AECU-3526

OPERATING INSTRUCTIONS

FOR

THE CP-5 REACTOR

DISCLAIMER

AECU-3526

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OPERATING MANUAL
FOR
THE CP-5 REACTOR

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by

The Laboratory Research Reactor Operations Division
Argonne National Laboratory

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To assure safe and reliable operation of the CP-5 Argonne Research Reactor, certain test procedures, work area checks, routine inspections and operational practices have been established as the Rules Governing the Operation of this reactor. These rules are set forth under the several headings listed in this manual.

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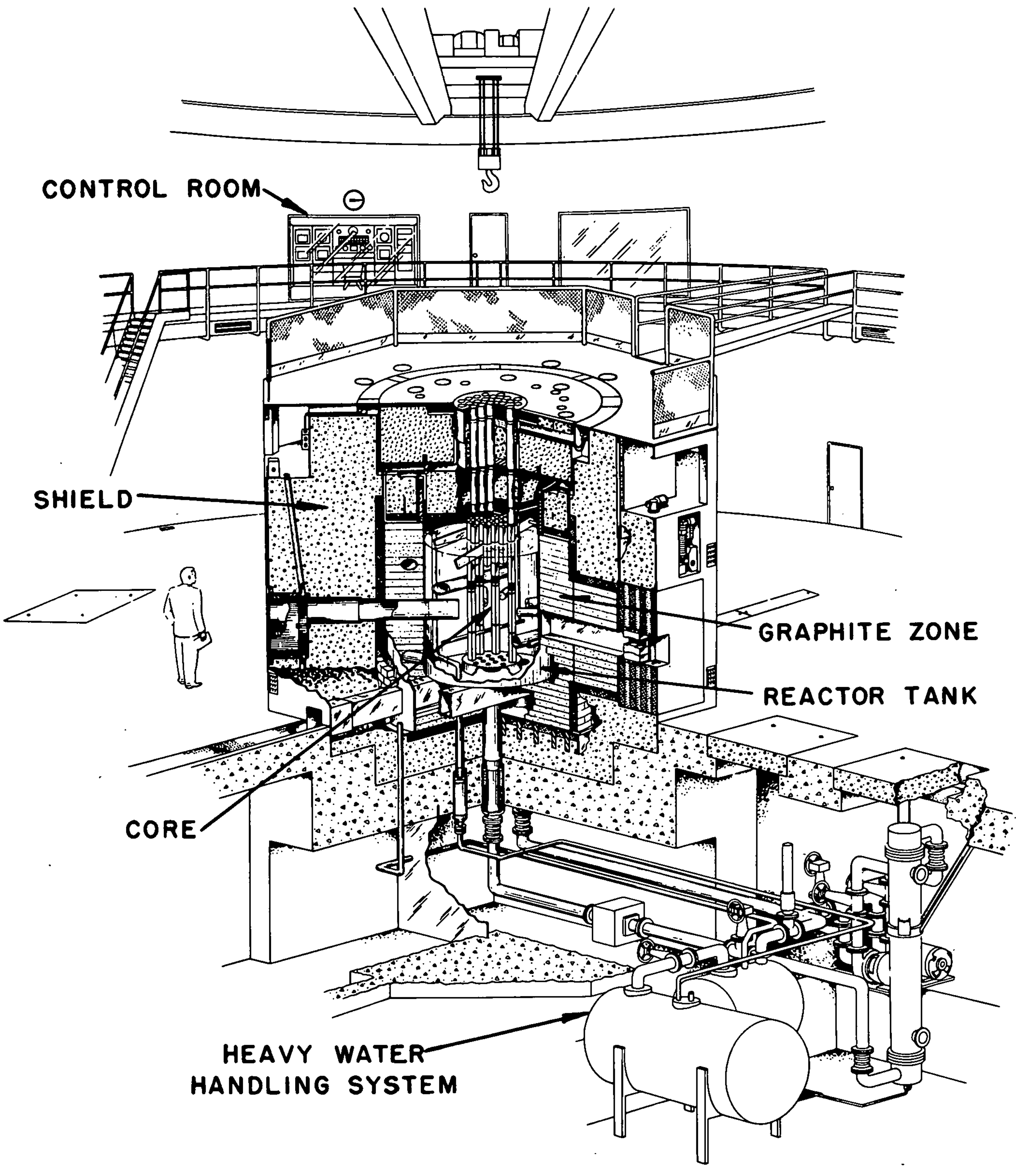

Cutaway View of the CP-5 Reactor

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TESTS, ADJUSTMENTS, CHECKS AND OPERATION OF THE REACTOR

There are two General Operating Conditions for the CP-5 Reactor. These involve (1) start-up of the reactor following extended shutdowns which might be associated with a complete fuel removal and reloading, and (2) essentially continuous operation of the reactor with only brief shutdowns. In the first situation the test and adjustment procedures and check practices enumerated are to be followed. Normally, operation is expected to be essentially continuous, and the adjustments are made as they become necessary to maintain satisfactory operation of the reactor. The check procedure is also then followed on a routine hourly, half hourly or operating shift schedule as indicated on the check sheet forms which are included in this manual.

RESTRICTIONS ON OPERATION OF THE CP-5 REACTOR

On all occasions the operation of the CP-5 Research Reactor is to be under the control or supervision of qualified pile operators of the L.R.R.O. Division of the Argonne National Laboratory as set forth below.

At all times when the reactor is operating, that is, whenever the reactor is not shut down and the control keys removed, never less than one qualified pile operator of the L.R.R.O. Division is to be in the control room in a position to observe operating signals and manipulate the reactor controls or shutdown devices, as any situation may require.

At all times when any person, such as a student in the School of Nuclear Science and Engineering or other person, is being instructed in the handling of reactor controls, a fully qualified L.R.R.O. pile operator must be stationed right alongside of such person in a position to immediately correct any mistake made.

Similarly, in any case where a student or other person is permitted to operate any valve or other contact control device, a fully qualified L.R.R.O. pile operator must be in such a position as to observe the action and be prepared to correct any error.

Under no circumstances may a student or other person be used to substitute for a qualified pile operator of the L.R.R.O. Division.

FUNCTIONAL TESTING AND ADJUSTMENT OF THE CP-5 COOLING SYSTEMS

(The Distilled Light Water Shield Cooling System)

The system is arranged with a stainless steel tank to serve as a reservoir and expansion chamber for the distilled water. Beneath the reservoir are mounted two motor-driven circulating pumps, either one of which is adequate for circulating the distilled water through the several cooling coils provided in the different sections of the reactor. Four manifolds, to which the distilled water is supplied by the selected circulating pump, serve to distribute the cooling water to the various coils at flow rates which may be adjusted and indicated to agree with estimates already made or to values which may be found desirable from temperature and heat transfer measurements made during actual operation of the reactor.

The estimated flows for the several regions are listed below.

Manifold No. 1	
Lower Shield	5 GPM
Annular Shield	5 GPM
Radial Shield	2 1/2 GPM
Thermal Column	1 GPM

Manifold No. 2	
Lower Shield	5 GPM
Annular Shield	5 GPM
Radial Shield	2 1/2 GPM
Thermal Column	1 GPM

Manifold No. 3	
Bottom Shield	5 GPM
	18 1/2 GPM

Manifold No. 4	
Dump Return Pump	1 1/2 GPM
Heat Exchanger #2	2 GPM
	17 GPM

The estimated total flow required from the distilled water system is seen to be slightly less than 36 gpm.

The components of the shield cooling system are indicated and the arrangements for providing and adjusting the coolant flows are shown on Table 1 and drawing RR-1251E which is Figure 1 of this manual.

Since the circulating pumps for this system are each rated at 60 gpm against an 80-foot head, it is necessary to have adjustments and indications of flow for cooling each of the shield sections. These are provided in Manifolds No. 1, 2 and 3 by rotoflow type flowmeters. The flows for the sections of the system associated with Manifold No. 4 are adjustable by suitably located valves.

