PULSTAR ANNUAL REPORT TO

UNITED STATES NUCLEAR REGULATORY COMMISSION

for the

Period 01 July 1991 - 30 June 1992

NCSU NUCLEAR REACTOR PROGRAM

21 August 1992

Reference: PULSTAR Technical Specifications
Section 6.7.5

Docket No. 50-297

Department of Nuclear Engineering
North Carolina State University
Raleigh, North Carolina 27695

DEPARTMENT OF NUCLEAR ENGINEERING

PULSTAR REACTOR ANNUAL REPORT

For the Period: 01 July 1991 - 30 June 1992

The following report is submitted in accordance with Section 6.7.5 of the PULSTAR Technical Specifications:

6.7.5.a Brief Summary

(1) Reactor Operating Experience:

The NCSU PULSTAR Reactor has been utilized for the following:

a.	Teaching and Short Courses	148.1	hours
b.	Faculty and Graduate Student Research	414.6	hours
c.	Neutron Activation Analysis	1,472.5	hours
d.	Nuclear Training (Utilities)	582.8	hours
e.	PULSTAR Reactor Training	39.9	hours
f.	Reactor Cal/Measurements & Surveillance	35.9	hours
g.	Reactor Health Physics Surveillance	18.7	hours
i.	Reactor Sharing	4.1	hours
	TOTAL	2,716.6	hours
	Same reporting period 1990-1991	3,190.4	hours

A cross section of experiments performed in the reactor:

a. Neutron Activation Analysis of filters, animal tissue, bone, protein solutions, hair, sediments/soil, rain/river water, tobacco, vegetation, electric components, fibers, resins, bauxite, coal, ash, graphite, etc.
b. Reactor thermal power measurements for teaching laboratories.
c. Neutron diffusion length measurements in graphite.
d. Neutron Radiography.
e. Neutron fluence and spectral measurements.

(2) Changes in Performance Characteristics Related to Reactor Safety:

None

(3) Results of Surveillance, Tests, and Inspections:

The reactor surveillance program has revealed no significant nor unexpected trends in reactor systems performance during this report period.

6.7.5.b Total Energy Output:

799.3 Megawatt • hours
33.3 Megawatt • days

Pulse Operations:

None

Reactor was Critical:

1,057.1 hours

Cumulative Total Energy Output since Initial Criticality:

17,666.5 Megawatt • hours[1]
736.1 Megawatt • days

6.7.5.c Number of Emergency and Unscheduled Shutdowns:

Unscheduled Shutdowns - 3 total

(1) Linear Power Channel spiked upscale.
(2) Sample basket stuck in irradiation facility.
(3) Unable to transfer to Intermediate Range.

Inadvertent SCRAMs - 12 total

(4) Operator error - 11
(5) Spurious signals - 1

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[1]Includes an additional 20.6 Megawatt•hours to correct a typographical error from a previous report.

Explanation of (1) above:

The Linear Power Channel exhibited several small upscale spikes of less than 50 pcm (0.05% $\Delta k/k$). The signal connector was cleaned and the channel calibrated.

Explanation of (2) above:

Handling tools were used to unstick the sample basket from its irradiation facility. It was retrieved by normal handling methods.

Explanation of (3) above:

During the first start up after completing Design Changes 90-1 through 91-6, the operator was unable to clear the Source Range Inhibit to continue on to the power range. Investigation revealed that a newly installed 117 VAC power cable inside the Control Console was inducing AC noise into the Intermediate Range Channel. The cable was re-routed and the problem cleared.

Explanation of (4) above:

Improper operation of the Linear Level Power Channel range switch by Nuclear Power Plant trainees (NT) and PULSTAR Reactor trainees (PRT) (10).

Operator stopped Primary Pump instead of starting Secondary Pump (1).

Explanation of (5) above:

Set point drift of a pressure-electric switch occured in the Primary Coolant Flow Measuring Channel.

6.7.5.d Major Maintenance Operations:

The PULSTAR facility has implemented a liquid waste reduction program. The first phase of the program addressed pump seal leakage. The Primary Pump seals were replaced with mechanical seals which reduced the amount of water discharged to a negligible amount. The design of the pump permitted the use of either type of seal. New packing seals were also added to the Secondary Pump which further reduced the total volume of water released. The second

phase will evaluate all remaining pumps to determine the feasability of adding mechanical seals to them.

6.7.5.e Changes in Facility, Procedures, Tests, and Experiments:

1. Design Changes

   (a) DC 90-1 installed new high and compensating voltage power supplies in a new rack adjacent to the Control Console.

   (b) DC 91-1 removed Pulse Channel hardware and instrumentation. There are no plans in the forseeable future for pulsing this reactor.

   (c) DC 91-2 added two digital electrometers (one is an installed spare) to the Control Console to monitor nitrogen-16 in the primary coolant.

   (d) DC 91-3 allowed various instruments to be repositioned in the Control Console to facilitate other design changes.

   (e) DC 91-4 has been approved but not started.

   (f) DC 91-5 installed a commercial annunciator system in the Control Console.

   (g) DC 91-6 provides eight digital displays to complement the analog multi-point recorder in the Temperature Measuring Channel.

