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PITA IP-27-I, PART I
INCREASED COOLANT FLOW - H REACTOR

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PITA IP-27-I, PART 1
INCREASED COOLANT FLOW - H REACTOR Classification Cancelled and Changed To

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PITA IP-27-I, PART I INCREASED COOLANT FLOW - H REACTOR

INTRODUCTION

In January, 1964, H reactor will undertake a major charge-discharge and maintenance outage which will increase reactor coolant flow about 10 per cent. The flow increase will result from modified charge loadings, enlarged rear crossheader Parker fittings, installation of modified rear nozzles and nozzle-connector adapters, and replacement of all front-face orifices and venturis with an enlarged venturi.

The requirements necessary to accomplish the programmed modifications and to control and monitor the effects of the increased flow are contained in PITA IP-27, which is issued in two parts. This is Part I and deals primarily with the engineering requirements. Part II¹ deals primarily with the operational physics requirements.

OBJECTIVE

This Process Improvement Transition Authorization, Part I, is issued to 1) specify special requirements to be followed in making the modifications authorized in approved Design Changes 590, 845, and 847; 2) to specify the process requirements resulting from the modifications, and 3) to define some of the equipment changes and tests necessary to solve problems associated with the transition to higher flow rates.

SUMMARY

The PITA's present the specific requirements necessary to accomplish the outage work and to control the use of this increased flow capability.

The procedures and methods to accomplish the programmed modifications are contained in the approved design changes or in supplemental procedures.

BASIS

Primarily, the modifications increasing coolant flow are justified on the basis of increased production and secondarily on the basis of reducing maintenance and operating costs. Detailed discussions of the incentives and justifications for all hardware modifications can be found in references 2 through 6, and for loading modifications in references 5 through 7.

DISCUSSION

Current H reactor bulk process coolant flow averages 84,500 gpm, whereas the other old reactors have coolant flows ranging from 87,000 to 90,000 gpm. Studies evaluating various methods of increasing H reactor coolant flow rates have been made during the past six months and have indicated bulk coolant flow could be increased to as high as 94,000 gpm through various hardware modifications and loading changes.² All the proposed modifications were indicated to be technically feasible and appropriate design changes and fuel loading schedules have been prepared to authorize the necessary modifications to achieve the 94,000 gpm capability.

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In brief, the H reactor flow increase program consists of the following elements:

- A. Replacement of existing rear nozzles with modified K inlet nozzles. The reworked K nozzles contain larger and more efficient flow passages.
- B. Installation of new nozzle adapters which have a larger I.D. and also are taper-bored to match the I.D. of the existing rear connectors.
- C. Reaming rear crossheader Parker fittings to the I.D. of the pigtails (0.543").
- D. Replacement of all .310" venturis and fringe zone double orifices with .344" I.D. venturis
- E. Replacement of solid Li-Al target pieces with I&E geometry target pieces.
- F. Transition from bumper to smooth-fuel elements.
- G. A systematic purging program.

It is felt that all these hardware modifications and loading changes can be accomplished with a nominal increase in scheduled outage time if they are performed in conjunction with the January, 1964, scheduled charge-discharge, thermocouple replacement outage for the following reasons:

- A. Thermocouple replacement requires less time if the rear nozzle is removed.
- B. Having both the rear nozzles and thermocouple well removed, provides an excellent opportunity to enlarge the rear crossheader Parker fittings at little cost in outage time.
- C. Rear face work is outage controlling and the enlarged venturi can be installed on the front with no increase in outage time.
- D. All irradiated uranium fuels and most of the Li-Al target material will be discharged during this major outage. Loading changes will not increase outage time.

The general order of work will be as follows:

- A. All irradiated uranium fuel material will be discharged and all but about 400 tubes recharged with "green" metal. This will be done 1) to permit total process coolant shutoff to eliminate the cascade of water in the rear face, and 2) to minimize radiation levels in the rear face.
- B. Rear nozzles, rear connectors (pigtails), thermocouples, thermocouple wells, and leads will be stripped from all tubes.
- C. Rear crossheader Parker fittings will be reamed to .543".

