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REAR FACE CROSSUNDER LINES AT B, D, DR,
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SCOPE AND JUSTIFICATION

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REAR FACE CROSSUNDER LINES
AT B, D, DR, F, AND H REACTORS
SCOPE AND JUSTIFICATION

June 16, 1959

PREPARED BY: F. J. Kempf Date 5-12-59
F. J. Kempf
Reactor Modification Design
FACILITIES ENGINEERING OPERATION

APPROVED BY: H. W. Heacock Date 6-19-59
H. W. Heacock, Supervisor
Reactor Modification Design
FACILITIES ENGINEERING OPERATION

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REAR FACE CROSSUNDER LINES AT B, D, DR, F, AND H REACTORS
SCOPE AND JUSTIFICATION

I. INTRODUCTION

A. PURPOSE

The purpose of this report is to outline the preliminary design and provide justification for the installation of crossunder lines at B, D, DR, F, and H Reactors.

B. BACKGROUND

A preliminary study of feasibility and justification for this installation has been previously made for budgetary purposes and reported in HW-54601(1). These crossunder lines as originally proposed would provide the necessary piping and control valve between one rear riser and downcomer to effectively valve the rear face to the drain with a minimum of crossheader valving. Lines were sized to provide 25,000 gpm flow to the downcomer while maintaining the water level in the riser below the bottom crossheader.

Since installation of a crossunder line at F reactor was contingent upon approval and completion of a 107-F retention basin by-pass, additional study was considered desirable to determine an alternate applicable to this reactor. The proposed alternate provides an arrangement which is independent of the 107-F retention basin by-pass.

In the preparation of this report consideration has been given to the effect of the following on both scope and justification of crossunder lines.

1. Operational charge discharge on a full pile basis at C reactor if installed, will negate the benefits obtained with a crossunder line. Pending resolution of operational charge discharge on a full pile basis, no design or construction funds will be requested for a crossunder line at C reactor. However, for the purpose of obtaining a total project cost estimate in the event that operational charge discharge is not obtained at C reactor, this report will list separately the total project costs including C reactor crossunder installation.
2. The use of air driven valve operators at all reactors will reduce somewhat the amount of saving in reduction of valving time previously attributed to crossunder lines. Periodic application of "Turco" to decontaminate the rear face piping in all reactors will reduce the amount of personnel radiation exposure savings previously attributed to crossunder lines. Justification for the proposed crossunder lines, considering the effects of both air driven valve operators and Turco decontamination, has been developed

- (1) Budget Study Report F.Y. 1960 Plant Acquisition and Construction Budget Crossunder Lines at B, D, F, DR, H and C Reactors - F. J. Kempf.

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by Industrial Engineering Operation. Records of operating activities and time motion studies conducted during the past year were the basis for this justification.

The original design for crossunder lines at B, D, and F reactors required excavation of the area below one rear riser. The crossunder line size has been reduced to provide a maximum of 9000 gpm shutdown flow to the downcomer while maintaining riser water level below the bottom cross-header. This reduction in pipe size allows crossunder connection to the downcomer without excavation below one riser at B and D reactors. The proposed installation at F reactor does not require a connection between the rear riser and downcomer.

II. SUMMARY

Installation of crossunder lines at B, D, DR, F and H will provide a method of reducing reactor shutdown time during charge discharge and maintenance operations thereby resulting in significant production gains.

A. GAINS CAPITAL INVESTMENT AND PAYOUT

	<u>B, D, F, DR, & H</u>	<u>B, D, F, DR, H & C</u>
Value of Production gained per year	\$399,800	\$500,200
Capital Investment	\$300,000	\$350,000
Amortization Period	2.2 years	2.2 years

B. INTANGIBLE BENEFITS

Reduced personnel exposure of approximately 17.7 roentgens per year can result from installation of crossunder lines at B, D, DR, F and H reactors. If C reactor is included in the proposed project an additional exposure saving of three roentgens per year can be obtained.

