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REPORT TO COMMITTEE ON POST OFFICE AND CIVIL SERVICE HOUSE OF REPRESENTATIVES

090420

Forecast Of Postal Service Self-Sufficiency Potential

United States Postal Service

BY THE COMPTROLLER GENERAL OF THE UNITED STATES

GGD-75-58

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FEB. 20, 1975

COMPTROLLER GENERAL OF THE UNITED STATES
WASHINGTON, D.C. 20548

B-114874

The Honorable David N. Henderson
Chairman, Committee on Post Office
and Civil Service
House of Representatives

Dear Mr. Chairman:

In accordance with discussions with your office, we have developed various estimates of mail volume and Postal Service income and expenses for 1984. The Service views the Postal Reorganization Act as mandating that it become self-sufficient by then.

On September 18, 1974, we briefed staff members of the House Committee on Post Office and Civil Service; the Subcommittee on Postal Service; and the Subcommittee on Postal Facilities, Mail and Labor Management on our estimates. We emphasized that the forecasts were based on assumptions and represent what might happen rather than what will happen. The appendixes contain the charts used in the briefing and details of our forecast.

As requested by your Committee, we did not obtain comments from the Service on this report. We did, however, brief Service officials on our estimates before briefing the Committee staff. Service officials, using our volume and revenue projections, gave us first-class postage rates somewhat different from our projections, which we also present in the appendixes.

The Service has its own projections, which it continually updates, but these are for its internal use only.

We do not plan to distribute this report further unless you agree or its contents are publicly announced.

Sincerely yours,

Elmer B. Staats

Comptroller General
of the United States

Contents

ABBREVIATIONS

BLS	Bureau of Labor Statistics
GAO	General Accounting Office
USPS	U. S. Postal Service

DETAILS OF GAO'S FORECAST OF POSTAL SERVICE SELF-SUFFICIENCY POTENTIAL

SUMMARY

As requested by the House Committee on Post Office and Civil Service, we have developed estimates of the Postal Service's expenses for 1984. In passing the Postal Reorganization Act (39 U.S.C. 101), the Congress hoped that the newly created Postal Service would, through more businesslike operation, become self-sustaining by that year.

In theory, self-sufficiency could be achieved by setting postal rates at whatever level is necessary to cover expenses. In reality, this could involve postage rates so high as to drive mail users to other means of communication, thereby reducing volume and revenue--maybe completely undermining the Service's financial position.

And even if the raising of rates was economically possible, they could reach a level that would, contrary to the intent of the Postal Reorganization Act, impair the personal, educational, literary, and business correspondence practices of the people.

The future level of postage rates depends directly on mail volume, the Service's expenses, and the amount of any Federal subsidy. The first two determine unit cost. The last determines the portion of this cost that will be borne by the taxpayer, rather than the mail user.

We have forecast 12 different situations for 1984, assuming the same volume but varying rates of productivity and inflation. We have projected the price of a unit of first-class postage for each situation and under various assumptions regarding a Federal subsidy--from none to 20 percent of projected expenses. (See apps. XIII to XVI.) To show the effect of inflation on expenses and stamp prices, the value of these two items is presented in 1973 as well as 1984 dollars. (See apps. XI and XII.)

For example, our forecast of what the postal expenses are most likely to be in 1984--$18.7 billion--assumes total mail volume of 105.5 billion pieces in that year, a slowly declining inflation rate between 1974 and 1984 (10.4 percent in 1974, decreasing to 4.4 percent in 1984), 1/ and productivity increases of 0.7 percent annually. With no Federal subsidy, these assumptions indicate that a unit of first-class postage in 1984 would cost approximately $0.18. (See app. XVII.) The effect of inflation can be seen by considering that,

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1/ Based on a study performed for the Service by Data Resources, Incorporated.

in 1973 dollars, expenses would be $10.4 billion (rather than $18.7 billion) and a unit of first-class postage would cost about $0.10 (rather than about $0.18). (See apps. XI and XII.)

The appendixes contain copies of the charts we used in briefing the Committee staff. They set forth the possibilities indicated by our analysis and explain our methodology and assumptions.

Forecasting necessitates making assumptions as to conditions during the forecast period and reactions to these conditions. Once the assumptions have been accepted, a technique to develop the forecast can be adopted. The forecasts must be viewed in terms of these assumptions. They do not represent certainties, but possibilities. Consequently, the forecasts set forth what the situation might be, rather than what it will be.

ASSUMPTIONS AND METHODOLOGY USED IN PROJECTING POSTAL SERVICE COSTS IN 1984

In forecasting costs for the Postal Service, we assumed that there would be no major breakthrough in mail-processing technology.

Forecast methodology

Though the Service has used several types of forecasting methods, including rate-of-change extrapolations, ratio analysis, and regression analysis in its forecasts, we limited our methodology to regression analysis. We chose this method because forecasting done by analysts throughout the world has shown this to be effective for forecasting postal volume. For example, in its report "Postal Market Research," the International Bureau of the Universal Postal Union made the following statement about regression analysis in forecasting postal volume:

> "All of these analyses have been able to produce very good fits to historical data of the past two to four decades. While these results do not provide precise guidance as to which basic parameters are the best determinants of mail usage, they do establish quite clearly that mail volume depends principally on the size of the population, its socio-economic characteristics, and its level of economic activity revealed by various indicators."

The report also stated that population and economic indexes can account for as much as 99 percent of the observed variance in mail volume.

Our preliminary work supported the Postal Union's position on the value of regression analysis in forecasting postal volume. Furthermore, our statistical test showed that regression analysis could be used to forecast other postal indicators with about the same degree of accuracy. Thus, we were able to develop forecasting equations (see app. XIX) using economic indicators, such as disposable personal income 1/ and the number of families and individuals, 2/ to forecast mail volume, revenue, and expense.

Regression analysis is a method of determining the influence of independent variables--disposable personal income--on a dependent variable--mail volume. Using the regression technique, the forecaster seeks to discover those variables which have the greatest impact on the dependent variable. Hopefully, the independent variables can be controlled or at least be more easily forecast than the dependent variable. Then, using the known or forecast values of the independent variables, the forecaster uses the equation determined by the regression analysis to forecast the variable of interest. We developed equations to forecast volume and then, using volume along with other independent variables, we forecast cost and revenue. The forecasts for national economic indicators were obtained from published Government sources as noted.

Volume-estimating equation

In developing this equation, we considered several measures of population and economic activity. It was finally decided that disposable personal income (to reflect the level of economic activity) and the number of families and individuals (to reflect population) would be satisfactory indicators. Pure population statistics were not used because we believed mail volume relates more directly to households than to total population.

Projections for disposable personal income were obtained for 1980 and 1985 from a published Bureau of Labor Statistics (BLS)

1/ Personal income less taxes on individuals, including income and other taxes not deductible as business expenses, and other general government revenues received from individuals as individuals.

2/ The term "family" refers to a group of two or more persons related by blood, marriage, or adoption and residing together; the term "individuals" refers to persons 14 years old and over, other than inmates of institutions, who are not living with any relatives.

forecast, and projections of numbers of families and individuals were obtained from a Bureau of the Census official. We then extrapolated the data for the interim years and substituted these values in our equation.

Using this approach, we obtained the following projections.