Thus, the check procedure is to start one of the circulating pumps by closing shield cooling pump switch No. 1 or No. 2 in the control room

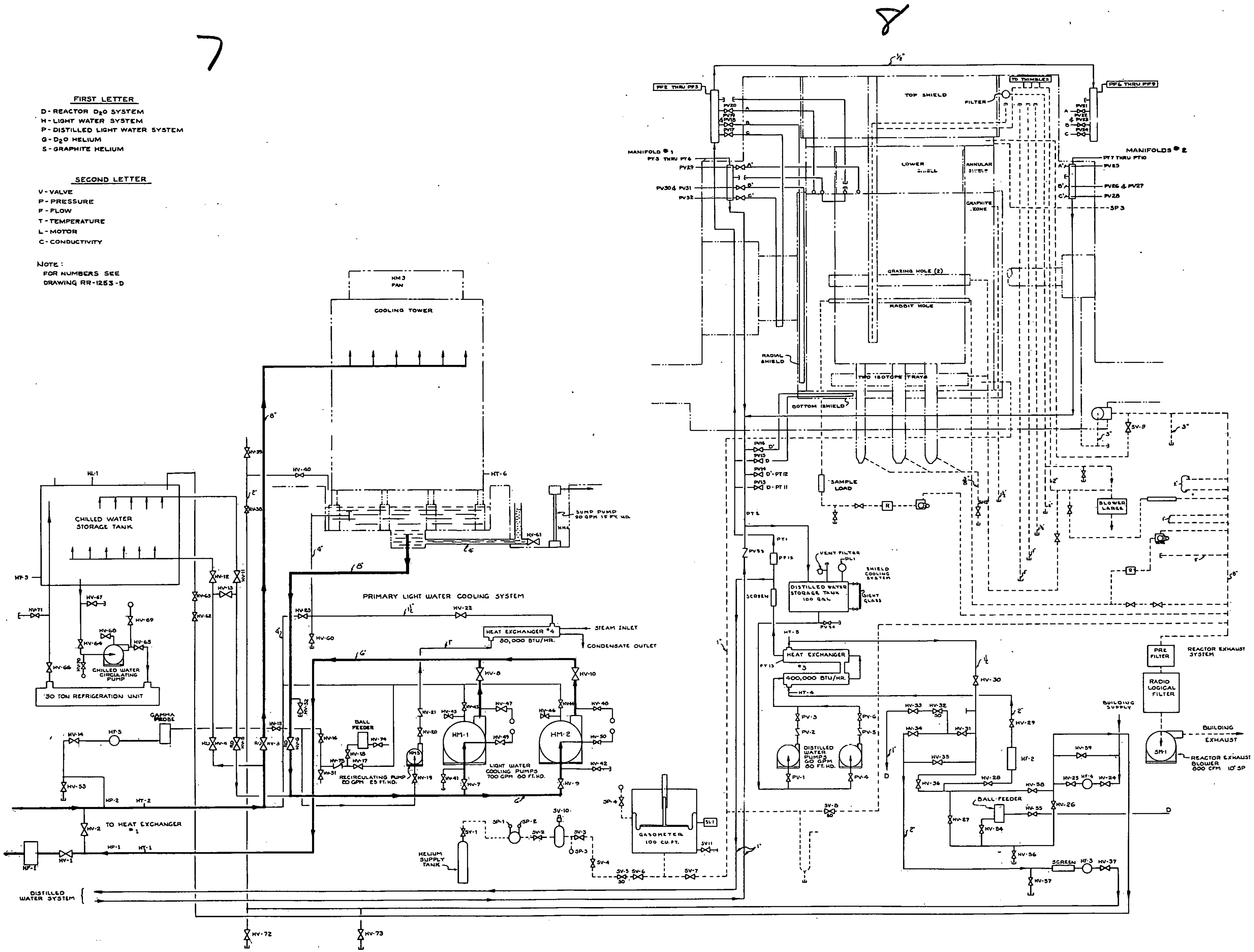

FIGURE 1

Flow Diagram for CP-5 Reflector, Shield, Thimble and Light Water Cooling Systems

REFLECTOR HELIUM SYSTEM

SV-1	MAIN SUPPLY VALVE
SV-2	ISOLATING VALVE INLET TO BALLAST TANK
SV-3	ISOLATING VALVE OUTLET FROM BALLAST TANK
SV-4	ISOLATING VALVE FOR SOLONOID VALVE
SV-5	SOLONOID VALVE MAIN SUPPLY
SV-6	ISOLATING VALVE FOR SOLONOID VALVE
SV-7	ISOLATING VALVE OUTLET OF GASOMETER
SV-8	BLOW OFF VALVE, SOLONOID OPERATED
SV-9	BY-PASS VALVE HELIUM EXHAUST
SV-10	BLOW OFF VALVE BALLAST TANK
SV-11	BLEED VALVE GASOMETER
SV-12	BLEED VALVE BOTTOM SEAL REACTOR PIPES
SP-1	MAIN SUPPLY TANK PRESSURE
SP-2	HELIUM SUPPLY PRESSURE
SP-3	PRESSURE REGULATING VALVE HELIUM SUPPLY
SP-4	GASOMETER PRESSURE
SL-1	GASOMETER LEVEL INDICATOR

DISTILLED LIGHT WATER SYSTEM

PV-1	ISOLATING VALVE INLET SIDE DISTILLED WATER PUMP
PV-2	CHECK VALVE OUTLET SIDE DISTILLED WATER PUMP
PV-3	ISOLATING VALVE OUTLET SIDE DISTILLED WATER PUMP
PV-4	ISOLATING VALVE INLET SIDE DISTILLED WATER PUMP
PV-5	CHECK VALVE OUTLET SIDE DISTILLED WATER PUMP
PV-6	ISOLATING VALVE OUTLET SIDE DISTILLED WATER PUMP
PV-7	ISOLATING VALVE INLET SIDE DUMP PUMP
PV-8	ISOLATING VALVE INLET SIDE DUMP PUMP
PV-9	ISOLATING VALVE OUTLET SIDE DUMP PUMP
PV-10	ISOLATING VALVE OUTLET SIDE DUMP PUMP
PV-11	ISOLATING VALVE OUTLET SIDE #2 HEAT EXCHANGER
PV-12	ISOLATING VALVE INLET SIDE #2 HEAT EXCHANGER
PV-13	ISOLATING VALVE INLET BOTTOM SHIELD
PV-14	ISOLATING VALVE OUTLET BOTTOM SHIELD
PV-15	ISOLATING VALVE INLET BOTTOM SHIELD
PV-16	ISOLATING VALVE OUTLET BOTTOM SHIELD
PV-17	ISOLATING VALVE INLET RADIAL SHIELD
PV-18	ISOLATING VALVE INLET RADIAL SHIELD
PV-19	ISOLATING VALVE INLET ANNULAR SHIELD
PV-20	ISOLATING VALVE INLET ANNULAR SHIELD
PV-21	ISOLATING VALVE INLET RADIAL SHIELD
PV-22	ISOLATING VALVE INLET RADIAL SHIELD
PV-23	ISOLATING VALVE INLET ANNULAR SHIELD
PV-24	ISOLATING VALVE INLET ANNULAR SHIELD
PV-25	ISOLATION VALVE OUTLET RADIAL SHIELD
PV-26	ISOLATING VALVE OUTLET RADIAL SHIELD
PV-27	ISOLATING VALVE OUTLET ANNULAR SHIELD
PV-28	ISOLATING VALVE OUTLET ANNULAR SHIELD
PV-29	ISOLATION VALVE OUTLET RADIAL SHIELD
PV-30	ISOLATION VALVE OUTLET RADIAL SHIELD
PV-31	ISOLATION VALVE OUTLET ANNULAR SHIELD
PV-32	ISOLATION VALVE OUTLET ANNULAR SHIELD
PV-33	CHECK VALVE OUTLET REACTOR SHIELD COOLING
PV-34	DRAIN VALVE DISTILLED WATER STORAGE TANK
PT-1	INLET TEMPERATURE SHIELD COOLING
PT-2	OUTLET TEMPERATURE SHIELD COOLING
PT-3	OUTLET TEMPERATURE RADIAL SHIELD
PT-4	INLET TEMPERATURE RADIAL SHIELD
PT-5	OUTLET TEMPERATURE ANNULAR SHIELD
PT-6	INLET TEMPERATURE ANNULAR SHIELD
PT-7	OUTLET TEMPERATURE RADIAL SHIELD
PT-8	INLET TEMPERATURE RADIAL SHIELD
PT-9	OUTLET TEMPERATURE ANNULAR SHIELD
PT-10	INLET TEMPERATURE ANNULAR SHIELD
PT-11	INLET TEMPERATURE BOTTOM SHIELD
PT-12	OUTLET TEMPERATURE BOTTOM SHIELD
PT-13	OUTLET TEMPERATURE HEAT EXCHANGE #3
PF-1	SHIELD COOLING FLOW
PF-2 THRU PF-5	SHIELD COOLING FLOW
PF-6 THRU PF-9	SHIELD COOLING FLOW

MAIN H_2O SYSTEM

HV-1	THROTTLE VALVE MAIN H_2O COOLING
HV-2	BY-PASS VALVE
HV-3	SHUT OFF VALVE COOLING TOWER RETURN
HV-4	SHUT OFF VALVE CHILLED WATER TANK RETURN
HV-5	SHUT OFF VALVE CHILLED WATER TANK OUTLET
HV-6	SHUT OFF VALVE COOLING TOWER OUTLET
HV-7	ISOLATING VALVE COOLING WATER PUMP INLET
HV-8	ISOLATING VALVE COOLING WATER PUMP OUTLET

MAIN H_2O SYSTEM CONT.

