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CGI-844 - 100-K COOLANT BACK-UP SYSTEM
SCOPE REQUIREMENTS

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Reactor Modification Design
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CGI-844 - 100-K COOLANT BACKUP SYSTEM
SCOPE REQUIREMENTS

INTRODUCTION

Several decisions regarding basic project philosophy must be made in order to proceed with scope design and the preparation of equipment procurement specifications. The purpose of this document is to present as much pertinent data as possible to allow the project representatives to become familiar with the problems involved. A meeting of Representatives is planned for the near future after receipt of project authorization to discuss the scope of this project and its relationship to CG-775.

SUMMARY AND RECOMMENDATIONS

Emergency flow requirements of the K reactors for planned future power levels is approximately 32,000 gpm within 68 sec. (Figure 1). A detailed study of the existing high pressure cross-tie line reveals that a duplicate cross-tie line and five low lift pump operation would be required to provide this flow. The existing emergency generation capacity is not adequate to supply five low lift pumps and all other necessary emergency electrical loads.¹ A possible solution to adequate emergency flows is to connect the proposed steam turbine pump directly to the risers and to consider the turbine pump as the last ditch system. If it is determined that this does not meet the criteria of separate systems, then an alternate solution must be found.

It is recommended for consideration of the Project Representatives that:

1. The proposed turbine driven pump be located in the 190 Building at the No. 2 back-wash location and that the pump be directly connected to the far risers as shown on Figure 7.
2. Consideration be given to abandonment of the present high pressure cross-tie line.
3. The steam turbine pump be started from a cold start upon a BPA outage or low pressure signal.
4. The steam turbine pump be supplied with steam from one of the operating boilers in its own area.
5. Only two primary pumps be carried on emergency power, one on each generator.
6. In the light of Item 5, consideration should be given to installing the 4160 V emergency cross-tie line as part of CG-775, if the installation of this system will not impair the safety, operability, or adequacy of the presently installed 4160 V system.
7. The proposed steam cross-tie line be deleted from the CGI-844 scope.

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DISCUSSION

The two backup systems proposed for inclusion in CGI-844 are the steam turbine drive pump installation and the high pressure cross-tie line. It was assumed that the turbine driven pump is considered as a part of the secondary system and that the high pressure crosstie line is the last ditch system. For convenience, the backup criteria² submitted to the AEC is repeated as follows:

"The secondary system shall be independent of the primary system - (common piping is acceptable) - and capable of providing adequate shutdown cooling indefinitely assuming instantaneous loss of power to the primary system. Serious consideration should be given the operation of the secondary system at partial flow capability at all times and preferably at a flow capability sufficient to satisfy the full requirements in event of primary system failure without relying upon actuation or acceleration of equipment. That flow provided by the secondary system during normal operation may contribute to the primary cooling system requirement.

"The last ditch cooling system must be independent of both the primary and secondary cooling systems, including piping to the reactor manifold. It must be capable of providing shutdown flow indefinitely assuming instantaneous loss of power to the primary system and concurrent failure of the secondary system to provide its rated flow.

"An independent system is defined as one with power sources and pumping systems such that failure or cause of failure in one cannot induce failure of the alternate systems.

"Adequate cooling is defined, as a minimum, as that required to maintain reactor components, including fuel elements, at temperatures below the melting point. In practice, the objective of requiring levels of cooling capable of protecting against all reactor or fuel element damage will be prudent to adopt.

"Failure of any single component in a system shall not be capable of rendering that system inadequate. In practice certain piping and valves may be qualified as exceptions."

HIGH PRESSURE CROSSTIE SYSTEM

The existing high pressure crosstie system is shown on Figure 6. The capacity of this system, modified systems and a double system is shown on Table I and Figure 3. Since the criteria for last ditch systems requires separate piping, it is assumed that no flow would be received by the stricken reactor from the low pressure crosstie line. As can be seen, nothing short of a complete double up of crosstie capacity and operation of five modified low lift pumps will provide the required 32,000 gpm, indicated by demand and decay curves on Figure 1.

The provision of additional backup capacity by modifying the existing high pressure crosstie line does not appear to be feasible for the following reasons:

1. The existing emergency generators are not adequate to supply five low lift pumps and all other existing emergency needs including KER increases and CGI-791 increases.
2. Any increase in cross-tie capacity will aggravate the problems of accidental opening of the crosstie line when one reactor is down unless automatic flow control apparatus is improved.
3. Crosstie capacity when backed up by No. 3 pump is shown on Figure 4. To provide 32,000 gpm through the crosstie, double lines would be required from the 165 Bldg. valve pit to a double crosstie and both No. 3 and No. 4 pumps would be required for backup. This requirement will considerably restrict pump maintenance during outages.
4. The location of the 1706 Building in the path of the HPCT lines will make installation of an additional line difficult. Present project estimates do not include funds for a complete double line. It is estimated that an additional \$70,000 would be required for the double installation.

A possible solution to the emergency generation limitation would be to relocate the automatic flow control valves to the 165 Bldg. valve pit so that Pumps 3 and 4 could gradually be isolated from the reactor to supply the double crosstie lines. The control features of this installation would be quite complicated and it is doubtful if reliability could be assured.

190 BUILDING STEAM TURBINE PUMP INSTALLATION

The turbine pump installation as outlined in the project proposal is shown on Figure 8. The capacities of this installation for various conditions is shown on Figure 2. In view of the high pressure cross-tie limitations outlined previously however, it is suggested that the installation shown on Figure 7 be considered instead. This installation will provide 33,000 gpm directly to the A&B risers. The capacity of this system is shown on Figure 5. As an alternate, the capacity of a similar pump installed at a midway station on the HPCT is indicated. The midway installation would be more expensive since a new structure, suction lines and steam lines would be required. The only advantage of the midway installation would be the ability to draw from either KE or KW clearwells.

