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GENERAL ELECTRIC

HANFORD ATOMIC PRODUCTS OPERATION – RICHLAND, WASHINGTON

DATE 8/29/58

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TITLE

Project Proposal - Crossheader Pressure Differential Indicators And Alarm Systems-Hanford Reactors (Project CGI-817)

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AUTHOR

A.A. Janos

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PROJECT PROPOSAL

CROSSHEADER PRESSURE DIFFERENTIAL INDICATORS
AND ALARM SYSTEMS - HANFORD REACTORS

(Project CGI-817)

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GENERAL ELECTRIC

HANFORD ATOMIC PRODUCTS OPERATION

DATE AUG 29 58

PROJECT NO. CGI-817 REV. NO. 0

TITLE

CROSSHEADER PRESSURE DIFFERENTIAL INDICATORS AND ALARM SYSTEMS - HANFORD REACTORS

Total Funds Requested	$360,000
Value of Transferred Capital Property	None
Total Estimated Project Cost	$360,000

RESPONSIBLE DEPARTMENT

IRRADIATION PROCESSING DEPARTMENT

PROJECT MANAGEMENT

GENERAL ELECTRIC COMPANY
IRRADIATION PROCESSING DEPARTMENT

SOURCE OF FUNDS

FY 1959 Operating Expense Budget, Sub-Program 2900, "Equipment Not Included in Construction Projects".

SCHEDULE: (Months after authorization requested herein)

PREPARED BY: A A Janos

Start

Design	1 Month
Procurement (Placement of First Order)	2-1/2 Months
Physical Performance	4 Months

Beneficial Use

First Reactor	8 Months
Last Reactor	18 Months

Complete

Design	4 Months
Procurement (Final Delivery)	8 Months
Physical Performance	22 Months

APPROVED:

Acting GENERAL MANAGER, IRRADIATION PROCESSING DEPARTMENT — DATE 8-18-58

for GENERAL MANAGER, HANFORD ATOMIC PRODUCTS OPERATION — DATE 9-12-58

ATTACHMENTS

Preliminary Drawing - SK-1-8561, Differential Pressure Gauge Piping and Alarm System (105-B, C, D, DR, F, H, KE & KW)

Project Cost Estimate Summary

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PROJECT PROPOSAL

CROSSHEADER PRESSURE DIFFERENTIAL INDICATORS
AND ALARM SYSTEMS - HANFORD REACTORS

(Project CGI-817)

I. INTRODUCTION

A. Purpose and scope of the Project

The purpose of this project is to provide instrumentation at B, C, D, F, H, KE, and KW Reactors that will (1) indicate front-to-rear differential pressure to assure process water flow in each group of tubes fed by a crossheader, and (2) actuate an alarm in the event of unsafe low flow conditions.

The scope of this work consists of the installation of tubing from the rear and front crossheaders to differential pressure instruments on the front face; the provision of a signal panel and alarm horn on the front elevator; and the provision of a lead to the annunciator in the control room.

Design services are included in this project.

B. Request for Authorization

It is requested that management by the General Electric Company and funds in the amount of $360,000 for this project be authorized in accordance with the provisions of Contract W-31-109-Eng.-52.

II. DESCRIPTION OF PROPOSED WORK

It is proposed to provide instrumentation that will measure front-to-rear differential pressure and signal unsafe low pressure water flows during low flow conditions (such as during fuel element discharge operations) at the B, C, D, F, H, KE, and KW Reactors.

As illustrated on the attached typical installation drawing SK-1-8561, a differential gauge will be mounted on a suitable bracket near each of the front face crossheader valves normally used to reduce process water flows and to control header pressures. Each gauge will be connected by copper tubing to each corresponding pair of front and rear crossheaders. Since front crossheader pressure is significantly lower at the downstream end of the crossheader than it is at the control valve, the pressure tap will be located at a downstream point as available connections permit. This will assure measurement of differential pressure where it is at or near its lowest value. All the gauges will be capable of withstanding static and/or

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II. DESCRIPTION OF PROPOSED WORK (Continued)

differential pressures well in excess of the maximum process water pressure; will indicate differential pressures up to 300" of water; and will be provided with two adjustable alarm contacts.

A gauge will be provided for each corresponding pair of crossheaders (304). Isolating valves will be installed where the pressure lines are connected to the crossheaders. Isolating valves, bleed valves, equalizing valves, and test tees will be installed at the gauges. Approximately 25 gauges will be provided as construction spares.