HV-9	ISOLATING VALVE COOLING WATER PUMP INLET
HV-10	ISOLATING VALVE COOLING WATER PUMP OUTLET
HV-11	ISOLATING VALVE CHILLED WATER TANK OUTLET
HV-12	ISOLATING VALVE CHILLED WATER TANK INLET
HV-13	BY-PASS VALVE CHILLED WATER TANK
HV-14	THROTTLE VALVE, LEAK MONITOR
HV-15	ISOLATING VALVE LEAK MONITOR
HV-16	ISOLATING VALVE BALL FEEDER
HV-17	ISOLATING VALVE BALL FEEDER
HV-18	THROTTLE VALVE BALL FEEDER
HV-19	ISOLATING VALVE COOLING TOWER RECIRCULATING PUMP INLET
HV-20	ISOLATING VALVE COOLING TOWER RECIRCULATING PUMP OUTLET
HV-21	CHECK VALVE COOLING TOWER RECIRCULATING PUMP OUTLET
HV-22	ISOLATING VALVE HEAT EXCHANGER #4 OUTLET
HV-23	THROTTLE VALVE, SPRAY NOZZLE BY-PASS
HV-24	ISOLATING VALVE BUILDING SUPPLY WATER METER
HV-25	ISOLATING VALVE BUILDING SUPPLY WATER METER
HV-26	ISOLATING VALVE BALL FEEDER
HV-27	ISOLATING VALVE BALL FEEDER
HV-28	THROTTLE VALVE SHIELD COOLING WATER
HV-29	ISOLATING VALVE SHIELD COOLING WATER FLOWMETER
HV-30	ISOLATING VALVE HEAT EXCHANGER #3 OUTLET
HV-31	ISOLATING VALVE FOR COOLING TOWER MAKE UP LINE
HV-32	SHUT OFF VALVE SHIELD COOLING WATER TO DRAIN
HV-33	ISOLATING VALVE SHIELD COOLING WATER TO DRAIN
HV-34	SHUT OFF VALVE COOLING TOWER MAKE UP
HV-35	BY PASS VALVE COOLING TOWER MAKE UP
HV-36	BY PASS VALVE SHIELD COOLING WATER
HV-37	ISOLATING VALVE COOLING TOWER MAKE UP WATER METER
HV-38	SHUT OFF VALVE COOLING TOWER MAKE UP
HV-39	SHUT OFF VALVE COOLING TOWER MAKE UP
HV-40	FLOAT VALVE COOLINT TOWER MAKE UP
HV-41	DRAIN VALVE HM-1
HV-42	DRAIN VALVE HM-2
HV-43	BLEED VALVE HM-1
HV-44	BLEED VALVE HM-2
HV-45	BLEED VALVE HM-1
HV-46	BLEED VALVE HM-2
HV-47	ISOLATING VALVE OUTLET PRESSURE GAUGE HM-1
HV-48	ISOLATING VALVE OUTLET PRESSURE GAUGE HM-2
HV-49	ISOLATING VALVE INLET PRESSURE GAUGE HM-1
HV-50	ISOLATING VALVE INLET PRESSURE GAUGE HM-2
HV-51	DRAIN VALVE BALL FEEDER
HV-52	DRAIN VALVE COOLING TOWER OUTLET LINE
HV-53	DRAIN VALVE LEAK MONITOR
HV-54	THROTTLE VALVE BALL FEEDER
HV-55	DRAIN VALVE BALL FEEDER
HV-56	DRAIN VALVE BALL FEEDER
HV-57	DRAIN VALVE COOLING TOWER MAKE UP LINE
HV-58	BY PASS BALL FEEDER
HV-59	BY PASS BUILDING SUPPLY
HV-60	DRAIN VALVE SPRAY NOZZLE BY PASS
HV-61	DRAIN VALVE COOLING TOWER BASIN
HV-62	SHUT OFF VALVE CHILLED WATER TANK SUPPLY
HV-63	ISOLATING VALVE CHILLED WATER TANK SUPPLY
HV-64	ISOLATING VALVE CHILLED WATER CIRCULATING PUMP INLET
HV-65	ISOLATING VALVE CHILLED WATER CIRCULATING PUMP OUTLET
HV-66	ISOLATING VALVE REFRIGERATION UNIT OUTLET
HV-67	DRAIN VALVE CHILLED WATER TANK OUTLET
HV-68	BLEED VALVE CHILLED WATER CIRCULATING PUMP
HV-69	ISOLATING VALVE OUTLET PRESSURE CIRCULATING PUMP
HV-70	ISOLATING VALVE INLET PRESSURE CIRCULATING PUMP
HV-71	DRAIN VALVE CHILLED WATER TANK INLET
HV-72, HV-73	DRAIN VALVES COOLING TOWER MAKE UP LINE
HV-74	DRAIN VALVE BALL FEEDER
HV-75	CHECK VALVE BALL FEEDER
HM-1	MAIN COOLING WATER PUMP
HM-2	MAIN COOLING WATER PUMP
HM-3	COOLING TOWER FAN
HM-4	COOLING TOWER SUMP PUMP
HM-5	COOLING TOWER RECIRCULATING PUMP
HT-1	H_2O COOLING WATER TEMPERATURE HEAT EXCHANGER #1 INLET
HT-2	H_2O COOLING WATER TEMPERATURE HEAST EXCHANGER #1 OUTLET
HT-3	CHILLED WATER TANK TEMPERATURE
HT-4	HEAT EXCHANGER #3 INLET TEMPERATURE
HT-5	HEAT EXCHANGER #3 OUTLET TEMPERATURE
HT-6	COOLING TOWER BASIN

MAIN H_2O SYSTEM CONT.

HF-1	COOLING WATER FLOW HEATING EXCHANGER #1
HF-2	COOLING WATER FLOW HEATING EXCHANGER #3
HF-3	COOLING TOWER MAKE UP WATER
HF-4	BUILDING SUPPLY WATER
HF-5	WATER FLOW TO LEAK MONITOR
HP-1	HEAT EXCHANGER #1 INLET PRESSURE
HP-2	HEAT EXCHANGER #1 OUTLET PRESSURE
HL-1	CHILLED WATER TANK LEVEL

TABLE 1

Components of the CP-5 Reflector, Shield, Thimble and Light Water Cooling Systems

and have one of the operating personnel observe and record the flow in each of the listed sections of the system. The desired circulating pump may also be operated from the reactor pump room by using switch No. PM-1 or switch No. PM-2.

Further functional testing of the circulating pumps should be done by simulating failure of one of the pumps by opening either of the manual switches associated with the pumps so that the operating pump is stopped, or by closing the valve on the discharge side of the operating pump, and then observing if the other pump may be started. After this test be sure the manual switches and the valves are set in their correct positions.

While a selected circulating pump is operating and all individual flows are observed to be correct, check the level of distilled water in the stainless steel reservoir. A sight glass on the tank is provided for this purpose. If the level is near the undesired low limit, add sufficient distilled water to bring the level within the indicated operating range.

(The Heavy Water Reactor Coolant-Moderator System)

By reference to drawing RR-1250E, Figure 2 of this manual, and Table 2, it may be observed that the heavy water reactor coolant system, because of the specialized functions, should be considered as composed of several sections.

Section 1

The storage tank, the dump tank, the transfer pump, the dump return pump, and the associated piping effectively constitute one section of the heavy water system, the functions of which are suggested by the names of its components.

Section 2

The main coolant pumps, the No. 1 heat exchanger, the reactor tank and the piping attached to it for pumping the heavy water through the reactor fuel assemblies and the heat exchanger and for returning a small amount of overflow to the storage tank, then via the transfer pump and overflow valve back into the circulating system, constitute the main part of the heavy water system. This portion of the heavy water system provides the means for transferring the heat developed in the reactor to the external cooling water circuit.