III. DISCUSSION

A. PRESENT FACILITIES

After normal operating flow has been reduced and the reactor has cooled sufficiently to permit rear face work, the discharge area is entered to perform crossheader valving prior to rear nozzle cap removal. These crossheaders are connected to a pair of process risers in each reactor which transport the coolant to the top of downcomers and hence to the effluent piping system. Present procedures require operation of individual crossheader valves near both risers in order to valve each crossheader to drain through the drain riser. This valving is necessary to eliminate the back pressure on each row of tubes caused by the process riser full of water. After each rear crossheader is valved to the drain, the corresponding front crossheader is valved to provide minimum flow. Only a limited number of rear crossheaders may be valved to the drain riser during each entry due to the limited capacity of this drain. This

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procedure requires close coordination between front and rear face operating crews and an excessive number of entries to the discharge area. In reactors containing special enriched charges, accountability and nuclear safety require separate discharges of this material and regular metal. The resulting multiple valving of the same crossheader considerably lengthens the discharging operation. Future power levels with increased reactor coolant flows will require longer cooling periods after shutdown and further limit the number of rear crossheaders that can be valved to the drain at one time. With the present facilities, valving causes frequent interruptions or delays in other operations and prevents front and rear face activities from being carried on independently. Replacement of thermo-couples on the rear face, venturi or orifices on the front face, and leaking caps or pigtails are examples of the type of normal shutdown work which valving frequently delays.

B. PROPOSED FACILITIES

It is expected that the information shown on the attached reference drawings (SK-1-3130; SK-1-3131; SK-1-3137; SK-1-3610) is essentially indicative of the proposed additions and modifications. The crossunder lines will have sufficient capacity to drain a maximum of 9000 gpm shut-down flow at B, D, and F reactors and 15,000 gpm at DR & H reactors while maintaining rear riser water level below the bottom crossheader. Crossunder line capacity with the exception of F reactor will be sufficient to drain between 24,000 gpm and 30,000 gpm with water level below the top crossheader. This eliminates the necessity for special front face valving procedures prior to minimum flow reduction. At F reactor the crossunder line capacity will be limited to the capacity of the 1608-F Building pumps during the transition period while the reactor is being valved to minimum flow.

In all areas, instrumentation will consist of connections between a mercoird type liquid level float switch and an annunciator drop in the control room via an auxiliary relay. The normal 440 volt, 3 phase power source in each 105 Building will be utilized for operation of the crossunder valve. Push buttons for control of the motor operated valve will be located in the control room. A pressure sensing line from the top of the front riser with pressure switch and auxiliary relay will be connected to the crossunder valve control. This system will automatically close the valve in the event of insufficient front riser pressure to supply adequate reactor cooling.

C. DETAILED JUSTIFICATION OF PROPOSED WORK

Installation of crossunder lines at B, D, F, DR, and H reactors will have four benefits which will decrease reactor outage time during charge discharge and maintenance operations. Significant reductions in personnel radiation exposure can also be obtained. The benefits which will decrease outage time are:

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1. The number of times the discharge area must be entered to perform necessary valving will be reduced. Due to the limited capacity of the discharge area drain only a portion of the reactor can presently be valved at any one time. Many entries to the discharge area are thus required during an outage for the purpose of performing crossheader valving. By reducing the number of times valving is required, corresponding time savings are obtained in the entry preparations. At B, D, DR, and H reactors upon completion of the crossunder line installation one entry will be required for crossheader valving to isolate the far riser prior to cap removal and once upon completion of charge discharge to return this valving to normal. Since the proposed crossunder lines at F reactor effectively drain both risers, the entry prior to cap removal will not be required.
2. Double valving of the same crossheader, which is currently required for discharge of enriched material, will be eliminated. Multiple valving of crossheaders for maintenance purposes of tube rows which are not scheduled for discharge will also be unnecessary upon completion of the proposed facilities. With the crossunder line the entire reactor can be valved to minimum flow in one continuous operation prior to charge discharge and returned to normal in the same fashion before start-up.
3. A decrease in the amount of time required to perform the actual valving operation can be obtained since the close coordination between front and rear face operating crews would not be necessary with crossunder lines.
4. Installation of crossunder lines will result in a reduction of delay time, and allow front and rear face activities to be conducted independently. By reducing the number of operations performed during an outage, and consequently the number of times an operator must change from one job to another, the normal delay associated with a job change is eliminated. The reduction of delay time brought about by fewer entries to the discharge area and less crossheaders to valve has been included in the savings which will result from front and rear face activities being conducted independently and without interruption. Outage studies show that at least one percent of total outage time is delay which valving currently inflicts on other operations. This type of delay would not occur when the entire reactor is valved at one time.