Year	Pieces of mail (billions)
1974	91.3
1975	93.1
1976	94.8
1977	96.5
1978	98.2
1979	99.8
1980	101.1
1981	102.1
1982	103.4
1983	104.5
1984	105.5
1985	106.3

These estimates have prediction intervals of ±5 percent at a 95-percent confidence level. For 1984, this would be as follows:

Lower bound	Estimated value	Upper bound
101.0 billion	105.5 billion	110.0 billion

Expense-estimating equation

Operating expenses and past volume and past productivity, as measured in pieces of mail per paid man-year, are closely related. However, because of the many accounting methods used in the past, the Service could not give us reliable expense data for years before 1963. Expenses for these years were converted into constant 1973 dollars, using the General Government (Federal) price deflator, 1/ before using them in developing the expense equation. The General Government deflator was used rather than the Gross National Product deflator, to provide for the rapid increase in prices that had been experienced in Government sector wages and prices during 1963-73. The equation, therefore, does not include the effects of inflation unless otherwise stated.

1/ Price deflator is a set of figures which provide for the relative change, if any, of prices, costs, or similar statistical phenomena between one period of time and some other period of time selected as the base period.

Projected expenses were made for increases in productivity levels of 0.7 percent, 2 percent, and 3 percent. The 3-percent level was selected because it is a goal set by postal management, and the 0.7-percent level was selected because it was the average annual historical increase of postal productivity for 1960-70. The 2-percent level is a compromise figure.

Expenses were projected on the basis of inflation rates used by BLS and those computed by Data Resources, Incorporated, for the U.S. Postal Service (USPS). Also expenses were computed for these inflation rates adding 3 percent to these rates to emphasize the importance of keeping postal cost increases in line with those of the rest of the economy. The figure of 3 percent was selected to show the effect of expenses growing at the same rate as Postal Service productivity estimates. (See app. XI.)

Income-estimating equation

The overriding consideration in developing this equation was the Committee's request for a forecast of the postal rate in 1984. Therefore, in every equation we developed and tested, the first-class postage rate was included as an independent variable. The equation selected as having the best predictive capability was one which included both the price of a first-class stamp and mail volume.

We presented our forecast to Service officials. Using our volume and expense projections, they forecast stamp prices by assuming that, in 1984, first-class mail volume and revenue would constitute about 56 percent of total mail volume and revenue. By dividing 56 percent of our revenue projection (in effect our expense figure in order to break even) by 56 percent of our volume projection, they forecast the price of a first-class stamp. Stamp prices obtained in this manner differ from those obtained by regression analysis.

Postal Service forecasts are presented together with ours in appendixes XIII to XVI.

METHODOLOGY

USE OF REGRESSION ANALYSIS TO PROJECT

A. VOLUME

B. EXPENSES

BY MAKING VARIOUS ASSUMPTIONS AS TO

A. PRODUCTIVITY

B. INFLATION

MAIL VOLUME PROJECTION BASED ON

- HISTORICAL DATA
- DISPOSABLE PERSONAL INCOME
- NUMBER OF FAMILIES AND INDIVIDUALS

MAIL VOLUME-1984 (IN BILLIONS)

LOWER LIMIT	BEST ESTIMATE	UPPER LIMIT
101.0	105.5	110.0

THE STATEMENTS ON PAGE 2 OF THIS REPORT ARE AN INTEGRAL PART OF THIS APPENDIX.

PROJECTED EXPENSES

- BASED ON:
  - A. HISTORICAL DATA
  - B. PROJECTED VOLUME
- MAKING VARIOUS ASSUMPTIONS:
  - A. PRODUCTIVITY AT 7/10%, 2% AND 3%
  - B. INFLATION RATES USED BY BLS AND USPS

PROJECTED EXPENSES BASED ON BLS INFLATION RATES

(IN BILLIONS)

(4.5%—1974/1979; 3.5%—1980/1984)

PRODUCTIVITY	EXPENSES
7/10%	$16.3
2%	$13.8
3%	$12.2

THE STATEMENTS ON PAGE 2 OF THIS REPORT ARE AN INTEGRAL PART OF THIS APPENDIX.

PROJECTED EXPENSES BASED ON USPS* INFLATION RATES

(IN BILLIONS)

(10.4%—1974; 7.4%—1975; 6.0%— 1976; 5.2%—1977; 4.6%—1978, 4.5%—1979/1983; 4.4%—1984)

PRODUCTIVITY	EXPENSES
7/10%	$18.7
2%	$15.9
3%	$14.0

*DATA RESOURCES INCORPORATED

THE STATEMENTS ON PAGE 2 OF THIS REPORT ARE AN INTEGRAL PART OF THIS APPENDIX.

PROJECTED EXPENSES BASED ON BLS INFLATION RATES PLUS 3% GROWTH IN USPS EXPENSES

(IN BILLIONS)

PRODUCTIVITY	EXPENSES
7/10%	$22.2
2%	$18.9
3%	$16.7

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PROJECTED EXPENSES BASED ON USPS* INFLATION RATES PLUS 3% GROWTH IN USPS EXPENSES

(IN BILLIONS)

PRODUCTIVITY	EXPENSES
7/10%	$25.9
2%	$22.0
3%	$19.4

*DATA RESOURCES INCORPORATED

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GROWTH IN EXPENSES FROM 1974 TO 1984
(IN BILLIONS)

	BLS			USPS			BLS+3%			USPS+3%		
	7/10%	2%	3%	7/10%	2%	3%	7/10%	2%	3%	7/10%	2%	3%
1984 EXPENSES	$16.3	$13.8	$12.2	$18.7	$15.9	$14.0	$22.2	$18.9	$16.7	$25.9	$22.0	$19.4
1974 EST. EXPENSES	$11.2	$11.2	$11.2	$11.2	$11.2	$11.2	$11.2	$11.2	$11.2	$11.2	$11.2	$11.2
GROWTH IN EXPENSES	$5.1	$2.6	$1.0	$7.5	$4.7	$2.8	$11.0	$7.7	$5.5	$14.7	$10.8	$8.2

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PROJECTED EXPENSES
1984
(IN BILLIONS)

	BLS			USPS			BLS+3%			USPS+3%		
	7/10%	2%	3%	7/10%	2%	3%	7/10%	2%	3%	7/10%	2%	3%
1984 DOLLARS	$16.3	$13.8	$12.2	$18.7	$15.9	$14.0	$22.2	$18.9	$16.7	$25.9	$22.0	$19.4
1973 DOLLARS	10.4	8.8	7.8	10.4	8.8	7.8	14.4	12.2	10.8	14.4	12.2	10.8

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RANGE OF COST OF FIRST – CLASS STAMP – BREAKEVEN LEVEL (IN 1984 DOLLARS AND 1973 CONSTANT DOLLARS)

	BLS			USPS			BLS+3%			USPS+3%		
	7/10%	2%	3%	7/10%	2%	3%	7/10%	2%	3%	7/10%	2%	3%
1984 CENTS	$0.16	$0.09	$0.05	$0.18	$0.10	$0.06	$0.31	$0.23	$0.17	$0.36	$0.26	$0.19
1973 CENTS	$0.10	$0.06	$0.03	$0.10	$0.06	$0.03	$0.21	$0.15	$0.11	$0.21	$0.15	$0.11
1974 LEVEL	← $0.10 →											

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POSTAGE RATES NEEDED TO BREAKEVEN AT PROJECTED EXPENSE LEVELS

(IN BILLIONS)

	BLS			USPS			BLS + 3%			USPS+ 3%		
	7/10%	2%	3%	7/10%	2%	3%	7/10%	2%	3%	7/10%	2%	3%
EXPENSES	$16.3	$13.8	$12.2	$18.7	$15.9	$14.0	$22.2	$18.9	$16.7	$25.9	$22.0	$19.4
COST OF FIRST-CLASS STAMP NEEDED TO BREAKEVEN												
GAO	$0.16	$0.09	$0.05	$0.18	$0.10	$0.06	$0.31	$0.23	$0.17	$0.36	$0.26	$0.19
USPS	$0.14	$0.12	$0.10	$0.16	$0.14	$0.12	$0.19	$0.16	$0.14	$0.22	$0.19	$0.17