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- D. New thermocouple wells and leads will be installed.
- E. Reworked K nozzles fitted with new adapters will be installed.
- F. Old pigtails which have been reformed to be compatible with the modified rear hardware will be installed.
- G. Concurrent with the rear hardware modifications, the front venturis and orifices will be replaced with the .344" I.D. venturis. In the control room, existing Panellit gauges will be replaced with 300 psi mid-range gauges.
- H. After all rear hardware changes and modifications are completed, coolant will be restored.

Special temperature and neutron monitoring will be performed during the course of the outage to assure personnel, nuclear, and equipment safety. Thorough pre-startup pressure checks and component inspections will also be performed. Full-reactor flow will not be realized initially with single downcomer operation or with less than eight process pumps in service. Flow will be increased in incremental steps so that the effects of this increased flow capability on various parts of the effluent piping system can be monitored.

TRANSITION DETAILS

General

This Process Improvement Transition Authorization is issued in two parts. The two parts are a composite package and have been separated to expedite review and issue. In broad terms, Part I covers engineering requirements and Part II covers physics requirements. The requirements contained in both Parts I and II, the Process Standards - Reactor, and Process Standards - Water Plant, will be complied with throughout and following completion of the January modification outage. Both parts of this PITA will contain additional requirements and details which are not specifically covered in existing standards. In addition, the PITA's provide the process requirements deemed necessary to handle the increased flow until the appropriate Process Standards can be issued.

Modifications

All hardware modifications will be authorized by the following design changes:

- A. Design Change #590 authorizes complete thermocouple and thermocouple well replacement - H reactor.
- B. Design Change #845 authorizes installation of venturis enlarged from a throat diameter of 0.310" to 0.344".
- C. Design Change #847 authorizes replacement of the present H reactor rear nozzle and adapter with a modified K inlet nozzle and tapered adapter plus reaming of the rear crossheader Parker fitting from a 0.469" I.D. to a 0.543" I.D.

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Reactor Coolant Flow

The reactor coolant supply system will consist of two independent, reliable sources during all stages of the outage. This requirement will be in effect during both the normal cooling situation and during the water shutoff period. The reactor cooling requirements following shutdown are determined by the rate at which the heat energy must be removed to avoid undesirable or hazardous temperatures from being reached in the reactor components. Even though the reactor is free of all irradiated fuel material, heat is still being generated by radioactive gamma and beta decay in the reactor materials. Conservative calculations indicate that heating rates as high as 6 C/hr. could exist in the uncooled reactor core and 2 C/hr. in an uncooled irradiated Li-Al charge.

The 1000 gpm minimum reactor flow requirement of Standard A-030 is waived and coolant flow may be discontinued provided the following conditions are met:

A. The reactor must contain no irradiated uranium fuel. Meeting this requirement is critical and it will be necessary to develop a reliable procedure in order to assure that all irradiated uranium fuel has been discharged. Assurance and basis for such will be reviewed by the Manager, Process Technology, prior to shutting off reactor process coolant flow.

B. Capability must be maintained to restore process flow to all headers within 30 minutes for the first 24 hours following complete coolant flow shutoff. During this 24-hour period, all graphite thermocouples shall be monitored to determine the reactor heating rate.

It is highly desirable that as many graphite thermocouple readings as possible be recorded continuously; in fact, the ten maximum temperature points will be required to be recorded constantly. Following water shutoff, all other points will be recorded once each half-hour for the first two hours and hourly thereafter. Data sheet for required temperature measurements will be provided by the Process Engineer. The Process Engineer will also evaluate the temperature readings and determine the reactor heating rate.

C. During and after the first coolant shutoff period, maximum allowable graphite temperature will be 80 C and flow will be restored prior to reaching this temperature. If the graphite heating rate exceeds 6 C/hr., coolant flow shall be restored permanently. The length of time process water will be shut off during the first and any subsequent shutoff periods will depend on the measured heat generation rate. It is suggested that 50 C be observed as the target maximum graphite temperature and that upon reaching 50 C, action leading to flow restoration be initiated such that the real limit of 80 C will not be exceeded even if some unforeseen obstacle to restoration should be encountered.

D. Two thermocouple pairs will be installed into each of two process tubes. One pair will be placed in a central zone channel containing an un-irradiated uranium charge and one pair in a fringe channel containing a charge of irradiated Li-Al target pieces. The channel location and

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thermocouple location within the channel will be selected by Process Engineering.

