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Atomic Energy of Canada Limited

**NRX AND NRU REACTOR RESEARCH FACILITIES  
AND IRRADIATION AND EXAMINATION CHARGES**

IOP-4-B

by

AECL STAFF

Chalk River, Ontario

August, 1960

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ATOMIC ENERGY OF CANADA LIMITED  
Chalk River Project  
Operations Division

NRX & NRU REACTOR RESEARCH FACILITIES

&

IRRADIATION & EXAMINATION CHARGES

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The charges quoted here are those in effect at the time this report was issued, but are liable to change without notice.

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INTRODUCTION

This manual is in two parts (5 & 6), parts 1-2-3 & 4 are detailed in part A of this manual "Method of Applying for Use of NRX and NRU Irradiation & Examination Facilities at Chalk River by External Organizations".

Part 5 - Reactor Research Facilities Available in NRX & NRU

Part 6 - Irradiation & Examination Charges

These parts supersede AECL reports IOP-2 and IOI-139-B.

REACTOR RESEARCH FACILITIES AVAILABLE IN NRX AND NRU

NRU General

NRU reactor is a heavy-water moderated, heavy-water cooled, high flux reactor. Light-water is used as a secondary coolant and as a reflector which surrounds the reactor vessel. The reactor vessel is 11' 6" in diameter x 11' 10" high. The present operating power is 200 megawatts. Fuel assemblies consist of five flat strips of uranium 10' long, encased in aluminum. The maximum heat output of such a rod is approximately 2,000 Kilowatts. There are 227 lattice positions; of these two are special loop facilities, 18 are occupied by control-shutoff rods, one is reserved for a pneumatic tray rod, 200 are available for fuel and research and six are plugged.

Flux values for the reactor are detailed in Part 6.

All dimensions given and flux figures are for guidance only, and should be confirmed with AECL before any design work is carried out. The flux figures are primarily design figures and definitely should not be used in design work.

Appendix "A" illustrates the NRU lattice.

NRU Experimental Holes

To provide facilities for research, about 20 horizontal holes are available that allow access to the high flux regions of the reactor. The holes pass through the reactor shield and permit insertion of samples for irradiation, or a beam of neutrons may be used for experiments at the face of the reactor. A flux as high as  $2.0 \times 10^{14}$  neutrons/cm<sup>2</sup>/sec is available (in the through tubes).

Two positions provide access through the reactor core by means of elliptical holes 4.125" x 2.875" inside dimensions. However, only one position, C2-N2, at present permits installation within the reactor core. Others are extended into the reactor core by re-entrant cans, extending inward about 17" into the vessel.

The holes are fitted with gates which can be raised or lowered by mechanisms at the top of the reactor. These gates provide adequate shielding while plugs or experiments are being removed from the reactor in a shutdown state.

#### NRU Thermal Column

The thermal column is a major research facility. It provides a large volume in which neutrons are present and is designed so that there is a minimum of high energy neutrons and gamma radiation.

The column is built up of high density graphite blocks to form a structure approximately 8' square at the inner end to 10' 5" square at the outside and it is 12' long. Access is provided by five longitudinal and eight transfer holes.

#### NRU J-Rod Annulus

Outside the reactor vessel is a 6" annulus filled with CO<sub>2</sub> known as the J-Rod Annulus. The Annulus can accommodate 46 vertical irradiation assemblies.

#### NRU J-Rods

The J-Rod holes are fitted with aluminum thimbles 28' long which extend from the master plate to a lower service space. The thimbles

are fitted at the top with stumps and stump caps and are secured to form a liquid seal with the master plate. There are coolant connections on each stump and expansion bellows are attached at the bottom to make a  $\text{CO}_2$  seal.

The J-rods are water cooled at a flow rate of 6 gpm.

There are four large J-rod positions, three being intended as vertical experimental irradiation facilities.

#### NRU Loops

It should be borne in mind, when planning experimental investigations in loops, that the insertion and removal of test elements is only possible when the reactor is shutdown. The phasing of experiments with scheduled reactor shutdowns, therefore, of great importance.

#### J-16 Loop

This loop, controlled by the United States Atomic Energy Commission, consists of five units:-

- a. In-pile pressure tube.
- b. A hot loop.
- c. A standby loop.
- d. A decontamination centre.
- e. A purification and instrument centre.

The loop is fabricated from Carbon Steel and is designed to remove a maximum of 1.5 MW of heat at an operating pressure of 2400 psi and an average temperature of  $560^{\circ}\text{F}$ .

