X-822

OAK RIDGE NATIONAL LABORATORY
Operated By
UNION CARBIDE NUCLEAR COMPANY

UCC

POST OFFICE BOX P
OAK RIDGE, TENNESSEE

1

"External Transmittal Authorized"

ORNL
CENTRAL FILES NUMBER
CF-56-7-58

DATE: July 12, 1956

SUBJECT: Fuel Charging System
HRT-CP Engineering Test T-11 and T-16

TO: W. D. Burch

FROM: R. E. Brooksbank

Photostat Price $ 3.30
Microfilm Price $ 2.40

Available from the
Office of Technical Services
Department of Commerce
Washington 25, D. C.

453-001

UNCLASSIFIED

DISCLAIMER

Fuel Charging System

HRT Engineering Test T-11 and T-16

1.0 Introduction:

At the beginning of each HRT chemical plant cycle, cold (thermally) fuel will be added to the underflow pot, T-1, and allowed to expand by heating to 300°C before the system is tied into the reactor circuit. The closed high pressure system has no surge volume when the system is at 300°C and 2000 psi; therefore, the exact quantity of liquid must be delivered to T-1 from the metering tank, T-5. Overfilling the high pressure system may result in a rupture of piping or equipment.

The fuel charging tank, T-11, and the D_2O storage tank, T-16, are small bomb type containers mounted on a removable charging rack. The calculated quantities of uranyl sulfate and D_2O will be added to the vessels in the laboratory, bolted to the fuel charging rack and pressured into the chemical plant high pressure system with oxygen.

The fuel charging system will be tested with the following objectives:

(1) Establish the quantity of the concentrated fuel charge that does not reach the high pressure system.

(2) Determine the exact level to which T-1, the hydroclone underflow pot, can be filled with cold solution to allow for thermal expansion at 300°C.

(3) Establish the holdup volume required by the metering tank, T-5, and to size the vessel to the proper dimensions.

(4) Evaluate the operability of the entire fuel charging system under simulated conditions.

2.0 Procedures:

Before the fuel charging system can be tested satisfactorily, the hydrostatic test should be completed. A pressure test of HCV T-1-4 should be conducted to determine when the valve stem will lift from its seat (~ 2800 psi). It is planned to use T-1-4 as a pressure relief valve during Procedure 2.3.

2.1 Volume Determination of the High Pressure System

(a) Check to see that all instruments are functioning properly.

(b) Install a vacuum pump line to the discharge of manual valve in line 1109 located in the sample cubicle. Place a 20-liter carboy between valve and vacuum pump.

(c) Install tygon tubing from condensate tanks (makeup area) to the fill side of the D_2O storage tanks (T-16). Close all manual valves in fuel charging rack.

(d) Check the following valve positions:

HCV T-11-2	Open
HCV T-1-2	Open
HCV H-5-2	Open
HCV P-1-2	Open
HCV-142	Closed
HCV-141	Closed
HCV T-2-2	Closed
HCV-1112-2	Closed
HCV-C-22	Closed
HCV C-1-2	Closed
HCV T-11-4	Closed
HCV P-1-4	Closed
HCV T-1-4	Closed

(e) Commence drawing a vacuum on system until 25 inches Hg is indicated on vacuum pump gage, at which time the valve to T-16 from the condensate supply may be opened.

(f) Open two manual valves between T-16 and T-11. Open both manual valves between T-11 and C cell. Allow solution to pass through line 1124.

(g) Continue drawing vacuum on system until liquid begins to collect in carboy. The dip leg on the system side of the carboy should be checked for the formation of air bubbles once the leg is below the surface of the liquid.

(h) When the carboy is half filled with liquid valve off the vacuum pump and close manual valve on line 1109.

(i) Install pump on line 1113 and withdraw an additional 10 liters from the system. Valve off vacuum pump and close manual valve on line 1113.

(j) Close manual valves between T-11 and C cell.

(k) Close the following valves:
HCV T-11-2, HCV P-1-2, HCV H-5-2, HCV T-1-2.