It is desirable that the central channel be as free of residual water as possible to ensure accurate temperature monitoring so the water will be removed or dried from this channel. Temperature readings will be recorded, once each half-hour for the first two hours following water shutoff and hourly thereafter, on data sheets supplied by Process Engineering. The maximum allowable temperature will be 80 C. Water shall be restored in sufficient time so as not to exceed this 80 C limit. The temperature rate of rise will be determined by Process Engineering upon review of the temperature data.

- E. During the first 24 hours of this water shutoff period, the HCR's will not be supplied coolant water. Thermal shield coolant flow shall be retained during all periods of water shutoff.

Modification Compatibility

In making the authorized modifications, there are certain combinations of fuel loading, orificing device, and Panellit mid-scale position which are not compatible because of critical flow, tube damage potential from chattering, and Panellit mid-scale range limit considerations.

The following specific requirements must be observed:

- A. The 0.222 primary-0.323 secondary double orifice must be replaced with a larger flow measuring device if either the tube is charged I&E Li-Al or rear hardware modifications are completed. The 0.261 primary-0.422 secondary double orifice or any less restrictive device is acceptable as a replacement.
- B. Neither the 0.310" nor the 0.344 venturi will be installed on a tube loaded with solid Li-Al target elements.
- C. A 300 psi mid-scale Panellit gauge must be installed on all tubes fitted with a 0.344" venturi.

Pre-Startup Requirements

- 1. Full Panellit base check of all guages will be performed and results reviewed by Process Engineering prior to startup.
- 2. A thorough visual inspection of all front and rear face fittings for proper installation and absence of leaks will be performed prior to startup. These checks will be performed with full water pressure on the system.
- 3. The ball 3X water pressure settings will be reset prior to startup to values determined by the tripout test.

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4. A tripout test as required by Process Standards - Water Plant, HW-27155, Rev. 1, Section 70.01, will be performed and the results reviewed by Research and Engineering prior to startup.
5. Any flow indicators and associated systems which would be over-ranged by the expected flow shall be corrected and calibrated prior to startup.

Process Flow Restrictions

1. Downcomer

Based upon measurements obtained at DR reactor in 1960, it would appear that the H downcomer is currently running nearly full of water. Therefore, it is required that the liquid level in the top of the downcomer be adequately measured to ensure adequate downcomer flow capacity and that the flow be increased in steps to monitor the relative liquid level change in the top of the downcomer. The following restrictions will apply:

- A. Single downcomer operation without adequate liquid level measurement device will be limited to 88,000 gpm (this is previous high). This limitation will remain in effect until such time as adequate liquid level instrumentation is available.
- B. Single downcomer operation with adequate liquid level measuring device will be limited to 90,000 gpm for at least 20 operating days. At the end of this operating period, a downcomer inspection will be conducted. Upon satisfactory inspection results, flow may be increased in 2000 gpm increments, with inspection required after operating 20 more days at each flow rate. The maximum liquid level shall not be less than 2 feet below the downcomer lid.
- C. There will be no flow restriction with two-downcomer operation.

With two-downcomer operation there may be some minor power calculation problems⁷ but it is not expected to give large enough power calculation errors to be operationally significant. The maximum measured outlet temperature from either downcomer will be used for complying with bulk outlet temperature limits.

2. Electric Process Pumps

Data concerning CGI-558 process pump characteristics were obtained in 1959 and individual pump flows cannot be reliably extrapolated much beyond 12,600 gpm due to the fact that the cavitation cutoff point is not precisely known. The cavitation cutoff point may be as low as 13,500 gpm. Operation with eight pumps and losing one presents no problem, but operating with seven pumps and losing one might result in cavitation. Therefore, flows greater than 90,000 gpm shall not be supplied by less than eight process pumps.

Tube Power Increase

The tube power limit associated with tubes containing a failed rear fitting as outlined in Process Standards - Reactor, HW-46000 H, Standard A-010, Section 10.05, shall be increased from its present value of 500 kw to 700 kw.