One loop (b) is on stream, and the other (c) is on standby at the same operating conditions of temperature and pressure as (b), so that in the event of a component failure, the loops can be switched and the test continued.

The pressure tube is 31' long 4" OD, 2.9" ID and is fabricated from Zircaloy-2.

The specimen holder consists of a cluster of four flow tubes 1.08" OD by 0.955" ID by 25' long, fabricated from Zircaloy-2.

In-reactor section of the loop was designed to provide an irradiation facility capable of handling a number of specimens. Experiments carried out consist largely of corrosion and heat transfer studies, using both integral and defected specimens.

#### E-20 Loop

This loop owned by AECL consists of:-

- a. Main Loop
- b. Auxiliary Systems
- c. Control Alarm & Indication Equipment
- d. Miscellaneous Equipment

The E-20 loop is fabricated from 300 series stainless steels and is designed to remove a nominal 1.65 MW of heat at maximum operating conditions of 2500 psig at 630°F.

In-reactor pressure tube is 31' long, 4" OD, 3" ID, and is fabricated from Zircaloy-2, maximum operating conditions for this pressure tube are 2050 psig at 600°F. An alternative pressure tube 4" OD and 3.25" ID fabricated from Zircaloy-2 is available

for installation and will be installed in July, 1960. It is unlikely that the smaller ID tube will ever be re-installed.

Some of the studies for which this facility can be used includes the following:-

- a. Behaviour of test elements and cladding when subjected to intense radiation and high heat transfer rates.
- b. Mass transfer of material leading to fouling of coolant passages and high activity outside the core area.
- c. Condition of coolant water - control of purity by ion exchangers and filters and decomposition effects due to neutron and gamma radiation.

#### NRX General

NRX reactor is a heavy-water moderated, light-water cooled, high flux reactor. The core is contained in a cylindrical aluminum vessel, 8.75' in diameter x 10.5' high, surrounded by a graphite reflector. The present operating power is 40 megawatts. Fuel assemblies consist of uranium metal rods, 1.36" in diameter x 10' long, encased in aluminum and cooled by river water. The maximum permissible heat output of such a rod is 400 kilowatts at a reactor power of 40 megawatts. There are 198 lattice positions, six of which are used for special loop facilities, six for shut-off rods and the remainder being used for fuel and research facilities, plus a Central Thimble (X-5 loop).

Flux values for the reactor are detailed in Part 6.

All dimensions given and flux figures are for guidance only, and should be confirmed with AECL before any design work is carried out.

Appendix B illustrates the NXR lattice and Appendix C indicates the circles applicable to any given position.

NRX J-Rod Annulus

The J-rod annulus surrounding the calandria is suitable for installing irradiations the full height (10.5 ft.) of the calandria and not more than 1.75" in diameter.

There are 89 positions in the J-rod annulus which can be used for irradiations. Rods are suspended from shoulders resting in conical seats in the master plate. Active sections of a rod are cooled by the main air-flow (approximately 16,000 cfm) through the reflector annulus.

Rate of heat production in one full length experimental rod must be limited to 0.5 to 1 KW if all heat is to be removed by the normal air cooling.

NRX Self-Serve Units

The self-serve units are designed to facilitate the irradiation of small specimens of material, contained in a capsule, in the pile. The primary limitation, imposed by the design, is that the specimen capsule must be of a suitable size and nature for enclosure in a 2.25" diameter sphere. The same capsule (1.75" height x 0.875" OD) as used in Tray-rods is normally utilized.

There are eighteen self-serve units, three capable of holding five spheres each and the remainder three spheres each. The three, five-sphere units, extend to the calandria face, while the remaining fifteen, three-sphere units, terminate in the J-rod annulus.

At each unit a stepped hole, 3.25" minimum diameter, extends horizontally through the pile shielding into the graphite reflector.

Spheres are cooled by air and their heat output limit is 30 Watts.

#### NRX Experimental Holes

The pile contains twelve 4" diameter holes and three 12" diameter holes which extend horizontally through the shielding and graphite reflector to the face of the calandria.

A hole is lined with aluminum through the graphite reflector and steel tubing through the side thermal shield and concrete. The latter section of the hole is stepped to provide breaks in the radiation path. When not in use for experimental purposes the hole is plugged.

#### NRX Thermal Column

Two thermal columns are provided as a means of obtaining thermal neutron beams of high purity and large cross-section.

The facility is built up of graphite block to form a structure six feet square.

