*3) TFPD :TIME TO FISSION PRODUCT DETECTION.
*4) PC :RAMP TERMINAL LEVEL - CONDITIONING TERMINAL LEVEL
*5) PL :RAMP TERMINAL LEVEL - LATEST

*6) PH :RAMP TERMINAL LEVEL - MAX.
*7) F :FAILURE
NF :NO FAILURE
HF :INCIPIENT NON-THROUGHGOING CLADDING CRACKS FUOND AT PIE .

(80) REFERENCE

<* 700208 *> FISSION GAS RELEASE AND VOID VOLUME DATA FOR CONNECTICUT YANKEE ** 700208 **

			(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
(1)	FUEL BATCH NO.		8	8	8	7				
(2)	FUEL ROD NO.		062E12	157E01	217E02	595A10				
(10)	ROD AVG. BURN-UP	(MWD/MTU)	36740.	36740.	36740.	38400.				
(11)	FUEL ROD VOID VOLUME	(CC)	20.86	18.66	20.3	20.62				
(12)	TOTAL VOL. OF GAS									
(13)	COLLECTED FROM ROD.	(STP CC)	38.49	36.83	45.28	154.74				
(20)	GAS COMPOSITION	(VOLUME %)								
(21)	H2		< 0.01	< 0.01	< 0.01	< 0.01				
(22)	HE		54.0	50.9	46.5	29.3				
(23)	H2O (WATER)		< 0.1	< 0.1	< 0.1	< 0.1				
(24)	N2		< 0.01	< 0.01	< 0.01	< 0.01				
(25)	O2		< 0.01	< 0.001	< 0.01	< 0.01				
(26)	A		11.2	8.74	10.3	1.43				
(27)	KR		3.47	3.90	4.44	7.79				
(28)	XE		31.3	34.9	40.3	61.4				
(30)	VOL. OF (XE+KR) RELEASED	(STP CC)	13.38	13.99	20.25	107.1				
(31)	VOL. OF (XE+KR) GENERATED*	(STP CC)	2336.	2336.	2336.	2440.				
(32)	PERCENT FISSION GAS RELEASED	(%)	0.57	0.60	0.87	4.41				

(997) NOTES

* : BASED ON 0.3 ATOM OF (XE+KR) GENERATED PER FISSION AND 4000 MWD/MTU = 10**20 FISSION/CC.

(998) REMARKS

THE CONNETICUT YANKEE REACTOR IS ONE OF THE FEW PWRS USING STAINLESS-STEEL CLAD FUEL RODS. FUEL ROD FAILURES APPEARED UNIQUE TO BATCH 8 FUEL ASSEMBLIES.

(999) REFERENCES

(A) : IWGFPT/12, P.196-210. SEE FDN-120004.
(B) : V. PASUPATHI, R.W. KLINGENSMITH, 'INVESTIGATION OF STAINLESS STEEL CLAD FUEL ROD FAILURES AND FUEL PERFORMANCE IN THE CONNECTICUT YANKEE REACTOR', EPRI NP-2119, (P.3-23), (NOV. 1981)

<* 700209 *> FISSION GAS ANALYSIS SUMMARY ** 700209 **

			(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
(10)	ROD NO.		6-A	6-B	6-C	6-E	8-B	8-C	8-D	8-E
(20)	RELEASE VOLUME (STP),	(CC)	16.4	20.4	23.1	17.8	31.2	94.0*	29.8	32.9
(30)	INTERNAL VOID VOLUME,	(CC)	12.8	12.3	13.0	14.8	12.5	13.3	13.0	16.8
(40)	HELIUM,	(CC)	N.A.	N.A.	N.A.	14.6	16.7	14.5	14.3	16.5
(50)	KRYPTON,	(CC)	0.56	1.25	1.42	0.60	2.52	1.59	2.29	2.42
(60)	XENON,	(CC)	3.88	8.42	10.16	4.25	18.52	10.44	14.87	16.25
(70)	XENON/KRYPTON		6.98	6.72	7.17	7.14	7.36	6.54	6.5	6.71
(80)	KR-85,	(ATOMS*1.0E-18)	1.05	3.00	2.99	1.12	3.97	2.51	3.70	5.60

(997) NOTES

N.A. : NO ANALYSIS PERFORMED.
* : AIR LEAK DURING PUNCTURING.
** : AIR LEAK DURING ALIQUOTING.
*** : VALUE NOT USED IN ANALYSIS (- 200 PERCENT RELEASE)

(998) REMARKS

1) SEE THE REMARKS OF FDN-900004.
2) SEE FDN-700211 TO 700212 FOR BURNUP.

(999) REFERENCES

R.C. NELSON, D.H. COPLIN, M.F. LYONS, B. WEIDENBAUM, 'FISSION GAS RELEASE FROM UO-2 FUEL RODS WITH GROSS CENTRAL MELTING', GEAP-4572 (JULY 1964). P.-16.

<* 700210 *> FISSION GAS ANALYSIS SUMMARY (CON'T) ** 700210 **

(10)	ROD NO.		10-A	10-B	10-C	10-E	12-A	12-E
(20)	FUEL BURNUP		36.8	34.9	39.0	45.2	138.9	58.0
(30)	INTERNAL VOID VOLUME,	(CC)	22.3	20.3	20.3	24.3	33.4	31.3
(40)	HELIUM,	(CC)	**	20.3	N.A.	24.9	23.4	37.3
(50)	KRYPTON,	(CC)	2.16	2.25	2.86	3.50	12.0	4.03
(60)	XENON,	(CC)	14.1	15.2	19.60	24.45	86.10	26.15
(70)	XENON/KRYPTON		6.53	6.75	6.87	7.00	7.18	6.50
(80)	KR-85,	(ATOMS*1.0E-18)	4.75	5.09	5.10	6.16	24.3	28.0***
(997)	NOTES		SEE THE NOTES OF FDN-700209.					
(999)	REFERENCES		SEE FDN-700209.					

<* 700211 *> FUEL BURNUP SAMMARY. ** 700211 **

(10)	TEST ASSEMBLY AND ROD NO.		EPT-6	EPT-6A	EPT-6D	EPT-8	EPT-8A	EPT-10	EPT-10D
(20)	FUEL BURNUP								
(30)	CHEMISTRY AVERAGE								
(31)		MWD/TE(U)	1195	1076	1334	1555	1660	1390	1460
(32)		(F/CC)*1.0E-19	2.88	2.59	3.21	3.75	4.00	3.35	3.52
(40)	PHYSICS (CALCULATED)								
(31)		MWD/TE(U)	1180	-	-	1442	-	1182	-
(32)		(F/CC)*1.0E-19	2.85	-	-	3.48	-	2.85	-
(50)	CALORIMETRY								
(31)		MWD/TE(U)	1249	1162	1354	1532	1630	1459	1524
(32)		(F/CC)*1.0E-19	3.01	2.80	3.26	3.69	2.93	3.52	3.67
(997)	NOTES		1) * : IRRADIATED TWO REACTOR CYCLES.						
			2) (MWD/TE(U))*(2.41E+16)=FISSIONS PER CUBIC CENTIMETER OF UO-2, (F/CC).						
(998)	REMARKS								
(999)	REFERENCES		SEE FDN-700209. P.17.						

<* 700212 *> FUEL BURNUP SUMMARY (CON'T) ** 700212 **

(10)	TEST ASSEMBLY AND ROD NO.		EPT-COM	EPT-12E	EPT-12*	EPT-12D	
(20)	FUEL BURNUP						
(30)	CHEMISTRY AVERAGE						
(31)		MWD/TE(U)	1816	2122	4884	4650	
(32)		(F/CC)*1.0E-19	4.38	5.11	11.77	11.21	
(40)	PHYSICS (CALCULATED)						
(31)		MWD/TE(U)	1564	-	5384	-	
(32)		(F/CC)*1.0E-19	3.77	-	12.89	-	
(50)	CALORIMETRY						
(31)		MWD/TE(U)	1725	2014	*5225	5050	
(32)		(F/CC)*1.0E-19	4.16	4.85	12.59	12.17	
(997)	NOTES		SEE THE NOTES OF FDN-700211.				
			* : IRRADIATED TWO REACTOR CYCLES.				
(999)	REFERENCES		SEE FDN-700209.				

<* 700213 *> TENSILE TESTS ON ZIRCALOY CLADDING OF DRESDEN TYPE I FUEL. ** 700213 **

DRESDEN TYPE I FUEL CLADDING WAS TESTED IN THE FORM OF FULL TUBE SEGMENTS IN WHICH THE FUEL HAD BEEN REMOVED AND IN THE FORM OF MINIATURE TENSILE COUPONS MACHINED FROM TUBE SEGMENTS. TESTING IN ALL CASES WAS IN THE LONGITUDINAL TUBE DIRECTION. THE FUEL RODS FROM WHICH THE CLADDING SAMPLES WERE REMOVED HAD EXPOSURES RANGING FROM 13800 TO 15800 MWD/METRIC-TON. ALL CLADDING SAMPLES WERE FROM NONFAILED FUEL RODS.

---(1)-*---(2)-*---(3)-*---(4)-*---(5)-*---(6)-*---(7)-*---(8)-*

(10)	SPECIMENS		FULL TUBE SPECIMENS					
(20)	IRRADIATION (>1 MEV),	(N./CM**2)	1.8 TO 2.7E+21					
(30)	TEMPERATURE	(DEG-F)	RT	RT	650	650	650	750
(40)	YIELD STRENGTH							
(41)	(0.2% OFFSET),	(KSI)	99.1	87.8	60.3	56.9	50.9	48.8
(45)	ULITIMATE TENSILE STRENGTH,	(KSI)	112.1	109.9	74.8	74.5	71.9	68.2
(50)	UNIFORM ELONGATION,	(%)	4.8	4.0	2.0	2.9	2.3	2.6
(55)	TOTAL ELONGATION,	(%)	6.8	5.4	3.2	4.6	2.8	3.9
(10)	SPECIMENS		COUPON SPECIMENTS					
(20)	IRRADIATION (>1 MEV),	(N./CM**2)	1.7 TO 2.2E+21					
(30)	TEMPERATURE	(DEG-F)	650*	650**	800	800		
(40)	YIELD STRENGTH							
(41)	(0.2% OFFSET),	(KSI)	68.9	6.12 TO 76.4**	58.6	59.6		
(45)	ULITIMATE TENSILE STRENGTH,	(KSI)	71.7*	66.6 TO 80.4**	61.0	61.9		
(50)	UNIFORM ELONGATION,	(%)	1.6**	1.2 TO 1.9 **	0.9	0.9		
(55)	TOTAL ELONGATION,	(%)	3.98*	2.7 TO 7.6 **	4.6	4.3		
(997)	NOTES		* : AVERAGE OF 10 TESTS.					
			** : RANGE.					
(999)	REFERENCES		H.E. WILLIAMSON, D.C. DITMORE, 'CURRENT BWR FUEL DESIGN AND EXPERIENCE', REACT. TECH. 14(1) (SPRING 1971), PP.68-98, (P.79)					
			ORIGINAL REPORT: H.E. WILLIAMSON, D.C. DITMORE, 'CURRENT STATE OF KNOWLEDGE, HIGH-PERFORMANCE BWR ZIRCALOY-CLAD UO-2 FUELS, REPORT NEDO-10173, GENERAL ELECTRIC CO., (MAY 1970).					

<* 700214 *> TENSILE TESTS ON ZIRCALOY-CLAD FUEL FROM AEC FUEL CYCLE PROGRAN ** 700214 **

THESE RODS HAD BEEN IRRADIATED IN THE VALLECITOS BOILING WATER REACTOR (VBWR) TO A CALCULATED AVERAGE EXPOSURE AS HIGH AS 10000 MWD/METRIC-TON. TENSILE SPECIMENS HAVING INTEGRATED FAST FLUXES RANGING FROM ABOUT 0.56 TO 1.4E+21 NUETRONS/CM**2 WERE MACHINED FROM FUEL-CLADDING SEGMENTS. SPECIMENS WERE ALL ORIENTED SUCH THAT TESTING WAS IN LONGITUDINAL TUBE DIRECTION.

---(1)-*---(2)-*---(3)-*---(4)-*---(5)-*---(6)-*---(7)-*---(8)-*

(20)	IRRADIATION (>1 MEV),	(N./CM**2)	0.56 TO 1.4E+21			
(30)	TEMPERATURE	(DEG-F)	RT*	RT**	650*	650**
(40)	YIELD STRENGTH					
(41)	(0.2% OFFSET),	(KSI)	80.6* ?	58.7-104**	56.7*	51.4-66.0**
(45)	ULITIMATE TENSILE STRENGTH,	(KSI)	76.4* ?	86.2-107.4**	57.7*	52.0-66.5**
(50)	UNIFORM ELONGATION,	(%)	0.98*	0.38-2.8 **	0.26*	0.13-0.80**
(55)	TOTAL ELONGATION,	(%)	3.17*	1.4 -5.3 **	1.67*	1.0 -2.3 **
(997)	NOTES		* : AVERAGE OF 21 TESTS.			
			** : RANGE.			
(999)	REFERENCES		SEE FDN-700213.			

