BNWL-1092 DR1
Draft Issue No. 1
May 15, 1969

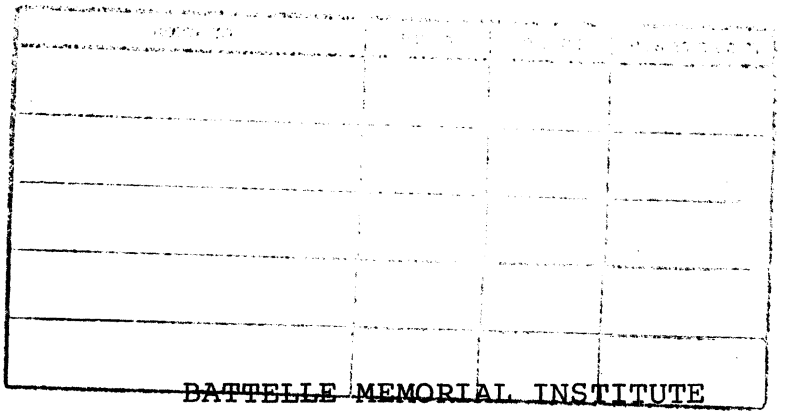
4

NUMBER AND TYPE OF OPERATING CYCLES FOR THE FFTF

By

D. C. Boyd

DRAFT ISSUE DOCUMENT



BATTELLE MEMORIAL INSTITUTE
PACIFIC NORTHWEST LABORATORY
RICHLAND, WASHINGTON 99352

INFORMATION CONCERNING USE OF THIS REPORT

PATENT STATUS

This document copy, since it is transmitted in advance of patent clearance, is made available in confidence solely for use in performance of work under contracts with the U. S. Atomic Energy Commission. This document is not to be published nor its contents otherwise disseminated or used for purposes other than specified above before patent approval for such release or use has been secured, upon request, from the Chief, Chicago Patent Group, U. S. Atomic Energy Commission. 9800 So. Cass Ave., Argonne, Illinois.

PRELIMINARY REPORT

This report contains information of a preliminary nature prepared in the course of work under Atomic Energy Commission Contract AT(45-1)-1830. This information is subject to correction or modification upon the collection and evaluation of additional data.

LEGAL NOTICE

This report was prepared as an account of Government sponsored work. Neither the United States, nor the Commission, nor any person acting on behalf of the Commission:

A. Makes any warranty or representation, expressed or implied, with respect to the accuracy, completeness, or usefulness of the information contained in this report, or that the use of any information, apparatus, method, or process disclosed in this report may not infringe privately owned rights; or

B. Assumes any liabilities with respect to the use of, or for damages resulting from the use of any information, apparatus, method, or process disclosed in this report.

As used in the above, "person acting on behalf of the Commission" includes any employee or contractor of the Commission, or employee of such contractor, to the extent that such employee or contractor of the Commission, or employee of such contractor prepares, disseminates, or provides access to, any information pursuant to his employment or contract with the Commission, or his employment with such contractor.

PACIFIC NORTHWEST LABORATORY
RICHLAND, WASHINGTON
operated by
BATTELLE MEMORIAL INSTITUTE
for the
UNITED STATES ATOMIC ENERGY COMMISSION UNDER CONTRACT AT(45-1)-1830

TABLE OF CONTENTS

NUMBER AND TYPE OF OPERATING CYCLES FOR THE FFTF

D. C. Boyd

I. INTRODUCTION AND SUMMARY

The choice of materials and other vessel design decisions necessary to provide the desired life expectancy for the FTR vessel are partially dependent upon estimates of the number and type of reactor shutdowns and startups which may be anticipated. Current estimates of these so-called "cycles" are given in Table I. This table is based upon data originally compiled in 1967.

TABLE I. FFTF Shutdown, Startup and Power Cutback Estimates

SCRAM FREQUENCY

One scram per two-month period plus one scram for each closed loop per two-month period.

EXPERIMENTAL OUTAGE FREQUENCY

One shutdown per eight-month period plus one shutdown for each closed loop per eight-month period.

STANDARD SHUTDOWNS

Four shutdowns per year.

STANDARD STARTUPS

Four startups per year plus one for each scram or experimental outage.

RAPID CONTROLLED SHUTDOWNS

Frequency of Rapid Controlled Shutdowns is estimated at one per eight-month period plus one for each eight-month period per closed loop.