#### NRX Loops

##### X-1, X-2, X-3, X-6 Loops

These loops (previously known as CRIV-X-1, CRIV-X-2, CRIV-X-3, and CRVI) are interchangeable consisting of pressurized water cooled tubes (0.935" ID). Test sections can be designed for up to 2,500 psia at 500°F. Three of the loops are controlled by the United States Atomic Energy Commission.

The loops are used primarily for the testing of reactor fuels and are located in circle 10 of NXR.

Sufficient space is available for an irradiation up to 10' in length.

#### X-4 Loop

This loop (previously known as the Leo-Loop or EEC Loop) is the same size as the X-1, 2, 3 & 6 loops. The section will be cooled with steam at about 800°F flowing at 800 lb/hr. Control of the loop is 50% UKAEA and 50% AECL.

#### X-5 Loop

This loop (previously known as the CRV or Central Thimble loop) consists of a Zircaloy-2 pressure tube, 3.136" ID, 4.52" OD, and extends vertically through the centre of the calandria. This position provides facilities for measurement or for sample irradiation and the neutron density is the highest available in NRX. The loop has space sufficient for an irradiation up to 10 ft. long.

#### X-7 Loop

The loop is located in Circle 16. This is an organic-cooled loop and has a 1.5" D pressure tube. The test section is designed for a minimum of 200 psig at 800°F. In order to keep the outer sheath below 300°F, the pressure tube is surrounded by an air insulating annulus and a H<sub>2</sub>O filled annulus.

#### X-Rod Positions

Positions in the calandria, normally used for fuel rods, may be utilized for experimental irradiations. These positions have a maximum diameter of 2.25" and a length of 10 feet.

#### NRX Instrument Holes

Instrument holes are available for experimental purposes. They are nearly tangential to the inner face of the reflector. The diameters are 2.875" through the reflector expanding to 3.75" through the shielding. A 2.875" square opening is cut at the point of tangency of each hole and the inner surface of the reflector to allow cooling air to flow from the outside of the pile to the calandria space.

#### NRX Hydraulic Rabbit Facility

This facility consists of a rod, with a bore of 0.625", located in circle 10. It is intended for the irradiation of fuel slugs of high specific power.

Fuel is propelled to and from the calandria by the cooling water stream and is stopped at the flux centerline.

Installation and removal is independent of reactor shutdowns.

Non-return springs are provided to support the lower end of the fuel during irradiation and to prevent irradiated slugs from returning to the installation area.

#### NRX Pneumatic Carrier Rods

The pneumatic carrier rods provide a means for easy rapid insertion and removal of very small samples in the high flux positions. The samples may be installed and removed while the reactor is operating.

NRX Tray-Rods

These can be installed in any circle of NRX and removed under power. A rod consists of an aluminum sheath and can hold up to 30 individual specimens. Each specimen is canned in an aluminum can 1.75" height x 0.875" OD. Heat output of any one specimen is limited to 50 watts - calculated at maximum reactor flux; air cooling is used.

NRX Transformer Rods

Three types of rod are in use:-

(1) Low temperature

This type contains a natural uranium sleeve into which a sample can be loaded for irradiation in a fast neutron flux.