Electrical circuits will be run from each gauge through a trail cable to the front-face elevator. These circuits will connect contacts in the instruments to an annunciator panel on the elevator. The low pressure contact will actuate a relay. This relay will actuate a red signal lamp, a horn on the front elevator, and an annunciator in the control room. The higher (second) set of contacts will be connected directly to a green light on this panel. Contacts in the gauge will be arranged so that a differential pressure in the safe range will indicate green, and a pressure of less than twenty inches of water (or as required) will indicate red and actuate the audio alarms.

Electrical power for the differential crossheader pressure monitor system will be obtained from the 115 volt alternating current emergency power supply source in the respective 105 Buildings. The low flow (low differential pressure) electrical circuits will be energized; therefore equipment contact failures, relay failures, and trail-cable line open circuits will be detected in a fail-safe manner.

III. ADVANTAGES TO BE GAINED AND JUSTIFICATION FOR THE PROPOSED WORK

The proposed work is justified on the bases of (1) personnel and reactor safety, and (2) operating continuity.

The specific problem involved is the occurrences of incidents and near incidents in which fuel elements reach higher than normal shutdown temperatures because of the lack of positive means of immediately measuring and signalling subnormal process coolant flows. Such incidents are commonly called "hot header incidents", since subnormal flows result in the overheating of one or more rows of process tubes. The frequency and severity of such happenings have increased with the higher power levels. Hot header incidents can result in large production losses and in the contamination of employees and equipment. Four incidents have occurred at HAPO reactors during the past eight months.

Hanford reactors are shut down to perform regular and special charge-discharge operations, ruptured fuel element discharges, and/or maintenance work. After the shutdown, heat continues to be generated by radioactive

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III. ADVANTAGES TO BE GAINED AND JUSTIFICATION FOR THE PROPOSED WORK (Continued)

fuel elements (slugs), and residual heat remains in the reactor components. Sufficient overall water flow must be maintained to prevent process tubes from boiling dry and causing excessive slug and reactor component temperatures. An important part of the preparation for charging operations or maintenance work during shutdown is the valving of crossheaders.

At the B, C, D, F, and H Reactors, the rear crossheader is valved first from the process riser to the drain riser to relieve the back pressure before reducing the front crossheader pressure for all charging or process tube maintenance purposes. The sequence of valving indicated above is done to prevent the stoppage of flow to an entire row of tubes, since the reduction of the front crossheader pressure to 20" without first valving the rear will cause a greater pressure at rear than at front. Valving too many headers to the drain causes water to back up in the drain riser. This can produce a back pressure on the tubes much like that caused by not valving the rear riser before the front riser.

At the KE and KW Reactors, the conditions of valving for special charge-discharge operations (including enriched slug discharges), routine maintenance on process tubes, and ruptured slug discharges are the same as given above for the older reactors with this exception: the static head on the tubes and crossheaders is always greater than 26" when valved to the rear risers. Back pressure from overloading the drain risers can be a problem at the K Reactors during the three types of work indicated immediately above. For regular charge-discharge operations, a rear cross-under line system is used instead of the drain riser to minimize exposure of personnel and eliminate the need for individual rear-face crossheader valving. Further, this system eliminates back pressure problems, but can only be utilized after the graphite cooling period.

The KE and KW cross-under systems each consists of a large outlet from the bottom of each rear riser to a larger cross-under line. This line carries the effluent directly to the river via 105-K junction boxes and outfall structures, relieving back pressure on the entire rear face.

Process Standards for the K Reactors establish the use of the cross-under system at under 100° C. graphite temperature, since below this temperature the relatively cool graphite inhibits boiling upon loss of water flow. Currently, K graphite cools down to 100° C. in about four to six hours after shutdown. During this time, special discharges, process tube maintenence, and rupture discharges are performed by valving the rear crossheaders to the riser drain. Thus, during these initial shutdown jobs, the K Reactors are as vulnerable to back pressure (tube flow stoppage) as the older reactors. To routinely schedule this type of work for after cooling-off periods (because of the possibilities of back pressures) would reduce outage efficiencies considerably because this work would need then to be done under cross-under line conditions four to six hours after the shutdown.