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POSTAGE RATES ASSUMING SUBSIDY AS PRESENTLY AUTHORIZED-- $460 MILLION IN 1984 (IN BILLIONS)

	BLS			USPS			BLS + 3%			USPS + 3%		
	7/10%	2%	3%	7/10%	2%	3%	7/10%	2%	3%	7/10%	2%	3%
EXPENSES	$16.3	$13.8	$12.2	$18.7	$15.9	$14.0	$22.2	$18.9	$16.7	$25.9	$22.0	$19.4
SUBSIDY	.5	.5	.5	.5	.5	.5	.5	.5	.5	.5	.5	.5
OPERATING REVENUE	15.8	13.3	11.7	18.2	15.4	13.5	21.7	18.4	16.2	25.4	21.5	18.9
POSTAGE RATE GAO	$0.14	$0.08	$0.04	$0.16	$0.09	$0.04	$0.29	$0.21	$0.15	$0.35	$0.25	$0.18
USPS	$0.14	$0.11	$0.10	$0.16	$0.13	$0.12	$0.19	$0.16	$0.14	$0.22	$0.18	$0.16

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POSTAGE RATES ASSUMING SUBSIDY OF 10% OF EXPENSES (IN BILLIONS)

	BLS			USPS			BLS + 3%			USPS + 3%		
	7/10%	2%	3%	7/10%	2%	3%	7/10%	2%	3%	7/10%	2%	3%
EXPENSES	$16.3	$13.8	$12.2	$18.7	$15.9	$14.0	$22.2	$18.9	$16.7	$25.9	$22.0	$19.4
SUBSIDY	1.6	1.4	1.2	1.9	1.6	1.4	2.2	1.9	1.7	2.6	2.2	1.9
OPERATING REVENUE	14.7	12.4	11.0	16.8	14.3	12.6	20.0	17.0	15.0	23.3	19.8	17.5
POSTAGE RATE GAO	$0.11	$0.05	*	$0.13	$0.06	*	$0.26	$0.17	$0.12	$0.29	$0.21	$0.14
USPS	$0.13	$0.11	$0.09	$0.14	$0.12	$0.11	$0.17	$0.15	$0.13	$0.20	$0.17	$0.15

* STAMP PRICE PROJECTION OUTSIDE SCOPE OF FORMULA

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POSTAGE RATES ASSUMING SUBSIDY OF 20% OF EXPENSES (IN BILLIONS)

	BLS			USPS			BLS + 3%			USPS + 3%		
	7/10%	2%	3%	7/10%	2%	3%	7/10%	2%	3%	7/10%	2%	3%
EXPENSE	$16.3	$13.8	$12.2	$18.7	$15.9	$14.0	$22.2	$18.9	$16.7	$25.9	$22.0	$19.4
SUBSIDY	3.3	2.8	2.4	3.7	3.2	2.8	4.4	3.8	3.3	5.2	4.4	3.9
OPERATING REVENUE	13.0	11.0	9.8	15.0	12.7	11.2	17.8	15.1	13.4	20.7	17.6	15.5
POSTAGE RATE GAO	$0.07	*	*	$0.08	*	*	$0.19	$0.12	$0.08	$0.23	$0.14	$0.09
USPS	$0.11	$0.10	$0.08	$0.13	$0.11	$0.10	$0.15	$0.13	$0.11	$0.18	$0.15	$0.13

* STAMP PRICE PROJECTION OUTSIDE SCOPE OF FORMULA

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COMMENTS ON APPENDIXES XIV, XV, AND XVI

These subsidies were selected because:

--The $0.5 billion subsidy is authorized by the Postal Reorganization Act of 1970 and can continue indefinitely.

--The 10 and 20 percent of expenses computations are based on legislative proposals.

THE RANGE OF POSSIBILITIES

	POSSIBLE SITUATIONS		
	WORST	BEST	MOST LIKELY
INFLATION	USPS*RATE+3%	BLS	USPS*RATE
PRODUCTIVITY GAINS	7/10%	3%	7/10%
EXPENSES	$25.9 B	$12.2 B	$18.7B
COST OF FIRST-CLASS STAMP	GAO $0.36 USPS $0.22¢	$0.05 $0.10¢	$0.18 $0.16¢

*DATA RESOURCES INCORPORATED

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COMMENTS ON APPENDIX XVII

We selected the 0.7-percent productivity rate because of the limited opportunities to mechanize postal operations. Almost half the work force has duties that require personal contact with the public--e.g., city and rural letter carriers; special delivery messengers; window clerks; and the postmasters of small, often one-man operations.

EFFECT OF VARYING SUBSIDIES ON MOST LIKELY SITUATION

	AMOUNT OF SUBSIDY		COST OF FIRST-CLASS STAMP
NO SUBSIDY-BREAKEVEN	NONE	GAO	$0.18
		USPS	$0.16
PRESENTLY AUTHORIZED SUBSIDY	$0.5 B	GAO	$0.16
		USPS	$0.16
SUBSIDY AT 10% OF EXPENSES	$1.9 B	GAO	$0.13
		USPS	$0.14
SUBSIDY AT 20% OF EXPENSES	$3.7 B	GAO	$0.08
		USPS	$0.13

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EQUATIONS FOR ESTIMATING POSTAL INDICATORS

(Computed T-Value in Parentheses)

1. Postal volume (note a)

$$V = -150349 + 34.3546\ DPI + 5441.82\ FAMIND - 35.0893\ FAMIND^2$$

(4.70100) (13.4447) (-11.3582)

$R^2 = .99783$

2. Postal expenses (note b)

$$\text{Log Exp} = 7.27660 + \text{Log } V - 1.15680\ \text{Log Prod}$$

(6.0649) (-5.61259)

$R^2 = 0.84079$

3. Postal revenues (note c)

$$INC = -3129.33 + 0.09227\ V(L) + 0.37390\ P$$

(22.8077) (7.15430)

$R^2 = 0.99044$

Where V = Number of pieces of mail, all classes.
DPI = Disposable personal income in 1973 constant dollars using the GNP price deflator.
FAMIND = Number of families and unrelated individuals.
EXP = Postal Service expenses in 1973 constant dollars using General Government (Federal) price deflator.
Prod = Pieces of mail per paid man-year.
INC = Postal Service operating income in 1973 constant dollars using GNP price deflator.
V(L) = Volume lagged 1 year.
P = Cost of first-class stamp in 1973 constant dollars using GNP price deflator.

a/ The original estimating equation using disposable personal income and families and individuals was rejected when the residuals indicated non-linearity in the data. After evaluating several types of data transformations, acceptable results were obtained by adding the term "families and individuals" squared to the equation.

b/ As in the case of volume, a simple linear relationship did not exist; therefore, a data transformation--this time a logarithmic form--was used to correct for nonlinearity.

c/ Because it takes a certain amount of time for business and individuals to respond to changes in postal rates, volume in this equation is represented as a lagged variable. The effect is that the equation is based on the relationship between 1 year's price and the following year's volume.

ATTACHMENT 3*

WESTINGHOUSE
REACTOR COOLANT PUMP TEST PROGRAM

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*Provided by Westinghouse Electic Corporation on November 7, 1975

W REACTOR COLLANT PUMP TEST PROGRAM

I. INTRODUCTION

The W reactor coolant pump test program is a series of separate effects tests using different fluids which will examine the behavior of a 0.382 scale model reactor coolant pump under calculated loss of coolant conditions. Pump performance effects core and ECCS performance during a postulated LOCA Pump performance affects core and ECCS performance during a postulated LOCA because of its effects on loop flow since the pump represents the dominate flow resistance in the primary coolant system.

