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SPECIAL REACTOR STUDY
REACTIVATION OF SHUT-DOWN REACTOR PLANTS

by

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August 27, 1963

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SPECIAL REACTOR STUDY

REACTIVATION OF SHUT-DOWN REACTOR PLANTS

Introduction

This report presents preliminary planning information which supplements two prior special reactor study reports, References (1) and (2). It is the purpose of this study to consider expedited reactivation of reactors and to evaluate the factors which are likely to be controlling to, or have a major influence on the time required to reactivate one or more of Hanford's six small reactors after an assumed period in the lay-away status outlined in Reference (1). It is assumed that the methods to be applied in preserving and protecting inactive equipment and facilities will be such that the plants which are shut down will, to the greatest extent practicable, be laid away with all essential equipment and systems assembled and in an operable state of repair.

It should be noted that, at best, the data presented herein represents "educated guesses". No rigorous development of specifications, procedures, or technical bases for laying away or reactivating these reactors has been undertaken.

Summary and Tentative Conclusions

The estimates of the probable minimum times required for reactivation are based upon the assumption that the action would be prompted by a high order of urgency or national emergency. Thus, compensating deviations from normal procedures, practices, and standards have been assumed.

The factors which have been considered as having a major influence on the time required to reactivate laid-away plants are: (a) the availability of competent personnel, (b) mechanical readiness of equipment and facilities, and (c) the availability of reactor fuels and essential materials. Tentative conclusions regarding each of these factors and rough estimates of the cost variables are summarized below. The study considers eight reactors (N excluded) under conditions in which one to six reactors are to be reactivated.

A. Availability of Competent Personnel

The preliminary studies made to date indicate that the availability of competent personnel will be the controlling factor in determining the time required to reactivate reactors. This conclusion is based on the fact that

- (1) Plant Shut-Down, Preservation and Reactivation Measures, by Earl A. Smith, dated June 19, 1963.
- (2) Hypothetical Cases for Stand-By and Lay-Away, by Earl A. Smith, dated October 1, 1962.

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many of the essential jobs are peculiar to Hanford; therefore, personnel fully qualified for these positions are not available on the labor market. New employees must be given special introductory on-the-job training which normally takes six to twelve months. This applies to supervisory personnel as well as to specialists and journeymen in the Processing and Instrument Maintenance functions. To a lesser degree, it also applies to Power, Electrical Maintenance, and Mechanical Maintenance functions if a major expansion of forces is involved.

The operating plants will be the only immediate source of fully competent personnel. A high level of operating competence, transferability, and promotability would be maintained to provide as much latitude as possible for expanding this force by the addition of relatively inexperienced personnel. The number of reactors operating and the number of reactors to be reactivated will determine the extent to which the existing personnel pool must be supplemented and the action that will be required to make those adjustments. The adjustments, of course, become more complicated and time-consuming as they increase in scope. The basic crew for reactor plants and the manning problems, including the option of having extra key personnel in stand-by, are discussed in more detail on page 7.

In regard to probable time requirements, it is tentatively concluded that man power requirements for starting a single reactor, or the first of a series, could be met rather quickly by upgrading and redistributing experienced personnel and filling in with new-hires. The time required to accomplish this adjustment is estimated to be approximately 60 days for cases in which six or seven reactors are operating, up to 90 days for cases in which four or five reactors are operating, and up to 180 days if only two or three reactors are operating. After starting the first reactor, an additional period of approximately nine to twelve months would be required to recruit, train, and readjust personnel for the start-up of one to five reactors remaining to be started in the cases considered. To cite cases typical of the two extremes, it appears feasible to have all laid-away units back in production in less than one year in the case in which the K Reactors and four small reactors are operating, and within eighteen months in the case in which only the K Reactors are operating. These time estimates do not require extra personnel in stand-by. Also, it is possible that this timing could be improved under conditions of extreme emergency in which maximum priorities and strong Government assistance is provided.

Engineering studies will be required to confirm or regute our present opinion that manning problems, not mechanical or structural problems, will be controlling to the time required to reactivate laid-away reactor plants. It should be noted that the expedited timing outlined above would require special pre-planned programs for the recruitment, security clearance, and training of personnel. Also, it was assumed that reactivation would be prompted by urgent conditions or a near-war situation in which the over-all national interest would dictate that normal administration procedures be streamlined, that considerable latitude for temporary adjustments to the

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employment practices would be allowed, and that Federal fiscal and executive policy would provide support and assistance to the extent that might reasonably be required to expedite the program.