<* 700215 *> BURST TESTS ON CLADDING OF DNP TYPE IIIF FUEL ** 700215 **

ELEVATED-TEMPERATURE BURST TESTS WERE PERFORMED ON CLADDING-TUBE SEGMENTS FROM IRRADIATED DNP (DRESDEN NUCLEAR PLANT) TYPE IIIF RELOAD FUEL. TUBE SEGMENTS WERE CUT FORM IRRADIATED FUEL RODS, AND THE UO-2 FUEL WAS REMOVED. THE ENDS OF EACH TUBE SEGMENT WERE WELDED CLOSED WITH END PLUGS, ONE OF WHICH HAD A SPECIAL FITTING FOR PRESSURIZATION OF THE TUBE.

			(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
(30)	TEMPERATURE	(DEG-F)	650		650		900			
(20)	IRRADIATION (>1 MEV),	(N./CM**2)	0.8E+21		0.8E+21		1.0E+21			
(60)	PLASTIC CIRCUMFERENTIAL ELON.,	(%)	6.22		7.35		13.56			
(70)	HOOP STRESS,	(PSI)	92700		94900		69300			
(999)	REFERENCES		SEE FDN-700213.							

<* 700216 *> DESIGN AND PERFORMANCE OF 304 STAINLESS STEEL CLAD FUELS IN VBWR ** 700216 **

FROM THAT POINT UNTIL THE PERMANENT SHUTDOWN OF THE VBWR IN DECEMBER 1963, FAILURES OCCURRED IN VIRTUALLY EVERY 304-SS-CLAD FUEL TYPE IRRADIATED IN THE VBWR.

SINCE FAILURES STARTED TO OCCUR IN THE VBWR A CONSISTENT PATTERN HAS BECOME APPARENT. THE FAILURES, WHICH CAN BE CORRECTED WITH TUBING VENDOR OR MINOR VARIATIONS IN THE CHEMICAL COMPOSITION OF VARIOUS HEATS OF THE TYPE 304 STAINLESS STEELS, ARE CHARACTERIZED AS FOLLOWS.

* THE CLADDING FAILURES ARE IN THE FORM OF CRACKS WHICH VARY IN SIZE FROM MICROSCOPIC PENETRATIONS TO LARGE CRACKS IN WHICH THE UO-2 IS COMPLETELY EXPOSED TO THE REACTOR COOLANT.
* ALL FAILURES HAVE OCCURRED IN THE HIGH HEAT-FLUX REGIONS. THE BOTTOM 6 IN. OF THE 30-36-IN.-LONG FUEL ROD AND THE TOP 15 IN. ARE FREE FROM CRACKING.
* METALLOGRAPIC EXAMINATIONS INDICATE THAT THE FAILURES ARE INVARIABLY INTERGRANULAR IN NATURE. NO PRECIPITATES CAN BE SEEN AT THE GRAIN BOUNDARIES USING EITHER LIGHT OR ELECTRON MICROSCOPY.
* CRACKING PATTERNS VARY WITH THE INITIAL CONDITION OF THE CLAD. CRACKS IN THE COLD-WORKED RODS ARE PREDOMINANTLY LONGITUDINAL, WHEREAS THOSE IN THE ANNEALED RODS ARE PREDOMINANTLY CIRCUMFERENTIAL.
* STATISTICAL ANALYSIS OF THE FAILURE DATA FOR THE TYPE 304 STAINLESS-STEEL-CLAD FUEL RODS INDICATES THE FOLLOWING:
 1) THERE IS NO SIGNIFICANT DIFFERENCE BETWEEN THE FAILURE RATES OF FUEL RODS CALD WITH ANNEALED OR WITH COLD-WORKED TYPE 304 STAINLESS STEEL;
 2) A MUCH HIGHER FAILURE RATE EXISTS FOR PELLET AND POWDER UO-2 FUEL RODS WITH THIN, COLLAPSED CLAD THAN WITH FREESTANDING CLAD
 3) FUEL RODS OPERATING AT >300000 BTU/HR/FT**2 SURFACE HEAT FLUXES DURING THE 500 TO 1000 HOURS PRIOR TO FAILURE SHOW AN INCREASED FAILURE RATE OVER RODS OPERATING <=300000 BTU/HR/FT**2;
 4) FUEL RODS WITH 0 TO 0.005-IN. DIAMETRAL COLD PELLET-TO-CLAD GAPS HAD HIGHER FAILURE RATES THAN FUEL RODS WITH GAPS OF >0.005 IN..

IN GENERAL, FAILURE IS ATTRIBUTED TO STRESS-ASSIATED INTERGRANULAR CORROSION OF THE 304 STAINLESS STEEL.

---(1)-*---(2)-*---(3)-*---(4)-*---(5)-*---(6)-*---(7)-*---(8)-*

(10) TOTAL NO. OF FUEL RODS		64	25	25	50	127	45	178	20
(11) DESIGN FEATURE									
(20) CLAD									
(21) OUTER DIAMETER,	(IN)	0.420	0.417	0.417	0.410	0.398	0.363	0.363	0.360
(22) THICKNESS,	(IN)	0.020	0.017	0.017	0.017	0.012	0.014	0.014	0.014
(23) NOMINAL UO-2-CLAD GAP,	(IN)	0.005	0.005	0.005	0.003	0.002	0.005	0.005	0.002
(24) CLAD YIELD STRENGTH,									
(25) (0.2% OFFSET),	(PSI)	38000	38000	95000	95000	94000	44000	90000	44000
(13) FABRICATION PROCESS		PL, NS	PL, NS	PL, NS	PL, SW	PL, SW	PL, SW	PL, NS	PL, SW
(12) PERFORMANCE									
(31) AVERAGE BUNDLE EXPOSURE,	(MWD/TU)	8500	7000	5900	5630	4950	8350	10000	8080
(32) PEAK FUEL-ROD EXPOSURE,	(MWD/TU)	12750	10500	9400	9000	7920	12500	15000	12900
(33) PEAK HEAT FLUX,	(BTU/HR/FT**2)	361000	377000	400000	400000	440000	492000	490000	500000
(34) MAX. AVE. POWER DENSITY,	(KW/L)	93	110	108	104	114	106	116	121
(14) CLADDING CRACKS (TYPE)		CIRCUM. -		LONG.	LONG.	LONG.	CIRCUM.	LONG.	-

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(997) NOTES

PL : PELLET / SW : SWAGED
NS : NOT SWAGED / PW : POWDER
UG : UNGROUND PELLET / VC : VIBRATORY COMPACTED
TR : TANDEM ROLLED / HS : HOT SWAGED

REFER NOTES OF FDN-140016.

CIRCUM. : CIRCUMFERENTIAL / LONG. : LONGITUDINAL

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(998) REMARKS

OVER THE YEARS THAT STAINLESS STEEL CLADDING HAS BEEN USED IN COMMERCIAL REACTORS, THERE HAVE BEEN FEW INSTANCES OF FUEL ROD FAILURES. THE MAJORITY OF FAILURES IN STAINLESS STEEL CLADDING WERE IN BOILING WATER REACTOR EMVIROMENTS. AN EXTENSIVE INVESTIGATION OF THESE FAILURES HAD BEEN PERFORMED BY DUNCAN ET AL.(9) UNDER THE JOINT US-EURATOM RESEARCH PROGRAM. THE INVESTIGATION PROVED THAT HIGHLY STRESSED UNSENSITIZED AUSTENITIC STAINLESS

STEELS (SUCH AS TYPE 304) ARE SUSCEPTIBLE TO STRESS-ASSISTED INTERGRANULAR CORROSION IN HIGH PURITY WATER ENVIROMENTS. IT APPEARS THAT THE FAILURE MECHANISM WAS WELL UNDERSTOOD AND WAS BELIEVED TO INVOLVE THE FOLLOWING ELEMENTS:
* HIGHLY LOCALIZED CLADDING STRESSES RESULTING FROM PELLET-CLAD INTERACTION.
* SEGREGATION OF IMPURITY ELEMENTS AT GRAIN BOUNDARIES DURING OPERATION.
* IRRADIATION-INDUCED DEFECTS, SUCH AS VACANCIES IN THE CLADDING , WHICH ENHANCE GRAIN BOUNDARY SUSCEPTIBILITY BY MIGRATING TO THE GRAIN BOUNDARIES ALONG WITH THE IMPURITY ATOMS.
* ACCUMULATION OF HARMFUL SPECIES SUCH AS CHLORIDE IONS AT THE CLADDING-WATER INTERFACE.
- V.PASUPATHI ET. AL., EPRI-NP-2119, (P.4-1), SEE FDN-700208. -*

V8WR : VALLECITOS BOILING WATER REACTOR.

(999) REFERENCES

R.N. DUNCAN, W.H. ARLT, J.S. ATKINSON, 'TOWARD LOW-COST HIGH-PERFORMANCE BWR FUEL - (SUBTITLE) - EXTENSIVE CLADDING FAILURES IN TESTS ON ABOUT 800 SS-CLAD RODS HAVE LED TO ON INCREASED USE OF ZIRCALOY-2 AND TO CONSIDERATION AND TESTING OF ALTERNATE CLADDING MATERIALS INCLUDING INCOLOY-800 AND INCOLOY-600. -
NUCLEONICS 23(4) PP.50-54. (P.52). (APRIL 1965).

(9) R.N. DUNCAN, 'STAINLESS STEEL FAILURE INVESTIGATION PROGRAM' FINAL SUMMARY REPORT, EURAEC-GEAP 5530, (FEBRUARY 1968).

<* 700217 *> DESIGN AND PERFORMANCE OF 304 STAINLESS STEEL CALD FUELS IN VBWR ** 700217 **

		---(1)-*-	(2)-*-	(3)-*-	(4)-*-	(5)-*-	(6)-*-	(7)-*-	(8)-*
(10)	TOTAL NO. OF FUEL RODS	80	4	12	13	49	15		
(11)	DESIGN FEATURE								
(20)	CLAD								
(21)	OUTER DIAMETER, (IN)	0.360	0.425	0.400	0.400	0.400	0.400		
(22)	THICKNESS, (IN)	0.014	0.010	0.010	0.008	0.010	0.012		
(23)	NOMINAL UO-2-CLAD GAP, (IN)	0.002	0.	0.	0.	0.	0.		
(24)	CLAD YIELD STRENGTH,								
(25)	(0.2% OFFSET), (PSI)	90000	40000	45000	52000	95000	80000		
(13)	FABRICATION PROCESS	PL, SW	PL, SW	UG, SW	UG, SW	PW, SW	PW, VC		
(12)	PERFORMANCE								
(31)	AVERAGE BUNDLE EXPOSURE,(MWD/TU)	8080	3000	5500	5500	6200	5250		
(32)	PEAK FUEL-ROD EXPOSURE, (MWD/TU)	12900	4500	8440	8440	9300	7900		
(33)	PEAK HEAT FLUX, (BTU/HR/FT**2)	500000	450000	410000	410000	490000	380000		
(34)	MAX. AVE. POWER DENSITY, (KW/L)	121	93	107	107	120	100		
(14)	CLADDING CRACKS (TYPE)	LONG.	-	-	LONG.	LONG.	LONG.		

(997) NOTES SEE FDN-700216.

(998) REMARKS SEE FDN-700216.

(999) REFERENCES SEE FDN-700216.

<* 700218 *> DESIGN AND PERFORMANCE OF 304 STAINLESS STEEL CLAD FUELS IN VBWR ** 700218 **

		(1)	(2)	(3)	(4)	(5)
(10) TOTAL NO. OF FUEL RODS		25	21	10	10	12
(11) DESIGN FEATURE						
(20) CLAD						
(21) OUTER DIAMETER,	(IN)	0.400	0.400	0.400	0.400	0.425
(22) THICKNESS,	(IN)	0.016	0.016	0.008	0.016	0.010
(23) NOMINAL UO-2-CLAD GAP,	(IN)	0.	0.	0.	0.	0.
(24) CLAD YIELD STRENGTH,						
(25) (0.2% OFFSET),	(PSI)	95000	90000	95000	45000	95000
(13) FABRICATION PROCESS		PW, SW	PW, TR	PW, SW	PW, HS	PW, SW
(12) PERFORMANCE						
(31) AVERAGE BUNDLE EXPOSURE,	(MWD/TU)	4500	4500	4600	4600	3000
(32) PEAK FUEL-ROD EXPOSURE,	(MWD/TU)	7100	7200	6900	6900	4500
(33) PEAK HEAT FLUX,	(BTU/HR/FT**2)	385000	380000	425000	425000	450000
(34) MAX. AVE. POWER DENSITY,	(KW/L)	93	100	109	109	93
(14) CLADDING CRACKS (TYPE)		LONG.	LONG.	-	-	-
(997) NOTES		SEE FDN-700216.				
(998) REMARKS		SEE FDN-700216.				
(999) REFERENCES		SEE FDN-700216.				