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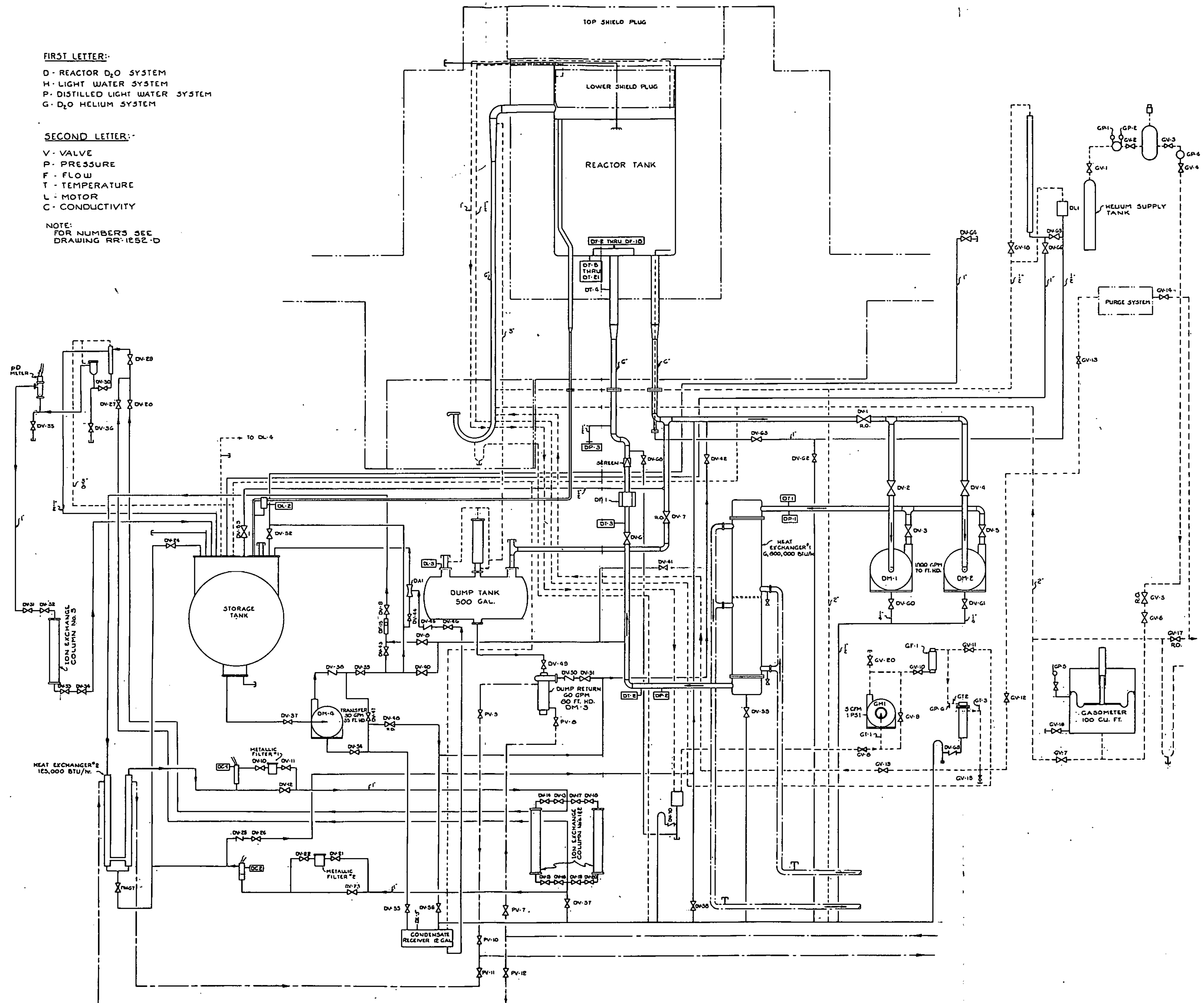

FIGURE 2

Flow Diagram for CP-5 Heavy Water and Reactor Gas Circulating Systems

MAIN D_2O SYSTEM

DV-1	ISOLATING VALVE REACTOR OUTLET
DV-2	ISOLATING VALVE INLET SIDE OF DM-1
DV-3	ISOLATING VALVE OUTLET SIDE OF DM-1
DV-4	ISOLATING VALVE INLET SIDE OF DM-2
DV-5	ISOLATING VALVE OUTLET SIDE OF DM-2
DV-6	THROTTLE VALVE DISCHARGE SIDE OF HEAT EXCHANGER
DV-7	DUMP VALVE
DV-8	THROTTLE VALVE FOR CLEAN-UP SYSTEM
DV-9	ISOLATING VALVE FOR CLEAN-UP SYSTEM
DV-10	ISOLATING VALVE FOR METALLIC FILTER #1
DV-11	ISOLATING VALVE FOR METALLIC FILTER #1
DV-12	BY-PASS VALVE FOR METALLIC FILTER #1
DV-13	ISOLATING VALVE INLET SIDE RESIN COLUMN #1
DV-14	ISOLATING VALVE INLET SIDE RESIN COLUMN #1
DV-15	ISOLATING VALVE OUTLET SIDE RESIN COLUMN #1
DV-16	ISOLATING VALVE OUTLET SIDE RESIN COLUMN #1
DV-17	ISOLATING VALVE INLET SIDE RESIN COLUMN #2
DV-18	ISOLATING VALVE INLET SIDE RESIN COLUMN #2
DV-19	ISOLATING VALVE OUTLET SIDE RESIN COLUMN #2
DV-20	ISOLATING VALVE OUTLET SIDE RESIN COLUMN #2
DV-21	ISOLATING VALVE FOR METALLIC FILTER #2
DV-22	ISOLATING VALVE FOR METALLIC FILTER #2
DV-23	BY-PASS FOR METALLIC FILTER #2
DV-24	ISOLATING VALVE CLEAN-UP RETURN TO STORAGE TANK
DV-25	CHECK VALVE TO KEEP PRESSURE OFF CONDUCTIVITY PROBE DC2 ON SHUT DOWN
DV-26	ISOLATING VALVE FOR DC2
DV-27	SHUT-OFF VALVE, SAMPLE STATION, BEFORE RESIN
DV-28	SHUT-OFF VALVE, SAMPLE STATION, AFTER RESIN
DV-29	THROTTLE VALVE FOR pD METER AND SAMPLING STATION
DV-30	ISOLATING VALVE FOR pD AND SAMPLING STATION
DV-31	ISOLATING VALVE FOR ION EXCHANGE COLUMN AFTER pD METER
DV-32	ISOLATING VALVE FOR ION EXCHANGE COLUMN AFTER pD METER
DV-33	ISOLATING VALVE FOR ION EXCHANGE COLUMN AFTER pD METER
DV-34	ISOLATING VALVE FOR ION EXCHANGE COLUMN AFTER pD METER
DV-35	DRAIN VALVE FOR pD METER
DV-36	DRAIN VALVE FOR SAMPLING STATION
DV-37	ISOLATING VALVE INLET SIDE OF TRANSFER PUMP
DV-38	CHECK VALVE FOR OUTLET SIDE OF TRANSFER PUMP
DV-39	ISOLATING VALVE FOR OUTLET SIDE OF TRANSFER PUMP
DV-40	ISOLATING VALVE, STORAGE TANK RETURN
DV-41	ISOLATING VALVE - CLEAN UP SYSTEM
DV-42	ISOLATING VALVE - DUMP RETURN TO REACTOR
DV-43	ISOLATING VALVE FOR TRANSFER PUMP & CLEAN-UP SYSTEM
DV-44	ISOLATING VALVE FOR ASPIRATOR
DV-45	CHECK VALVE OUTLET SIDE OF CONDENSATE RECEIVER
DV-46	ISOLATING VALVE ON VACUUM SIDE OF ASPIRATOR
DV-47	ISOLATING VALVE IN OVERFLOW RETURN LINE
DV-48	SHUT-OFF VALVE, OVERFLOW RETURN
DV-49	ISOLATING VALVE ON INLET SIDE OF DUMP PUMP
DV-50	CHECK VALVE ON DISCHARGE SIDE OF DUMP PUMP
DV-51	ISOLATING VALVE ON DISCHARGE SIDE OF DUMP PUMP
DV-52	ISOLATING VALVE ON INLET SIDE OF STORAGE TANK
DV-53	DRAIN VALVE ON 6" D_2O DUMP LINE
DV-54	DRAIN VALVE ON TRANSFER PUMP
DV-55	VALVE ON INLET SIDE OF CONDENSATE RECEIVER
DV-56	ISOLATING VALVE ON INLET SIDE OF CONDENSATE RECEIVER
DV-57	DRAIN VALVE FOR ION EXCHANGE COLUMNS
DV-58	DRAIN VALVE ON REACTOR OUTLET
DV-59	DRAIN VALVE ON HEAT EXCHANGER
DV-60	DRAIN VALVE ON DM-1
DV-61	DRAIN VALVE ON DM-2
DV-62	DRAIN VALVE - SIGHT LEVEL GAUGE
DV-63	SIGHT GLASS AND DL1
DV-64	D_2O LOADING STATION
DV-65	ISOLATING VALVE FOR SIGHT GAUGE LEVEL
DV-66	DRAIN VALVE FOR SIGHT GAUGE LEVEL
DV-67	DRAIN VALVE FOR CLEAN-UP SYSTEM HEAT EXCHANGER

MAIN D_2O SYSTEM CONT.