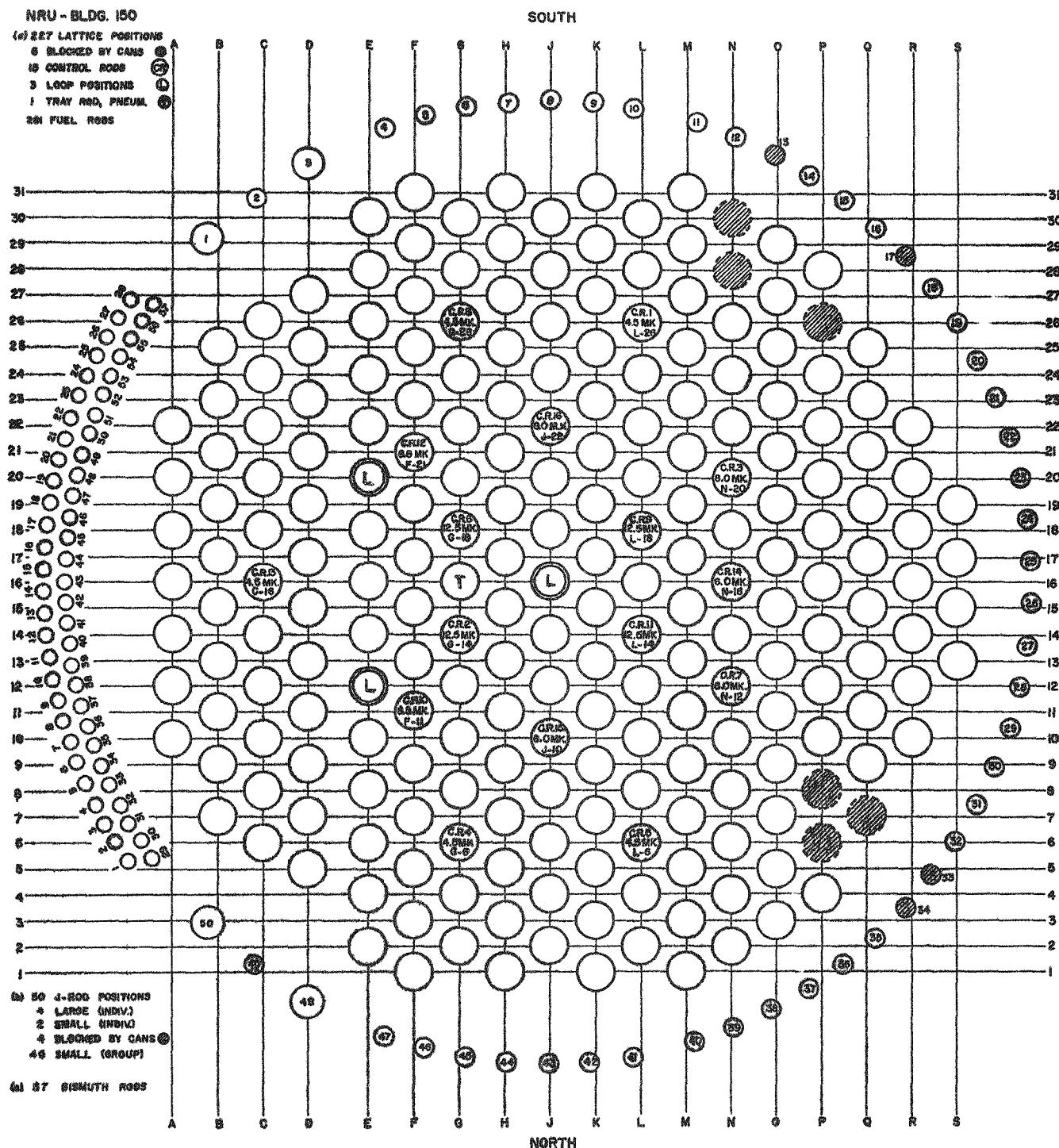
(2) Multi-Sample

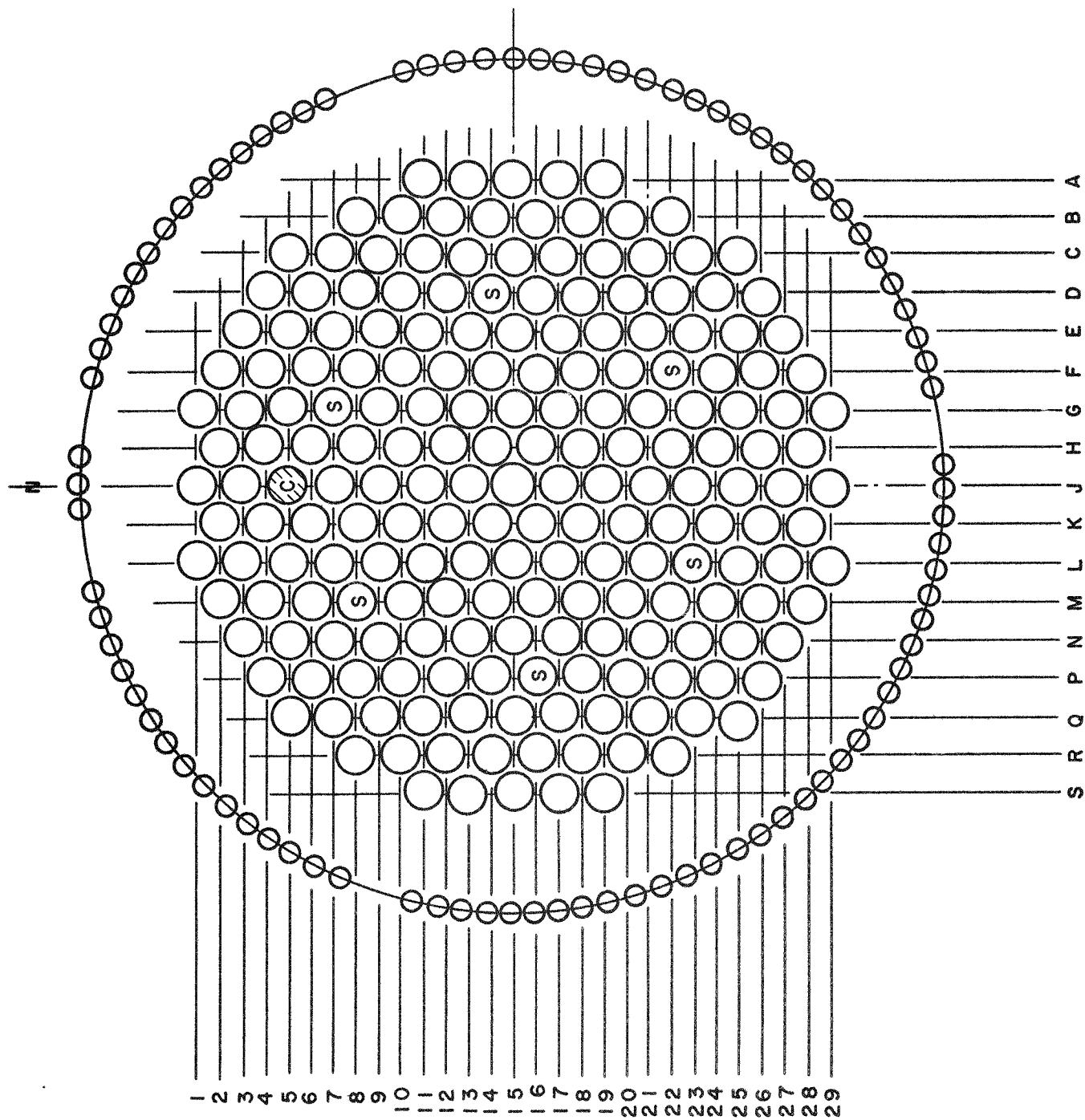
This type contains a natural uranium sleeve into which several specimens can be placed in a fast neutron flux.

(3) High Temperature

This type is designed to irradiate samples in a fast neutron flux at high temperatures of  $\sim 500^{\circ}\text{F}$ .

## Appendix A





ROD POSITIONS

CIRCLE	A	B	C	D	E	F	G	H	J	K	L	M	N	P	Q	R	S
1								14 16	13 17	14 16							
2							15	12 18		12 18	15						
3							13 17		11 19		13 17						
4					14 16	11 19	10 20		10 20	11 19	14 16						
5					12 18			9 21			12 18						
6				15		9 21				9 21		15					
7				13 17	10 20		8 22		8 22		10 20	13 17					
8				11 19				7 23				11 19					
9				14 16		8 22	7 23			7 23	8 22	14 16					
10				12 18	9 21		6 24		6 24		9 21	12 18					
11				10 20				2 25			6 24		10 20				
12			15			6 24				6 24		15					
13			13 17		23		5 25			5 25	7 23	13 17					
14			11 19	8 22			4 26		4 26		8 22	11 19					
15			9 21				3 27					9 21					
16		14 16			5 25	4 26				4 26	5 25	14 16					
17		12 18		6 24		3 27			3 27		6 24	12 18					
18		10 20	7 23				2 28		2 28			7 23	10 20				
19	15				3 27						3 27				15		
20	13 17			4 26		2 28				2 28	4 26		13 17				
21			8 22					1 29		1 29		8 22					
22	11 19		5 25			1 29				1 29	5 25	11 19					

IRRADIATION & EXAMINATION CHARGES

1. INTRODUCTION

This part supersedes IOP-2 and IOI-139-B.

All costs at Chalk River will be accrued on a 100% basis. However, if an irradiation is of interest to AECL a portion of the costs incurred, other than Reactivity, may be paid by AECL. This division, if any, will be determined by AECL. (See IOP-4-A, Part 1, Section 5.)

Should an applicant require costs to be assessed differently to those contained in this section, he should submit his request, in writing, to Production Planning and Control Branch.

All charges assessed against an irradiation will be billed to the applicant monthly by AECL Finance Division under a charge number allocated for the irradiation.

Fabrication, assembly, installation and operational maintenance costs will be accrued against work orders issued by AECL Maintenance and Power Branch.

Overhead charges are 100% of all labour costs incurred by Maintenance and Power Branch and will be charged at AECL prevailing rate wage scale.