Experimentally determined pump characteristics are historically supplied for the normal range of operating conditions of a reactor coolant pump. These tests are based on single phase incompressible flow. However, in order to evaluate LOCA, it is necessary to determine pump performance under the range of conditions typical of a LOCA. During a postulated loss-of-coolant accident (LOCA) fluid conditions are calculated which result in the pump operating under conditions such as:

1) Positive or negative reactor coolant flows which causes the pump to operate outside of its normal range,

2) pump speed - changes would allow the impeller to accelerate or coast down according to the flow transient, and

3) a depressurization transient of the reactor coolant which leads to two phase and eventually steam flow through the pumps.

The W test program is designed to provide experimental data at all these conditions such that a pump model be developed which will correctly predict the pump performance during a calculated LOCA. The tests will be run in a steady-state fashion such that accurate control of the pump inlet conditions are possible. The steady-state assumption is valid since the transport time of the fluid in the pump is so short (est 10 sec).

The test program consist of three test phases:

1) Air Tests - to establish the complete pump characteristics of a typical W RCP for single phase flow

2) Air/Water Tests - to determine the effect on these characteristics of pumping a two component two phase mixture

3) Steam/Water Tests - to determine the effect on these characteristics of pumping a compressible, flashing mixture

The tests in all three phases are being performed on a 0.382 scale model of the W 60 cycle RCP under steady flow conditions. In addition single phase tests are being performed on a 0.452 scale made of the W 50 cycle pump.

II. TEST PHILOSOPHY

The philosophy used in establishing the reactor coolant test program was that the pump would be tested as a separate component, separated from the remainer of the reactor coolant system. In this manner, the necessary boundary conditions are prescribed at the pump inlet and the pump performance is then measured and modeled. In order to insure that the range of boundary conditions would overlap those calculated for the pump in the system, SATAN analyzes are examined with different pump models and with updated pump models, based on the experimental data, to insure tests matrix covers all the fluid conditions which would be calculated for a LOCA.

It is felt that separating the pump performance for a given set of inlet conditions, from the entire system response results in clearer understanding of the pump behavior under LOCA conditions. This in turn will result in a more accurate model of the pump performance. If a system test approach were used, the pump boundary conditions could not be determined with sufficient accuracy such that a meaningful model of the pump performance could be obtained. Eventually, however, the resulting pump model which has been generated from separate effects tests, will be used to predict systems tests behavior such as LOFT and semiscale. The prediction of intergral tests with models generaged from separate effects tests will further verify that a sufficient range of boundary conditions were used in the original separate effects test.

III, PROGRAM STATUS

A. Air Tests - completed

The objective of this portion of the test program was to determine, experimentally, the hydraulic characteristics of the W model, 60 cycle RCP over a range of conditions representative of a LOCA. The range of parameters were:

1) -100% volumetric flow +500%

2) 0% impeller speed +200%

3) 30 psia inlet pressure 60 psia

These tests were performed using air as the pumped medium. The test pump is shown in Figure 1. Data from these tests was compared to data from tests using water as the pumped medium in the normal range of conditions. The results agreed verifying that air could be used to determine the RCP hydraulic characteristics to be used for water flow. Adherence to the affinity laws was also verified in these tests as shown in Figure 2.

As a result of this phase of the test program, the performance of the W 60 cycle RCP is well known over the complete range of expected LOCA conditions. This data is currently incorporated in W LOCA analyses.

B. Air/Water Pump Tests - Completed

The air tests were repeated except that a second component of flow was added to the pumped medium, air. Thus, in addition to the parameters listed for the air tests, flow quality was also varied over a range of 0 to approximately 100%. The test facility is shown in Figure 3 for these tests.

The reasons for performing these tests in advance of steam/water testing were:

1) to separate two component flow effects from compressible, flashing flow effects

2) to establish some design guidelines for the steam/water test facility as well as to provide a model which could be used to obtain

more accurate inlet conditions for the steam/ water tests.

These tests indicated that the W RCP homologous curves were somewhat degraded using inlet homogeneous density as a basis. The tests also showed that the degree to torque degradation was not necessarily the same as for head.

C. Steam/Water Pump Testing

The objective of these tests is to determine the degree of degradation of the pump hydraulic characteristic due to pumping compressible, flashing medium. The test parameters to be varied in these tests are:

1) flow - -100% to +500%

2) speed - -100% to +200%

3) quality - 0% to 100%

4) pressure - 100 psia to 400 psia

The range of these parameters, again cover the conditions calculated in the W RCP during a LOCA for the time period of interest.

The steam/water tests are being conducted jointly by W, Framatome and the French Atomic Energy Commission, CEA. The test facility is located at the Center for Nuclear Studies, Cadarache, France.

The test facility has been completed designed including all major components. Construction is nearly complete on the loop and all of the major equipment has been procured. The tests are scheduled to begin late in 1975.

The ultimate product of all these programs will be a two phase flow pump performance model developed by Westinghouse for use in safety analysis calculations.

D. Single Phase W Model 93D Pump Tests

The 50 cycle pump is designed to operate at 1500 rpm instead of 1200 rpm, nominal speed. It also has a specific speed, N_S = 6870 compared to N_S = 5200 for the 60 cycle pump. Therefore, additional single phase flow tests are being run on a scale model of this pump.

1) Air Tests - W has completed testing the 50 cycle scale model pump in air at the W Cheswick facility. Preliminary results that the predicted pump performance matches the data well. The predicted pump performance was based on generalized pump curves as in Stepanoff and extrapolation of the 60 cycle results.

2) Water Tests - The French utility, EDF, will conduct similar tests on the same scale model pump while pumping water. W PWR-SD is reviewing the test plans and will have access to the test results. The testing should be completed by the end of 1975.

IV. CONCLUSIONS

W is developing a data base and a resulting model for RCP behavior during a postulated LOCA for a PWR. The test programs established by W increase in complexity and are designed to provide data which can then be utilized to develop a two-phase pump model. As part of the development efforts, there is continuous feedback from the analysts and previous tests into the steam/water test program in France. In this manner, we can be assured that the resulting pump model will accurately predict the pump performance under all LOCA postulated conditions and thus increase the safety margin for ECCS design.

Figure 1 View of the Model 93A Pump as Mounted in the Test Cell at JPC.