II. DISCUSSION

A. SCRAM FREQUENCY

A review of operating statistics from MTR, ETR, and PRTR given in Tables II, III, and IV indicate that the number of power reductions and scrams encountered at a test facility are related to the number of closed loops contained in the facility. A reasonable correlation derived from the above referenced data indicate that these facilities have a predictable scram frequency of one scram per two month period for each closed loop. (This assumes that the entire reactor system is also considered equivalent to one additional closed loop.)

B. EXPERIMENTAL OUTAGE FREQUENCY

There will be occasions when the experimental test data will warrant a reactor shutdown to permit a check-out of the test instrumentation or an investigation into unpredicted behavior of the test. There are very few documented data upon which to base any predictions of this type of outage; thus, the following prediction is based on operating experience and judgment.

Frequency of experimental shutdowns will average one shutdown for each eight month period per closed loop. (Again considering the reactor proper as one closed loop.)

C. STANDARD SHUTDOWNS AND STARTUPS

The current thinking as to what constitutes a normal operating cycle is a nine weeks reactor operating period followed by a three-week outage period. This results in four such cycles per year. However, there will be standard startups from other types of shutdowns such as scrams.

D. RAPID CONTROLLED SHUTDOWNS

It is expected that there will be occasions when one (or more) operating variable will be off standard to the extent that a rapid

shutdown, short of a scram, will be required. This rapid shutdown is defined as a programmed power reduction, from full power to zero power in a two-minute time interval. Based upon operating experience, the frequency is estimated as one rapid controlled shutdown per eight-month period plus one rapid controlled shutdown per each eight-month period per closed loop.

E. ABNORMAL HEATUP OR COOLDOWN

It is also reasonable to expect that there will be occasions when, because of equipment malfunction, there will be abnormal heatup or cooldown rates encountered during the operation of the facility. Pure speculation fixes the number of these occurrences at one of each type for each five years of operation.

F. TEMPERATURE CONTROL GOALS

Tentative goals for temperature control, based upon operating experience, are listed below. These goals are tentative and subject to design analysis evaluation and unification.

(1) The primary coolant temperatures should be maintained at 350 to 400 °F during shutdown periods.

(2) All preplanned startups or shutdowns, such as scheduled and experimental shutdowns and startup and scram recovery startups should be programmed such that the coolant temperature change is maintained in the 50 to 75 F° per hour range.

(3) Primary coolant temperature control during a semi-emergency power cutback cycle should be sufficient to limit the coolant temperature change to 10 F° per minute or less. The duration of such a temperature change is not expected to exceed three minutes. After three minutes, the cooldown should be controlled within the normal rates of 50 to 75 F° per hour.

(4) Thermal transients should be controlled to within acceptable limits as quickly as possible following a scram and the total transient on a scram should not exceed 200 F°, i.e., if the

coolant outlet temperature was 1100 °F at the time of the scram it would not drop to less than 900 °F during the event and ensuing stabilization period, unless some indication such as an individual channel high outlet temperature dictated the need to drop the coolant temperature lower.

TABLE II. MTR Operating History 1952 - 1965

	Year		Year		Year		Year		Year		Year		Year	
	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965
MWD Production	3845	9409	8059	8045	9622	9553	10,290	10,480	10,830	11,324	11,223	10,625	11,355	11,799
Operating Time (percent)	55	87.5	78.4	71.4	69.3	69.4	73.8	73.3	75.7	78.7	78.1	75	78.6	82.5
Average Number Samples	--	220	290	--	492	557	480	278	--	190	179	152	122	87
Average Number Loops	1	1	3	--	5	7	7	9	8	6	7	6	5	5
Average Number Lead Experiments	--	--	--	--	--	--	--	--	--	20	19	22	29	20
Total Reactor Power Reductions	--	--	--	--	136	145	129	158	171	180	158	157	158	117
Scheduled Scrams	--	--	--	--	26	24	22	25	--	23	23	23	27	31
Unscheduled Power Reductions from Reactor and Plant	22	12	17	9	31	27	18	14	--	114	94	88	71	68
Unscheduled Power Reductions from Experiments	0	6	26	29	79	94	45	38	--	43	41	46	60	18
Scheduled Shutdown (hours)	1848	1038	1542	2342	2326	2444	1,913	1,756	1,706	1,548	1,471	1,868	1,458	1,342
Unscheduled Shutdowns from Reactor (hours)	287	0	98	8	82	57	342	417	404	294	320	69	31	68
Unscheduled Shutdowns from Experiments (hours)	26	52	249	151	294	180	342	417	404	294	320	90	303	116
Production Factor (percent)	46.6	85.9	73.6	67.2	65	66.3	71.4	72.8	75.2	78.6	77.9	72.8	78.0	80.8
Scheduled Shutdowns (percent)	28	11.9	17.6	26.7	26.5	27.9	21.9	20.0	19.5	17.7	16.8	21.3	16.6	15.3
Reactor Downtime Due to Reactor Tests or Trouble (percent)	25	1.1	3	1.2	2.1	1.5	6.7	7.2	5.3	3.7	5.3	2.6	0.5	1.4
Reactor Downtime Due to Experiment Trouble (percent)	0.4	1.1	5.8	4.9	6.4	4.3	6.7	7.2	5.3	3.7	5.3	3.3	4.9	2.5