(l) Freeze the following plugs to a temperature of $< -30^{\circ}C$:
FP-3, FP-5, FP-8, FP-10, FP-4. Should the refrigeration system be inoperable at the time of the test, dry ice wired to the pipes in cardboard cartons will suffice.

(m) Withdraw solution in line 1113 between closed HCV P-1-2 and manual valve in sample cubicle with a vacuum pump. Repeat this step for line 1109 and H-5-2.

(n) Drain all liquid from the fuel addition line (1124) into a tared container or a 4-liter graduate by opening HCV T-1-2, HCV 1112-2, HCV C-1-2, JC-1-1. A portable vacuum pump may have to be installed on line 1112 to completely drain line. No means of venting is provided for this operation. _____ cc H_2O. _____ Temp.

(o) Prepare to measure the volume and temperature of the high pressure system by placing a suitable container under JC-1-1, line 1112. Approximately 2.5 to 3 gallons of liquid should be collected.

Actual _____ liters

Temp _____ °C

(p) Vent system by opening manual valves on lines 1113 and 1109 in sample cubicle and opening the following valves:
JC-1-1, HCV 1112-2, HCV C-1-2, HCV T-1-2.

Then the following freeze plugs:
FP-3, FP-5, FP-8, and FP-10.

(q) Repeat steps 2.1 (a) through (p).

Actual _____ liters

Temp _____ °C

2.2 Volume Check of High Pressure System at Temperature and Pressure

Before T-5 can be adjusted, the volumes obtained from Procedure 2.1 should be checked by adding the proper amount of water to the high pressure system and heating the underflow pot, T-1, to 300°C. Overheating the system by 10°C will establish the gas vapor space above the liquid in the clone underflow pot. Valve HCV-T-1-4 will be used as a safety relief valve, should the pressure exceed 2800 psi.

(a) When the volume within the high pressure system has been established the proper quantity of water may be added to the system through T-11 and T-16. The specific gravity of the water in the high pressure system will be 0.7209 gms/cc, the fuel charging line, 1124, will contain water that has a specific gravity corresponding to the temperature of the charged water.

(b) Close valves HCV-141 and HCV-142 to and from the reactor. Check that freeze plug temperatures at these valves are $< -30°C$.

(c) Set cell C valves as follows:

HCV T-1-2	Open
HCV T-1-4	Open
HCV P-1-4	Open
HCV H-5-2	Closed
HCV P-1-2	Closed
HCV 1112-2	Closed
HCV T-2-2	Closed
HCV T-11-2	Closed

(d) Freeze plug temperatures should be:

FP-3	Ambient temperature
FP-4	Ambient temperature
FP-5	-30°C
FP-6	Ambient temperature
FP-7	Ambient temperature
FP-8	-30°C
FP-9	Ambient temperature
FP-10	Ambient temperature
FP-11	Ambient temperature
FP-12	Ambient temperature

(e) Charge the amount of water calculated from Section 2.2 (a) by adding solution to T-16 and pressurizing with oxygen. The oxygen cylinder should be piped to T-11 rather than T-16 to permit T-16 to be vented.

_____ grams added.

(f) Close all manual valves on fuel charging rack.

(g) Close HCV T-11-2, HCV T-1-4 and HCV P-1-4.

(h) Freeze FP-3, FP-8 and FP-10.

(i) Set T-1 temperature controller on automatic, turn on manual heater, H-11-2 and start P-12 blower. Raise set point on TRC-1 in 50°C increments pausing 15 minutes at each level. Continue raising temperature until the underflow pot is at 250°C at which time raise temperature in 10°C increments to 300°C.

(j) When temperature and pressure has stabilized at 300°C for 15 minutes, cautiously raise temperature to 310°C in 1°C increments. Record pressure with each 1° rise. In this manner, the gas vapor space in T-1 may be estimated.

(k) Cool solution to ambient temperature and drain solution to a tared or graduated container.