FIGURE 2

NORMAL HEAD FLOW CURVE 93A MODEL PUMP WATER AND AIR TEST MEDIA

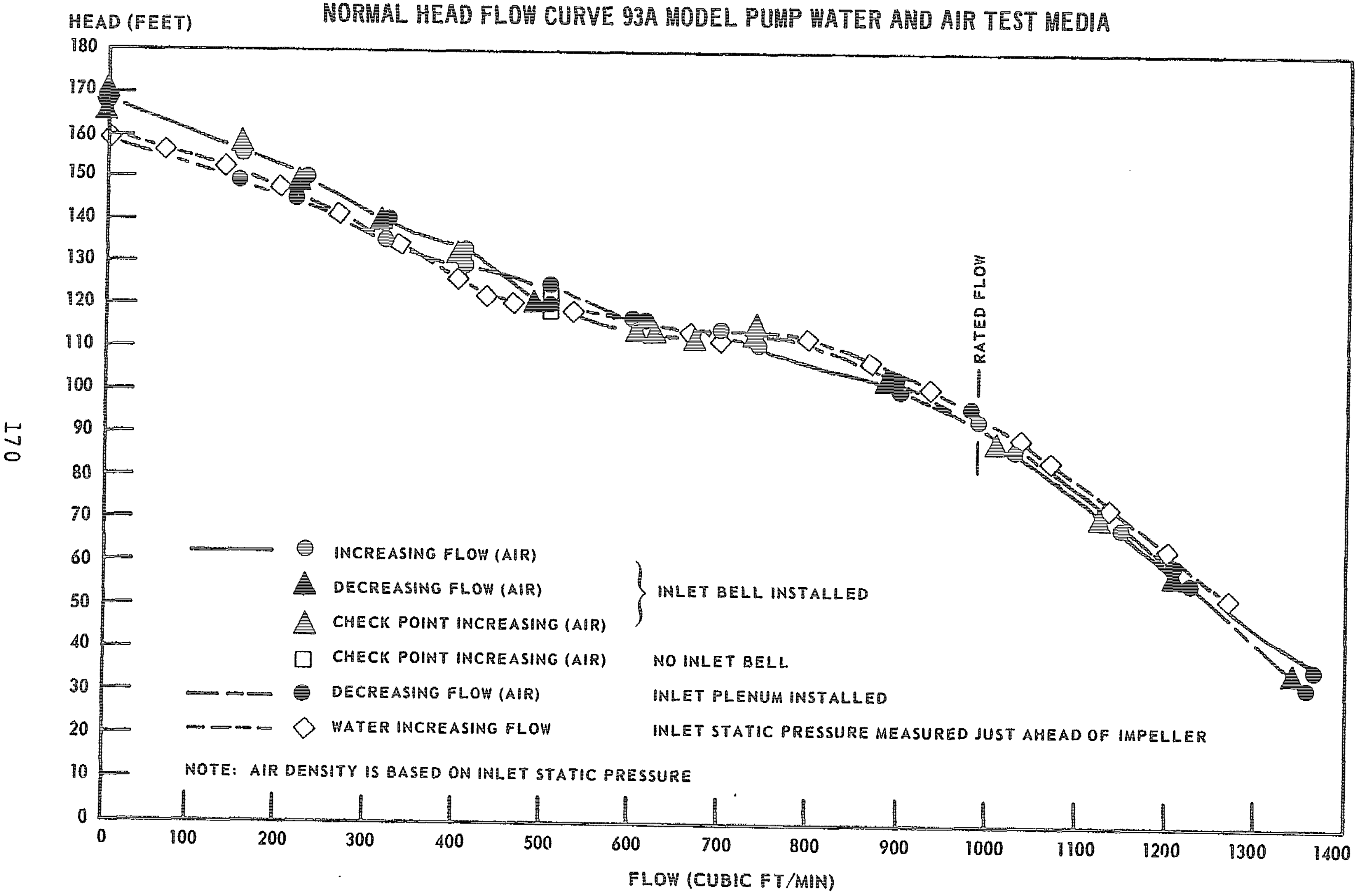
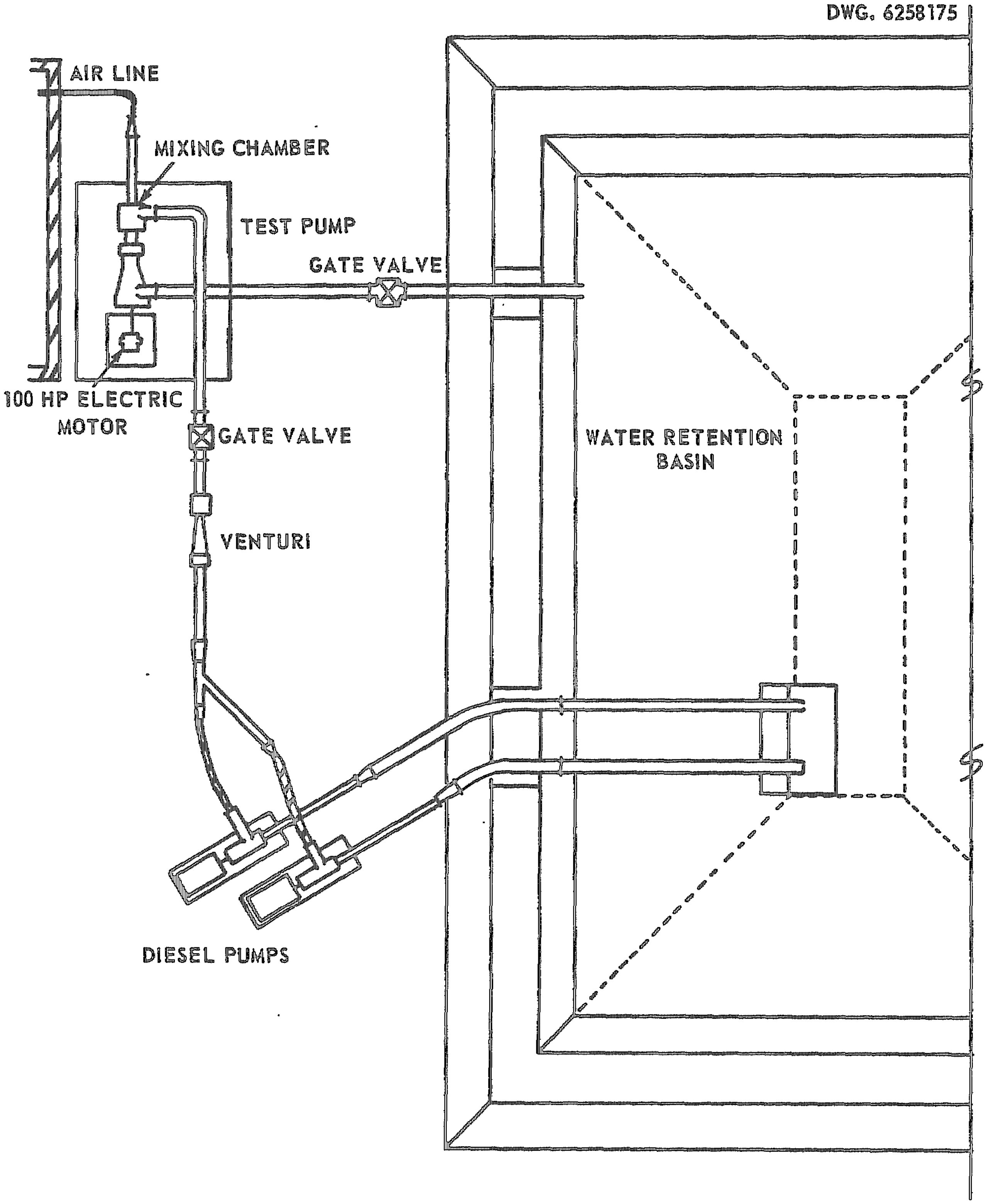


FIGURE 3

TEST FACILITY SCHEMATIC



ATTACHMENT 4

LOFT - LONG TERM PLAN

Attachment 4

Aerojet Nuclear Company
Rogers 304
550 SECOND STREET
IDAHO FALLS, IDAHO 83401

October 23, 1975

Mr. Romano Salvatori
201 South Lexington Avenue
Pittsburg, PA 15208

Per our telephone conversation of yesterday, please find enclosed copies (I apologize for their quality, our originals are at the print shop), which are excerpts of our LOFT Long Term Program Plan Document, that deal with the potential uses of the LOFT Facility.

If you need further information, or if I can be of further assistance, please do not hesitate to call.