The amount of savings for each of the above is shown in Appendix C, which includes a graphical illustration of these time savings as related to total time requirements.

The personnel radiation exposure savings that can be attributed to crossunder line installation at B, D, DR, F and H reactors is 17.7 roentgens per year. This saving results from less time being spent in the discharge area and is based upon exposure rates of 25 mr/hr for normal valving and 50 mr/hr for the valving required during the reactor

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cooling period. Although the necessity of isolating the rear riser which is not drained by the crossunder line is subject to question at this time, exposure savings have been calculated assuming that this valving would be performed.

D. OTHER RELATED WORK

C Reactor

Installation of a crossunder line at C reactor becomes desirable in the event that operational charge discharge on a full pile basis is not accomplished. The decision as to whether or not C reactor is included in the proposed crossunder line project will be made prior to requesting total project funds. Since crossunder installation at C is similar to that at H reactor the required design effort will not be significantly increased if C is included. However, it is estimated that installation of a crossunder line at C will increase total project costs by \$50,000 (Appendix B).

All Reactors

The current project for installation of differential pressure indicators at all reactors may allow significant changes in crossunder line operation procedure. This project is scheduled for completion prior to installation of crossunder lines, and will provide a method of maintaining a positive pressure differential across each pair of front and rear crossheaders. If the presence of water above the bottom rear crossheader in the rear risers is permitted, the rear face entry currently required to isolate the riser which is not drained by the crossunder line will be eliminated. This will increase the amount of personnel radiation exposure savings which can be attributed to crossunder line installation and will also increase the crossunder line capacity.

Power operated front face crossheader valves are currently proposed for installation at the K reactors. Similar valves could possibly be utilized at B, D, F, DR and H reactor upon completion of the proposed crossunder lines. However, the economic justification of power operated crossheader valves at these reactors has not been determined.

E. ALTERNATE SOLUTIONS

1. Connect Both Risers to One Downcomer

This solution eliminates the necessity of discharge area entry to isolate one riser. There are two apparent methods of attaining this rear riser connection, differing only in the piping route across the rear face.

Case a - The riser connecting line would tie into the bottom of the far riser, extend horizontally across the rear face at the 0'-0" elevation and tie into the bottom of the near riser.

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Case b - The existing air plenum located at the minus fourteen foot elevation could be utilized for traversing the rear face. Excavation beneath the far riser and tunneling between the air plenum and the area below the near riser limit the feasibility of this method at B, D, F and DR reactors. Piercing four feet of concrete walls in addition to the downcomer wall to attain access to a suitable control valve location makes the desirability of this solution at H reactor appear dubious.

Severe space limitations in Case "A" and the amount of excavation and concrete chipping in Case "B", together with reasonably high exposure rates and additional outage time required for installation, render this alternate impractical. Cost per reactor would be on the order of \$260,000 plus seven days outage time.

2. Connect One Riser to Each Downcomer

This solution, applicable at DR and H reactors eliminates riser connecting piping and riser isolation valving prior to charge-discharge. Piping would extend from the bottom of each riser to the adjacent downcomer and require a control valve for each connection.

Architectural features between risers and downcomers and the necessity of piercing two downcomer walls again limit consideration of this solution. Project costs at DR reactor, where provision of this alternate would be most feasible are approximately \$180,000 plus four days outage time for installation.

3. Connect One Riser to the Storage Basin and the Other Riser to the Downcomer

Due to the limited storage basin drain capacity at B and DR reactors and the absence of 1608 Building pumping facilities this solution has limited application. However, this alternate can be applied to H reactor if it becomes necessary to drain the far riser completely. The required modifications will include increasing the pumping capacity at both the 105 storage basin and the 1608-H building as well as installing connecting piping between the far riser and the storage basin.