B. Mechanical Readiness

It is estimated that a minimum period of 60 days would be required to perform the mechanical work required to prepare a single laid-away plant for start-up. This minimum period applies to conditions in which it is possible to draw heavily on the Maintenance forces of other plants to man an ABCD shift operation. For other conditions where more than one reactor is down, 90 days should be allowed to accomplish mechanical readiness. These estimates assume that plant forces and local minor construction forces can perform all of the mechanical and structural work required for reactivation. No time has been allowed for contracting procedures. Also, it is assumed that plants were laid away and maintained in a state of good repair with all essential equipment, auxiliaries, and spare parts available on site.

C. The Availability of Fuels and Essential Materials

The minimum lead-time required for reactor fuels and essential materials is estimated to be 60 days. This assumes that a full reactor fuel charge (225 tons) is available in finished inventory for each reactor to be started on less than five to six month's notice. It is also assumed that an adequate stock of fuel core material will be available in billet form to permit the fuel core supplier to increase delivery rates as required to supply initial charges for reactors which are to be started up six months or more after notice to proceed. Other important assumptions are:

- 1) Delivery of components for fuel element jackets will be expedited to meet production requirements within four months.
- 2) Delivery of fuel element cores will be expedited to meet production requirements within four months.
- 3) The facilities of Production Fuels Section will remain intact or in a state of preservation which will permit reactivation in less than four months.
- 4) Priorities for the supply and transport (tank cars) of helium will be expanded as required.
- 5) Other essential materials; coal, fuel oil, and chemicals will have normal market availability.

D. Cost Variables

An estimate of the cost of reactivating reactor plants has not been made. Only very broad generalizations can be made until an engineering study is

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made to identify the scope of the work involved. However, from preliminary studies, it appears that the major element of cost will be the man power costs. The man power costs for reactivating a single reactor on an 18 month schedule may be roughly approximated by assuming the payroll costs for that period to be the equivalent of nine months' payroll costs for a full basic crew of 170 people. At \$10,000 per man year, this would be \$1,275,000. Rough estimates of the elements of cost associated with expedited reactivation are discussed briefly below.

- 1) Fuel Element Inventory - The investment in fuel inventory has been estimated for a stand-by inventory in billet form and in the form of finished fuel elements. For a full reactor charge, these values are estimated to be; in billet form \$5,500,000, in finished fuel element form \$6,500,000. The difference of \$1,000,000 is the extra inventory burden required to ensure that fuel availability will permit start-up within 60 to 90 days rather than the five to six months start-up schedule which is required if the fuel inventory is in the billet form. This time advantage applies to a maximum of two reactors, each of which would require a full charge of finished fuel elements in order to meet the estimated 90 day start-up schedules.
- 2) Man Power Costs - The major variable in man power costs would be that associated with the option of retaining personnel in a stand-by status. It is assumed that these people could be used advantageously for special training and relief assignments in operating plants as well as for surveillance and maintenance assignments in shut down plants. An average cost of \$10,000 per year for each employee in stand-by status can be used to estimate the added costs for the stand-by arrangements discussed on page 6. In comparing stand-by with the alternatives of hiring and training new employees, it should be recognized that, during their initial training period of six to twelve months, these trainees are not in a productive status; so \$10,000 per man year of training time or \$7,500 per man should be offset against the estimated stand-by costs in comparing these alternatives.
- 3) Mechanical Reactivation Costs - No appreciable added costs are expected to result from the expedited schedule as the mechanical work is estimated to be noncontrolling in the cases examined.

Discussion

A. Personnel Considerations

For the purposes of this study, it has been assumed that the reactivation of reactors has been dictated by a state of major urgency. Accordingly, the proposed parameters and the resulting conditions for the manning, start-up, and the operation of the reactors must be considered to be a departure from normal standards. Feasibility of the suggested courses of action

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depends strongly upon the assumed effectiveness of special recruiting and training programs and upon extensive latitude to make temporary adjustments to existing manning and personnel practices.