DV-68	DRAIN VALVE REACTOR INLET
DV-69	CHECK VALVE FOR CATALYST CHAMBER DRAIN
DV-70	CHECK VALVE FOR CONDENSER
DT-1	D_2O REACTOR OUTLET TEMPERATURE
DT-2	D_2O REACTOR INLET TEMPERATURE
DT-3	D_2O REFERENCE TEMPERATURE
DT-4 THRU DT-21	FUEL ASSEMBLY D_2O OUTLET TEMPERATURE
DP-1	D_2O INLET PRESSURE, HEAT EXCHANGER
DP-2	D_2O OUTLET PRESSURE, HEAT EXCHANGER
DP-3	PLENUM PRESSURE
DF-1	MAIN D_2O FLOWMETER
DF-2 THRU DF-18	FUEL ASSEMBLY D_2O FLOWMETER
DF-19	D_2O CLEAN-UP SYSTEM FLOWMETER
DL-1	REACTOR D_2O LEVEL
DL-2	OVERFLOW PROBE
DL-3	DUMP PUMP LEVEL
DL-4	STORAGE TANK LEVEL
DL-5	CONDENSATE RECEIVER FULL
DC-1	CONDUCTIVITY PROBE BEFORE RESIN
DC-2	CONDUCTIVITY PROBE AFTER RESIN
DM-1	MAIN D_2O PUMP
DM-2	MAIN D_2O PUMP
DM-3	DUMP RETURN
DM-4	TRANSFER PUMP

REACTOR HELIUM SYSTEM

GV-1	ISOLATING VALVE HELIUM SUPPLY TANK
GV-2	ISOLATING VALVE INLET TO BALLAST TANK
GV-3	ISOLATING VALVE OUTLET TO BALLAST TANK
GV-4	ISOLATING VALVE PRESSURE GAUGE
GV-5	SOLENOID VALVE GASOMETER INLET
GV-6	ISOLATING VALVE GASOMETER INLET
GV-7	ISOLATING VALVE GASOMETER OUTLET
GV-8	ISOLATING VALVE HELIUM BLOWER INLET
GV-9	HELIUM BLOWER BY-PASS
GV-10	ISOLATING VALVE HELIUM FLOWMETER INLET
GV-11	ISOLATING VALVE CATALYST CHAMBER
GV-12	THROTTLE VALVE PURGE SYSTEM
GV-13	ISOLATING VALVE PURGE SYSTEM INLET
GV-14	ISOLATING VALVE PURGE SYSTEM OUTLET
GV-15	DRAIN VALVE CATALYST CHAMBER
GV-16	BLEED VALVE GASOMETER
GV-17	BLOW OFF VALVE GASOMETER
GV-18	ISOLATING VALVE SIGHT LEVEL GAUGE
GV-19	ISOLATING VALVE HELIUM RETURN
GV-20	BLEED VALVE HELIUM SAMPLE STATION
GP-1	PRESSURE MAIN HELIUM SUPPLY TANK
GP-2	PRESSURE REGULATOR BALLAST TANK
GP-3	PRESSURE GASOMETER SUPPLY
GP-4	PRESSURE REGULATOR GASOMETER SUPPLY
GP-5	PRESSURE GAUGE GASOMETER
GP-6	PRESSURE GAUGE CATALYST CHAMBER
GT-1	HELIUM TEMPERATURE INLET SIDE OF BLOWER
GT-2	HELIUM TEMPERATURE INLET SIDE CATALYST
GT-3	HELIUM TEMPERATURE OUTLET SIDE CATALYST
GF-1	HELIUM FLOWMETER
GM-1	HELIUM BLOWER

TABLE 2

Components of the CP-5 Heavy Water and Reactor Gas Circulating Systems

Section 3

A third section of the heavy water system consists of mixed-bed ion exchange resin columns, the No. 2 heat exchanger, the conductivity cells, the pD flow chamber, the sampling station and the required piping. This part of the heavy water system serves as the quality indicating and control section which is arranged to by-pass a small portion of the heavy water coolant flow from the No. 1 heat exchanger to perform the functions indicated.

Section 4

A fourth section of the heavy water system may be considered as made up of the catalyst chamber, the condensate receiver and the various drain lines of the complete system. The functions of this section are to recombine dissociated heavy water and return it and condensed or other drainage heavy water to the storage tank or the condensate receiver from which it may be returned to the storage tank by the aspirator. The absence of forced circulation of the liquid phase distinguishes this section from the other parts of the heavy water coolant section.

Routine adjusting and testing of these components and several sections of the heavy water coolant system should be performed at regular intervals during normal operation of the reactor.

Adjustment and Performance Checks

Section 1

A. For a startup of the reactor or a circulation test of the heavy water coolant system, refer to Figure 2. With all of the heavy water initially contained in the storage tank, the transfer pump isolating valves DV37 and DV39 and also valve DV40 should be open. By starting the transfer pump DM4 with the valves DV8, DV41, DV42, DV43, DV46, and DV7 closed, heavy water may be pumped from the storage tank into the lower end of the No. 1 heat exchanger. With the heat exchanger drain valve DV59 closed, the main coolant pump drain valves DV60 and DV61 closed and the isolating valve DV1 along with valves DV2 and DV3 or DV4 and DV5 of either the main coolant pump DM1 or DM2 open, the heavy water may continue opposite to the direction of flow in normal operation through the heat exchanger, the selected coolant pump and into the reactor tank via the 6 in. discharge line. By pumping the heavy water from the storage tank into the reactor tank in this way, the gas contained in the empty heat exchanger and pumps may be displaced to the reactor gas system to result in less turbulence upon starting the main coolant pump for circulating the heavy water through the fuel assemblies and the heat exchanger.

Some time before the heavy water in the reactor tank has reached its overflow level, the throttle valve DV6 should be opened so that gas contained in the 6-inch supply line, the plenum chamber and fuel assemblies may be carried upward above the liquid level in the reactor tank. After the desired level of heavy water has been reached in the reactor tank, the transfer pump should be stopped and the valve DV1 closed.

B. When the reactor is to be started up from a shutdown for which only the approximately 500 gallons containable in the dump tank has been transferred from the reactor to the dump tank and the dump valve DV7 closed, the heavy water reactor coolant system is already in a state which permits circulation of the heavy water through the fuel assemblies and the main heat exchanger. This may be accomplished if the isolating valve DV1 is opened along with valves DV_2 and DV3 or DV4 and DV5 of either the main coolant pump DM1 or DM2, and the throttle valve DV6 is partially opened, then either pump DM1 or DM2 started. Upon opening valves DV42, DV49, and DV51 with valve DV7 closed and having cooling water flowing at a rate of approximately 1 gpm through the jacket of the dump-return pump DM3, this pump may be started to pump the heavy water from the dump tank into reactor tank via the intake line for the main coolant pumps. When the dump tank has been emptied, the pump DM3 will automatically stop.

Section 2

The coolant pump DM1 or DM2 may now be started and the throttle valve DV6 slowly opened as the coolant pump takes hold. Adjustment of the throttle valve should be continued until the desired flow is indicated by the Reactor D_2O Flowmeter in the control room. While adjusting the throttle valve, the reactor tank plenum chamber pressure, given by DP3 and shown in the control room by the Plenum Pressure Indicator, should be observed to be below the upper limit of 20 $lbs/in.^2$. Likewise, the flow of heavy water through each individual fuel assembly of the reactor should be in the safe range indicating free passage of the coolant between the elements of the fuel assemblies. The individual flows are given by DF2 through DF18 which cover a range from 0-119 gpm. Any considerable departure from the mean value should be investigated and corrected. With valves DV37, DV39, and DV47 open, and valves DV40, DV43 and DV56 closed, start the transfer pump DM5 and open valve DV48. This will permit the overflow of about 5 gpm from the reactor tank to be pumped back into the main circulating system. When the reactor is operating at appreciable power, indications of the temperatures of the heavy water flowing through each fuel assembly may be observed as differential temperatures given by DT5 through DT21 compared to DT4. Uniform temperature differentials for the several fuel assemblies are desirable. Any considerable departure from the mean value should be investigated and corrected.