<* 700219 *> PERIPHERAL FUEL ROD FLATTENING OBSERVATIONS **700219 **

(1) CYCLE	(2) REGION -A)	(3) ROD PREPRESSURIZATION	(4) FUEL DENSITY (% TD)	(5) PER CENT FLATTENED
(10) PLANT NAME				
(11) BEZNAU 1	1			
	1	NO	94	0
	2	NO	92	2.3
	3	NO	90	0
	2			
	1	NO	94	0.8
	2	NO	92	4.5
	4,4B,5	YES	91 & 92	0
(12) GINNA	1B			
	1	NO	94	2.0
	2	NO	92	7.3
	3	NO	90	3.5
	4,4A,4B	YES	92 & 94	0
	2			
	1	NO	94	3.8
	2	NO	92	6.5
	4A	YES	92	0
(13) MIHAMA 1	1B			
	1	NO	94	1.0
	2	YES	92	0
	3	YES	91	0
(14) POINT BEACH 1	1			
	1	NO	94	3.2
	2	YES	92	0
	3	YES	91	0
	2			
	2	YES	92	0.7-*B)
	3	YES	91	0.05
	4	YES	94	0
(15) H. B. ROBINSON 2	1			
	1	NO	94	1.1
	2	YES	92	0
	3	YES	91	0

(997) NOTES

*A): TYPICAL CORE CONSISTS OF THREE FUEL REGIONS WHICH DIFFER IN DESIGN PARAMETERS AND ARE INTENDED TO BE SEQUENTIALLY DISCHARGED. LETTERS DEGINATE PARTIAL REGIONS.
*B): AN ADDITIONAL 0.3% EXHIBITED HIGH OVALITY.

FLATTENED FUEL RODS WERE FIRST DETECTED IN REGION 2 OF BEZNAU UNIT 1 DURING THE 1971 REFUELLING AFTER CYCLE 1. APPROXIMATELY 2% OF THE REGION 2 RODS WERE FOUND TO CONTAIN A SINGLE FLATTEDED LENGTH OF 15-75 MM IN THE UPPER 40% OF FUEL COLUMN.

BASED ON NON-DESTRUCTIVE EXAMINATION IN THE BEZNAU POOL AND DESTRUCTIVE EXAMINATIONS IN THE HOT CELLS, FUEL DENSIFICATION AND AXIAL SETTLEMENT WAS IDENTIFIED AS THE CAUSE OF GAP FORMATION IN THE FUEL COLUMN. SUBSEQUENTLY, IRRADIATION-ENHANCED CRREP OF THE CLADDING UNDER THE COOLANT PRESSURE RESULTED IN A FLATTENING OF THE FUEL RODS IN UNSUPPORTED SECTIONS.

(999) REFERENCES

SEE REFERENCES OF FDN-110009. (P.89)
ORIGINAL PAPER: JORDAN, K.R., PROC. TOPICAL MEETING COMMERCIAL NUCLEAR FUEL TECHNOLOGY TODAY, TRONTO (1975) 2-86.

<* 900001 *> VALUES OF BASIC NUCLEAR PARAMETERS - CRITICAL - ** 900001 **

		U-235 RECOMMENDED	U-235 MINIMUM CRITICAL	U-233 RECOMMENDED	U-233 MINIMUM CRITICAL	PU-239 RECOMMENDED	PU-239 MINIMUM CRITICAL	
(10)	MASS, KG:							
(11)	SOLUTION	0.35	0.82	0.25	0.59	0.22	0.51	
(12)	METAL	10.0	22.8	3.2	7.5	2.6	5.6	ALPHA-PHASE
						3.5	7.6	DELTA-PHASE
(20)	DIAMETER OF INFINITE CYLINDER,IN							
(11)	SOLUTION	5.0	5.4	3.7	4.4	4.2	4.9	
(13)	(CM)	(12.7)	(13.7)				(12.5)	
(12)	METAL	2.7	3.1	1.7	1.9	1.4	1.7	ALPHA-PHASE
						1.8	2.1	DELTA-PHASE
(30)	THICKNESS OF INFINITE SLAB, IN							
(11)	SOLUTION	1.5	1.7	0.8	1.2	0.9	1.3	
(13)	(CM)	(3.8)	(4.3)					
(12)	METAL	0.5	0.6	0.2	0.3	0.18	0.24	ALPHA-PHASE
(13)	(CM)	(1.27)	(1.55)					
						0.22	0.28	DELTA-PHASE
(40)	SOLUTION VOLUME, LITERS	4.8	6.3	2.3	3.3	3.4	4.5	
(50)	CHEMICAL CONCENTRATION OF AQUEOUS SOLUTION,							
(52)	GRAM (OF ISOTOPE)/LITER	10.8	12.1	10.0	11.2	6.9	7.8	
(60)	U-235 ENRICHMENT OF HOMOGENEOUS HYDROGEN-MODERATED URANIUM,							
(62)	WEIGHT PERCENT	0.95	1.0	-	-	-	-	
(999)	REFERENCES	NUCLEAR SAFETY GUIDE, TID-7016(REV.1), (1961), P.10.						

<* 900002 *> SUMMARY OF FUEL MATERIAL PROPERTIES - PU-02 ETC.- ** 900002 **

		UO-2	PU-02	(U,20 W/O PU)-02
(10)	THEORETICAL DENSITY, G/CC	10.96	11.45	11.04
(20)	MELTING POINT, DEG-C	2840 +- 40	2400 +- 30	2810 +-(25)
(30)	CRYSTAL SYSTEM	FFC(FLUORITE)	FFC (FLUORITE)	FFC (FLUORITE)
(31)	CRYSTAL PARAMETER, A0=	5.4705+-0.0003	5.3960+-0.0003	5.4559+-0.0005
(40)	COEFFICIENT OF LINER THERMAL			
(42)	EXPANSION, /DEG-C	10.1X10**-6	10.9X10**-6	10.3X10**-6
(43)	(RANGE 25 TO 1000 DEG-C)			
(50)	THERMAL CONDUCTIVITY,			
(51)	W/CM-DEG C AT 95%TD	0.022 >1600 C	0.023 AT 1000 C	0.021 >1600 C
(60)	ELECTRICAL RESISTIVITY,			
(61)	OHM-CM	1X10**3	1.3X10**8	2X10**4
(70)	RESISTANCE TO THERMAL			
(71)	SHOCK	GOOD	FAIRLY GOOD	GOOD
(80)	COMPATIBILITY WITH CLADDING			
(81)	MATERIAL	EXCELLENT	**A)	**B)
(90)	YOUNG'S MODULUS, KILOBARS	1930	--	1400+-100 (O/M=1.98)
(92)	SHEAR MODULUS, KILOBARS	770	--	550+- 50 (O/M=1.98)
(94)	POISSON'S RATIO	0.302	--	0.28 TO 0.29
(997)	NOTES	**A) COMPATIBLE WITH STAINLESS STEEL, INCONEL, CR, MO, NB, V, BELOW 1400 DEG-F. NOT COMPATIBLE WITH TI, W, ZRY-2.		
		**B) SAME AS PU-02. HYPERSTOICHIOMETRIC COMPOUND REACTS WITH STAINLESS STEEL AND INCONEL AT TEMPERATURES TO 1400 DEG-F.		
(999)	REFERENCES	COMPILED BY B.F. RUBIN, 'SUMMARY OF (U,PU)02 PROPERTIES AND FABRICATION METHODS', GEAP-13582 (NOV. 1970), P.2.		

<* 900003 *> MELTING AND BOILING POINTS OF OXIDE AND CARBORIDE FUEL ** 900003 **

				(1)	(2)	(3)	(4)
				UC	(0.8U,0.2PU)C	UO2	(0.8U,0.2PU)O2
(10)	MELTING POINT,	TM	(K)	2780.	2758.	3123.	3040.
(20)	BOILING POINT,	TV	(K)	4814.	4558.	3678.	3423.
(30)	TV - TM ,		(K)	2034.	1800.	550.	383.

(998) REMARKS

FUEL TEMPERATURE DESIGN BASIS:
THE UO-2 MELTING TEMPERATURE FOR AT LEAST 95% OF THE PEAK KW/FT FUEL RODS WILL NOT BE WXCEEDED AT THE 95% CONFIDENCE LEVEL . MELTING TEMPERATURE OF UO-2 IS TAKEN AS 5080 DEG-F (2804.4 DEG-C) *(1) UNIRRDIATED AND DECREASING BY 58 DEG-F (32.2 DEG-C) PER 10000 MWD/MTU.
- WESTINGHOUSE, RESAR-41 (DEC. 1973), P.-4.4-2. -

(999) REFERENCES

RESERCH COMMITEE ON FUEL PERFORMANCE, 'SOME PHYSICAL PROCESSES OF IRRADIATED OXIDE FUEL' (IN JAPANESE), J. AESJ, 21(10), P.777. (1979).

A. SHETH, ET. AL., ANL-AFP-11, (1975).

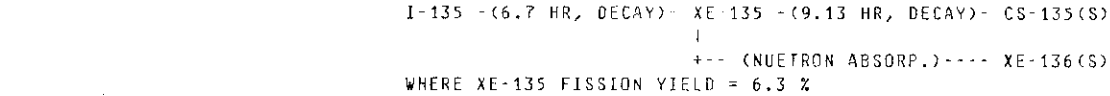
*(1) J.A. CHRISTENSEN, R.J. ALLIO, A. BIANCHERIA, 'MELTING POINT OF IRRADIATED UO 2', WCAP-6065 (FEB. 1965).

<* 900004 *> VOLUME OF FISSION GAS FORMED AND XE-135 TO XE-136 CONVERSION (1) ** 900004 **

		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
(10)	THERMAL NUETRON FLUX								
(11)	(X10**13 N/CM**2-SEC)	0.01	0.05	0.1	0.5	1.0	5.0	10.0	50.0
(20)	CUBIC CENTIMETER OF FISSION GAS								
(21)	PER GRAM U-235 FISSIONED	24.6	24.8	25.2	26.9	27.8	29.7	30.1	30.35
(30)	VOLUME (CC) OF XE-136 PRODUCED	0.1	0.3	0.7	2.4	3.3	5.2	5.6	5.85
(40)	CONVERSION XE-135 TO XE-136, (%)	1.67	5.0	11.67	40.0	55.0	86.7	93.3	97.5

(997) NOTES

BASIC:
(1) 24.5 CC(STP) INERT GAS FORMED PER GRAM OF U-235 FISSIONED. (MINIMUM).
(2) PLUS XENON-136 FORMED BY NEUTROM ABSORPTION.



WHERE XE-135 FISSION YIELD = 6.3 %
XE-135 SIGMA = 2.72+-0.11 X10**6 BARNS,
XE-135 DECAY CONST.= 9.13 HOURS.
(3) 1 GRAM U-235 FISSIONED NEARLY EQUALS 1 MWD/MTM.

(998) REMARKS

1)ABOUT 30 STABLE OR LONG-LIVED INERT GAS ATOMS ARE PRODUCED PER 100 FISSIONS OF U-235 OR PU-239. EARLY IN LIFE THE FISSION GAS CONSISTS OF 86 A/O XENON AND 14 A/O KRYPTON. LATER THE COMPOSITION SHIFTS TO A HIGHER PERCENTAGE OF XENON DUE TO AN INCREASING AMOUNT OF PU-239.
- H. STEHLE, H. ASSMAN, F. WUNDERLICH, 'URANIUM DIOXIDE PROPERTIES FOR LWR FUEL RODS', NUCL. ENG. DESIGN, 33(1975), P.P. 230-260. (P.239) -
2) SEE THE NOTES OF FDN-700208.
3) FISSION GAS IS GENERATED WITHIN THE FUEL AT A RATE OF 1.35E-3 GRAM MOLES/MWD.
- H.E. WILLIAMSON, DANA C. DITMORE, 'CURRENT BWR FUEL DESIGN AND EXPERIENCE',REACT.TECH. 14(1) (SPRING 1971), PP.68-98, P.75.-

(999) REFERENCES

R.C. NELSON, D.H. COPLIN, M.F. LYONS, B. WELDENBAUM, 'FISSION GAS RELEASE FROM UO-2 FUEL RODS WITH GROSS CENTRAL MELTING', GEAP-4572 (JULY, 1964), P.5, FIG.3-1.

<** 900005 *> VOLUME OF FISSION GAS FORMED AND XE-135 TO XE-136 CONVERSION (2) ** 900005 **

		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
(10)	THERMAL NUETRON FLUX								
(11)	(X10**13 N/CM**2-SEC)	100.	500.	1000.					
(20)	CUBIC CENTIMETER OF FISSION GAS								
(21)	PER GRAM U-235 FISSIONED	30.4	30.5	30.5					
(30)	VOLUME (CC) OF XE-136 PRODUCED	5.9	6.0	6.0					
(40)	CONVERSION XE-135 TO XE-136, (%)	98.3	100.	100.					
(999)	REFERENCES	SEE FDN-900004.							