2. Procedure Changes

   (a) PC 1-91 was Revision 7 to the PULSTAR Operations Manual. This documented changes required by the deletion of the Pulse Channel and added additional requirements to the Key-Off Checklist.

   (b) PC 2-91 was Revision 8 to the PULSTAR Operations Manual. This documented the design changes to the Control Console mentioned above.

6.7.5.f Radioactive Effluent:

Liquid Waste (summarized by quarters)

1. Radioactivity released during the reporting period:

Period	(a) No. of Batches	(b) Total μCi	(c) Tot. Vol. Liters	(d) Diluent Liters	(e) Tritium μCi
01 Jul - 30 Sep 91	21	483.07	7.06×10^4	1.13×10^6	230.05
01 Oct - 31 Dec 91	2	117.96	6.84×10^3	2.88×10^5	113.30
01 Jan - 31 Mar 92	6	294.66	2.05×10^4	7.15×10^5	253.25
01 Apr - 30 Jun 92	3	155.10	1.02×10^4	3.76×10^5	141.12

(f) 1,050.79 μCi total activity released during this reporting period.

(g) 737.72 μCi of tritium were released during this reporting period.

2. Identification of Fission and Activation Products:

The gross alpha-beta-gamma activity of the batches in (a) above were less than 4×10^{-5} μCi/ml (the maximum specific activity given in Health Physics Procedure HP 20-2). An isotopic analysis of these batches indicated only background activity.

3. Disposition of liquid effluent not releasable to Sanitary Sewer System:

All batches of 1(a) above when diluted by campus water (2.80×10^6 liters; the minimum daily campus intake) resulted in activity considerably less than 4×10^{-7} μCi/ml (10 CFR 20 limit). Therefore, all batches were released to the sanitary sewer system.

Gaseous Waste (summarized monthly)

1. Radioactivity discharged during the reporting period (in Curies) for:

(a) Gases:

Year	Period	Total Time In Hours	Curies
1991	25 Jun - 24 Jul	687.10	0.658
	24 Jul - 22 Aug	689.83	0.365
	22 Aug - 20 Sep	702.83	0.425
	20 Sep - 04 Nov	1,072.33	0.619
	04 Nov - 06 Dec	775.32	0.368
	06 Dec - 03 Jan	Rx. S/D	0.000
1992	03 Jan - 29 Jan	615.80	0.170
	29 Jan - 27 Feb	697.25	0.032
	27 Feb - 27 Mar	703.33	0.282
	27 Mar - 24 Apr	672.00	0.500
	24 Apr - 22 May	672.25	0.829
	22 May - 22 Jun	735.41	0.285
	Totals	8,014.44	4.533

(b) Particulates with a half-life of greater than eight days:

Filters from the particulate monitoring channel were analyzed upon removal and again the following week. There was no particulate activity ((b) above) indicated on any filter during this reporting period.

2. Gases and particulates discharged during this reporting period:

(a) Gases:

The yearly average concentration of argon-41 released from the PULSTAR reactor facility exhaust stack during this period was 1.52×10^{-8} μCi/cc.

(b) Particulates:

See gaseous waste 1(b) above.

Solid Waste from Reactor

1. Total volume of solid waste 0.22 m^3 (7.77 $ft.^3$)
2. Total acuvity of solid waste - < 0.283 mCi
3. Dates of shipments and disposal:

   27 March 1992 Chem-Nuclear Systems Inc. (CNSI)

6.7.5.g Personnel Radiation Exposure Report[2]

Faculty and Staff	Total Exposure (rem)
ARMISTO, Antonio C.	0.020
BIDDY, Oscar D.	0.000
BILYJ, Stephen J.	0.010
BOURHAM, Mohamed	0.000
DAVIS, Glenda F.	0.000
DOSTER, J. Michael	0.000
DUDZIAK, Donald J.	0.010
DUFOUR, Laurence R.	0.000
ELLEMAN, Thomas S.	0.010
GARDNER, Robin P.	0.000
GILLIGAN, John G.	0.000
HANKINS, Orlando E.	0.000
KINKAID, Kerry L.	0.070
MANI, Kolam V.	0.000
MAYO, Charles W.	0.000
MAYO, Robert M.	0.000
MUNN, R. Hugh	0.050
MURTY, K. Linga	0.000
PEREZ, Pedro B.	0.010
PLAVNEY, Christopher	0.010
TURINSKY, Paul J.	0.000
VERGHESE, Kuruvilla	0.000
WEAVER, Jack N.	0.000

Other:
Approximately 19 film badges were issued monthly to graduate students and temporary staff;
Approximately 174 film badges were issued for short courses;
Approximately 300 film badges were issued for visitors.

No significant radiation exposures were reported; the majority of these exposures were in the "no measureable exposure" range.

6.7.5.h Summary of Radiation and Contamination Surveys Within the Facility

Neither the radiation nor the contamination surveys indicated any trend or shift of data from past experience or surveys.

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[2]Compiled and prepared by the Radiation Protection Office.

6.7.5.i Description of Environmental Surveys Outside of the Facility

See Attachment A