L. J. Ybarrondo, Manager
LOFT Program

nls

Enclosures as stated

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3.2 Potential Uses of the LOFT Facility

3.2.1 LOCA Testing

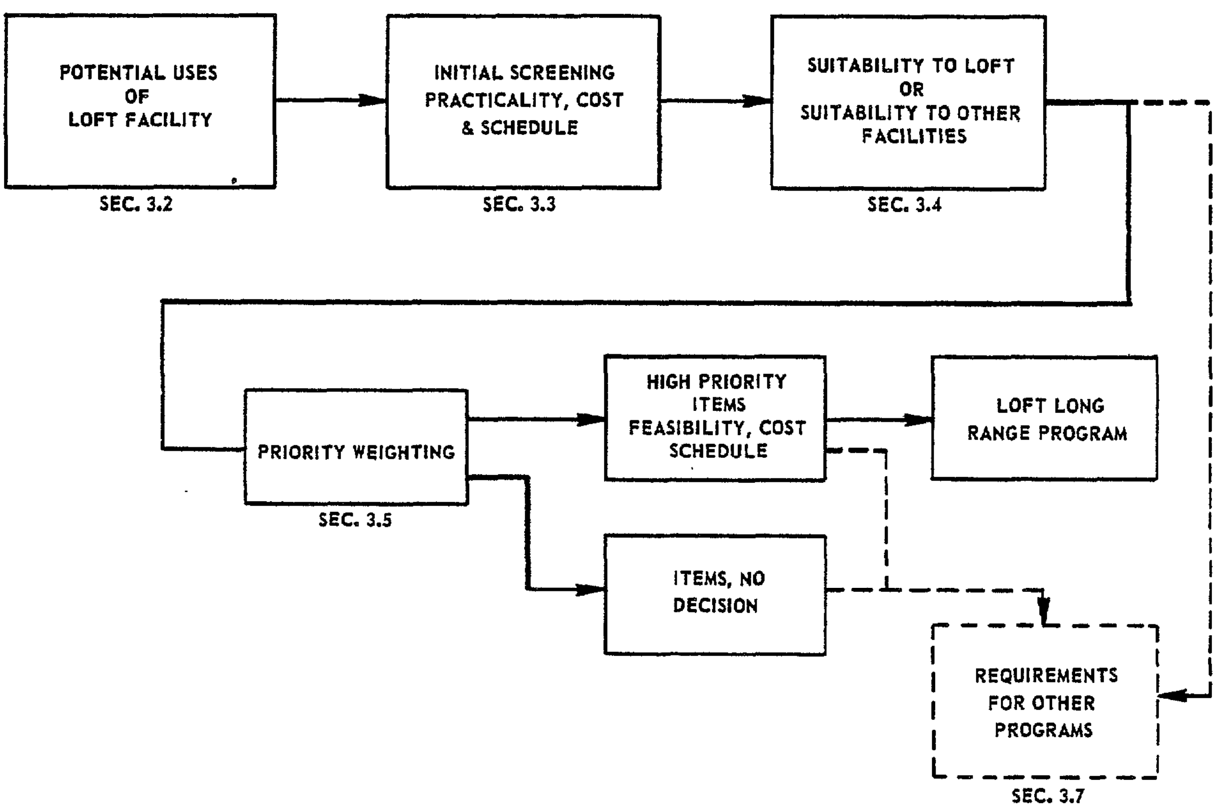
A. Nonnuclear Testing

Nonnuclear testing involves depressurization of the primary coolant loop at zero (negligible) reactor power conditions, with other plant conditions varied (i.e., break location, pressure, and ECC injection mode and location). There are two major categories of nonnuclear tests, blowdown with a core simulator, and blowdown with a reactor core at "zero" power. The test matrix for this series of tests is given in Table 2-1.

(1) With Core Simulator

Prior to the initial fill process of the primary loop, a filter assembly will be installed in the reactor vessel. During initial

ACTIVITY FLOW CHART – LOFT LONG TERM PROGRAM SELECTION



circulation of the primary coolant, this filter removes particulate matter from the circulating fluid. The filter assembly is designed to be converted into a core simulator (i.e., it yields the same pressure drop as that calculated for the reactor core assembly for the same fluid conditions). This approach allows investigation of system blowdown response prior to core load.

(2) With Nuclear Core

Once core load and installation of the experimental instrumentation are completed, zero power LOCA testing may be conducted on the plant. This allows testing of all effects other than those associated with reactor power (reactor temperature rise across the core, fission products, etc.).

B. Nuclear Testing at Power (5-1/2 ft Core)

The use of the LOFT facility for nuclear (power) LOCEs is given in Section 2.0 for the as-built configuration. However, testing could be performed with modifications for other blowdown loop configuration and ECCS configurations, if desired. Potential modifications include:

(1) 4X4 Passive Components, Offset Shear Breaks (without communication)

The present LOFT configuration provides this type of blowdown loop. The type of LPWR plant being simulated is a four loop plant. The LOFT operating loop represents three operating loops of an LPWR, and the blowdown loop represents the broken loop. The pipe break configuration simulates offset shear breaks without communication, (the flow from the hot and cold legs does not mix prior to flowing through the simulated break plane(s)).

(2) 4X4 Passive Components with Communicative Breaks

LOCA testing for this configuration allows the study of effects from hot leg flow and cold leg flow mixing prior to discharge out the break plane.

(3) Broken Loop ECC Injection

This configuration provides for ECC injection into the broken (blowdown) loop, and better simulates conditions during a LOCA on a PWR plant.

(4) 2X4 Passive Component Loop

Two manufacturers of LPWRs utilize two loops (steam generators) and four pumps[1]. This is referred to as a 2X4 loop arrangement. The postulated break location and flow paths on a 2X4 loop plant are different than those of a 4X4 loop plant. Also, one of the 2X4 plants uses a "once through" steam generator design. The typicality analysis performed by these vendors indicates that cold leg break representation of their plant performance with the current blowdown loop is poor. Additional analysis by one vendor (B&W) indicates that modifications to the blowdown loop alone will provide good comparison.

(5) Active Blowdown Loop

An active blowdown loop contains a primary coolant pump and a steam generator, similar to the operating loop, instead of passive simulators consisting of fixed coolant flow resistances. This type of blowdown loop provides more realistic LOCA testing.

(6) Advanced ECC System

Initial LOCA testing on LOFT will employ those types of ECC systems in use in present generation LPWR plants. Based on measured performance, and performance calculations advanced ECC concepts will be developed and implemented. The LOFT plant as built provides for varying coolant injection locations, flow rates, and initiation. Other requirements, such as additional locations, etc., could be implemented as required.

C. Nuclear Testing at Power (9-12 ft core)

One of the concerns in scaling the LOFT plant is the length core to be used[1]. It has been requested that LOCA tests be carried out with a longer core. The blowdown configurations to be tested could cover the same types as in Section B, that is:

(1) 4X4 Passive Components

(2) 4X4 Passive Components with Communicative Breaks

(3) Broken Loop ECC Injection

(4) 2X4 Passive Components

(5) Active Blowdown Loop

(6) Advanced ECC Systems

3.2.2 Anticipated Transients

Anticipated transients are discussed in Reference [9] as follows:

"The first part of ATWS, "anticipated transients," is concerned with various events that may happen during the operation of a water-cooled reactor power plant. These deviations from normal operating conditions are called "anticipated transients," and might occur one or more times during the service life of a plant. They are thus distinguished from "accidents," which have a much lower likelihood of occurrence. There are a number of anticipated transients, some of quite trivial nature and others that are more significant in terms of the demands imposed on plant equipment. Anticipated transients include such events as a loss of electrical load that leads to closing of the turbine stop valves, a load increase such as the opening of a condenser bypass valve, a loss of feedwater flow, and a loss of reactor coolant flow. Nuclear power plants are designed with various safety and control systems to preclude adverse effects from these and other anticipated transients.