Section 3

To clean up the heavy water or to maintain its high quality, a small fraction of the total flow originating in Section 2 is diverted into the quality control section by opening valve DV8 at the low pressure or outlet end of the No. 1 heat exchanger. With valve DV41 closed when pump DM1 or DM2 is operating, heavy water under a pressure of 20 psi - 25 psi or less will be supplied to the valve DV9. Upon opening valves DV9, DV10, and DV11, the heavy water in this section will be directed through heat exchanger No. 2 and metallic filter No. 1 to supply a pressure at the inlet valves for the resin columns No. 1 and No. 2 and the inlet valve DV28 for the sampling station and the pD flow chamber. With either valves DV13, DV14, DV15 and DV16 or valves DV17, DV18, DV19 and DV20 open, the pressure will be transmitted through the No. 1 or No. 2 resin column to the No. 2 metallic filter and to valve DV27 for the sampling station and the pD flow chamber. Upon opening valves DV21, DV22 and DV24 with valves DV26, DV27, DV28 and DV57 closed, heavy water flows from Section 2 through heat exchanger No. 2, metallic filter No. 1, resin column No. 1 or No. 2, as selected, metallic filter No. 2 and is returned to the storage tank. By adjusting the valves DV8 and DV9, the flow through Section 3 may be controlled to give the desired value of about 4 gpm, which will be indicated by flowmeter DF15. In normal operation, by adjusting valves DV27 or DV28 and DV29, a small portion, about 1/2 gpm, of the heavy water flowing in Section 3 will be directed through the sampling station, the pD flow chamber, the No. 3 resin column and into the storage tank.

The level of heavy water in the reactor tank will automatically be adjusted to the proper value by the transfer pump DM5 while Section 3 is being filled.

Section 4

The reactor coolant system is a closed or isolated system to be maintained under a very nearly constant pressure by a gas atmosphere supplied above the liquid surfaces in all reservoirs or tanks of the system. All of these reservoirs are joined or vented together and connected to a variable volume gas holder or gasometer which will automatically adjust to provide a nearly constant pressure above atmospheric pressure for the system.

The reactor coolant system gas atmosphere is provided by helium which, in addition to being kept under a given pressure, is circulated through the free space in the reactor tank above the heavy water surface and a catalyst chamber to recombine the deuterium and oxygen dissociated by neutron bombardment of the heavy water. Some heavy water vapor from this process, as well as the heavy water vapor from warm regions of the coolant system which may condense in cooler parts of the system and then drain to lower regions under certain circumstances will migrate to the condensate receiver. Some condensed heavy water vapor will naturally drain to the storage and dump tanks. When the transfer pump DM4 is operating, open valves DV44 and DV46 and the water in the condensate receiver will be pumped into the storage tank of Section 1 by means of the aspirator.

WORK AREA CHECKS

At the start of each operating shift, the operators are required to make a check of the work area and experimental openings associated with the reactor. The Check Sheet for this record is shown by Figure 3.

TESTING OF REACTOR SAFETY DEVICES

Following extended reactor shutdowns as previously referred to, and as a routine part of Monday morning tests during continuous operation of the reactor, the series of checks of reactor safety and alerting devices indicated by Figure 4, are to be carried out.

In making the power level safety trip tests, the reactor is to be taken up to full (100%) power using the normal operating procedure set forth in a following section of this manual. Upon reaching full power, the reactor must be shifted from automatic control to manual control, or if the reactor has been brought up to full power on manual control, this is continued until the reactor rises the 10% to 20% above full power required to actuate the power level trips. A safety trip testing switch is provided on the control console so that the highest level trip may be tested first, then in descending order, the successively lower level trips may be tested. Signals for the testing of the other warning and alerting systems indicated on Figure 4 will appear on the annunciator panel as the respective systems are tested.

EXPERIMENTAL OPENING CHECK SHEET

DATE ____________________ SHIFT ____________________

HOLE NO.	EXPERIMENTER		EQUIPMENT		TIME	
	NAME	PRESENT	ON	OFF	ON	OFF
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						
16						
17						
18						
19						
20						
21						
22						
23						
24						
25						
26						
27						
28						
29						
30						
31						

OPERATORS ____________ ____________ ____________

____________ ____________ ____________

FIGURE 3

19

SAFETY CIRCUIT REPORT FOR CP-5

DATE ____________________

SAFETY CIRCUITS

FREE FALL: ROD #1 __________ ROD #2 __________

ROD #3 __________ ROD #4 __________

POWER LEVEL TRIPS: #1 ________ #2 ________ #3 ________

INDICATED ALARMS: ______________________________

1. Building Activity	26. H_2O Flow
2. Safety Power Trip	27. Cooling Tower Purge Flow
3. Safety Power Trip	28. Shield Cooling Flow
4. Safety Power Trip	29. Shield Cooling Low Level
5. Low D_2O Flow	30. Reactor He Valves
6. Pile Period Rec.	31. Graphite He Valves
7. Reactor D_2O Level	32. Air Pressure
8. D_2O Inlet Temp.	33. D_2O Condensate Full
9. D_2O In and Out Diff.	34. Low H_2O Inlet
10. Auto. Reg. In	35. H_2O Heat Exc. In Temp.
11. Safety Power Trip #4	36. Spare
12. D_2O Overflow	37. Shield Cooling Flow
13. Spare	38. Shield Cooling Temp.
14. Spare	39. Rec. #1 High
15. Plenum Pressure	40. Work Room Activity
16. Relief Valve Op.	41. Process Room Activity
17. Cooling Tower Basin Low	42. Spare
18. Tower Temp.	43. Spare
19. Chilled H_2O Hi Level	44. H_2O Heat Exc. Out Temp.
20. Chilled H_2O Level Low	45. Spare
21. Spare	46. Shield Cooling Flow Pit
22. Spare	47. Shield Cooling Out Temp.
23. Spare	48. Rec. #2 High
24. D_2O Clean-up Temp.	49. Basement Act.
25. D_2O Flow Low	50. Rod Storage Act.

ALL SAFETY CIRCUITS CHECKED AND FOUND TO BE OPERATING PROPERLY

YES ______ NO ________ REMARKS:

SIGNED ______________________________ (SHIFT SUPERVISOR)

FIGURE 4

NORMAL OPERATING PROCEDURE FOR THE CP-5 REACTOR

After the preoperational testing of the component equipment and instrumentation for the CP-5 reactor has proven that all non-neutron dependent parts of the reactor function properly, and after the fissionable material loading and the reactor calibrations have shown all neutron related functions of the reactor are as desired, the reactor will be run up to full power. Following a full power run of sufficient duration to provide equilibrium concentrations of xenon-135 and iodine-135, the reactor power will be reduced to a level of a few kilowatts while the change in xenon poisoning is observed. If the xenon effect is close to the expected magnitude, the reactor will be ready for normal operation.

Reactor Startup

A. (General)

Normally the reactor will be started up after a shutdown of sufficient length that the xenon has decayed to a negligible value or a shutdown of short enough duration that the xenon has not built up much higher than the equilibrium value just prior to the shutdown. Under these conditions the reactor moderator-coolant would either be in the reactor tank at the dump level corresponding to the removal of approximately 500 gallons by dumping it into the dump tank, or to the overflow level which is maintained during operation of the reactor.

I. It is assumed here, with the reactor shut down, that the heavy water in the reactor tank has been lowered to the dump level, the dump valve is closed, all circulation systems of the reactor are stopped and the power switches in the control room are locked off. In this case, to start the reactor it is necessary (1) to unlock the D_2O and reactor control switches on the control console by inserting the appropriate keys in the switches and turning them to the on positions. With the D_2O system circuits energized, (2) the D_2O isolating valve DV1 should be opened by operating its push button switch on panel K of the control room. (3) The D_2O throttle valve DV6 should now be opened to about midway between the open and closed positions.

II. The distilled water system, for removing heat from the radiation shields of the reactor, from the dump return pump and from the heavy water fed into the resin columns, should now be put in operation. This may be done after the building water supply to the heat exchanger of this system has been adjusted to the proper flow, ~ 10 gpm, which either goes to the cooling tower basin as make-up or is diverted into a drain. The distilled water circulating pump PM1 or PM2 may be turned on by manipulating the appropriate switch button on panel L of the control room or in the basement pump room. Starting of the distilled water circulation is necessary at this time because the pump for returning the heavy water from the dump tank to the reactor tank is interlocked to stop unless a cooling water flow of about 1 gpm is maintained around its field coils.

III. Begin the circulation and adjustment of the level of the heavy water in the reactor tank by (1) starting the transfer pump DM4, then (2) starting the dump return pump DM3; (3) after the dump return pump is stopped by the dump tank low level interlocking switch, start the main D_2O circulating pump DM1 or DM2. As the level of heavy water rises in the reactor tank, this will be indicated in the control room on panel O. Continued operation of the transfer pump will establish and maintain the moderator level in the reactor tank at the full position. With the overflow level established, the overflow alarm indicator light above the control panel may be set to dim by pressing the annunciator reset button.