Line 1124 holdup _____ cc's

High pressure system _____ cc's

2.3 Sizing of the Metering Tank -- T-5

Using the volumes obtained from Section 2.1, the D_2O metering tank can be fabricated to the size required by means of a weight balance.

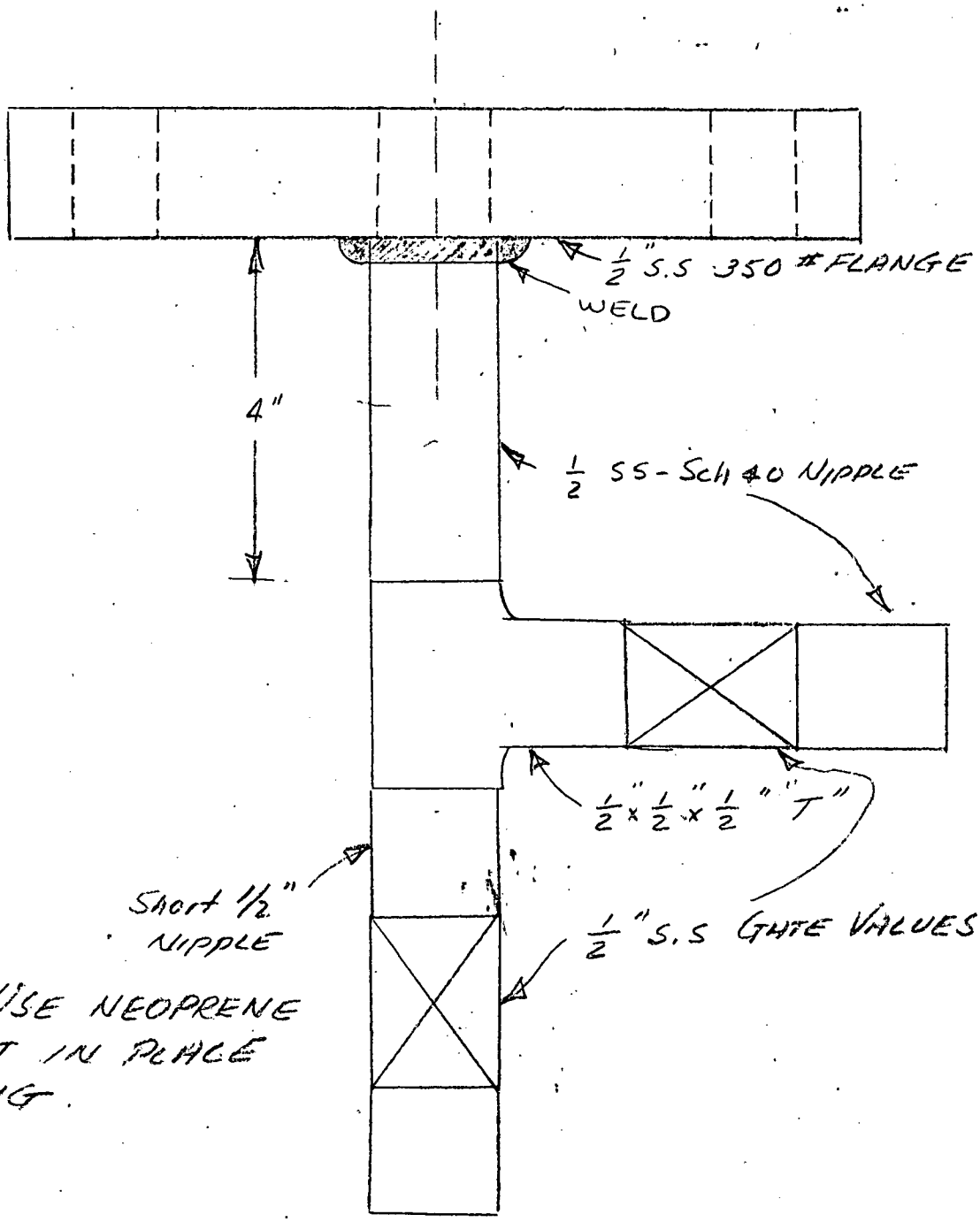
When T-5 has been fabricated to the proper length, the holdup volume may be checked using the following procedure:

(a) Install adapter flange on line 1112 on the discharge end of valve JC-1-1. (See Figure 1).