IV. ACKNOWLEDGEMENTS

The author wishes to express appreciation to R. G. Ruff, D. M. Diediker, L. S. Sandlin, L. W. Lang, W. G. Albert and W. Ferguson for their assistance in preparing this report.

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V. APPENDICES

A. Economic Analysis

B. Study Estimates

C. Time Savings

D. Study Drawings

1. SK-1-3130 - 105-B, D, and F, Riser Crossunder Lines
2. SK-1-3131 - 105-C and H, Riser Crossunder Lines
3. SK-1-3137 - 105-DR, Riser Crossunder Lines
4. SK-1-3610 - 105-F and 1608-F, Drain System Modifications - Riser Crossunder Lines.

Reactor Modification Design
FACILITIES ENGINEERING OPERATION

FJ Kempf:bsm

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APPENDIX A

ECONOMIC ANALYSIS

COST ASSUMPTIONS

Incremental Fuel Costs - Provided by L. W. Lang Process and Reactor Development

Cyclic Metal Costs	\$3580/ton-U
Burnout Costs	\$8.22/gm Pu
Conversion Ratio	0.864 gm Pu/MWD at 700 $\frac{\text{MWD}}{\text{Ton}}$
	0.855 gm Pu/MWD at 750 $\frac{\text{MWD}}{\text{Ton}}$
Overall Operating Efficiency	78%
Product Worth	\$50/gm Pu

Production Increase (Appendix C)

49.3 $\frac{\text{hours}}{\text{year-reactor}}$ or 2.05 $\frac{\text{days}}{\text{yr.-reactor}}$ at B, D, F

47.9 $\frac{\text{hours}}{\text{year-reactor}}$ or 2.00 $\frac{\text{days}}{\text{yr.-reactor}}$ at DR and H

53.6 $\frac{\text{hours}}{\text{year-reactor}}$ or 2.24 $\frac{\text{days}}{\text{yr.-reactor}}$ at C

Maximum Yearly Average Operating Level - Forecasted Rates FY-1961 - Provided by W. G. Albert, Production Scheduling and Forecasting Operation

1620 MW at B, D, F and DR
1660 MW at H
1860 MW at C

Outage Time Required For Performance of Work - Provided by D. M. Diediker, Project Engineering Operation - Three days/reactor

PRODUCTION INCREASE

B, D, and F $2590 \frac{\text{MWD}}{\text{yr}} @ 750 \frac{\text{MWD}}{\text{Ton}} = 2215 \frac{\text{gm Pu}}{\text{yr}}$ each reactor

DR $2525 \frac{\text{MWD}}{\text{yr}} @ 750 \frac{\text{MWD}}{\text{Ton}} = 2160 \frac{\text{gm Pu}}{\text{yr}}$

H $2590 \frac{\text{MWD}}{\text{yr}} @ 750 \frac{\text{MWD}}{\text{Ton}} = 2215 \frac{\text{gm Pu}}{\text{yr}}$

Fuel Costs

B, D, F, and H

Cyclic = \$12,400/yr
Burnout = \$16,200/yr
\$30,600/yr each reactor

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DR

Cyclic = \$12,050/yr
Burnout = $\frac{\$17,750}{\text{yr}}$
\$29,800/yr

NET GAIN

Production worth minus fuel costs = net gain/yr.

B, D, F, and H \$80,400/yr each reactor

DR \$78,200/yr

PROJECT COSTS (Appendix B)

B, D, F, DR, and H \$300,000

PAYOUT PERIOD

Time required to regain outage production (15 days total)
Amortization of project costs

1.5 yrs.
0.7 yrs.

Total payout period

2.2 yrs.