IV. The thimble cooling system for maintaining sample temperatures within the proper limits should be started by operating its switch buttons on panel C. When the blower for this system is producing the proper circulation of air through the several thimbles, the warning signal light above the control console may be set to dim if the annunciator reset button is depressed.

V. (1) The reactor helium circulation system should be turned on at panel C by pushing the start button for its blower. (2) At this time it will also be desirable to turn on the blower system for carrying away activated air or other gases from the beam hole tubes as well as the pile building ventilating system.

VI. The light water cooling tower and main heat exchanger system should now be turned on by (1) starting the circulating pump HM1 or HM2 and adjusting the throttle valve HV1 by use of the switch buttons on panel K to give a positive D_2O to H_2O differential pressure as indicated on the same panel. (2) Start the cooling tower fan by use of its switch on panel K. (3) After running the pump briefly, to complete the observations referred to above, stop the cooling water circulation of this system by opening the switch to pump HM1 or HM2 as appropriate. Also stop the cooling tower fan.

B. (Semi-automatic)

The reactor is now in a preliminary state of readiness for adjusting the nuclear chain reaction from a subcritical to a supercritical condition and leveling off to critical at the desired power.

I. Various interlocks and safety trips require startup conditions which must be satisfied by the reactor instruments and control devices in addition to those already referred to for the circulating systems of the reactor. These are fulfilled when: (1) all shim-safety rods are at their In positions as shown by the rod position indicators and the pilot lights on panel H above the control console, (2) the power galvanometer shunt is set for maximum sensitivity, (3) the wide range galvanometer shunt is set for maximum sensitivity, (4) the safety by-pass switch is at the clear position and (5) the annunciator reset button clears all the safety trips dimming the annunciator panel lights as the safety and warning devices are placed in their ready states.

It is now possible to energize the drive mechanisms for the shim-safety rods and the regulating rod by pressing the reactor control power reset button which will also at this time illuminate the "Reactor Control Power On" signal with repeater lights on four faces of the reactor and in the basement work area.

II. The shim rods may now be withdrawn to their intermediate positions manually in any sequence, or automatically in a progressive sequence from 1 to 4. Manually, one selected shim rod may be positioned anywhere between its In and Out limits or the four shim rods may be run outward one at a time only, anywhere between their In and intermediate positions by manipulating the rod selector switch and the shim raise or lower button. Automatically, the shim rods will move out to their intermediate positions one at a time in only the sequence 1 to 4 as they are successively selected by the shim rod selector switch and started out by pressing momentarily the automatic shim sequence raise button, after the previously selected shim rod has reached its intermediate position. The intermediate positions are announced by the amber lights above each rod position indicator dial. The regulator rod may be adjusted now or at any time before or during the automatic shim raise operating to any position between its In and Out limits by manipulating the regulator rod raise or lower buttons, except that it cannot be run outward simultaneously with the manual raising of a shim rod. While a shim rod is being run outward by use of the automatic raise feature, it may be stopped by changing the shim selector switch and also by depressing either the manual shim raise or lower button. The automatic withdrawal may be resumed by having the shim selector switch set on the shim rod that was stopped in its outward motion and again pressing the automatic shim raise button.

When the chosen manipulations of the shim and regulating rods eventually place all of them at their intermediate positions, their amber lights are on and a warning buzzer sounds to emphasize the attainment of the subcritical ready condition of the reactor.

By pressing the sub-critical acknowledge button, the operator silences the buzzer and by-passes the interlock feature which otherwise prevents a shim rod from being withdrawn if any other shim rod is beyond its intermediate position. The operator's action also illuminates the reactor subcritical ready indicator and de-energizes the automatic shim raise control. Now all shim and regulating rods must be positioned as desired, by the operator manipulating the shim rod selector switch, the shim rod raise or lower button and the regulating rod raise or lower buttons, restricted by the interlock condition that no two rods may be moved outward simultaneously, and the further requirement that the regulating rod must be at its intermediate position to permit transfer from manual to automatic adjustment of the regulating rod and control of the reactor power level.

III. To set up the control system for the semi-automatic rise of the reactor to the desired operating power, observe that the regulating rod is adjusted to its intermediate position as indicated by the associated amber light above its position indicator. The regulating rod δk limiter must be reset if tripped, and the automatic transfer button on the console should be depressed to switch the control from manual to transfer into automatic as the indicators will show on the regulator rod position dial. (If the regulating rod is run without stopping for more than 5 seconds, the δk limiter will be tripped and must then be reset before the automatic transfer button can operate to place the reactor on automatic control or to restore it to automatic control.) If a fault is indicated by the illuminated operating rod position indicator and information panel when the automatic transfer button is depressed, this most likely is due to failure to turn on the power supply and amplifiers for the automatic control system. When the fault signal continues to be illuminated with the power supply and amplifiers turned on, an actual fault is present in the automatic control system and the necessary repairs must be made before it will be possible to operate the reactor with automatic control. Since the automatic control system is adjusted to demand and control reactor power from 1% to 100% of full power, as set, and since so far the reactor has not been made critical, it will be noticed that the Up arrow on the regulating rod position dial is illuminated. (This will be the case as long as the reactor power is below the demanded power when the automatic reset button is actuated.) Now slowly adjust the shim rods outward from their intermediate positions by using the shim raise button while at the same time observing the deflection of the differential and power galvanometers. Nearly identical settings of the shim rods will probably be desired for the final adjustment to operating power, thus relatively small outward motions of successive shim rods should probably be made in this process of bringing the reactor up to power. As the reactor is brought up to critical, the source neutrons, from photo-neutron effects in the heavy water of the reactor, will be multiplied and the galvanometer deflections will increase. When a slightly above critical condition of the reactor exists, a rising period will be evident by a continuing increase of the galvanometer deflections and the indication given by the period meter. Additional adjustments of the shim rods should be made to give a period of 30 or more seconds.

When the reactor power rises to the 1% value, or the selected power demand, the control indicators will switch from Transfer to Automatic and the automatic control system will lock in and take over control of the reactor to maintain the reactor at that power until a change is made in the power demand setting. (At this time switch the power recorders and the period recorder to high speed.)

While the reactor is being maintained at the selected power through automatic control adjustment of the regulating rod position, it is not possible to move the regulating rod by using the manual raise or lower buttons for the regulating rod. If for some reason it is desired to adjust the regulating rod manually, it is necessary to press the manual reset button which transfers the control from automatic to manual. Return to automatic control may be accomplished by complying with the conditions which have already been discussed.

IV. By manipulating the power demand raise button, the power demand indicator will change to higher power in such a way that the regulating rod will be automatically adjusted so reactor power will rise with a 40 second period and level off at the setting on the power demand dials. Rise of reactor power should be accompanied by adjusting the power and differential galvanometer shunts to indicate the reactor power and to maintain the differential galvanometer deflection on scale or set it to zero after the power galvanometer deflection has become sufficient to follow the reactor behavior. (When the desired power level has been attained, the power recorders and the period recorder should be switched back to low speed.)

V. While the reactor is operating at normal power with automatic control, there will be a gradual withdrawal of the regulating rod to compensate for fission product build-up in the fuel assemblies, temperature rise of the reactor and consumption or burn-up of the fissile material of the fuel assemblies. At a position of the regulating rod between intermediate and full out, the shim out light is energized to request the operator to adjust the shim rods outward. If this shimming operation is not performed, eventually the regulating rod will be withdrawn to its full out limit at which position an alarm rings and the operator is warned to adjust the shim rods outward. The alarm continues to sound until the regulating rod moves in away from its limit switch. The shimming operation may be carried out either manually or automatically. By using the manual shim raise or lower button to move a selected shim, the regulating rod will compensate by moving in from the Out limit to a position chosen by the operator. If instead the operator presses the automatic shim button, the shim rod indicated by the shim selector switch will be caused to move toward the proper position at a pre-set speed while the regulating rod compensates to its intermediate position or until the shim button is released, thereby stopping the automatic shimming operation. Further shim rod movement must now be accomplished by using the manual shim adjusting buttons or the operator must wait until the regulating rod moves to either of its shimming limits at which time automatic shim adjustment may again be employed.

If during the shimming operation the regulator rod moves below its lower shim limit, an alarm sounds and the operator is warned to shim inward to move the regulating rod upward. Failure of the operator to comply with the shim warning before the regulating rod reaches its In limit switch will cause the reactor to be shut down.

By proper attention to shim adjustments, the operator may maintain the power at the desired level within ± 1/2% by automatic control until it is desired to shut down the reactor.