ORNL-LR-Dwg.-15001

FIGURE I

ADAPTER FLANGE



NOTE: USE NEOPRENE GASKET IN PLACE OF RING.

(b) Connect tygon tubing from condensate tanks to flange nipple. Open condensate supply valve.

(c) Open valves JC-1-1 and HCV T-3-2. Close HCV T-2-2 and HCV C-1-2, HCV 1112-2, HCV T-11-2, and HCV T-1-2.

(d) Allow liquid to build up in T-2 until ~ 5 gal is indicated.

(e) Close condensate supply valve, and HCV T-3-2.

(f) Freeze FP-7 to $< -30^{\circ}C$.

(g) Drain liquid from T-5 by opening HCV T-2-2, HCV 1112-2, HCV C-1-2, JC-1-1 and manual drain on adapter flange. Allow to drain for 15 minutes.

(h) Close valves mentioned in step (g).

(i) Thaw FP-7. When liquid level in T-2 has ceased dropping, refreeze FP-7.

(j) Open valves mentioned in step (g) and collect the liquid discharged from line 1112.

(k) Repeat procedure with volume in T-2 at 3 and 7 gallons. Use the data sheet provided in the Appendix Section 3.0.

2.4 Composite Test of the Fuel Charging System

After T-5 has been refabricated and tested the entire fuel charging system will be checked. Since light water will be used in the tests, volume corrections will be made by adding the additional quantity of water through T-11 (~ 80 mls). Recording the pressure and temperatures of T-1 during the heat up period will establish the validity of Sections 2.1, 2.2 and 2.3. Overheating the system by $10^{\circ}C$ will establish the gas vapor space in the clone underflow pot. By leaving FP-4 thawed, HCV T-1-4 may be used as a safety relief should the pressure in the system exceed 2800 psi.

It is also planned to establish the quantity of concentrated soup solution that does not reach the high pressure system during the charging operation. A simulated K_2SO_4 solution shall be analyzed and charged to the system in the normal manner. The diluted solution in lines 1124 and 1110 will be analyzed upon completion of the charging cycle.

(a) Fill T-2 through the adapter flange on line 1112 following the procedure as outlined in Section 2.2 (a) through and including step (h).

(b) Fill T-11 with the calculated amount of K_2SO_4 solution. Fill T-16 with calculated quantity of H_2O.

(c) Follow filling procedure as outlined in "Operating Procedure For HRT Chemical Plant," R. B. Lindauer, CF 56-3-22. This procedure is as follows:

I. Charging Fuel to the Hydroclone System

1. Fill T-11 with the calculated amount of concentrated fuel and T-16 with the calculated amount of D_2O. Mount in the fuel system rack with all valves closed.

2. Close valves HCV-141 and HCV-142 to and from the reactor. Check that freeze plug temperatures at these valves are $< -30^{\circ}C$.

3. Set cell C valves as follows:

HCV T-1-2	Open
HCV T-1-4	Open
HCV P-1-4	Open
HCV H-5-2	Closed
HCV P-1-2	Closed
HCV T-2-2	Closed
HCV T-11-2	Closed

4. Freeze plug temperatures should be:

FP-3	HCV T-1-2	Ambient temperature
FP-4	HCV T-1-4	Ambient temperature
FP-5	HCV H-5-2	$-30^{\circ}C$
FP-6	T-1 Drain	Ambient temperature
FP-7	T-2 to T-5	Ambient temperature
FP-8	HCV P-1-2	$-30^{\circ}C$
FP-9	F-1 to S-1	Ambient temperature
FP-10	HCV P-1-4	Ambient temperature
FP-11	P-1 drain	Ambient temperature
FP-12	T-1 to P-1	Ambient temperature