Probolog Requirement

Increasing flow rates in fringe tubes containing light Li-Al target material increases the potential for tube damage through the slug chattering mechanism. A representative sample of tubes containing I&E, Li-Al target material having operated at high flow rates should be probologged each time discharged. Samples shall be selected by Process Engineering with concurrence from H Processing Operation.

ROL Data

Rear header pressures are an important part of TAI calculations as reported in the ROL report. A complete set of hot and cold flow rear header pressures will be required for each operating period until maximum flow levels have been obtained. Later data will be at the direction of Process Engineering.

Programs1. Pump Cavitation Cutoff Tests

The cavitation cutoff points for H reactor's CGI-558 process pumps have not been determined. Before evaluating the effects of losing a process pump during operation at pump flow rates higher than this PITA permits, it is necessary to know the cavitation cutoff limit. A test to evaluate this condition is planned for separate authorization at an early date.

2. Vibration and Stress Measurements

Vibration and stress measurement readings on both front and rear face hydraulic components should be programmed to determine the effects of increased flow on such components as front and rear crossheaders, main effluent piping, cross-over line, and entry into downcomer. Details for such a program will be provided by Applied Reactor Engineering, Process and Reactor Development.

COST

All costs will be borne by Manufacturing.

HAZARDS

Hazards associated with this program are:

A. Crossheader Parker Fittings

Crossheader Parker fittings may be damaged during reaming. Should a fitting become damaged, cracked, or broken, an approved crossheader fitting repair unit will be installed.

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B. Front-Face Components

Critical front-face components will be disturbed while accomplishing the venturi changeout and may result in some leaks or damage. A detailed front-face inspection shall be made prior to startup.

C. Panellit Line Damage

During venturi changeout, Panellit lines will be disconnected and subjected to abnormal flexing which may cause damage. It will be necessary to test each line following venturi installation to verify continuity. A hydrostatic test of each impulse line is suggested.

D. Fuel Element Discharge

There is a possibility of irradiated fuel elements remaining in the reactor following discharge operation. A method of visual verification of discharge through a supervised triple flag inspection and detailed RM survey is under consideration. A procedure to verify that all irradiated fuel elements are removed from the reactor prior to completely removing water must be reviewed by the Manager, Process Technology.

PROCESS STANDARDS

1. Process Standards - Reactor, HW-46000 H, Standard A-050, concerning minimum Panellit pressures does not contain an equation for the 0.344 venturi. The equation to be used in determining the minimum Panellit operating pressure for the 0.344 venturi will be: $0.090FH+35$.
2. Process Standards - Reactor, HW-46000 H, Standard A-010, Section 10.05, specifying tube power limit on tubes containing failed rear fitting shall be increased from 500 kw to 700 kw.
3. Process Equipment Standards, HW-41000, Standard A-010, on component specifications affected by the program modifications, will be waived.
4. Process Standards - Reactor, HW-46000 H, Standard A-030, General, is waived under conditions specified on pages 6 and 7 to permit reactor flow halt.

RESPONSIBILITIES

General

All responsibilities contained in approved design changes and in PITA IP-22-C and supplements will be complied with.

H Processing

H Processing Operation will have over-all responsibilities for coordinating the activities required to accomplish the programmed modifications and specifically for reactor safety and continuity; for scheduling all outage work, for collecting

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and recording the required data to comply with temperature monitoring requirements in this PITA; for performing a complete inspection of all hardware modifications to insure proper assembly, installation, and response; and for performing a complete Panellit base check prior to startup.

Applied Reactor Engineering

Applied Reactor Engineering will be responsible for evaluating and reporting the results obtained from PT IP-637-IS prior to performing the rear hardware modifications, and for providing engineering inspection of the modifications.

Process Engineering

Process Engineering will be responsible for:

- A. Providing engineering assistance to all affected organizational components during the course of the outage.
- B. Providing continuous coverage during startup.
- C. Updating the ROL and reviewing all Panellit base check data prior to startup.
- D. Determine ball 3X pressure settings.
- E. Selecting representative fringe process tubes to be inspected for "chatter" damage at subsequent outages.
- F. Evaluating the temperature measurements obtained during complete water shutoff.

Operational Physics

Operational Physics' responsibilities will be contained in PITA IP-27, Part II.

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