The other part of ATWS, "without scram", is concerned with the reactor protection system. The reactor protection system, or shutdown system, involves numerous instruments, cables, amplifiers, switching devices, alarms, trips, control rods and drive mechanisms, etc. The protection system is arranged to detect off-normal conditions in the plant and to institute automatically whatever safety action is needed. If plant conditions indicate there is a potentially damaging situation, the automatic reaction of the protection system is to cause the control rods to move rapidly into the reactor core to shut down the nuclear reaction. This most drastic form of automatic response of the protection system, which results in a very rapid shutting down of the reactor, is called the "scram". In some of the anticipated transients, shutting down the nuclear reaction and hence rapidly reducing the amount of heat being generated by the reactor core, is an important step in assuring that no damage to the plant or risk of accident occurs. If such a transient should occur and if, in spite of all the care built into the reactor shutdown system, a scram should not result, then an ATWS event would have occurred."

It has been suggested that anticipated transients with protection be investigated in the LOFT Integral Test Facility, using an approach that precludes core or plant damage. Safety margins and design and safety code verification should be determined.

A. Anticipated Transients With Protection (ATWP)

The transients to be considered include, but are not limited to:

(1) Small primary coolant system break.

(2) Loss of primary coolant flow - partial loss and full loss of flow

(3) Positive Reactivity Insertion

Included are reactivity insertion by reactor control rods, boron concentration change and introduction of colder water into the reactor core region.

(4) Change in reactor power demand - Includes loss-of-load, simulated steam line rupture, and overpower demand, etc.

(5) Loss of feed water flow.

(6) Loss of electric power - partial or full.

B. Anticipated Transients with Delayed Protection (ATWDP)

These tests would involve performance of anticipated transients with delayed protection (scram) to investigate the safety margins involved in each transient. A comprehensive and detailed experiment safety analysis (ESA) would be required to allow evaluation of safety margins prior to experiment performance.

3.2.3 Fuel Behavior Studies

A. Operation With Irradiated Fuel

Irradiated fuel performance (i.e., fuel with extensive burnup) during plant transients is of concern to the reactor designer. It has been proposed that

LOFT be partially loaded with irradiated fuel and tested to obtain the effects of LOCA transients on high burnup fuel.

B. Operation With Failed Fuel

It has been suggested that LOFT be partially loaded with failed fuel (or produce known failures) and tested to obtain the effects of LOCA transients on failed fuel.

C. Fuel Design Study Support

It has been suggested that LOFT be used to obtain an integral system check of fuel performance.under accident conditions. Large fuel bundle effects could be obtained to provide checkpoints for the Power Burst Facility (PBF) fuel behavior studies.

D. Operation With Mixed Fuel

It has been suggested that LOFT be operated with mixed fuels, i.e., a mixture of uranium and plutonium fuels, to provide experience and information on this type of fuel use. This is expected to be a viable use in the future.

3.2.4 Measurements

There are some measurements of a special nature required to provide data for the state-of-the-art design of nuclear steam supplies.

A. Reactor Decay Heat

There is a need to characterize reactor decay heat on an operating reactor. Within the time frame of interest for a LOCA, the existing decay heat data is inaccurate (Ref. 11). It is suggested that the LOFT plant be used to obtain more accurate data (Ref. 12).

B. Two Phase Flow Measurement

The basic behavior of steam-water mixtures during transient processes that occur in a reactor plant during blowdown are not fully understood. It is requested that LOFT provide basic measurements in this area. The needed measurements are in the following areas:

(1) Two phase flow phenomena

(2) Density

(3) Choked, or critical flow through various geometrics.

3.2.5 Nuclear Steam Supply (NSS) Design Support

There are certain areas in the design of NSS that require experimental information for design confirmation. LOFT has been suggested as the possible test bed for the collection of some ot this information.

A. Reactor Vessel Check Valve

One method used by a NSS vendor to enhance reflood of the core after a LOCA is the use of check valves in the reactor that provides communication between the top of the downcomer and the upper plenum for steam flow. It has been suggested that this concept be tested on LOFT.

B. Shrouded Fuel Assemblies

Shrouded fuel assemblies are used in certain type BWR's. The shrouds prevent cross flow between assemblies. It has been suggested that LOFT examine effect of fuel assembly shrouds under accident conditions.

C. Relief Valve Transients

It has been requested that LOFT collect data on the forces on relief valves and associated piping during valve-lifting transients.

D. Partial Fuel Melt

If certain reactor accidents are not mitigated and allowed to progress, fuel melt may result. The effect of partial melt is of concern and it has been requested that such tests be done in the LOFT Facility.

3.2.6 Fission Product Transport

Fission products accumulate in the fuel rods of an operating reactor. The release and transport of these products is of concern. Once released from the fuel, the transport processes determine whether a fission product release to the environs occurs.

A. Transport Within the Primary Coolant System

It has been suggested that LOFT investigate transport of fission products (if released from the fuel) about the primary loop. This gives a space distribution of products for potential release to the containment.

B. Transport Within the Containment Vessel

It has been suggested that LOFT be used to study fission product release and transport from a break in the primary system to the containment. The transport of products about the containment is also to be studied. The distribution of fission products gives a space distribution for potential release to the environs.

3.2.7 Reactor Plant Component Performance

Data has been requested on reactor plant component performance during LOCA testing.

3.2.8 Light Water Breeder Safety Program (LWB)

It has been suggested that LOFT be used as the test bed to conduct safety research on LWBs. The safety problems are similar to those of a PWR. The research could show that LWB cores are suitable from a safety standpoint for use in LPWR plants.

3.2.9 Boiling Water Reactor (BWR) LOCA Testing

The LOFT Facility could be used for this testing. A new reactor plant would have to be built.

3.2.10 Gas Cooled Reactor Safety Studies

The LOFT Facility test bed could be used for study of gas cooled reactor safety. A new reactor plant would have to be built.

3.3 Initial Program Screening

The LOFT Facility Potential Use List (Section 3.2) was evaluated for initial screening for use in the LOFT program. The factors considered for deletion of items from the list are:

(1) Not practical at this time

(2) Clearly out of range on costs

(3) Clearly not reasonable from schedular considerations

The items deleted from the list are given in Table 3-I.

3.4 Suitability to the LOFT Facility

The LOFT Facility Potential Use List, as modified by Table 3-I, was evaluated for suitability for execution in LOFT. The items deferred are given in Table 3-II.

3.5 Priority Weighting

The resulting list of potential uses for the LOFT Facility, after the items evaluated in Sections 3.3 and 3.4 are deleted, is given in Table 3-III. The items in Table 3-III are priority weighted for execution on LOFT. The weighting factor is subjective based on light water cooled reactor research data needs, and timeliness, in the subject areas. The items are assigned a weighting number, where 100 is top priority and zero is the lowest priority.

The weightings were assigned as follows:

When the various sources (Section 3.1) were contacted for suggestions of use of the LOFT Facility in support of the AEC's light water, pressurized reactor safety research program, along with use suggestions, an idea also was obtained as to the urgency of the data need. In addition, intimate contact with the liscensing process of PWR's, safety research, and reactor safety analysis gives an excellent idea of data priority need.

Several senior engineers in the LOFT Program, independently, assigned a weighting factor to the suggested programs for the LOFT Facility based on engineering judgement, with the above influence factors. This weighting is averaged to obtain the figures given in Table 3-III.