5. Check pressures in high and low pressure systems.

6. Charge fuel:

a) Open HCV T-11-2
b) Open 2 valves between T-11 and cell C
c) Open valve between T-11 and oxygen cylinder
d) Slowly apply oxygen pressure until bullseye indicates fuel has been added.
e) Close valve between T-11 and oxygen cylinder

7. Charge D_2O rinse:

a) Open 2 valves between T-16 and T-11
b) Open valve between T-16 and oxygen cylinder

c) Slowly apply oxygen pressure until bullseye indicates fuel has been added.
d) Close valve between T-16 and oxygen cylinder
e) Close 2 valves between T-16 and T-11
f) Close 2 valves between T-11 and cell C
g) Close HCV T-11-2

8. Charge remainder of D_2O from T-2:

a) Check that HCV T-2-2 is closed
b) Fill D_2O gauge tank T-5 from D_2O receiver T-2 by thawing FP-7
c) After T-2 level stops falling, freeze FP-7
d) When FP-7 temperature is $< -30^{\circ}C$, open HCV T-2-2.
e) Allow D_2O to drain for 15 minutes, then close HCV T-2-2.

II. Startup of the Hydroclone System

1. Set valves as follows:

HCV T-1-2	Closed
HCV T-1-4	Closed
HCV P-1-4	Closed
HCV H-5-2	Closed
HCV P-1-2	Closed
HCV 141	Closed
HCV 142	Closed

2. Freeze plug temperatures should be:

FP-3	HCV T-1-2	$-30^{\circ}C$
FP-4	HCV T-1-4	Ambient temperature
FP-5	HCV H-5-2	$-30^{\circ}C$
FP-6	T-1 drain	Ambient temperature
FP-7	T-2 to T-5	Ambient temperature
FP-8	HCV P-1-2	$-30^{\circ}C$
FP-9	F-1 to S-1	Ambient temperature
FP-10	HCV P-1-4	$-30^{\circ}C$
FP-11	P-1 drain	Ambient temperature
FP-12	T-1 to P-1	Ambient temperature

(d) Drain solution from fuel addition lines by opening HCV T-1-2, HCV 1112-2, HCV C-1-2, JC-1-1 and adapter drain valve at casrier flange. Vent system by opening HCV T-11-2 and manual valves at fuel rack.

(e) Close valves that were opened in step (d) and flush fuel addition lines by thawing FP-7 and opening HCV T-2-2, HCV T-1-2 (freeze plug FP-3 should be $< -30^{\circ}C$), HCV 1112-2, HCV C-1-2, JC-1-1 and manual drain valve on adapter flange. Combine wash solution collected in step (d).

(f) Charge 400 mls through T-16 and T-11 through line 1124 to line 1112 and collect with solutions saved from steps (d) and (e).

(g) Agitate solution, note volume and submit a 1 quart sample to laboratory for analysis.

(h) Set T-1 temperature controller on automatic, turn on manual heater H-11-2 and start P-12 blower. Raise set point on TRC-1 in 50°C increments pausing 15 minutes at each level. Continue raising temperature until 250°C is reached at which time raise temperature in 10°C increments to 300°C.

(i) After temperature and pressure has stabilized at 300°C for 15 minutes, cautiously raise temperature to 310°C in 1°C increments recording pressure with each 1° rise. In this manner, the gas vapor space remaining in T-1 may be estimated.

(j) Cool system to ambient temperature and drain solution to a tared or graduated container.

_____ liters

_____ temp

R. E. Brooksbank

REB:jsw

3.0 Appendix:

Data Sheets

3.1 Calibration of Tank T-5

Volume Added to T-2		Volume Dropped to T-5		△CC	Volume Collected Adapt. Flange	Solution Temp.
LR-T-2	CC	LR-T-2	CC		CC	°C

3.2 Composite Fuel System Test

Time (Min)	Temp. TRC-T-1	Pressure PR-1