Examples of problems which will require exceptions or special methods for handling are: Special priorities and expediting methods for recruiting personnel and obtaining security clearances would definitely be required; present trainee programs and progression schedules would have to be replaced with faster, more effective mass training methods; union agreements relative to, seniority, trainee status, work assignments, and the ratio of journeymen to trainees would require significant changes (no attempt has been made to estimate the costs which might accompany union agreement changes); the upgrading and reapportionment of experienced personnel will be so severe that a program for pre-qualifying, testing, and certifying experienced personnel for immediate advancement will be required; the licensing or certification requirements for reactor supervisory and operating personnel will probably need to be waived or modified; and, power levels and other operating limits and standards may need to be modified to provide increased margins of safety. A detailed study should be made to develop programs and planned courses of action designed to ensure that such manning problems can be effectively dealt with.

Two major factors which have a limiting influence on the timed availability of competent man power have been evaluated to provide a basis for forecasting a feasible course of action and estimating the minimum time required to provide adequate personnel to start up reactors after an extended period in lay-away status. These factors and their parameters are:

- 1) The number of people and level of competence of the personnel pool which is to be expanded. It is assumed that the level of competence of the crews of all operating reactors will be such that about 25 per cent of that experienced work force could readily be withdrawn and replaced by new employees without prohibitive effects on operating safety and efficiency. Based on this premise, the availability of competent personnel would not be limiting to the reactivation of one laid-away reactor under any of the conditions in which four or more reactors are operating. Under all conditions where two or more reactors are to be reactivated, the availability of competent personnel will be controlling to the time required to prepare for start-up. Unless extra personnel have been maintained in a stand-by status, the time required to recruit and train becomes a governing factor. Estimated requirements for experienced stand-by personnel to alleviate this condition are discussed in a later paragraph.
- 2) The time required to recruit and train new personnel. As a general guide, it is assumed that the minimum time required for recruiting and in-plant training is twelve months for key Processing personnel and six months for key Power and Maintenance personnel. Also, it is assumed that our normal capacity for in-plant training is limited to a ratio of one new trainee to two experienced workmen (two operating reactors can train one completely

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new reactor crew). These assumptions would dictate a minimum delay of one year for start-up conditions which must depend upon the recruiting and training of new crews. Under conditions in which the training capacity of operating plants is limiting (five or six reactors down), special training cycles utilizing simulated conditions in non-critical reactors would be required to avoid excessive delays.

The limiting effects of these factors can be alleviated by having an extra number of experienced key personnel in stand-by status. This would have the effect of reducing the number of new employees that would otherwise require extensive training and, thereby, provide greater latitude for expediting the start-up schedules. It is not possible at this time to specifically relate numbers of standby-personnel to potential savings in start-up time. It appears impractical to hold enough people in stand-by to make a significant reduction in the over-all 12 to 18 month start-up schedules; however, rough evaluations indicate that a stand-by force of 20 to 30 key people in the supervisor and certified specialist classifications could expedite the start-up of at least one reactor in a series by as much as one year; the time otherwise required to recruit and train new people for these critical assignments. Because of the hypothetical nature of the cases considered in this study, there was no specific allowance in the time estimates for the utilization of stand-by forces.

The most stringent case is that in which only the two K Reactors are operating, and all six of the smaller reactors are to be reactivated. The time estimate of six months to start the first reactor and one additional year to reactivate the other five would require that a continuing program of training and rotational job assignments be carried on in the K Reactors during the full time that the smaller reactors are in lay-away. This training would be designed to qualify virtually all Operating and Maintenance personnel for upgrades and/or reassignments essential to the reactivation and start-up of the laid-away reactors, the continued operation of the K Reactors, and the direction and training of new personnel. To the greatest extent practicable, engineering personnel and other exempt people in the department would be prepared to participate in the crash program required to complete reactivation of the six small reactors within 18 months of the notice to proceed. The intensive program of training for new supervisors, specialists, operators, and specialized craftsmen involves the utilization of plants which have been physically readied for reactivation but would be operated in a non-critical condition for training purposes. Training under full operating conditions would be carried on at the three operating reactors. Start-ups would be made under limited powers and special operating standards which would provide a prudent margin of safety throughout the training and shake-down periods required for the crews to become thoroughly oriented and familiar with all aspects of their work. Many of the normal formalities of employment practices, job classifications, work jurisdictions, certification requirements, and certain union agreements would need to be modified or temporarily set aside. The most difficult jobs to fill with competent personnel are the exempt positions and the control console operators in the Processing function. Other critical positions include the specialized maintenance assignments in the instrument and electrical crafts. The basic crews for one reactor are shown on the following pages:

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BASIC CREW FOR REACTOR

Processing

Basic Day Crew		
Ex.	N-E	Title
1		Manager, Processing
1		Analyst, Processing
1		Analyst, Rad. Mon.
2		Super., 100 Oper'n.
1		Super., Assignment
1		Spec., Reactor Op.
	2	File Operator
	4	Utility Operator
	2	Rad. Mon. Jrnymn.
7	8	Days
8	24	Shift
15	32 =	47 Total Processing*

Basic Shift Crew (4 Regd.)		
Ex.	N-E	Title
1		Super., 100 Oper'n.
1		Specialist, Reactor
	4	File Operator
	1	Utility Operator
	1	Rad. Mon. Jrnymn.
2	6	Ex. N-E
		Four Shifts = 8 24

*A Supplemental Crew of 115 for charge-discharge operations serves 8 reactors

Power

Basic Day Crew		
Ex.	N-E	Title
1		Manager, Power
1		Power Engineer
2		Supervisor, Power
	1	Clerk
	1	Chief Operator
	2	Power Operator
	1	Jr. Power Operator
4	5	Days
4	40	Shift
8	45 =	53 Total Power

Basic Shift Crew (4 Regd.)		
Ex.	N-E	Title
1		Supervisor, Power
	3	Chief Operator
	5	Power Operator
	2	Jr. Power Operator
1	10	Ex. N-E
		Four Shifts = 4 40

*Supplemental Crew (For 8 Reactors)

Basic Crew		
Ex.	N-E	Title
1		Manager, Supp. Crews
1		Analyst, Rad. Mon.
1		Super., Supp. Crews
11		Super., Processing
4		Supervisor, Rad. Mon.
	32	File Operators
	28	Utility Operators
	37	Rad. Monitors
18	97 =	115 Total

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Maintenance*

Basic Day Crew		
Ex.	N-E	Title
1		Manager, Maintenance
1		Super., Pl. & Sched.
2		Super., Mech. Maint.
	1	Anal., Maint. Method
	2	Clerks
4	3 = 7	

Basic Shift Crew (A&C Only)		
Ex.	N-E	Title
1		Super., Mech. Maint.
	2	Millwrights
	2	Pipefitters
1	4	
		Ex. N-E
		Two Shifts = 2 8

Mech. Maint. (2 Crews)

1		Super. Mech. Maint.
	4	Millwrights
	5	Pipefitters
	5	Other (Painter, Pipecoverer, Welder)
1	14	Ex. N-E
= for Two Crews 2 28 = 30		

Inst. Maint.

1		Super. Inst. Maint.
	2	Spec., Inst.
	7	Tech., Inst.
	3	Trainee
1	12 = 13	

Elec. Maint.

1		Super., Elec. Maint.
	7	Journeyman
	1	Trainee
1	8 = 9	

TOTALS FOR MAINTENANCE

10 59 = 69

*A Central Maintenance group of 140 furnishes shop and special outage services for 8 reactors.

B. Mechanical Readiness

The time required to reactivate reactor plants will depend almost entirely upon the degree to which lay-away and preservation methods permit equipment, systems, and facilities to be maintained in an assembled condition and the effectiveness of protective measures to limit deterioration of critical components. The estimates contained in this study and in the referenced study are based on the assumption that the results which can be attained for reactor lay-away, preservation, and reactivation will approach those which have been experienced by the U.S. Navy. Detailed engineering studies have not been made;

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so, at this time, feasibility can only be assumed. The time estimates for this study are based on the assumption that completely detailed specifications and procedures are prepared for both lay-away and reactivation. These procedures must cover craft procedures for all steps of the reactivation, testing, and start-up. To ensure efficient execution of the reactivation work, a manning plan should be made at the time of shut-down and key personnel trained and kept familiar with the work during the lay-away period. It has been assumed that reactivation work could, if necessary, be scheduled on a seven-day work week using ABCD shifts.

C. Availability of Fuels and Essential Materials

In considering fuel and essential requirements, it was assumed that at least two Hanford reactors would be operating. Therefore, the fuel stream and essential material sources would be active and would need only to step up their production rates. The most limiting factor would be the lead-time required to obtain fuel element cores and components for the initial loading of the first reactor to be started. It is estimated that a minimum lead-time of four to five months would be required to adjust production rates, produce a full reactor charge, and continue to supply fuel elements at the rate required for all operating reactors. This assumed that core material would be available in billet form at Fernauld. It will be necessary to have a full reactor charge in finished inventory for each reactor to be started up on less than five to six months.

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