Charges for Reactor Personnel will be accrued against a job number allocated for the irradiation by Finance Division and will be assessed at a set rate of \$14.00/hr. staff and \$7.50/hr. prevailing rate employees.

Time spent by prevailing rate personnel will be obtained from "Time-Cards" and staff time from "Staff Work Sheets".

However, Research and Development Division personnel participating in an irradiation will not charge their time to the irradiation.

Requests for new equipment & modifications to existing equipment will be handled through Production Planning and Control Branch.

If a new facility is built the owner should negotiate regarding charges for Rental, Reactivity (if any), Special Equipment (if applicable), and Commissioning of the installation during its testing period.

Maximum fluxes quoted for NRU are for empty holes. \*For NRX they are based on a hole containing an X-rod fuel assembly without fuel.

\*Average fluxes quoted are those along the length of a hole containing an X-rod assembly without fuel.

Charges for positions used as a loop apply for as long as the position is reserved unless utilized by another irradiation. That is, if an irradiation is scheduled for one cycle of reactor operation, and it is removed prematurely and no standby is installed, then the whole cycle will be charged.

A position is considered as being a loop when it has a separate cooling circuit, otherwise it will be charged on a normal use basis.

A position used on a normal use basis will be charged actual MWD reactor output utilized and not as for a loop, which is charged for as long as the position is reserved.

\*An X-rod assembly without fuel consists of an inner aluminum tube 0.080" thick, a 0.070" water annulus and an outer sheath 1.74" OD and 1.66" ID.

2. SCALE OF CHARGES

For charging purposes a month will be considered as 900 MWD reactor output for NRX and 5,000 MWD reactor output for NRU.

Where an experiment in NRU unduly delays a reactor start-up or causes a reactor shutdown, the lost operating time may be charged in part or total to the experiment at a rate of \$1,000 per hour. Experiments will be charged a maximum of \$50,000 for each shutdown. Any one experiment will be limited to a maximum of four shutdowns during a year.

Reactivity

This is calculated on a milli-k month basis where a milli-k month is 1 milli-k load (See NEI-118) each 950 MWD reactor output for NRX and 5,000 MWD reactor output for NRU.

Therefore, assuming an irradiation is carried out in NRX for 850 MWD and its load is 2.8 milli-k, the milli-k months attributed to the experiment, using the assumptions, are:-

$$\frac{2.8 \times 850}{950} = 2.5 \text{ milli-k months}$$

An NRX milli-k month is rated at \$935.

An NRU milli-k month is rated at \$3,000.

An alternative method of paying for reactivity load is to supply compensating reactivity. Arrangements for this are made separately and should be negotiated through Production Planning and Control Branch.

Reactor Rental  
NRX

Fuel or Loop Posi- tions Circle No.	Dist. from Centre in cms	Max Flux n/cm <sup>2</sup> /sec	Average Flux n/cm <sup>2</sup> /sec	Normal Use/Mo.	Loop Use/Mo.
1	17.304	$6.4 \times 10^{13}$	$4.1 \times 10^{13}$	\$3990	\$2990
2	29.973	$6.7 \times 10^{13}$	$4.2 \times 10^{13}$	4250	3190
3	34.608	$6.7 \times 10^{13}$	$4.2 \times 10^{13}$	4250	3190
4	45.783	$6.5 \times 10^{13}$	$4.1 \times 10^{13}$	4050	3040
5	51.912	$6.3 \times 10^{13}$	$4.0 \times 10^{13}$	3890	2920
6	59.946	$6.1 \times 10^{13}$	$3.9 \times 10^{13}$	3730	2800
7	62.391	$6.0 \times 10^{13}$	$3.8 \times 10^{13}$	3730	2800
8	69.216	$5.8 \times 10^{13}$	$3.7 \times 10^{13}$	3400	2550
9	75.430	$5.5 \times 10^{13}$	$3.5 \times 10^{13}$	3140	2360
10	79.297	$5.2 \times 10^{13}$	$3.3 \times 10^{13}$	2940	2210
11	86.520	$4.8 \times 10^{13}$	$3.1 \times 10^{13}$	2750	2060
12	89.919	$4.7 \times 10^{13}$	$3.0 \times 10^{13}$	2690	2020
13	91.566	$4.6 \times 10^{13}$	$2.9 \times 10^{13}$	2620	1970
14	96.340	$4.3 \times 10^{13}$	$2.7 \times 10^{13}$	2490	1870
15	103.824	$3.9 \times 10^{13}$	$2.5 \times 10^{13}$	2290	1720
16	105.260	$3.8 \times 10^{13}$	$2.4 \times 10^{13}$	2090	1570
17	108.060	$3.5 \times 10^{13}$	$2.3 \times 10^{13}$	2030	1520
18	113.470	$3.2 \times 10^{13}$	$2.1 \times 10^{13}$	1830	1370
19	119.887	$2.8 \times 10^{13}$	$1.8 \times 10^{13}$	1640	1230
20	121.128	$2.7 \times 10^{13}$	$1.7 \times 10^{13}$	1500	1130
21	121.128	$2.7 \times 10^{13}$	$1.7 \times 10^{13}$	1500	1130
22	124.782	$2.4 \times 10^{13}$	$1.5 \times 10^{13}$	1370	1030
X-5 Loop (Central Thimble)		$6.0 \times 10^{13}$	$3.8 \times 10^{13}$		8390
J-Rod Annulus		$1.0 \times 10^{13}$	$0.6 \times 10^{13}$		590
Horizontal Holes		4" up to $10^{13}$			440
		12" up to $10^{13}$			1780
Thermal Column		up to $10^{13}$			1320
Self-Serve Positions		Flux range $0.2 \times 10^{13}$ to $1.7 \times 10^{13}$ . The irradiation charge is \$25/capsule (0.74 inches ID by 1.6 inches internal height) in a flux of $1 \times 10^{13}$ n/cm <sup>2</sup> /sec for one day (24 hours). \$5.00 will be charged for each additional capsule on the same basis. A handling charge of \$10 is applied to each specimen.			