TABLE 3-I

ITEMS DELETED FROM POTENTIAL USE LIST
RESULTING FROM INITIAL SCREENING

Item	Discussion
3.2.3.D Operation with mixed fuels (U and Pu)	Commercial mixed fuel design is not available; it is felt that testing of mixed fuels under transient conditions is further in the future than the programs suitable for LOFT at this time.
3.2.5.D Partial fuel melt	The consequences of reactor fuel melt down could be quite extensive, depending on the magnitude of meltdown. The control of this experiment would be quite difficult. This would be a "one shot" test in that the core (and maybe the facility) would not be reusable. The cleanup and requalification of the facility could take one or two years. A new MTA would probably be required.
3.2.6.B Fission product transport within the containment	The practicality of conducting fission product transient experiments in the LOFT containment, at this time, is questionable. The Facility would be unusable for other purposes until it was decontaminated which gives long turn-around times. If such testing were to be done it should be coordinated with fuel melt tests.
3.2.10 Gas cooled reactor	This type of test program would represent a complete departure from the present, committed thrust of LOFT testing, (Section 2.0). This program is further in the future than the programs considered suitable for LOFT.

TABLE 3-II

ITEMS DEFERRED FROM POTENTIAL USE LIST
RESULTING FROM SUITABILITY SCREENING

Item	Discussion
3.2.3.A Operation with irradiated fuel	Generation of irradiated fuel of known power history and typical state-of-the-art design is a major problem. It is estimated to take about three years. There are presently no irradiation fuel storage and core assembly facilities at LOFT. The testing program with irradiated fuel has not been developed.
3.2.3.B Operation with failed fuel	The problems of operation with failed fuel are quite similar to those for operation with irradiated fuel. The rationale for such a program has not been developed. Once such a program is completed, requalification of the facility would be quite lengthy.
3.2.5.B Shrouded fuel assemblies	The cores considered for tests in LOFT do not have shrouds. Tests in this area should be considered in conjunction with Item 3.2.4 BWR LOCA testing.
3.2.9 BWR LOCA testing	BWR plant tests would require a new MTA, and Facility modifications. The cost is on the order of $60,000,000. The decision to do this type of program is deferred at this time.

TABLE 3-III

PRIORITY WEIGHTED POTENTIAL USES
FOR THE LOFT FACILITY

Item	Weighting (100 ∆ Top Priority)
A. LOCA Testing:	
(1) NONNUCLEAR TESTING:	
(a) WITH CORE SIMULATOR	100
(b) WITH NUCLEAR CORE	100
(2) Nuclear Testing At Power (5-1/2 ft core):	100
(a) 4x4 Loop, Passive Components, Offset Shear Breaks	100
(b) 4x4 Loop Passive Components, Communicative Breaks	80
(c) Broken Loop ECC Injection	75
(d) 2x4 Loop, Passive Components	25
(e) Active Blowdown Loop	70
(f) Advanced ECC Systems	100
(3) Nuclear Testing At Power (9-12 ft core):	100
(a) 4x4 Loop, Passive Components, Offset Shear Breaks	90
(b) 4x4 Loop, Passive Components, Communicative Breaks	66
(c) Broken Loop ECC Injection	70
(d) 2x4 Loop Passive Components	20
(e) Active Blowdown Loop	65
(f) Advanced ECC Systems	100
B. Anticipated Transients:	
(1) Anticipated Transients With Protection (ATWP):	
(a) Small Primary Coolant System Break	100
(b) Loss of Primary Coolant Flow	80
(c) Positive Reactivity Insertion	45
(d) Change in Reactor Power Demand	80
(e) Loss of Feedwater Flow	80
(f) Loss of Electrical Power	35
(2) Anticipated Transients With Delayed Protection (ATWDP):	
(a) Small Primary Coolant System Break	100
(b) Loss of Primary Coolant Flow	80
(c) Positive Reactivity Insertion	45
(d) Change in Reactor Power Demand	80
(e) Loss of Feedwater Flow	80
(f) Loss of Electrical Power	35
C. Fuel Behavior Studies:	
(1) Fuel Design Study Support	

TABLE 3-III (contd.)

Item	Weighting
D. Measurements:	
(1) Reactor Decay Heat	100
(2) Two-Phase Flow	
(a) Flow Regime	100
(b) Density	100
(c) Choked Flow	100
E. NSS Design Support:	
(1) Reactor Vessel Check Valve	70
(2) Relief Valve Transients	70
F. Fission Product Transport:	
(1) Primary Coolant System	60
G. Reactor Plant Component Performance	100
H. Light Water Breeder Safety Program	80

LOFT Program Activity	LOFT Long Range Program Plan - LOFT Integral Test Facility										
	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
Non Nuclear LOCE Tests With Core Simulator	11/20 — 6/10 4 Tests										
Core I Load, Low Power Physics, Non Nuclear Blowdown With Core Installed		6/10 — 2/4 1 LOCE Test									
Power Range Test, Decay Heat Test, Reduced Power Anticipated Transients with Protection		2/4 — 4/18									
Reduced Power LOCE's Core 1 (5 1/2')			5 Tests 4/18 — 12/18 10 Mo								
Anticipated Transients with Protection			2/18 — 3/18 4 Tests								
Change Out Center Assembly For Destructive Examination, Load "F" Assembly (Pressurized)			3/18 — 5/18								
Full Power LOCE Core 1 (5 1/2')				5/18 — 6/18 1 Test (Test Series May Continue)							
Modifications for Broken Loop ECC Injection	Design 7/1 — 7/1 Procurements — 6/18 — 12/18 Installation; Semiscale Tests										
Load Core 2 (5 1/2') (Pressurized)				6/18 — 10/22							
Design Study and Modification For Advanced ECC Systems		Semiscale Tests; Design Study Procurement 6/18 — 12/18 Installation									
Acceptance Tests Core 2 (5 1/2'), Low Power Physics, Power Range Tests				12/18 — 4/1							
Advanced ECC Tests at Reduced Power Core 2 (5 1/2')					4/1 — 6 Tests 12 Months — 4/1						
Anticipated Transients with Delayed Protection	Control Modification for Anticipated Transients Tests → 6/18 — 12/18 4/1 — 5/1 4 Tests										
Change Out Center Assembly For Destructive Examination, Load "A" Assembly (Unpressurized)						5/1 — 7/1					
Full Power LOCE Core 2 (5 1/2')						7/1 — 8/1 1 Test (Test Series may Continue)					
Active 4 X 4 Blowdown Loop	Design Phase; Semiscale Tests; Procurement 6/1 8/1; Installation — 8/1										
Design, Procurement, and Long Core (9-12), 3	Preliminary Design; Semiscale Tests; 9/1 Final Design, Analysis, Procurement, Modification 8/1 Installation 8/1; Plant Requalification Examinations										
Acceptance Tests Core 3 (9 12) Low Power Physics, Power Range Tests, Anticipated Transients with Protection								8/1 — 12/1			
Reduced Power LOCE's Core 3 (9-12)								12/1 — 6 Test 12 Mo — 12/1			5/1/75 1 test
Anticipated Transients with (Delayed) Protection									12/1 — 2/1 6 Tests		
Change Out Center Assembly For Destructive Examination									2/1 — 4/1		
Full Power LOCE Core 3 (9-12')									1 Test — 4/1 — 5/1 Test Series may Continue		
Load Core 4 (9-12)										5/1 — 10/1	
Acceptance Tests Core 4 (9-12') Low Power Physics, Power Range Tests										10/1 — 2/1	
Reduced Power LOCEs, Core 4 (9 12) Anticipated Transients with Delayed Protection										2/1 — 6 Tests 12 months — 2/1	

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