The steam turbine installation meets the criteria of a complete third system since the boiler and turbine generator set to which the turbine is connected completely separates from BPA and from the adjoining emergency generator set upon loss of BPA. Since only one low lift pump is required for emergency flows with the high pressure water crosstie deleted, three complete systems are then available for each area: BPA as primary; a boiler, emergency generator and pump as secondary; and a boiler and steam turbine pump as last ditch.

[REDACTED]

Operation of the turbine from a cold start with steam from one of the two operating boilers rather than a third boiler should be considered for the following reasons:

1. G. E. Turbine engineers indicate a three stage turbine will pick up full load from a cold start in 20 seconds or less.
2. Little pickup reliability is gained by operating at 1/3 speed.
3. Equipment reliability is reduced when equipment is in continual use.
4. Valve operation reliability is not better at 1/3 speed than when starting cold since positive valve action is required in each case.
5. Based upon present 165 steam costs of \$1.80/1000#/hr., operation of one turbine pump will cost approximately \$62,000/year at 1/3 speed.
6. Present boilers do not reliably steam at less than 10,000#/hr., therefore turbines must be operated at more than 1/3 speed to load the boiler to this minimum. This will increase operating costs to \$78,750/year/turbine. The increase can be avoided in part if the additional load is supplied to 1706 Building and to other boiler auxiliaries. Diverting a portion of the load from existing boilers, however, will lower the efficiency of those boilers.
7. Existing boilers will carry a turbine driven pump, one low lift pump, and all other emergency electrical requirements including anticipated 1706- KER increases (CGI-839) and 105 Building increases (CGI-791) if some of the minor emergency loads are carried by the boiler not connected to the steam turbine pump. (See Table II)
8. If steam is supplied from one of the two operating boilers, boiler response will be more rapid than from an idly third boiler since they are normally operating at approximately 25,000 #/hr.

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1. HW-59166, 100-K Area Emergency Generators Maximum Loading, F. J. Mollerus, Dated February 17, 1959.
2. HW-59696, K Water Plant Improvements, R. E. Trumble, Et. al. March 19, 1959
3. HW-58614, K Reactor Water Plant Analysis, R. L. Dickeman, Dated Dec. 22, 1958.
4. HW-60607, Analysis of 100-K Emergency Water Requirements after CGI-844 Pump Failure, R. F. Corlett, Dated May 28, 1959.

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TABLE I

100-K HIGH PRESSURE CROSSTIE LINE
CAPACITY SUMMARY

Condition

Both reactors operating, BPA outage, No emergency power at one reactor.

Case 1, 5 pump operation, existing low lifts

<u>Crosstie Condition</u>	<u>Reactor Flow</u>	<u>Crosstie Flow</u>
A. Existing Crosstie	58,000	14,000
B. Existing Crosstie, V-73 open	56,500	17,500
C. Parallel Crosstie, V-73 open	57,500	21,500

Case 2, 5 pump operation, modified low lift pumps

A. Existing Crosstie	62,000	15,000
B. Existing Crosstie, V-73 open	60,000	19,000
C. Parallel Crosstie, V-73 open	59,000	23,000
D. Double Crosstie Line, V-73 Open	58,000	32,000

Case 3, 4 pump operation, modified low lift pumps

A. Existing Crosstie	60,000	14,500
B. Existing Crosstie, V-73 open	58,500	17,500
C. Parallel Crosstie, V-73 Open	58,000	21,500
D. Double Crosstie, V-73 Open	56,500	30,500

Case 4, 2 pump operation, modified low lift pumps

A. Existing Crosstie	52,000	13,000
B. Existing Crosstie, V-73 Open	51,000	16,000
C. Parallel Crosstie, V-73 Open	49,500	19,000
D. Double Crosstie, V-73 Open	46,000	26,000

NOTE: A parallel crosstie line is a parallel 24" line that joins the existing line west of the 1706 Building and east of the KW crosstie valve pit.

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TABLE II

ESTIMATED GENERATOR AND BOILER LOAD

	<u>No. Units</u>	<u>Bus B-E</u> kilowatts	<u>No. Units</u>	<u>Bus C-F</u>
1. Street lights		45		
2. 1500 HP Primary pump	1	1132	1	1132
3. 200 HP service pump	1	243	2	486
4. 165 Bldg. Service		350		350
5. 183 Bldg. Service		100		100
6. 105 Bldg. Service		300		300
7. 1706-KER New Load (CGI-839)		425		425
8. 105 Bldg. New Load (CGI-791)		<u>150</u>		<u> </u>
TOTAL		2735 KW		2793 KW

Max. Boiler Load:

2793 KW x 12 #/KW Hr. =	33,516		33,516
Steam Auxiliaries =	5,000		5,000
Turbine Pump on Service Loop	<u>20,400</u>	Turbine Pump as Last Ditch	<u>18,000</u>
Total Boiler Load	58,916 #/Hr.	Total	56,516 #/Hr.

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FIGURE 1

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SYSTEM HEAD AND TDH AT LOOP CROSSTIE

FIGURE 2

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FIGURE 4

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FIGURE 4

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FIGURE 5

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- LEGEND**
- V-70 Emergency Supply
 - V-71 24" Flush Valve
 - V-72 Guard Valve
 - V-73 Auto. Valve (Air Operated)
 - V-74 12" Drain Valve (KW Only)
 - Orifice
 - Motor Operated Valve

HIGH PRESSURE CROSS-TIE SYSTEM
FIGURE 6

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STEAM TURBINE PUMP AS LAST DITCH SYSTEM

FIGURE 7

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STEAM TURBINE PUMP AS SECONDARY BACK-UP

FIGURE 8

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