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III. ADVANTAGES TO BE GAINED AND JUSTIFICATION FOR THE PROPOSED WORK (Continued)

During outages at KE and KW, the front C and D ("near") risers can be isolated from the process water system without closing the crossheader valves. This can be accomplished by shutting down the riser pumps, closing the pump discharge valves, opening C and D riser vents and relatively large drains, and depending on check valves on the crossheaders on these risers to hold fast. As long as the check valves do not leak back into the C and D risers, the closing and opening of large, tight valves at each of the front C and D crossheaders can be eliminated. One-half hour per outage (or about 12 hours per year) per K Reactors can be saved. However, assurance that such a procedure can be followed safely depends upon positive knowledge of status of coolant flow that can be provided by the proposed work. (The near risers at the older reactors can be similarily isolated. However, due to the location or small size of their front riser drain valves and the relative ease with which their crossheader valves are manually operated, very small or no time savings can be expected by routinely isolating their near risers during outages.)

At any Hanford reactor, stoppage of coolant will, of course, result in overheating of slugs, tubes, and other reactor components. The removal of a front process nozzle cap when the related rear crossheader is still valved to the riser could cause enough backflow to flush contaminated water to the front. In fact, backflow could be great enough to flush slugs out the front. Conversely, during flush discharge, slugs overheated due to low or stopped flow can easily boil new flushing water and create enough steam pressure to eject the slugs with greater than normal force from the rear. Such ejection causes slugs to bounce off the rear wall and scatter about the discharge area.(1)

Losses from overheating of slugs and hot header incidents can be considerable. Two important examples are the DR Reactor occurrence of December 13, 1957(1), and the F Reactor incident of December 31, 1957. Other near, or less, serious incidents are those which occurred at C Reactor on December 4, 1957, and KW Reactor on February 5, 1958. As tube temperatures and power rates have increased, the probability and severity of hot header incidents have become greater.

The DR incident resulted in 149.5 outage hours for recovery of scattered slugs in the rear face area, ruptured slug removals, and the discharging of 19 tubes at one-half goal exposure.

The F incident caused a loss of 15.5 hours for leak testing, the need to discharge 13 tubes at one-half goal exposure, and the replacement of four tubes.

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(1) Document HW-54257, "Overheated Metal Charges, DR Reactor", dated December 23, 1957 (SECRET).

III. ADVANTAGES TO BE GAINED AND JUSTIFICATION FOR THE PROPOSED WORK (Continued)

Hot header incidents result from one or more of the following factors:

1. Manipulation of reactor coolant flows involves working with a complex hydraulic system in a manner based on experience and observation. Reduced coolant flows are also created by decreased pump speeds or by increased throttling of discharge valves in the water plant after the front and rear face valving has been completed.

2. Fine flow adjustments must be made at the older reactors with large valves.

3. Due to the production loss involved, there is continual stress on accomplishing all downtime work on a minimum schedule basis.

4. Exceeding the capacity of the rear drain riser, causing an increase in hydrostatic head on the rear face. The increased "back pressure" then results in a lower coolant flow to the affected headers than that which normally results when the front header pressures are adjusted for charge-discharge operations.

5. Human errors, such as:

   a. Valving a rear header to the drain riser and erroneously adjusting the pressure on a header which is not valved to the drain riser.

   b. Reducing front header pressures, by valving, before rear headers are valved to the drain riser.

   c. Throttling crossheader valves more than intended.

6. There is no instrumentation to measure flow and immediately indicate results of valving adjustments.

Exact cooling flows during shutdown work cannot be immediately determined by the temperature monitoring systems nor the crossheader standpipe systems. The temperature monitoring system requires flow past the sensing element. During past incidents, indicated tube outlet temperatures were not abnormally high when low flow conditions were discovered. The practice of attempting to assure adequate reduced flow by maintaining a static head by means of an overflowing standpipe and appropriate valving-to-drain is obsolete and inadequate for current operating conditions. The use of restrictive operating procedures and standards with present facilities would unduly prolong outages and result in lost production of considerable magnitude, and would still not provide positive assurance of adequate protection.

In summary, crossheader pressure differential indicator systems should eliminate, at all Hanford reactors, hot header incidents that can result from

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III. ADVANTAGES TO BE GAINED AND JUSTIFICATION FOR THE PROPOSED WORK (Continued)

lower than proper shutdown flows or back pressures in process tubes. This elimination will in turn eradicate the related dangers to personnel and process equipment and possibilities of large production time losses. Also, the K Reactors together could save about 24 hours per year by not valving their C and D risers under pressure differential conditions.