<** 900006 *> HIGH TEMPERATURE PHYSICAL PROPERTIES OF FUEL ELEMENT MATERIALS-1 ** 900006 **

		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
(5)	MATERIAL	ZIRCONIUM		ZIRCALOY-4		TYPE 304 SS			
(10)	MELTING POINT, DEG-C	1852+-10.		1849.		1400. TO 1455.			
(20)	BOILING POINT, DEG-C	4325.		-		CR	FE	NI	
						2567.	2772.	2142.	
(30)	HEAT OF FUSION, D-HM, KCAL/MOLE	4.9		-		CR	FE	NI	
						3.5	3.7	4.21	
(40)	HEAT OF VAPORIZATION, KCAL/MOLE	145.76+-1.0		-					
(41)	D-HV,					CR	FE	NI	
						94.85	99.95	102.67	
(50)	VAPOR PRESSURE ABOVE SOLID,								
(51)	P IN TORR AT T DEG-K	LOG P=10.216-31066/T -0.0002419*T		-		CR) LOG P=7.127-20059/T FE) LOG P=7.023-20826/T NI) LOG P=7.341-21911/T			
(60)	PHASE TRANSFORMATION	ALPHA-BETA (870 DEG-C) BATA-CUBIC (2285 DEG-C)		ALPHA + (900 TO 1000 DEG-C)		-			
(70)	COEFFICIENT OF THERMAL EXPANSION								
(71)	AT T DEG-C;								
(72)	GIVEN AS 10**-6/DEG-C	5.768+0.00615*T FOR ALPHA		5.63+3.16X 10**-3 *T (25 TO 800 C)		MC=20.2 (0 TO 1000 C)			
		9.7 FOR BETA							
(80)	DENSITY AT 25 DEG-C, GRAM/CC	6.49		-		7.9			
(90)	TOTAL NORMAL EMITTANCE AT T DEG-C	0.118 + 0.000127*T		0.112+0.000085*T		0.707+0.000232*T (300 TO 800 DEG-C)			
(100)	THERMAL CONDUCTIVITY, W/CM-C	0.221 AT 25 DEG-C 0.204 AT 100 DEG-C 0.187 AT 300 DEG-C							
(140)	MODULUS OF ELASTICITY, KG/MM**2			(ZIRCALOY) 9841-5.78*T (TO 320 DEG-C)		21840-9.326*T (TO 1000 DEG-C)			
(141)	T IN DEG-C.								
(997)	NOTES	MC : MEAN COEFFICIENT.							
(999)	REFERENCES	H.C BRASSFIELD, J.F. WHITE, L. SJODHAL, J.T. BITTEL, 'RECOMMENDED PROPERTY AND REACTION KINETICS DATA FOR USE IN EVALUATING A LIGHT-WATER REACTOR LOSS OF COOLANT INCIDENT INVOLVING ZIRCALOY-4 OR 304-SS-CLAD UO-2', GEMP-482 (APRIL 1968), P.87,88,89.							

<* 900007 *> HIGH TEMPERATURE PHYSICAL PROPERTIES OF FUEL ELEMENT MATERIALS-2 ** 900007 **

---(1)-*---(2)-*---(3)-*---(4)-*---(5)-*---(6)-*---(7)-*---(8)-*

			UO-2	ZR-O2	
(5)	MATERIAL				
(10)	MELTING POINT,	DEG-C	2840.	2710+-15.	
(20)	BOILING POINT,	DEG-C	-	4297.	
(30)	HEAT OF FUSION, D-HM,	KCAL/MOLE	18.2+-0.5	20.8	
(40) (41)	HEAT OF VAPORIZATION, D-HV,	KCAL/MOLE	137.1+-1.7	157.3-0.0078*T-400/T	T IN ?
(50) (51)	VAPOR PRESSURE ABOVE SOLID, P IN TORR AT T DEG-K		LOG P=25.686-33115/T -4.026X LOG T	LOG P=-(35900+-1000)/T +(10.77+-0.39)	
(60)	PHASE TRANSFORMATION		NONE	MONOCLINIC-TETRAGONAL (? TO 1250 DEG-C) TETRAGONAL-CUBIC (2250 DEG-C)	
(70) (71) (72)	COEFFICIENT OF THERMAL EXPANSION AT T DEG-C; GIVEN AS 10**-6/DEG-C		6.797+5.792X10**-3 *T (1000 TO 2250 DEG-C)	MC=7.8 (0 TO 1000 DEG-C)	
(80)	DENSITY AT 25 DEG-C,	GRAM/CC	10.96	5.68	
(110)	TENSILE STRENGTH		S=287.56*G**(-0.837)X EXP(-5.84*P) WHERE S IS IN KG/MM2 G IS GRAIN SIZE,MICRON-M P IS FRACTION PROSITY.	TEMP.(C) KG/MM**2 (MG-O STAB.) 1030 9.30 1200 8.42 1540 1.3	
(120)	COMPRESSIVE STRENGTH			TEMP.(C) KG/MM**2 1000 120. 1200 80. 1400 13. 1500 2.	
(140)	MODULUS OF ELASTICITY,	KG/MM**2	16900 KG/MM**2 AT 800 DEG-C FOR 93 %TD.	TEMP.(C) KG/MM**2 1050 11600. 1180 11100. 1225 10700. 1290 10300. 1360 9600.	
(997)	NOTES		MC : MEAN COEFFICIENT		
(999)	REFERENCES		SEE FDN-900006.		

<* 900008 *> PHYSICAL PROPERTIES OF ZIRCON ** 900008 **

---(1)-*---(2)-*---(3)-*---(4)-*---(5)-*---(6)-*---(7)-*---(8)-*

(10)	THERMAL-NUETRON CROSS SECTION,		
(13)	(UNIT: BARNS/ATOM)		
(11)	ABSORPTION CROSS SECTION		
(12)	(2200 M/SEC NUETRONS)		0.18+-0.02
(14)	SCATTERING CROSS SECTION		8. +-1.
(15)	ISOTOPIC CROSS SECTION		
(16)	ISOTOPES	ISOTOPIC ABUNDANCE %	
(17)	ZR-90	51.5	0.1 +-0.07
(18)	ZR-91	11.2	1.5 +-0.12
(19)	ZR-92	17.1	0.25+-0.08
(20)	ZR-94	17.4	0.08+-0.04
(21)	ZR-96	2.8	0.1 +-0.1
(30)	THERMAL PROPERTIES		
(31)	SPECIFIC HEAT,	CAL/MOLE/DEG-C	CP
(32)	ALPHA ZIRCONIUM	(298-1135 K)	6.83+1.12E-3 *T-0.87E5 /T**2
(33)	BETA ZIRCONIUM	(1135-1400 K)	7.27
(40)	HEAT CONTENT, H(T)-T(298.16)		
(41)		CAL/MOLE	
(32)	ALPHA ZIRCONIUM	(298-1135 K)	6.83*T+0.56E-3*T**2+0.87E5/T-2378
(33)	BETA ZIRCONIUM	(1135-1400 K)	7.27*T-1163
(50)	VAPOR PRESSURE	(1949-2054 K)	
(51)	P IN ATM,		LOG10 P=-31.066/T+7.3551-2.415E-4 *T
(60)	HEAT OF SUBLIMATION,	CAL/MOLE	142,150+-350
(61)	HEAT OF FUSION,	CAL/MOLE	5,500
(62)	HEAT OF TRANSFORMATION,	CAL/MOLE	920
(63)	TRANSFORMATION TENPERATURE,	DEG-C	862
(64)	BOILING POINT,	DEG-C	3,580-3,700.
(65)	MELTING POINT,	DEG-C	1,852+-2
(70)	CRYSTALLOGRAPHY		
(71)	STRUCTURE, ALPHA ZIRCONIUM		HEXAGONAL CLOSE PACKED.
(72)	LATTICE CONSTANTS, ALPHA, 20DEG-C		
(73)	C,	ANGSTOROM	5.14756 A
(74)	A,	ANGSTOROM	3.23115 A
(75)	C/A		1.9310
(76)	STRUCTURE, BETA ZIRCONIUM		BODY-CENTERED CUBIC.
(78)	LATTICE CONSTANTS, BETA		
(79)	AO (AT 20 DEG-C),	ANGSTOROM	3.545 A (EXTRAPOLATED)
(80)	AO (AT 862 DEG-C),	ANGSTOROM	3.609 A
(90)	TENPERATURE COEFFICIENT OF		
(91)	EXPANCIVITY, T IN DEG-C.		
(92)	COEFFICIENT OF EXPANSIVITY		
(93)	ALONG C AXIS		
(94)	(1/C*DC/DT), 0-600 C, 1.0E-6/C		6.106+0.01398*T
(95)	ALONG A AXIS		
(96)	(1/A*DA/DT), 0-600 C, 1.0E-6/C		5.599+0.02241*T
(97)	ISOTROPIC COEFFICIENT OF		
(98)	EXPANSIVITY (BY X-RAY)		
(99)	(1/L*DL/DT), 0-600 C, 1.0E-6/C		5.768+0.00154*T
(97)	ISOTROPIC COEFFICIENT OF		
(101)	EXPANCIVITY (BY DILATATION)		5.7 +0.001 *T
(102)	COEFFICIENT OF EXPANCIVITY,		
(103)	BCC PHASE,		
(104)	(1/L*DL/DT),	1.0E-6/C	9.7
(110)	DENSITY,	GR/CC	
(111)	20 DEG-C		6.51
(112)	862 DEG-C (ALPHA)		6.39
(113)	862 DEG-C (BETA)		6.44
(120)	ELECTRICAL RESISTIVITY,	OHM-CM	
(121)	0 DEG-C		41.E-6
(112)	862 DEG-C (ALPHA)		129.E-6
(113)	862 DEG-C (BETA)		110.E-6
(130)	TEMPERATURE COEFFICIENT OF		
(131)	RESISTIVITY,	1/DEG-C	
(132)	0-100 DEG-C		44.E-4
(133)	0-862 DEG-C		24.9E-4
(999)	REFERENCES		OKUBO SADAJIRHO, 'REACTOR MATERIAL' (IN JAPANESE), UCHIDARHOKAKU-SHINSHA (1970), P.41-42.

<* 900009 *> ISOTOPIC ABUNDANCE OF ZIRCONIUM ** 900009 **

		(1) ISOTOPIC ABUNDANCE (A/0)*A)	(2) ATOMIC WEIGHT	(3) CROSS SECTION BARNS
(10)	ZR-90	51.452+-0.009		0.0114 MILI-BARNS
(20)	ZR-91	11.223+-0.012		
(30)	ZR-92	17.146+-0.007		
(40)	ZR-94	17.380+-0.012		
(50)	ZR-96	2.299+-0.005		
(60)	ATOMIC WEIGHT OF ZIRCONIUM		91.224+-0.002	
(997)	NOTES	*A) : AT 95 % CONFIDENCE LEVEL.		
(999)	REFERENCES	M. OKAMOTO, J. AESJ, 26(5) (1984), P.399-400.		

<* 900010 *> FISSION GAS RELEASE MODELS - DIVIDED INTO TEMPERATURE RANGES - ** 900010 **

			(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
(10)	TEMPERATURE RANGE	(DEG-C)	<1650	1650=<						
(20)	FISSION GAS RELEASE RATE,	(%)	4.	100.						
(30)	REFERENCE NO.		REF-1)							
(10)	TEMPERATURE RANGE	(DEG-C)	<1650	1650 TO 1900	1900=<					
(20)	FISSION GAS RELEASE RATE,	(%)	0.	20.	100.					
(30)	REFERENCE NO.		REF-2)							
(10)	TEMPERATURE RANGE	(DEG-C)	<1000	1000 TO 1300	1300 TO 1600	1600<				
(20)	FISSION GAS RELEASE RATE,	(%)	0.5	10.	60.	95.				
(30)	REFERENCE NO.		REF-3)							

(999) REFERENCES

REF-1)
H.E. WILLIAMSON, D.C. DITMORE, 'CURRENT BWR FUEL DESIGN AND EXPERIENCE', REACT. TECH. 14(1), (SPRING 1971), PP.68-98. P-75.

REF-2)
R.C. NELSON, D.H. COPLIN, M.F. LYONS, B. WEIDENBAUM, 'FISSION GAS RELEASE FROM UO-2 FUEL RODS WITH GROSS CENTRAL MELTING', GEAP-4572 (JULY 1964).

REF-3)
W.B. LEWIS, NUCL. APL. 2, PP.171-?, (1966)

<* 900011 *> FISSION GAS RELEASE MODEL OF HOFFMANN AND COPLIN ** 900011 **

			---(1)-*---(2)-*---(3)-*---(4)-*---(5)-*---(6)-*---(7)-*---(8)-*							
(10)	MAXIMUM FUEL ROD VOLUMETRIC									
(11)	AVERAGE TEMPERATURE,	(DEG-C)	700	745	753	760	785	800	805	816
(20)	FISSION GASES RELEASED,	(%)	0.02	0.06	0.08	0.1	0.2	0.28	0.3	0.4
(10)	MAXIMUM FUEL ROD VOLUMETRIC									
(11)	AVERAGE TEMPERATURE,	(DEG-C)	957	833	840	843	850			
(20)	FISSION GASES RELEASED,	(%)	0.5	0.6	0.7	0.8	0.9			
(10)	MAXIMUM FUEL ROD VOLUMETRIC									
(11)	AVERAGE TEMPERATURE,	(DEG-C)	853	890	913	934	957	973	986	1010
(20)	FISSION GASES RELEASED,	(%)	1.0	2.0	3.0	4.0	5.0	6.0	7.0	8.0
(10)	MAXIMUM FUEL ROD VOLUMETRIC									
(11)	AVERAGE TEMPERATURE,	(DEG-C)	1037	1100	1157	1200	1300	1217	1400	1500
(20)	FISSION GASES RELEASED,	(%)	10.	16.	20.	23.	29.	30.	32.	33.
(10)	MAXIMUM FUEL ROD VOLUMETRIC									
(11)	AVERAGE TEMPERATURE,	(DEG-C)	1600	1700	1800	1900				
(20)	FISSION GASES RELEASED,	(%)	34.	36.	38.	39.				