C REACTOR

PRODUCTION INCREASE

$$3250 \frac{\text{MWD}}{\text{yr}} @ 700 \frac{\text{MWD}}{\text{Ton}} = 2805 \frac{\text{gm Pu}}{\text{Yr}}$$

FUEL COSTS

Cyclic = \$16,600/yr
Burnout = $\frac{\$23,000}{\text{yr}}$
\$39,600

NET GAIN (C Reactor) \$100,400/yr

Project Costs (Appendix B)

B, D, F, DR, H and C \$350,000

PAYOUT PERIOD

Time required to require outage production (18 days total)
Amortization of project costs

1.5 yrs
0.7 yrs

Total Payout Period

2.2 yrs

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APPENDIX B

REAR FACE CROSSUNDER LINES

<u>Description</u>	<u>105 B, D, F, DR, H & C</u>
105-B & D:	
Piping	\$ 26,200
Electrical	2,000
105-F:	
Piping	13,800
Electrical	2,000
1608 - Equipment	47,500
105-DR:	
Piping	12,800
Electrical	1,000
105-H & C:	
Piping	30,800
Electrical	2,500
Sub-Total Direct Cost	\$ 138,600
Other Direct & Indirect Cost	\$ 52,400
Total Direct Cost	\$ 191,000
Field Engineering	13,000
Contingency	80,000
General Overhead	14,000
Management Services	17,000
Design	35,000
Total Project Cost	\$ 350,000

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PROJECT COST ESTIMATE SUMMARY
REAR FACE CROSSUNDER LINES
105 - B, D, DR, F, & H

Construction Operation	\$178,000
Supervision of Construction (Title III)	10,500
Contingency	<u>56,000</u>
Sub Total	\$244,500
General Overhead (5% of Sub-Total)	<u>13,000</u>
Total Installation & Erection Cost	\$257,500
Management Services	9,500
Design Services (Title I and II)	<u>33,000</u>
Total Funds Requested	\$300,000
Total Project Cost	\$300,000

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CONSTRUCTION OPERATION COST
105-B, D, DR, F & H

	<u>Labor</u>	<u>Material</u>	<u>Equipment Usage</u>	<u>Total</u>
105 B-D:				
Piping	23,600	7,400	1,000	32,000
Electrical	600	600	100	1,300
105-DR:				
Piping	12,600	4,000	500	17,100
Electrical	300	300	100	700
105-F:				
Piping	10,000	5,600	500	16,100
Electrical	2,600	18,200	200	21,000
1608 Equipment	3,500	25,000	500	29,000
105-H:				
Piping	11,800	4,800	500	17,100
Electrical	300	300	100	700
1) Subtotal Direct Cost	65,300	66,200	3,500	135,000
2) Other Direct Costs 35% (12/15/8)	7,800	9,700	5,200	22,700
3) Payroll Burden 6 1/2%	4,800			4,800
4) Indirect Costs 16% of 1), 2), and 3)				12,700
5) Fee for Labor Service Contractor				<u>2,800</u>
6) Total Construction Operation Cost				\$178,000

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APPENDIX C

SAVINGS RESULTING FROM
CROSSUNDER LINE INSTALLATION

(Provided by W. G. Ruff - Industrial Engineering Operation)

All calculations are based on the average number of outages, excluding scrams, for the period of 1-1-58 to 8-31-58 (Production Records).

Average number of outages:

B, D, and F - 25 outages/year/reactor
DR and H - 30 outages/year/reactor
C - 27 outages/year/reactor

Number of crossheaders:

B, D, and F - 39 headers/reactor
DR and H - 23 headers/reactor
C - 46 headers/reactor

Savings Resulting from Reduction of the Number of Required Entries to the Discharge Area

Average Savings (Based on IEO Studies 58-1, 58-2, 58-3) 31.8 minutes/outage/reactor

Annual Savings:

B, D, & F	13.2 hours/year/reactor
DR & H	15.9 hours/year/reactor
C	14.3 hours/year

Savings Resulting from Eliminating Multiple Valving of Crossheaders

Average Savings (Based on IEO Studies 58-1; 58-2; 58-3 and Time Study DR, 1-28-59)

B, D, F, and C	38 minutes/outage/reactor
DR and H	19 minutes/outage/reactor

Annual Savings:

B, D, and F	15.8 hours/year/reactor
DR and H	9.5 hours/year/reactor
C	17.1 hours/year

Savings Resulting from Reduction of Coordinating Time Required During the Actual Valving Operation

Average Savings 0.26 minutes/header

Annual Savings:

B, D, and F	4.2 hours/year/reactor
DR and H	3.0 hours/year/reactor
C	5.4 hours/year/reactor

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Savings Resulting from Reduction of the Delay Time Caused by Current Valving Procedures

Savings per reactor is one percent of all outage time. (Based on IEO Studies 58-1; 58-2; 58-3 and 58-6)

Outage Time (Based on Production Records 1-1-58 to 8-31-58)

B, D, & F	134 hours/month/reactor
DR and H	163 hours/month/reactor
C	140 hours/month

Annual Savings:

B, D, & F	16.1 hours/year/reactor
DR & H	19.5 hours/year/reactor
C	16.8 hours/year/

TOTAL ANNUAL SAVINGS:

B, D, & F	49.3 hours/year/reactor
DR & H	47.9 hours/year/reactor
C	53.6 hours/year/reactor

Definitions of Terms on Outage Time Summary - Page 15

Valving: All elements of work required to open and close crossheader valves. (Elevator moves, turning valves, checking flows, and coordinating activity inherent in this operation).

Entry: The time required to enter the work place, including preparations necessary for work in a radiation zone.

All Other Outage Work: All work other than valving and entry. (Charge-discharge tube replacement, probologing etc.)

Outage Delay: The time during an outage which would not be included in a standard method such as: Abnormal conditions, equipment failure, shift change, procedural limitations obtaining instructions or approval and work out of sequence.

Extra Headers: The number of crossheaders valved open or closed more than once during an outage.

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OUTAGE TIME - HOURS/YEAR B, D, DR, F, & H REACTORS

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ZONE 18 (1) FLOAT SWITCH ADDED (2) OUTLINE ADDED 100% SC. ZONE 107. (DISTANCE 8000) (3) 10" PIPELINE DELETED ZONE 118 (4) (5) 10" PIPELINE ADDED ZONE 58, 59, 70 (6) (A) 12" PIPELINES ADDED.		DATE 1-2-57
REVISIONS		DATE
SK-3130		2
NONE		T. B. B. 1-2-57
SCALE: NONE		ACRONYMS
PROJECT: 775/11		DATE: 1-2-57
DRAWN: 4603		DATE: 1-2-57
CHECKED: 02-0118		DATE: 1-2-57
U. S. ATOMIC ENERGY COMMISSION HANFORD ATOMIC PRODUCTS OPERATION GENERAL ELECTRIC		
"RISER CROSSUNDER LINES"		
SK-3130		2

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REPLACE EXISTING 75 HP
3000 GPM PUMPS WITH
TWO 7000 GPM, 90' TON
PUMPS - 200 HP MOTORS

2 PUMP BLDG.

EXISTING 16"
PUMP DISCH
HEADER

BLANKED

STEAM
PUMP

REPLACE EXISTING EQUIPMENT
WITH 200 HP MOTOR
CONTROLLERS & SWITCH GEAR

ELECTRICAL
CUBICLES

1608-F

PLAN

SEE SECTION 'A-A' ON HW-75046

SECTION 2-2

DETAIL 'A'

TYPICAL OF 3 STORAGE BASIN DRAINS

REF HW-70825 & 70681 FOR 108-F

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TO 105P 40
EFFLUENT LINE
SEE 4-1-76-12

SECTION I-I
SEE SECTION 'D-D' ON HW-75047

STUDY

REVISIONS		NO.	DATE	BY
NONE				
SK-1-3610		-	-	-
SCALE NONE		APPROVAL		
DATE 10525		BY		
DR. 0265		BY		
U. S. ATOMIC ENERGY COMMISSION BARBERS POINT ATOMIC PRODUCTS OPERATION GENERAL ELECTRIC				
DRAIN SYSTEM MODIFICATIONS RISER CROSSUNDER LINES				
SK-105-F (1608-P)		ECL. 8401		
SK-1-3610		-		

END

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