Tray Rod Positions

Flux range up to  $6 \times 10^{13}$ . The irradiation charge is \$25/hr. for the first unit (0.74 inches ID by 1.6 inches internal height)

in a flux of  $1 \times 10^{13}$  n/cm<sup>2</sup>/sec for one day (24 hours). \$5 will be charged for each additional unit on the same basis. A handling charge of \$10 is applied to each specimen.

A unit charge is based on its reactivity effect. If it is greater than 0.05 milli-k an additional unit will be charged for each 0.05 milli-k or fraction thereof.

Reactivity effect of a capsule is proportioned to its effective neutron absorption. This varies dependent on the position of the capsule in the reactor, e.g.,

1 milli-k load in a vertical central position in the inner circle will be 0.13 milli-k in the outermost circle.

Cost of target materials for Self-Serve and Tray-rod ir-radiations, in excess of \$10 will be charged to the applicant.

NRU

<u>Position</u>	<u>Size</u>	<u>Max. Flux n/cm<sup>2</sup>/sec</u>	<u>Rental/Month</u>
Fuel Rod Position	4 3/4"	$3.0 \times 10^{14}$	\$39,870
" " "	4 3/4"	$2.5 \times 10^{14}$	33,225
" " "	4 3/4"	$2.0 \times 10^{14}$	26,580
" " "	4 3/4"	$1.5 \times 10^{14}$	19,935
" " "	4 3/4"	$1.0 \times 10^{14}$	13,290
" " "	4 3/4"	$0.5 \times 10^{14}$	6,645

The fuel rod position fluxes may not be available, therefore, the actual charge would be directly proportional to the flux in the position used on the above basis.

<u>Loop Positions</u>	<u>Size</u>	<u>Max. Flux n/cm<sup>2</sup>/sec</u>	<u>Rental/Month</u>
J-16	0.955"	$2.1 \times 10^{14}$	\$66,450
E-20	3 1/4"	$1.9 \times 10^{14}$	66,450
E-12		$1.9 \times 10^{14}$	

Special installations such as the loop equipment are charged with applicable amortization costs:-

E-20 \$15,800/month

Loop positions are charged for special equipment, required for the operation of loop equipment, such as standby electrical power. This cost is \$690/month/loop.

<u>Tray Rod Positions</u>	<u>Size</u>	<u>Max. Flux n/cm<sup>2</sup>/sec</u>	<u>Rental/Month</u>
G-16	4 3/4"		\$53,160
One Sample			1,329

### J-Rod Positions

Pneumatic Carrier One Sample		$0.2 \times 10^{14}$	\$ 9,968 250
Large J-Rod	5"	$0.2 \times 10^{14}$	6,645
Small J-Rod (with piping for loop)	2 5/8"	$0.2 \times 10^{14}$	2,658
Small J-rod (with- out piping)	2 5/8"	$0.2 \times 10^{14}$	1,329