Another potential benefit is that differential systems will assure proper tube flow for routine rear crossheader and nozzle decontamination procedures planned for the future. Such procedures will reduce personnel exposure rates on rear-face work significantly. The current concept requires rear crossheader pressurization. Under such condition, a differential system will be a necessity.

IV. WHY ALTERNATE FACILITIES CANNOT BE USED

Attempts at providing means for detecting abnormal shutdown coolant flow rates have been undertaken. For example, attempts were made to use relatively simple devices for accurately measuring the water level in the rear drain risers to help eliminate back pressures. The small diameters of the drain risers and other factors, however, prevented the successful use of devices such as manometers or air bubblers. Further endeavors at relatively inexpensive or simple approaches were abandoned.

On a long-range basis, individual tube flow meters may find usefulness at reduced flow conditions, but current development indicates that this concept could be most reliable at full-flow monitoring with a much lesser degree of reliability for use with shutdown flows. Further, the development work required precludes the adaptation of relatively complex and costly flow meters, monitors, or scanners to the current need.

One scheme for the K Reactors was examined: the use of direct pressure gauges at each front crossheader, eliminating the proposed rear-face work. This was explored on the basis that the rear pressure during cross-under system usage would be essentially zero due to the small size of front crossheaders as compared to the much larger rear risers and cross-under line. As indicated in Section III, there are other shutdown jobs prior to going on the cross-under line that require differential pressure indication for safety and production reasons. Further, a direct pressure indication is not necessarily a true indication of flow or the desired direction of flow.

V. CLASSIFICATION OF THE PROJECT

All of the proposed work is classified as capital addition of plant improvement nature chargeable to capital accounts.

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VI. METHODS OF PERFORMING WORK

It is recommended that design services (Title I and II work), procurement of all items, and supervision of construction (Title III work) be performed by the General Electric Company.

It is recommended that all physical performance of work be performed by General Electric Company plant forces.

Minor deviations from the recommended methods above may be made in accordance with policy regularly in effect at Hanford.

VII. EFFECT ON CONTINUITY OF OPERATION

Portions of the proposed work will be performed during scheduled outages. It is anticipated that eight hours chargeable downtime may be required for each of the older reactors for rear crossheader work. The C, KE, and KW Reactors may each require approximately 16 hours chargeable downtime due to the greater number of crossheaders at these reactors.

VIII. REMARKS

Equipment of the proposed type is being installed at the DR Reactor under a Request for Appropriations, "Crossheader Differential Pressure Indicators and Alarms", dated April 9, 1958.

The design cost estimate of $9,000 is based upon providing approximately 12 drawings for detailed design, a set of specifications, and acceptance test procedures.

It is estimated that Radiation Work Procedure conditions will apply to about 85 per cent of the proposed work. All physical work will be accomplished within the seven 105 Buildings involved except for prefabrication work and with the possible exception of pre-installation testing of system components, such as the gauges.

An expenditure pattern, based upon estimated procurement schedules and costs and upon predicted availability of scheduled outages, follows for the proposed work in quarters after authorization:

1st Quarter	$ 20,000
2nd Quarter	100,000
3rd Quarter	85,000
4th Quarter	50,000
5th Quarter	50,000
6th Quarter	35,000
7th Quarter	20,000
TOTAL	$360,000

The project cost estimate is based upon a 40-hour week for all phases of work.

VIII. REMARKS (Continued)

None of the proposed equipment is considered critical relative to number of items to be procured, fabrication, or availability.

There will be no Transferred Capital Property in this project.

As noted in Section III, the use of the existing cross-under line systems at the K Reactors does not preclude the need for the proposed work at these reactors. Similarly, the proposed cross-under system work in the FY-1960 HOO Budget (entitled "Rear Face Cross-Under Lines, B, C, D, DR, F, and H" under Budget Item AEC 223-60(1) of Subprogram 9200) would not obviate the work proposed herein for the older reactors. (Even if future rear cross-under systems would make pressure differential indicators unnecessary, the former item would not reach its beneficial use stage until one to three years after the expected beneficial use date of the proposed work. Furthermore, human errors could be made in valving to a cross-under system just as they are made with the existing piping system.)

This project proposal was prepared by the Facilities Planning Operation, Facilities Engineering Operation, Irradiation Processing Department.

END

DATE
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6/7/93