C. (Manual)

When the reactor is in the state of readiness attained by carrying the start-up operations through the six steps of Section A, it may, if desired, be brought up to normal operating power level by a manual rather than the semi-automatic start-up procedure.

I. When all safety trips, annunciator warning signals and safety interlock switch have been set to their ready conditions, as in Step I of Section B, manual adjustment of the shim rods and the regulating rod may be accomplished to take the reactor up to power.

II. Set the regulating rod near its intermediate position so that positive or negative changes in reactivity may be conveniently made with this rod after the reactor is brought to critical or slightly above by proper manipulation of the shim rods. By relatively small and slow outward adjustments of one shim rod after another through use of the shim selector switch and the manual shim raise button, the reactor can be brought nearer and nearer to critical. While adjustments of the shim rods are being carried on, the galvanometer deflections should be observed for indications of a positive reactor period. Once a positive period is attained, the shim rods may be moved in or out by using the selector switch and the manual shim lower or raise button as needed to give the reactor the desired period. The speed of the shim rod movement should be adjusted, by using the shim rod speed control knob so that the motion of the shim rods is sufficiently slow and coasting is negligible.

The rise of the reactor to power should be accompanied by galvanometer shunt adjustments as necessary. When the desired power is reached, the reactor may be maintained at that level manually by adjusting the shim rods or the regulating rods. However, it will generally be preferred to hold the reactor at a selected power level by means of the automatic control system.

III. To arrange for take-over of the reactor control by the automatic system, have the regulating rod at its intermediate position and adjust the shim rods to maintain the correct power level. Set the power demand dials at the desired power level by using the demand raise and lower buttons as needed. Make the automatic control ready by pressing its reset button. Adjust the power demand as needed to match the reactor power at which time the automatic system will lock into control and the regulating rod will be automatically adjusted to maintain constant reactor power to within ± 1/2%.

ROUTINE OPERATING CHECKS

After the reactor is taken up to power and is in routine operation, checks of the behavior of the various components of the reactor are to be made on shift-wise, hourly and half-hourly schedules as indicated respectively by Figure 5, Figure 6, and Figure 7.

DATE ____________ 27 SHIFT ____________

REACTOR AREA CHECK

Time			
H_2O Heat Exch. Press. In			
H_2O Heat Exch. Press. Out			
H_2O Throttle Valve Pos.			
D_2O Reactor Level In			
D_2O Heat Exch. Press. In			
D_2O Heat Exch. Press. Out			
D_2O Throttle Valve Pos.			
Disaster Monitor			
Work Room Monitor			
Pump Room Monitor			
Basement Monitor			
Rod Storage Area Monitor			
Trip Chamber Currents #1			
#2			
#3			
#4			
Vapor Sphere Level			
Indicated Power Level			
Sight Glass D_2O Level			
Reactor Helium Supply Tank No.			
Reactor Helium Supply Tank Press.			
Reflector Helium Supply Tank No.			
Reflector Helium Supply Tank Press.			
Leak Detectors			
Building Supply Water Meter			
Cooling Tower Water Meter			
Reflector Gasometer Level			
Reactor Gasometer Level			
D_2O Pump in Operation			
H_2O Pump in Operation			
Ion Exchange in Operation			
Cooling Tower			

OPERATORS ____________ ____________

____________ ____________

____________ ____________

FIGURE 5

575 025

28

DATE ______________ SHIFT ______________

OPERATORS

1 ______________
2 ______________
3 ______________
4 ______________
5 ______________
6 ______________

KWH OUT ______________ TIME ______________
KWH IN ______________ TIME ______________
TOTAL KWH ______________ TIME ______________
CALCULATED POWER ______________ TIME ______________

HOURLY INSTRUMENT CHECK
CONTROL ROOM AND BASEMENT

Time									
Galvanometer Zero Check									
Reactor on Auto. or Man.									
D_2O Storage Tank Level	In.								
Shield Cooling H_2O In	°C								
Shield Cooling H_2O Out	°C								
Shield Cooling Flow	GPM								
Main Cooling H_2O In	°C								
Main Cooling H_2O Out	°C								
Main Cooling H_2O Flow	GPM								
D_2O Flow	GPM								
D_2O Diff. Temp.	°C								
D_2O Reactor Inlet	°C								
Thermal Power	KWH								
D_2O pD									
Conductivity In	UMHOS								
Conductivity Out	UMHOS								
Gasometer Level	Cu. Ft.								
D_2O Heat Exch. Press. In									
D_2O Heat Exch. Press. Out									
H_2O Heat Exch. Press. In									
H_2O Heat Exch. Press. Out									
Building Air Supply	PSI								
Dump Valve Press.	PSI								
Catalyst Helium Press.									
Gasometer Helium Press.									
Overflow Valve Press.	PSI								
D_2O Storage Tank Level	In.								
Storage Tank He Flowmeter									
Graphite Helium Flowmeter									
Shield Cooling H_2O Flow	GPM								
Shield Cooling Water Level									
Helium Circulating Flowmeter	CF/M								
Clean-up System Flowmeter	GPM								
Leak Monitor Flowmeter	GPM								

578 026

FIGURE 6

HALF HOUR INSTRUMENT CHECK

DATE ____________ SHIFT ____________

CONTROL ROOM

29 30 31

Time																	
Power Galvanometer	meg.																
Power Demand	%																
Regulating Rod	cm.																
Shim Safety Rod #1	°																
#2	°																
#3	°																
#4	°																
Catalyst Temp. In	° C.																
Catalyst Temp. Out	° C.																
Fuel Rod D2O Flow 1																	
2																	
3																	
4																	
5																	
6																	
7																	
8																	
9																	
10																	
11																	
12																	
13																	
14																	
15																	
16																	
17																	
Fuel Rod Temp. Diff. 1																	
2																	
3																	
4																	
5																	
6																	
7																	
8																	
9																	
10																	
11																	
12																	
13																	
14																	
15																	
16																	
17																	
D2O Plenum Press.	psi																
Leak Monitor																	
Catalyst Helium Press.	psi																
Gasometer Helium Press.	psi																
Dump Valve Press.	psi																
Overflow Valve Press.	psi																

027

FIGURE 7

OPERATORS ____________ ____________ ____________ ____________ ____________

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SAMPLE PREPARATION, INSERTION AND REMOVAL

In addition to supplying neutrons for beams used in numerous experiments, the CP-5 reactor is arranged to accommodate several in-pile experiments and a large number of samples of materials to be rendered radioactive, or variously modified by neutron bombardment in different zones of the reactor.

All in-pile experiments and sample irradiations require the approval of the director of the L.R.R.O. Division or his designated alternates, before they may be inserted in any of the reactor zones. Such approval will be indicated by signature on the irradiation request form, Figure 8, which the experimenter or his assistant must supply to the pile operators who will supervise the insertion and removal of the equipment or samples.

It is the duty of the reactor operations supervisor and the pile operators whom he designates, to receive and properly record all irradiation requests. The insertions and removals of all experimental equipment and samples for the several reactor zones are, in general, to be performed by the reactor operations supervisor or the selected pile operators. For specially delicate equipment and samples, these operations may be performed by the experimenter under the supervision and with the assistance of the reactor operations supervisor and the pile operators of this division.

During all activated instrument and sample removals, the pile operators are responsible to see that proper monitoring of radioactivity and exposures are carried out.

No sample or equipment is to be placed in or removed from the vertical thimbles of the core and heavy water reflector zones of the reactor while the reactor is at power. Any special measurements which involve movement of materials of any sort in these zones while the reactor is not shut down, must be supervised by the director of this division or by the supervisor of reactor operations who has specifically been advised of the particular operation by the director of this division.

IRRADIATION REQUEST

33

CHEM. DESC. ______________________ DATE ______________

______________________ NAME ______________

______________________ DIV. ______________

AMOUNT ______________________ NO. ______________

DESC. OF MATERIALS ______________________________

____

DESC. OF CONTAINERS ______________________________

____

IRR. LOC. ______________________ EXPOSURE TIME REQ. ______________

FLUX REQ. ______________________ ESTIMATED ACTIVITY ______________

CM^2 OF ABSORBER ______________________ REC'D BY ______________

THE UNDERSIGNED HAS INSPECTED THE SAMPLE DESCRIBED ABOVE AND HAS DETERMINED THAT THE DESCRIPTION IS CORRECT. IT IS APPROVED FOR IRRADIATION IN MANNER INDICATED.

____

AUTHORIZED OFFICIAL

INITIAL TIME IN ______________________ OPERATORS ______________

KWH IN ______________________

SPECIAL INSTRUCTIONS ______________________________

____

REMARKS ______________________________

____

____

FIGURE 8

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WAS INTENTIONALLY

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