(997) NOTES

THESE VALUES WERE TAKEN FROM THE FIGURE OF THE REPOERT OF GEAP-5496.

THE MAXIMUM FUEL ROD VOLUMETRIC AVERAGE TEMPERATURE (VAT) IS DEFINED AS

VAT=(TCLP+TSP)/2./FP

WHERE TCLP= PELLET CENTER LINE TEMP. OF PEAK LOCATION ON ROD.
TSP = PELLET SURFACE TEMP. OF PEAK LOCATION ON ROD.
FP = RATIO OF PEAK TO AVERAGE FLUX AS DETERNINED BY GAMMA PROFILE.

-SAMPLE CALCULATION-

TCLP=1950 (C), TSP = 560 (C), FP = 1.48.

VAT =2510/2./1.48 = 849 (C).

PERCENT FISSION GAS RELEASE

THE THEORETICAL PRODUCTION OF KR-85 IS CALCULATED AS FOLLOWS:

ATOMS KR-85 PRODUCED=(BURN UP (FISSION/CC))*
(VOLUME UO-2 (CC))*(F.Y. KR-85)

WHERE F.Y. KR-85= FISSION YIELD= 0.293%.

-SAMPLE CALCULATION-

ATOMS KR-85 PRODUCED=(2.6E+20)*66.9*0.00293= 5.02E+19

THEREFORE:

THE PERCENT GAS RELEASED=(ATOMS KR-85 MEASURED/ATOMS KR-85 PRODUCED) * 100
=(1.05E+18/5.02E+19)*100.= 2.1 %

APPROXIMATELY 30 PERCENT OF THE FISSION PRODUCTS OF THE U-235 ISOTOPE ARE GASES, PRIMARILY THE STABLE ISOTOPIC SPECIES OF XENON AND KRYPTON. THE RATE OF FISSION GAS PRODUCTION IN A UO-2 FUEL ROD IS ABOUT 5.E-25 GRAM-MOLE PER FISSION. THUS, BY THE TIME THE FUEL HAS REACHED AN EXPOSURE OF 3.E+20 FISSION/CC OF UO-2, 300 CUBIC CENTIMETERS (STP) OF GAS WILL HAVE BEEN GENERATED FOR EACH KIOGRAM OF UO-2.

- REFER THE REMARKS OF FDN-900004. -

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(998) REMARKS

THIS MODEL, SLIGHTLY MODIFIED, IS USED TO CALCULATE FP GAS RELEASE RATE FROM PELLETS IN COMPUTER PROGRAMS, GAPCON AND GAPCON-THERMAL.

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(999) REFERENCES

J.P. HOFFMANN, D.H. COPLIN, 'THE RELEASE OF FISSION GASES FROM URANIUM DIOXIDE PELLET FUEL OPERATED AT HIGH TEMPERATURES', GEAP-4596 (SEPTEMBER, 1964).

表－3　データタイトル索引

(Table 3 KWIC Index of data title)

FUEL PERFORMANCE DATA SAKUIN DATA=86-05 PAGE **K- 1**

FUEL PERFORNANCE DATA SAKUIN DATA=86-05 PAGE **K- 4**

INDEX WORD	DATA TITLE	F.D.N	DATA PAGE
DATA	< INTER RAMP,PRE-RAMP IRRADIATION DATA AND RAMP IRRADIATION DATA 1	>700024	D-114
DATA	< INTER RAMP,PRE RAMP IRRADIATION DATA AND RAMP IRRADIATION DATA 2	>700025	D-115
DATA	< INTER RAMP,PRE RAMP IRRADIATION DATA AND RAMP IRRADIATION DATA 3	>700026	D-116
DATA	< INTER RAMP (PRE-RAMP IRRADIATION DATA AT AXIAL PEAK POWER (1))	>700007	D- 97
DATA	< INTER RAMP (PRE-RAMP IRRADIATION DATA AT AXIAL PEAK POWER (2))	>700008	D- 98
DATA	< INTER RAMP (PRE-RAMP IRRADIATION DATA AT AXIAL PEAK POWER (3))	>700009	D- 99
DATA	< FISSION GAS RELEASE AND VOID VOLUME DATA FOR CONNECTICUT YANKEE	>700208	D-142
DATA	< CONSTITUTION OF FILING DATA NUMBER FOR FUEL PERFORMANCE DATA	> 1	D- 1
DATA	< DATA OF PWR AND HCPWR (APWR)	>100003	D- 4
DATA	< INTER RAMP,PRE-RAMP IRRADIATION DATA AND RAMP IRRADIATION DATA 1	>700024	D-114
DATA	< INTER RAMP,PRE RAMP IRRADIATION DATA AND RAMP IRRADIATION DATA 2	>700025	D-115
DATA	< INTER RAMP,PRE RAMP IRRADIATION DATA AND RAMP IRRADIATION DATA 3	>700026	D-116
DATA	< TEST ASSEMBLY DATA - IFA-106 -	>120002	D- 22
DATA	< TEST ASSEMBLY DATA - IFA-106 - (CON'T)	>120003	D- 23
DATA	< TYPICAL NUCLEAR POWER REACTOR DATA (1)	>100001	D- 2
DATA	< INTER RAMP FISSION GAS REREASE DATA (1)	>700030	D-118
DATA	< INTER RAMP IRRADIATION DATA (1) -LR,LS,TR-	>700004	D- 94
DATA	< INTER RAMP HOT CELL PIE DATA (1) -LR,LS,TR-	>700017	D-107
DATA	< INTER RAMP ROD LENGTH MEASUREMENT DATA (1) -LR,LS,TR-	>700021	D-111
DATA	< INTER RAMP DIAMETER MEASUREMENT DATA (1) -LR,LS.TR-	>700010	D-100
DATA	< INTER RAMP MEASUREMENTS DATA (1) FOR BIRP-2 AND BIRP-4	>700013	D-103
DATA	< TYPICAL NUCLEAR POWER REACTOR DATA (2)	>100002	D- 3
DATA	< INTER RAMP FISSION GAS REREASE DATA (2)	>700031	D-119
DATA	< INTER RAMP IRRADIATION DATA (2) -LS,TS,DR,HR-	>700005	D- 95
DATA	< INTER RAMP HOT CELL PIE DATA (2) -LS,TS,DR,HR-	>700018	D-108
DATA	< INTER RAMP DIAMETER MEASUREMENT DATA (2) -LS,TS,DR,HR-	>700011	D-101
DATA	< INTER RAMP ROD LENGTH MEASUREMENT DATA (2) -LS,TS,DR,HR-	>700022	D-112
DATA	< INTER RAMP MEASUREMENTS DATA (2) FOR BIRP-2 AND BIRP-4	>700014	D-104
DATA	< INTER RAMP DIAMETER MEASUREMENT DATA (3) -HS,BR-	>700012	D-102
DATA	< INTER RAMP IRRADIATION DATA (3) -HS,BR-	>700006	D- 96
DATA	< INTER RAMP HOT CELL PIE DATA (3) -HS,BR-	>700019	D-109
DATA	< INTER RAMP ROD LENGTH MEASUREMENT DATA (3) -HS,BR-	>700023	D-113
DATA	< INTER RAMP MEASUREMENTS DATA (3) FOR BIRP-2 AND BIRP-4	>700015	D-105
DATA	< INTER RAMP MEASUREMENTS DATA (4) FOR BIRP-2 AND BIRP-4	>700016	D-106
DEFINITION	< DEFINITION OF FUEL DAMAGE	>110204	D- 18
DEMO	< DEMO RAMP FUEL RODS SPECIFICATION -BWR (1)-	>130013	D- 41
DEMO	< DEMO RAMP FUEL RODS SPECIFICATION -BWR (2)-	>130014	D- 42
DENSIFICATION	< THERMAL SINTERING TEST CONDITION FOR PELLET DENSIFICATION	>140015	D- 62
DENSITY	< METHOD OF MEASUREMENT FOR PELLET GEOMETRICAL DENSITY	>140018	D- 65
DENSITY	< JPDR-II FUEL PELLET DENSITY MEASUREMENT (1)	>140008	D- 58
DENSITY	< JPDR-II FUEL PELLET DENSITY MEASUREMENT (2)	>140009	D- 59
DENSITY	< JPDR-II FUEL PELLET DENSITY MEASUREMENT (3)	>140010	D- 60
DENSITY	< JPDR-II FUEL PELLET DENSITY MEASUREMENT (4)	>140011	D- 60
DENSITY	< JPDR-II FUEL PELLET DENSITY MEASUREMENT (5)	>140012	D- 61
DENSITY	< JPDR-II FUEL PELLET DENSITY MEASUREMENT (6)	>140013	D- 61
DENSITY	< JPDR-II FUEL PELLET DENSITY MEASUREMENT (7)	>140014	D- 62
DENSITY	< MAIN CORE CHARACTERISTICS - AVERAGE POWER DENSITY -	>100004	D- 5
DESCRIPTION	< GENERAL DESCRIPTION OF REACTOR CHARACTERISTICS (1)	>110001	D- 8
DESCRIPTION	< GENERAL DESCRIPTION OF REACTOR CHARACTERISTICS (2)	>110002	D- 10
DESCRIPTION	< GENERAL DESCRIPTION OF REACTOR CHARACTERISTICS (3)	>110003	D- 12
DESCRIPTIONS	< DESCRIPTIONS OF FUEL ASSEMBLY STRUCTURE DESIGN	>120007	D- 26
DESIGN	< SPECIFICATION OF CANDU STANDARD DESIGN	>100005	D- 6
DESIGN	< DESCRIPTIONS OF FUEL ASSEMBLY STRUCTURE DESIGN	>120007	D- 26
DESIGN	< NUCLEAR DESIGN PARAMETERS - PWR -	>110005	D- 13
DESIGN	< DESIGN AND PERFORMANCE OF 304 STAINLESS STEEL CALD FUELS IN VBWR	>700217	D-147
DESIGN	< DESIGN AND PERFORMANCE OF 304 STAINLESS STEEL CLAD FUELS IN VBWR	>700216	D-146
DESIGN	< DESIGN AND PERFORMANCE OF 304 STAINLESS STEEL CLAD FUELS IN VBWR	>700218	D-148
DESIGN	< BASIS FOR FUEL DESIGN - DESIGN CRITERIA -	>110203	D- 18
DESIGN	< SUMMARY OF MIXED-OXIDE FUEL DESIGN PARAMETER - BWR -	>120009	D- 28
DESIGN	< JOYO (FBR) MK-I FUEL ASSEMBLY DESIGN PARAMETERS	>120006	D- 25
DESIGN	< CONNECTICUT YANKEE FUEL SUPPLIERS AND DESIGN PARAMETERS	>120004	D- 23
DESIGN	< CONNECTICUT YANKEE FUEL SUPPLIERS AND DESIGN PARAMETERS (CON'T)	>120005	D- 24
DESIGN	< BASIS FOR FUEL DESIGN - DESIGN CRITERIA -	>110203	D- 18
DESIGNATION	< ZIRCALOY TUBE CHEMICAL REQUIREMENTS - ASTM DESIGNATION -	>150001	D- 66
DESIGNATION	< ROD DESIGNATION - CHARACTERISTIC SETS OF PARAMETER VALUES	>130004	D- 34
DESIGNATION	< PELLET TYPE DESIGNATION - INTER RAMP -	>140001	D- 54
DESIGNS	< CORE DESIGNS FOR OPTIMUM PERFORMANCE - HISTORICAL BWR -	>110201	D- 16
DIAMETER	< INTER RAMP DIAMETER MEASUREMENT DATA (1) -LR,LS.TR-	>700010	D-100
DIAMETER	< INTER RAMP DIAMETER MEASUREMENT DATA (2) -LS,TS,DR,HR-	>700011	D-101
DIAMETER	< INTER RAMP DIAMETER MEASUREMENT DATA (3) -HS,BR-	>700012	D-102