TABLE III. ETR Operating History 1957 - 1965

	Year		Year		Year		Year		
	1957	1958	1959	1960	1961	1962	1963	1964	1965
MWD Production	42	26,787	18,653	30,066	25,898	30,481	34,635	38,177	28,080
Operating Time (Percent	--	58.9	34.9	49.7	44.3	50.4	58.0	62.9	52.2
Average Number Samples	--	79	--	--	--	140	185	173	152
Average Number Loops	--	1	8	9	10	12	11	11	12
Average Number Lead Experiments	--	--	--	--	--	29	25	29	24
Total Power Reductions	--	157	136	119	198	145	181	154	130
Scheduled Scrams	--	60	12	14	11	9	21	10	13
Unscheduled Power Reductions from Reactor and Plant	--	93	84	52	83	61	91	86	68
Unscheduled Power Reductions from Experiments	--	4	40	53	104	75	69	58	49
Scheduled Shutdown (hours)	--	1,862	4,899	2,666	3,922	3,514	3,092	2,420	3,014
Unscheduled Shutdowns from Reactor (hours)	--	849	321	398	832	790	583	843	293
Unscheduled Shutdowns from Experiment (hours)	--	41	511	398	832	790	583	843	880
Production Factor (percent)	--	50	29.2	46.9	40.6	47.6	54.2	59.8	43.9
Scheduled Shutdowns (percent)	--	41.2	56.5	44.8	44.2	40.0	35.3	29.7	34.4
Reactor Downtime Due to Reactor Tests or Trouble (percent)	--	8.4	6.2	4.0	8.5	12.4	10.5	10.5	8.1
Reactor Downtime Due to Experiment Trouble (percent)	--	0.3	8.1	4.2	6.7	12.4	10.5	10.5	13.6

TABLE IV. Typical PRTR Operating History 1963 - 1964

	11 Months, 1963	6 Months 1964
Scrams	29	20
Unscheduled Outages	34	18
Scheduled Outages	8	4
	71	42
Outages/Month	6.5	7.0

Outage Length Summary for 1963

	% of Outages
<1 Hour	45
>1 <10	17
>10 <24	10
>24	28

DISTRIBUTION

No. of Copies

6 U.S. Atomic Energy Commission
Division of Reactor Dev & Tech
Washington, D.C. 20545

Assistant Director for Project Mgmt., A Giambusso
FFTF Project Office, JJ Morabito
Assistant Director for Plant Engineering, MA Rosen
Assistant Director for Engineering Standards, JW Crawford
Assistant Director for Reactor Engineering, EE Kintner
Assistant Director for Reactor Technology, EE Sinclair
Assistant Director for Nuclear Safety, AJ Pressesky

3 AEC Richland Operations Office

FFTF Program
JM Shivley

4 AEC Site Representatives - BNW

PG Holsted

1 LMFBR Program Office

2 Liquid Metal Information Center

JJ Droher

2 Bechtel Corporation

JJ Teachnor
DH Weiss (Richland)

2 Westinghouse Electric Corporation

JCR Kelley
RS Strzelecki (Richland)

22 BNW/FFTF On Site

ER Astley
DC Boyd (2)
CP Cabell
JC Cochran
DL Condotta
EA Evans
FC Gronemeyer
RE Heineman
PL Hofmann
WB McDonald
JS McMahon
RJ Squires
Tech Files (5)
FFTF Files (2)
Legal (2)