<u>Re-Entrant Cans</u>	<u>Elevation</u>	<u>Size</u>	<u>Max. Flux n/cm<sup>2</sup>/sec</u>	<u>Rental/Month</u>
E-2	461'	12"	1.0 x 10 <sup>14</sup>	\$9,968
L-2	461'	12"	1.0 x 10 <sup>14</sup>	9,968
D-3	458'	12"	0.7 x 10 <sup>14</sup>	6,645
L-3	458'	12"	0.7 x 10 <sup>14</sup>	6,645
D-2	461'	6"	1.0 x 10 <sup>14</sup>	5,316
E-3	458'	6"	0.7 x 10 <sup>14</sup>	3,987

## Thru-Tubes

C-2	461	2	7/8"	x	4	1/8"	2.0	x	10 <sup>14</sup>	\$13,290
N-2	461	2	7/8"	x	4	1/8"	2.0	x	10 <sup>14</sup>	13,290
C-5	458	2	7/8"	x	4	1/8"	1.4	x	10 <sup>14</sup>	9,968
N-5	458	2	7/8"	x	4	1/8"	1.4	x	10 <sup>14</sup>	9,968

### Thru-Holes

C-1	462'6"	12"	0.5 x 10 <sup>14</sup>	\$6,645
N-1	462'6"	12"	0.5 x 10 <sup>14</sup>	6,645
C-4	459'6"	6"	2.3 x 10 <sup>13</sup>	3,987
N-4	459'6"	6"	2.3 x 10 <sup>13</sup>	3,987
A-2	459'6"	12"	1.0 x 10 <sup>14</sup>	3,322
Q-2	459'6"	12"	1.0 x 10 <sup>14</sup>	3,322
A-1	462'6"	6"	1.0 x 10 <sup>14</sup>	1,329
Q-1	462'6"	6"	1.0 x 10 <sup>14</sup>	1,329

Longitudinal Holes	Elevations	Size	Max. Flux n/cm <sup>2</sup> /sec	Rental/Month
T-1	463'6"	4 3/4"	0.5 x 10 <sup>14</sup>	\$3,987
T-2	461'	4 3/4"	0.65 x 10 <sup>14</sup>	3,987
T-3	461'	4 3/4"	0.65 x 10 <sup>14</sup>	3,987
T-4	461'	4 3/4"	0.65 x 10 <sup>14</sup>	3,987
T-5	485'6"	4 3/4"	0.5 x 10 <sup>14</sup>	3,987

Inside Thermal Shield

M-2	458'	12"	3.0 x 10 <sup>10</sup>	\$1,329
M-1	461'	6"	4.0 x 10 <sup>10</sup>	664
N-3	461'	6"	4.0 x 10 <sup>10</sup>	664
C-3	461'	6"	4.0 x 10 <sup>10</sup>	664
N-6	458'	6"	3.0 x 10 <sup>10</sup>	664
C-6	458'	6"	3.0 x 10 <sup>10</sup>	664

Holes are circular in cross section unless otherwise noted.

Where an assembly in NRU causes loss of use of a fuel rod position, due to its installation or that of its associated enriched rods, an off-setting charge will be made to recover the costs applicable to the operation of the facility. This charge is computed at \$90 per MWD power output that a normal fuel rod would develop in the position utilized, or the power output of the experiment and its enriched fuel rod, whichever is the greater.

Examination Cell Charges

Metallurgy Cell Bldg. 465:

The cost of this facility is \$100/day (8 hours).

Universal Cell:

Charges for examination in this cell will be considered in the following categories:-

- a. Rental of Universal Cell
- b. Work Order & Stores Requisitions
- c. Personnel Charges

A rental charge of \$15.00 per hour will be made starting from the time that cell preparation is started for the examination and cannot be used for other work, until the time that the cell has been cleaned up and available for a new job. No charge will be made when the cell is shut down for holidays or maintenance and repairs not associated with the examination.

If overtime is necessary, the cell rental of \$15.00 per hour will be charged for the number of overtime hours required.

Cell rental will be rounded off to the nearest hour.

Materials acquired on Stores Requisitions or Work Orders which are not charged to the Universal Cell account (524-06) will be charged to the applicant at the actual cost of these materials.

Labour charges on work orders will be charged at AECL prevailing rate wage scale, plus an overhead of 100% of these labour charges.

Time spent by Chemical Operations Branch or Radiation Hazards Control Branch personnel in preparing the cell for the examination, designing equipment, the actual examination, disposition of material and cleaning up the cell after the examination will be charged at a rate of \$7.50/hour for prevailing rate personnel and \$14.00/hour for staff.