FUEL PERFORMANCE DATA SAKUIN DATA=86-05 PAGE **K- 6**

INDEX WORD	DATA TITLE	F.D.N	DATA PAGE
FUEL	< FUEL ROD ARRAYMENT OF MIXED-OXIDE FUEL ASSEMBLY - BWR -	>120008	D- 27
FUEL	< FUEL BURNUP SANNARY.	>700211	D-143
FUEL	< FUEL BURNUP SUMMARY (CON'T)	>700212	D-143
FUEL	< TENSILE TESTS ON ZIRCALOY-CLAD FUEL FROM AEC FUEL CYCLE PROGRAM	>700214	D-144
FUEL	< DEFINITION OF FUEL DAMAGE	>110204	D- 18
FUEL	< SUMMARY OF MIXED-OXIDE FUEL DESIGN PARAMETER - BWR -	>120009	D- 28
FUEL	< BASIS FOR FUEL DESIGN - DESIGN CRITERIA -	>110203	D- 18
FUEL	< HIGH TEMPERATURE PHYSICAL PROPERTIES OF FUEL ELEMENT MATERIALS-1	>900006	D-152
FUEL	< HIGH TEMPERATURE PHYSICAL PROPERTIES OF FUEL ELEMENT MATERIALS-2	>900007	D-153
FUEL	< COMPARATIVE MANPOWER COSTS FOR FUEL FABRICATION PROCESSES	>140016	D- 63
FUEL	< FUEL FABRICATION QUALITY CONTROL FLOW CHART -INTER RAMP-	>130001	D- 29
FUEL	< CLASSIFICATION OF OBSERVED FUEL FAILURES - ZIRCALOY CLAD -	>300002	D- 90
FUEL	< TENSILE TESTS ON ZIRCALOY-CLAD FUEL FROM AEC FUEL CYCLE PROGRAM	>700214	D-144
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FUEL	< FUEL LINEAR HEAT-GENERATION RATES	>110205	D- 19
FUEL	< SUMMARY OF FUEL MATERIAL PROPERTIES - PU-02 ETC.-	>900002	D-150
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FUEL	< JPDR-II FUEL PELLET DENSITY MEASUREMENT (3)	>140010	D- 60
FUEL	< JPDR-II FUEL PELLET DENSITY MEASUREMENT (4)	>140011	D- 60
FUEL	< JPDR-II FUEL PELLET DENSITY MEASUREMENT (5)	>140012	D- 61
FUEL	< JPDR-II FUEL PELLET DENSITY MEASUREMENT (6)	>140013	D- 61
FUEL	< JPDR-II FUEL PELLET DENSITY MEASUREMENT (7)	>140014	D- 62
FUEL	< CONSTITUTION OF FILING DATA NUMBER FOR FUEL PERFORMANCE DATA	> 1	D- 1
FUEL	< DRAWINGS REFERENCE - PELLET, FUEL ROD, ASSEMBLY, PARTS -*	>130005	D- 34
FUEL	< FUEL ROD ARRAYMENT OF MIXED-OXIDE FUEL ASSEMBLY - BWR -	>120008	D- 27
FUEL	< FUEL ROD COMPONENTS AND SPECIFICATIONS -INTER RAMP-	>130003	D- 33
FUEL	< TEST FUEL ROD DATA -INTER RAMP HS,BR-	>130008	D- 37
FUEL	< TEST FUEL ROD DATA -INTER RAMP LR,LS,TR-	>130006	D- 35
FUEL	< TEST FUEL ROD DATA -INTER RAMR LS,TS,DR,HR-	>130007	D- 36
FUEL	< CHEMICAL ANALYSIS OF ZIRCALOY BAR FOR FUEL ROD END PLUGS	>160001	D- 86
FUEL	< MECHANICAL PROPERTIES OF MATERIAL FOR FUEL ROD END PLUGS	>160002	D- 87
FUEL	< PERIPHERAL FUEL ROD FLATTENING OBSERVATIONS	>700219	D-149
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FUEL	< SUPER RAMP FUEL RODS SPECIFICATION -BWR (1)-	>130019	D- 47
FUEL	< DEMO RAMP FUEL RODS SPECIFICATION -BWR (2)-	>130014	D- 42
FUEL	< SUPER RAMP FUEL RODS SPECIFICATION -BWR (2)-	>130020	D- 48
FUEL	< SUPER RAMP FUEL RODS SPECIFICATION -BWR (3)-	>130021	D- 49
FUEL	< INTER RAMP FUEL RODS SPECIFICATION -HS,BR-	>130012	D- 40
FUEL	< INTER RAMR FUEL RODS SPECIFICATION -LR,LS,TR-	>130010	D- 38
FUEL	< INTER RAMP FUEL RODS SPECIFICATION -LS,TS,DR,HR-	>130011	D- 39
FUEL	< OVER RAMP FUEL RODS SPECIFICATION -PWR (1)-	>130022	D- 50
FUEL	< SUPER RAMP FUEL RODS SPECIFICATION -PWR (1)-	>130015	D- 43
FUEL	< OVER RAMP FUEL RODS SPECIFICATION -PWR (2)-	>130023	D- 51
FUEL	< SUPER RAMP FUEL RODS SPECIFICATION -PWR (2)-	>130016	D- 44
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FUEL	< SUPER RAMP FUEL RODS SPECIFICATION -PWR (3)-	>130017	D- 45
FUEL	< OVER RAMP FUEL RODS SPECIFICATION -PWR (4)-	>130025	D- 53
FUEL	< SUPER RAMP FUEL RODS SPECIFICATION -PWR (4)-	>130018	D- 46
FUEL	< OVER RAMP FUEL RODS SPECIFICATION -PWR (5)-	>130026	D- 54
FUEL	< INTER RAMP FUEL RODS WEIGHT INCREASES (1) -LR,LS,TR-	>700027	D-117
FUEL	< INTER RAMP FUEL RODS WEIGHT INCREASES (2) -LS,TS,DR,HR-	>700028	D-117
FUEL	< INTER RAMP FUEL RODS WEIGHT INCREASES (3) -HS,BR-	>700029	D-118
FUEL	< CONNECTICUT YANKEE FUEL SUPPLIERS AND DESIGN PARAMETERS	>120004	D- 23
FUEL	< CONNECTICUT YANKEE FUEL SUPPLIERS AND DESIGN PARAMETERS (CON'T)	>120005	D- 24
FUEL	< OPERATIONAL REQUIREMENTS FOR LWR FUEL - TYPICAL VALUES -	>110009	D- 15
FUELS	< IRRADIATION BEHAVIORS OF REACTOR FUELS	>300001	D- 88
FUELS	< DESIGN AND PERFORMANCE OF 304 STAINLESS STEEL CALD FUELS IN VBWR	>700217	D-147
FUELS	< DESIGN AND PERFORMANCE OF 304 STAINLESS STEEL CLAD FUELS IN VBWR	>700216	D-146
FUELS	< DESIGN AND PERFORMANCE OF 304 STAINLESS STEEL CLAD FUELS IN VBWR	>700218	D-148
FUEL.	< TENSILE TESTS ON ZIRCALOY CLADDING OF DRESDEN TYPE I FUEL.	>700213	D-144

***** G *****

GAS	< FISSION GAS ANALYSIS SUMMARY	>700209	D-142
GAS	< FISSION GAS ANALYSIS SUNNARY (CON'T)	>700210	D-143
GAS	< VOLUME OF FISSION GAS FORMED AND XE-135 TO XE-136 CONVERSION (1)	>900004	D-151
GAS	< VOLUME OF FISSION GAS FORMED AND XE-135 TO XE-136 CONVERSION (2)	>900005	D-152
GAS	< FISSION GAS RELEASE AND VOID VOLUME DATA FOR CONNECTICUT YANKEE	>700208	D-142
GAS	< FISSION GAS RELEASE MODEL OF HOFFMANN AND COPLIN	>900011	D-156
GAS	< FISSION GAS RELEASE MODELS - DIVIDED INTO TEMPERATURE RANGES -	>900010	D-155
GAS	< INTER RAMP FISSION GAS REREASE DATA (1)	>700030	D-118
GAS	< INTER RAMP FISSION GAS REREASE DATA (2)	>700031	D-119
GASEOUS	< ANALYSIS OF THE CONTENT OF GASEOUS CONSTITUENTS IN TUBES	>150003	D- 68
GENERAL	< GENERAL DESCRIPTION OF REACTOR CHARACTERISTICS (1)	>110001	D- 8

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INDEX WORD	DATA TITLE	F.D.N	DATA PAGE
PARAMETER	< POWER RAMP TEST PARAMETER (DEMO RAMP *BWR* (2))	>700048	D-130
PARAMETER	< POWER RAMP TEST PARAMETER (GE R2 *BWR* (1))	>700042	D-124
PARAMETER	< POWER RAMP TEST PARAMETER (GE R2 *BWR* (2))	>700043	D-125
PARAMETER	< POWER RAMP TEST PARAMETER (INTER RAMP *BWR* (1))	>700044	D-126
PARAMETER	< POWER RAMP TEST PARAMETER (INTER RAMP *BWR* (2))	>700045	D-127
PARAMETER	< POWER RAMP TEST PARAMETER (INTER RAMP *BWR* (3))	>700046	D-128
PARAMETER	< POWER RAMP TEST PARAMETER (OVER RAMP *PWR* (1))	>700055	D-137
PARAMETER	< POWER RAMP TEST PARAMETER (OVER RAMP *PWR* (2))	>700056	D-138
PARAMETER	< POWER RAMP TEST PARAMETER (OVER RAMP *PWR* (3))	>700057	D-139
PARAMETER	< POWER RAMP TEST PARAMETER (OVER RAMP *PWR* (4))	>700058	D-140
PARAMETER	< POWER RAMP TEST PARAMETER (OVER RAMP *PWR* (5))	>700059	D-141
PARAMETER	< POWER RAMP TEST PARAMETER (PETTEN PWR (1))	>700036	D-121
PARAMETER	< POWER RAMP TEST PARAMETER (PETTEN PWR (2))	>700037	D-122
PARAMETER	< POWER RAMP TEST PARAMETER (PETTEN PWR (3))	>700038	D-123
PARAMETER	< POWER RAMP TEST PARAMETER (SUPER RAMP *BWR* (5))	>700053	D-135
PARAMETER	< POWER RAMP TEST PARAMETER (SUPER RAMP *BWR* (6))	>700054	D-136
PARAMETER	< POWER RAMP TEST PARAMETER (SUPER RAMP *PWR* (1))	>700049	D-131
PARAMETER	< POWER RAMP TEST PARAMETER (SUPER RAMP *PWR* (2))	>700050	D-132
PARAMETER	< POWER RAMP TEST PARAMETER (SUPER RAMP *PWR* (3))	>700051	D-133
PARAMETER	< POWER RAMP TEST PARAMETER (SUPER RAMP *PWR* (4))	>700052	D-134
PARAMETERS	< JOYO (FBR) MK-I FUEL ASSEMBLY DESIGN PARAMETERS	>120006	D- 25
PARAMETERS	< CONNECTICUT YANKEE FUEL SUPPLIERS AND DESIGN PARAMETERS	>120004	D- 23
PARAMETERS	< VALUES OF BASIC NUCLEAR PARAMETERS - CRITICAL -	>900001	D-150
PARAMETERS	< PELLETIZING PARAMETERS - INTER RAMP -	>140003	D- 55
PARAMETERS	< MAIN CORE PARAMETERS - MODERATOR/FUEL VOLUME RATIO -	>110004	D- 13
PARAMETERS	< NUCLEAR DESIGN PARAMETERS - PWR -	>110005	D- 13
PARAMETERS	< CONNECTICUT YANKEE FUEL SUPPLIERS AND DESIGN PARAMETERS (CON'T)	>120005	D- 24
PARTS	< DRAWINGS REFERENCE - PELLET, FUEL ROD, ASSEMBLY, PARTS -*	>130005	D- 34
PEAK	< INTER RAMP (PRE-RAMP IRRADIATION DATA AT AXIAL PEAK POWER (1))	>700007	D- 97
PEAK	< INTER RAMP (PRE-RAMP IRRADIATION DATA AT AXIAL PEAK POWER (2))	>700008	D- 98
PEAK	< INTER RAMP (PRE-RAMP IRRADIATION DATA AT AXIAL PEAK POWER (3))	>700009	D- 99
PEAK-TO-AVERAGE	< PEAK-TO-AVERAGE POWER RATIOS (PEAKING FACTOR) IN BWR CORES	>110202	D- 17
PELLET	< DRAWINGS REFERENCE - PELLET, FUEL ROD, ASSEMBLY, PARTS -*	>130005	D- 34
PELLET	< THERMAL SINTERING TEST CONDITION FOR PELLET DENSIFICATION	>140015	D- 62
PELLET	< JPDR-II FUEL PELLET DENSITY MEASUREMENT (1)	>140008	D- 58
PELLET	< JPDR-II FUEL PELLET DENSITY MEASUREMENT (2)	>140009	D- 59
PELLET	< JPDR-II FUEL PELLET DENSITY MEASUREMENT (3)	>140010	D- 60
PELLET	< JPDR-II FUEL PELLET DENSITY MEASUREMENT (4)	>140011	D- 60
PELLET	< JPDR-II FUEL PELLET DENSITY MEASUREMENT (5)	>140012	D- 61
PELLET	< JPDR-II FUEL PELLET DENSITY MEASUREMENT (6)	>140013	D- 61
PELLET	< JPDR-II FUEL PELLET DENSITY MEASUREMENT (7)	>140014	D- 62
PELLET	< METHOD OF MEASUREMENT FOR PELLET GEOMETRICAL DENSITY	>140018	D- 65
PELLET	< PELLET TYPE DESIGNATION - INTER RAMP -	>140001	D- 54
PELLET	< SPACER PELLET - CHEMICAL COMPOSITION AND IMPURITIES, INTER-RP.-	>140006	D- 57
PELLET	< MIXED OXIDE PELLET - CHEMICAL COMPOSITION AND IMPURITIES -	>140005	D- 56
PELLET	< PELLET - CHEMICAL IMPURITIES -	>140002	D- 55
PELLETIZING	< PELLETIZING PARAMETERS - INTER RAMP -	>140003	D- 55
PELLETS	< MOISTURE CONTENT OF PELLETS - INTER RAMP -	>140004	D- 55
PERFORMANCE	< CONSTITUTION OF FILING DATA NUMBER FOR FUEL PERFORMANCE DATA	> 1	D- 1
PERFORMANCE	< DESIGN AND PERFORMANCE OF 304 STAINLESS STEEL CALD FUELS IN VBWR	>700217	D-147
PERFORMANCE	< DESIGN AND PERFORMANCE OF 304 STAINLESS STEEL CLAD FUELS IN VBWR	>700216	D-146
PERFORMANCE	< DESIGN AND PERFORMANCE OF 304 STAINLESS STEEL CLAD FUELS IN VBWR	>700218	D-148
PERFORMANCE	< CORE DESIGNS FOR OPTIMUM PERFORMANCE - HISTORICAL BWR -	>110201	D- 16
PERIPHERAL	< PERIPHERAL FUEL ROD FLATTENING OBSERVATIONS	>700219	D-149
PHYSICAL	< HIGH TEMPERATURE PHYSICAL PROPERTIES OF FUEL ELEMENT MATERIALS-1	>900006	D-152
PHYSICAL	< HIGH TEMPERATURE PHYSICAL PROPERTIES OF FUEL ELEMENT MATERIALS-2	>900007	D-153
PHYSICAL	< PHYSICAL PROPERTIES OF ZIRCON	>900008	D-154
PIE	< INTER RAMP HOT CELL PIE DATA (1) -LR,LS,TR-	>700017	D-107
PIE	< INTER RAMP HOT CELL PIE DATA (2) -LS,TS,OR,HR-	>700018	D-108
PIE	< INTER RAMP HOT CELL PIE DATA (3) -HS,BR-	>700019	D-109
PLUGS	< CHEMICAL ANALYSIS OF ZIRCALOY BAR FOR FUEL ROD END PLUGS	>160001	D- 86
PLUGS	< MECHANICAL PROPERTIES OF MATERIAL FOR FUEL ROD END PLUGS	>160002	D- 87
POINTS	< MELTING AND BOILING POINTS OF OXIDE AND CARBORIDE FUEL	>900003	D-151
POWDER	< UO-2 POWDER CHARACTERISTICS - INTER RAMP -	>140007	D- 57
POWER	< MAIN CORE CHARACTERISTICS - AVERAGE POWER DENSITY -	>100004	D- 5

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FUEL PERFORMANCE DATA SAKUIN DATA=86-05 PAGE **K- 13**

INDEX WORD	DATA TITLE	F.D.N	DATA PAGE
RAMP	< INTER RAMP DIAMETER MEASUREMENT DATA (3) -HS,BR-	>700012	D-102
RAMP	< INTER RAMP FISSION GAS REREASE DATA (1)	>700030	D-118
RAMP	< INTER RAMP FISSION GAS RERELEASE DATA (2)	>700031	D-119
RAMP	< DEMO RAMP FUEL RODS SPECIFICATION -BWR (1)-	>130013	D- 41
RAMP	< SUPER RAMP FUEL RODS SPECIFICATION -BWR (1)-	>130019	D- 47
RAMP	< DEMO RAMP FUEL RODS SPECIFICATION -BWR (2)-	>130014	D- 42
RAMP	< SUPER RAMP FUEL RODS SPECIFICATION -BWR (2)-	>130020	D- 48
RAMP	< SUPER RAMP FUEL RODS SPECIFICATION -BWR (3)-	>130021	D- 49
RAMP	< INTER RAMP FUEL RODS SPECIFICATION -HS,BR-	>130012	D- 40
RAMP	< INTER RAMP FUEL RODS SPECIFICATION -LS,TS,DR,HR-	>130011	D- 39
RAMP	< OVER RAMP FUEL RODS SPECIFICATION -PWR (1)-	>130022	D- 50
RAMP	< SUPER RAMP FUEL RODS SPECIFICATION -PWR (1)-	>130015	D- 43
RAMP	< OVER RAMP FUEL RODS SPECIFICATION -PWR (2)-	>130023	D- 51
RAMP	< SUPER RAMP FUEL RODS SPECIFICATION -PWR (2)-	>130016	D- 44
RAMP	< OVER RAMP FUEL RODS SPECIFICATION -PWR (3)-	>130024	D- 52
RAMP	< SUPER RAMP FUEL RODS SPECIFICATION -PWR (3)-	>130017	D- 45
RAMP	< OVER RAMP FUEL RODS SPECIFICATION -PWR (4)-	>130025	D- 53
RAMP	< SUPER RAMP FUEL RODS SPECIFICATION -PWR (4)-	>130018	D- 46
RAMP	< OVER RAMP FUEL RODS SPECIFICATION -PWR (5)-	>130026	D- 54
RAMP	< INTER RAMP FUEL RODS WEIGHT INCREASES (1) -LR,LS,TR-	>700027	D-117
RAMP	< INTER RAMP FUEL RODS WEIGHT INCREASES (2) -LS,TS,DR,HR-	>700028	D-117
RAMP	< INTER RAMP FUEL RODS WEIGHT INCREASES (3) -HS,BR-	>700029	D-118
RAMP	< INTER RAMP HOT CELL PIE DATA (1) -LR,LS,TR-	>700017	D-107
RAMP	< INTER RAMP HOT CELL PIE DATA (2) -LS,TS,DR,HR-	>700018	D-108
RAMP	< INTER RAMP HOT CELL PIE DATA (3) -HS,BR-	>700019	D-109
RAMP	< INTER RAMP,PRE RAMP IRRADIATION DATA AND RAMP IRRADIATION DATA 2	>700025	D-115
RAMP	< INTER RAMP,PRE RAMP IRRADIATION DATA AND RAMP IRRADIATION DATA 3	>700026	D-116
RAMP	< INTER RAMP,PRE-RAMP IRRADIATION DATA AND RAMP IRRADIATION DATA 1	>700024	D-114
RAMP	< INTER RAMP,PRE RAMP IRRADIATION DATA AND RAMP IRRADIATION DATA 2	>700025	D-115
RAMP	< INTER RAMP,PRE RAMP IRRADIATION DATA AND RAMP IRRADIATION DATA 3	>700026	D-116
RAMP	< INTER RAMP IRRADIATION DATA (1) -LR,LS,TR-	>700004	D- 94
RAMP	< INTER RAMP IRRADIATION DATA (2) -LS,TS,DR,HR-	>700005	D- 95
RAMP	< INTER RAMP IRRADIATION DATA (3) -HS,BR-	>700006	D- 96
RAMP	< RESULTS OF SCC TESTING OF INTER RAMP MATERIAL *1)	>700020	D-110
RAMP	< INTER RAMP MEASUREMENTS DATA (1) FOR BIRP-2 AND BIRP-4	>700013	D-103
RAMP	< INTER RAMP MEASUREMENTS DATA (2) FOR BIRP-2 AND BIRP-4	>700014	D-104
RAMP	< INTER RAMP MEASUREMENTS DATA (3) FOR BIRP-2 AND BIRP-4	>700015	D-105
RAMP	< INTER RAMP MEASUREMENTS DATA (4) FOR BIRP-2 AND BIRP-4	>700016	D-106
RAMP	< INTER RAMP,PRE RAMP IRRADIATION DATA AND RAMP IRRADIATION DATA 2	>700025	D-115
RAMP	< INTER RAMP,PRE RAMP IRRADIATION DATA AND RAMP IRRADIATION DATA 3	>700026	D-116
RAMP	< INTER RAMP,PRE-RAMP IRRADIATION DATA AND RAMP IRRADIATION DATA 1	>700024	D-114
RAMP	< TEST MATRIX OF THE INTER RAMP PROJECT (1) -LR,LS,TR-	>700001	D- 91
RAMP	< TEST MATRIX OF THE INTER RAMP PROJECT (2) -LS,TS,DR,HR-	>700002	D- 92
RAMP	< TEST MATRIX OF THE INTER RAMP PROJECT (3) -HS,BR-	>700003	D- 93
RAMP	< INTER RAMP ROD LENGTH MEASUREMENT DATA (1) -LR,LS,TR-	>700021	D-111
RAMP	< INTER RAMP ROD LENGTH MEASUREMENT DATA (2) -LS,TS,DR,HR-	>700022	D-112
RAMP	< INTER RAMP ROD LENGTH MEASUREMENT DATA (3) -HS,BR-	>700023	D-113
RAMP	< POWER RAMP TEST PARAMETER (DEMO RAMP *BWR* (1))	>700047	D-129
RAMP	< POWER RAMP TEST PARAMETER (DEMO RAMP *BWR* (2))	>700048	D-130
RAMP	< POWER RAMP TEST PARAMETER (GE R2 *BWR* (1))	>700042	D-124
RAMP	< POWER RAMP TEST PARAMETER (GE R2 *BWR* (2))	>700043	D-125
RAMP	< POWER RAMP TEST PARAMETER (INTER RAMP *BWR* (1))	>700044	D-126
RAMP	< POWER RAMP TEST PARAMETER (INTER RAMP *BWR* (2))	>700045	D-127
RAMP	< POWER RAMP TEST PARAMETER (INTER RAMP *BWR* (3))	>700046	D-128
RAMP	< POWER RAMP TEST PARAMETER (OVER RAMP *PWR* (1))	>700055	D-137
RAMP	< POWER RAMP TEST PARAMETER (OVER RAMP *PWR* (2))	>700056	D-138
RAMP	< POWER RAMP TEST PARAMETER (OVER RAMP *PWR* (3))	>700057	D-139
RAMP	< POWER RAMP TEST PARAMETER (OVER RAMP *PWR* (4))	>700058	D-140
RAMP	< POWER RAMP TEST PARAMETER (OVER RAMP *PWR* (5))	>700059	D-141
RAMP	< POWER RAMP TEST PARAMETER (PETTEN PWR (1))	>700036	D-121
RAMP	< POWER RAMP TEST PARAMETER (PETTEN PWR (2))	>700037	D-122
RAMP	< POWER RAMP TEST PARAMETER (PETTEN PWR (3))	>700038	D-123
RAMP	< POWER RAMP TEST PARAMETER (SUPER RAMP *BWR* (5))	>700053	D-135
RAMP	< POWER RAMP TEST PARAMETER (SUPER RAMP *BWR* (6))	>700054	D-136
RAMP	< POWER RAMP TEST PARAMETER (SUPER RAMP *PWR* (1))	>700049	D-131
RAMP	< POWER RAMP TEST PARAMETER (SUPER RAMP *PWR* (2))	>700050	D-132
RAMP	< POWER RAMP TEST PARAMETER (SUPER RAMP *PWR* (3))	>700051	D-133
RAMP	< POWER RAMP TEST PARAMETER (SUPER RAMP *PWR* (4))	>700052	D-134
RAMP	< PELLETIZING PARAMETERS - INTER RAMP -	>140003	D- 55
RAMP	< PELLET TYPE DESIGNATION - INTER RAMP -	>140001	D- 54
RAMP	< MOISTURE CONTENT OF PELLETS - INTER RAMP -	>140004	D- 55
RAMP	< UO-2 POWDER CHARACTERISTICS - INTER RAMP -	>140007	D- 57
RAMP	< GRAIN SIZE IN ZIRCALOY TUBES - INTER RAMP -	>150012	D- 73
RAMP	< WALL THICKNESS OF TUBES - MEASUREMENT, INTER RAMP -	>150004	D- 68
RAMP	< MECHANICAL PROPERTIES OF CLADDING TUBES - INTER RAMP -	>150006	D- 70
RAMP	< POWER RAMP TEST PARAMETER (INTER RAMP *BWR* (1))	>700044	D-126
RAMP	< POWER RAMP TEST PARAMETER (INTER RAMP *BWR* (2))	>700045	D-127
RAMP	< POWER RAMP TEST PARAMETER (INTER RAMP *BWR* (3))	>700046	D-128
RAMP	< POWER RAMP TEST PARAMETER (SUPER RAMP *BWR* (5))	>700053	D-135
RAMP	< POWER RAMP TEST PARAMETER (SUPER RAMP *BWR* (6))	>700054	D-136

表－4　燃料集合体等の名称と番号

(Table 4 Name and numbering of compiled fuel assemblies and rods)

EDIT NO.	IDENTIFICATION NASS	IDENTIFICATION NROD	NAME OF ASSEMBLY OR ROD ETC. (1)	(2)	(3)	(4)	(5)	(6)	(7)
1	1001000	0	STUDVIK	INTER-RP	COMMON	DATA			
2	1001010	0	STUDVIK	INTER-RP	HS				
3	1001020	0	STUDVIK	INTER-RP	LS				
4	1001030	0	STUDVIK	INTER-RP	TS				
5	1001040	0	STUDVIK	INTER-RP	BR				
6	1001050	0	STUDVIK	INTER-RP	HR				
7	1001060	0	STUDVIK	INTER-RP	DR				
8	1001070	0	STUDVIK	INTER-RP	LR				
9	1001001	1000000	STUDVIK	INTER-RP	LR-1(E)	PELLET			
10	1001001	1001001	STUDVIK	INTER-RP	LR-1(E)	CLADDING			
11	1001080	0	STUDVIK	INTER-RP	TR				
12	1002000	0	STUDVIK	DEMO -RP	COMMON	DATA			
13	1003000	0	STUDVIK	SUPER-RP	COMMON	DATA			
14	1004000	0	STUDVIK	OVER -RP	COMMON	DATA			
15	2001000	0	BATTELLE	TASK 2A	COMMON	DATA			
16	2001001	1	BATTELLE		D-209	PELLET			
17	2001001	2000000	BATTELLE		D-209	CLADDING			
18	3001001	0	HALDEN	IFA-106					
19	3001001	10	HALDEN	IFA-106	MA1068	UPPER			
20	3002001	0	HALDEN	IFA-107					
21	3003001	0	HALDEN	IFA-149					
22	3004001	0	HALDEN	IFA-150					
23	3005001	0	HALDEN	IFA-208					
24	3006001	0	HALDEN	IFA-209					
25	3007001	0	HALDEN	IFA-224					
26	3008001	0	HALDEN	IFA-225					
27	3009000	0	HALDEN	IFA-405					
28	3009001	1000000	HALDEN	IFA-405	/613	PELLET			
29	3009001	2000000	HALDEN	IFA-405	/613	CLADDING			
30	50000001	0	PWR	11X11	MUTSU				
31	50001001	0	PWR	14X14	STD.				
32	50002002	0	PWR	15X15	STD.				
33	50003001	0	PWR	17X17	STD.				
34	50020000	0	PWR	16X16	KWU				
35	50020001	0	HCPWR	KWU	TRIANGLE				
36	70000001	0	BWR	6X6	JPDR				
37	70000002	0	BWR	7X7	JPDR-II				
38	70001001	0	BWR	7X7	INITIAL				
39	70001002	0	BWR	7X7	REV.				
40	70002001	0	BWR	8X8	WR(1)				
41	70002002	0	BWR	8X8	WR(2)				
42	70003000	0	BWR	9X9	CONCEPT				
43	80001001	0	ATR	EXP.					
44	80002001	0	FBR	EXP.					

表－5　燃料集合体．等の番号からの索引

(Table 5 Index from number of fuel assemblies and rods)

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        *--IDENTIFICATION--*
EDIT NO. *-NASS--*  *-NROD--*  *----- <NAME OF ASSEMBLY OR ROD ETC.> OR  DATA TITLE  ----------*   -*FDN-*-

      1    1001000          0  <STUDVIK  INTER-RP COMMON   DATA                                >

                                FUEL FABRICATION QUALITY CONTROL FLOW CHART   -INTER RAMP-          -130001-
                                OVERALL FLOW SCHEME FOR THE INTER-RAMP EXPERIMENTAL FUEL          -130002-
                                FUEL ROD COMPONENTS AND SPECIFICATIONS   -INTER RAMP-            -130003-
                                ROD DESIGNATION - CHARACTERISTIC SETS OF PARAMETER VALUES         -130004-
                                DRAWINGS REFERENCE - PELLET, FUEL ROD, ASSEMBLY, PARTS -*         -130005-
                                TEST FUEL ROD DATA   -INTER RAMP  LR,LS,TR-                       -130006-
                                TEST FUEL ROD DATA   -INTER RAMR  LS,TS,DR,HR-                    -130007-
                                TEST FUEL ROD DATA   -INTER RAMP  HS,BR-                          -130008-
                                TEST ROD DIMENSIONS AND WEIGHTS   -INTER RAMP  LR-                -130009-
                                INTER RAMR FUEL RODS SPECIFICATION   -LR,LS,TR-                   -130010-
                                INTER RAMP FUEL RODS SPECIFICATION   -LS,TS,DR,HR-                -130011-
                                INTER RAMP FUEL RODS SPECIFICATION   -HS,BR-                      -130012-
                                PELLET TYPE DESIGNATION - INTER RAMP -                            -140001-
                                PELLETIZING PARAMETERS - INTER RAMP -                             -140003-
                                MOISTURE CONTENT OF PELLETS - INTER RAMP -                        -140004-
                                UO-2 POWDER CHARACTERISTICS - INTER RAMP -                        -140007-
                                CLADDING MATERIAL - ZIRCALOY CHEMICAL COMPOSITION & IMPURITIES -  -150002-
                                ANALYSIS OF THE CONTENT OF GASEOUS CONSTITUENTS IN TUBES           -150003-
                                WALL THICKNESS OF TUBES - MEASUREMENT, INTER RAMP -               -150004-
                                MECHANICAL PROPERTIES OF CLADDING TUBES - INTER RAMP -            -150006-
                                BURST PROPERTIES FOR CLADDING TUBES                               -150007-
                                CORROSION PROPERTIES FOR ZIRCALOY CLADDING TUBES                  -150009-
                                HYDRIDE ORIENTATION METHOD AND RESULTS FOR CLADDING TUBES         -150010-
                                HYDRIDE ORIENTATION FACTOR (FN) FOR CLADDING TUBES - INTER-RP. -  -150011-
                                GRAIN SIZE IN ZIRCALOY TUBES - INTER RAMP -                       -150012-
                                CHEMICAL ANALYSIS OF ZIRCALOY BAR FOR FUEL ROD END PLUGS          -160001-
                                MECHANICAL PROPERTIES OF MATERIAL FOR FUEL ROD END PLUGS          -160002-
                                CHEMICAL ANALYSIS RESULTS OF FUEL HOLDOOWN SPRING MATERIAL        -160003-
                                MECHANICAL PROPERTIES OF HOLDDOWN SPRING MATERIAL                 -160004-
                                TEST MATRIX OF THE INTER RAMP PROJECT (1)   -LR,LS,TR-           -700001-
                                TEST MATRIX OF THE INTER RAMP PROJECT (2)   -LS,TS,DR,HR-         -700002-
                                TEST MATRIX OF THE INTER RAMP PROJECT (3)   -HS,BR-               -700003-
                                INTER RAMP IRRADIATION DATA (1)   -LR,LS,TR-                      -700004-
                                INTER RAMP IRRADIATION DATA (2)   -LS,TS,DR,HR-                   -700005-
                                INTER RAMP IRRADIATION DATA (3)   -HS,BR-                         -700006-
                                INTER RAMP (PRE-RAMP IRRADIATION DATA AT AXIAL PEAK POWER (1) )   -700007-
                                INTER RAMP (PRE-RAMP IRRADIATION DATA AT AXIAL PEAK POWER (2) )   -700008-
                                INTER RAMP (PRE-RAMP IRRADIATION DATA AT AXIAL PEAK POWER (3) )   -700009-
                                INTER RAMP DIAMETER MEASUREMENT DATA (1)   -LR,LS.TR-             -700010-
                                INTER RAMP DIAMETER MEASUREMENT DATA (2)   -LS,TS,DR,HR-          -700011-
                                INTER RAMP DIAMETER MEASUREMENT DATA (3)    -HS,BR-               -700012-
                                INTER RAMP MEASUREMENTS DATA (1) FOR B1RP-2 AND BIRP-4            -700013-
                                INTER RAMP MEASUREMENTS DATA (2) FOR BIRP-2 AND BIRP-4            -700014-
                                INTER RAMP MEASUREMENTS DATA (3) FOR BIRP-2 AND BIRP-4            -700015-
                                INTER RAMP MEASUREMENTS DATA (4) FOR BIRP-2 AND BIRP-4            -700016-
                                INTER RAMP HOT CELL PIE DATA (1)   -LR,LS,TR-                     -700017-
                                INTER RAMP HOT CELL PIE DATA (2)   -LS,TS,DR,HR-                  -700018-
                                INTER RAMP HOT CELL PIE DATA (3)   -HS,BR-                        -700019-
                               RESULTS OF SCC TESTING OF INTER RAMP MATERIAL  *1)                 -700020-
                                INTER RAMP ROD LENGTH MEASUREMENT DATA (1)   -LR,LS,TR-           -700021-
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        *--IDENTIFICATION--*
EDIT NO. *-NASS--*  *-NROD--*  *----- <NAME OF ASSEMBLY OR ROD ETC.> OR  DATA TITLE ----------*   -*FDN-*-

                                INTER RAMP ROD LENGTH MEASUREMENT DATA (2)    -LS,TS,DR,HR-          -700022-
                                INTER RAMP ROD LENGTH MEASUREMENT DATA (3)    -HS,BR-                -700023-
                                INTER RAMP,PRE-RAMP IRRADIATION DATA AND RAMP IRRADIATION DATA 1      -700024-
                                INTER RAMP,PRE RAMP IRRADIATION DATA AND RAMP IRRADIATION DATA 2      -700025-
                                INTER RAMP,PRE RAMP IRRADIATION DATA AND RAMP IRRADIATION DATA 3      -700026-
                                INTER RAMP FUEL RODS WEIGHT INCREASES (1)    -LR,LS,TR-             -700027-
                                INTER RAMP FUEL RODS WEIGHT INCREASES (2)    -LS,TS,DR,HR-          -700028-
                                INTER RAMP FUEL RODS WEIGHT INCREASES (3)    -HS,BR-                -700029-
                                INTER RAMP FISSION GAS REREASE DATA (1)                             -700030-
                                INTER RAMP FISSION GAS REREASE DATA (2)                             -700031-
                                INTER RAMP CLAD TENSILE TESTING RESULT (1)    -LS-                  -700032-
                                INTER RAMP CLAD TENSILE TESTING RESULT (2)    -LS-                  -700033-
                                INTER RAMP CLAD TENSILE TESTING RESULT (3)    -HR-                  -700034-
                                INTER RAMP CLAD TENSILE TESTING RESULT (4)    -TR-                  -700035-
                                POWER RAMP TEST PARAMETER (PETTEN  PWR (1) )                        -700036-
                                POWER RAMP TEST PARAMETER (PETTEN  PWR (2) )                        -700037-
                                POWER RAMP TEST PARAMETER (PETTEN  PWR (3) )                        -700038-
                                POWER RAMP TEST PARAMETER (GE  R2   *BWR* (1) )                     -700042-
                                POWER RAMP TEST PARAMETER (GE  R2   *BWR* (2) )                     -700043-
                                POWER RAMP TEST PARAMETER (INTER RAMP *BWR* (1) )                   -700044-
                                POWER RAMP TEST PARAMETER (INTER RAMP *BWR* (2) )                   -700045-
                                POWER RAMP TEST PARAMETER (INTER RAMP *BWR* (3) )                   -700046-

     9    1001001    1000000  <STUDVIK  INTER-RP LR-1(E)  PELLET                                  >

                                PELLET - CHEMICAL IMPURITIES -                                      -140002-
                                SPACER  PELLET - CHEMICAL COMPOSITION AND IMPURITIES, INTER-RP.-     -140006-

    12    1002000          0  <STUDVIK  DEMO -RP COMMON   DATA                                     >

                                DEMO RAMP FUEL RODS SPECIFICATION   -BWR (1)-                      -130013-
                                DEMO RAMP FUEL RODS SPECIFICATION   -BWR (2)-                      -130014-
                                POWER RAMP TEST PARAMETER (DEMO RAMP  *BWR* (1) )                   -700047-
                                POWER RAMP TEST PARAMETER (DEMO RAMP  *BWR* (2) )                   -700048-

    13    1003000          0  <STUDVIK  SUPER-RP COMMON   DATA                                     >

                                SUPER RAMP FUEL RODS SPECIFICATION   -PWR (1)-                     -130015-
                                SUPER RAMP FUEL RODS SPECIFICATION   -PWR (2)-                     -130016-
                                SUPER RAMP FUEL RODS SPECIFICATION   -PWR (3)-                     -130017-
                                SUPER RAMP FUEL RODS SPECIFICATION   -PWR (4)-                     -130018-
                                SUPER RAMP FUEL RODS SPECIFICATION   -BWR (1)-                     -130019-
                                SUPER RAMP FUEL RODS SPECIFICATION   -BWR (2)-                     -130020-
                                SUPER RAMP FUEL RODS SPECIFICATION   -BWR (3)-                     -130021-
                                POWER RAMP TEST PARAMETER (SUPER RAMP *PWR* (1) )                   -700049-
                                POWER RAMP TEST PARAMETER (SUPER RAMP *PWR* (2) )                   -700050-
                                POWER RAMP TEST PARAMETER (SUPER RAMP *PWR* (3) )                   -700051-
                                POWER RAMP TEST PARAMETER (SUPER RAMP *PWR* (4) )                   -700052-
                                POWER RAMP TEST PARAMETER (SUPER RAMP *BWR* (5) )                   -700053-
                                POWER RAMP TEST PARAMETER (SUPER RAMP *BWR* (6) )                   -700054-

    14    1004000          0  <STUDVIK  OVER -RP COMMON   DATA                                     >

                                OVER RAMP FUEL RODS SPECIFICATION   -PWR (1)-                      -130022-
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            *--IDENTIFICATION--*
EDIT NO. *-NASS--*  *-NROD--*  *---- &lt;NAME OF ASSEMBLY OR ROD ETC.&gt; OR  DATA TITLE -----------*  -*FDN-*-
                                JOYO (FBR) MK-I FUEL ASSEMBLY DESIGN PARAMETERS                   -120006-
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