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February 3, 1981

Letter No.: AD-1680
Contract: DE-AC05-76ET10143
Project: H-Coal Pilot Plant
Subject: Annual Report No. 3

Mr. John F. Pearson
U.S. Department of Energy
Oak Ridge Operations
P.O. Box E
Oak Ridge, TN 37830

Dear Mr. Pearson:

Enclosed is the H-Coal Pilot Plant Annual Report No. 3 which covers the period September 1, 1979 through September 30, 1980.

By copy of this letter, Annual Report No. 3 is being submitted to the Oak Ridge Technical Information Center for distribution within DOE.

Sincerely,

David L. Hess
Contracts Manager

DLH:rcs

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H-COAL PILOT PLANT

PHASE II
CONSTRUCTION

AND

PHASE III
OPERATION

ANNUAL REPORT
NO. 3

DATE PUBLISHED: February 4, 1981

ASHLAND
SYNTHETIC FUELS, INC.

POST OFFICE BOX 391
ASHLAND, KENTUCKY 41101

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THE UNITED STATES
DEPARTMENT OF ENERGY

CONTRACT NO. DE-AC05-76ET10143

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FOREWARD

The H-Coal Pilot Plant Project consists of three phases:

PHASE I - Design
PHASE II - Construction
PHASE III - Operations

Contract DE-AC05-76ET10143 was awarded on August 16, 1976 for Phase II and III work. Construction was effectively complete in December, 1979. Operations are currently scheduled to continue through December, 1981. Mr. John F. Pearson, Jr., Assistant Manager for Coal Projects, U.S. Department of Energy (DOE), Oak Ridge Operations, has primary Project management responsibility for the Government. The on-site DOE Project Manager is Mr. Richard R. Santore.

The work is being performed by Ashland Synthetic Fuels, Incorporated (ASFI), a wholly owned subsidiary of Ashland Oil, Incorporated (AOI), with offices at P.O. Box 391, Ashland, Kentucky, 41101. Mr. C. D. Hoertz is President of ASFI, Mr. J. C. Swan is the H-Coal Project Manager for ASFI.

Hydrocarbon Research, Incorporated (HRI), 1313 Dolley Madison Boulevard, McLean, Virginia, 22101, developer of the H-Coal Process, had primary responsibility for design of the Plant under Phase I. The Lummus Company (Lummus), 1515 Broad Street, Bloomfield, New Jersey, 07033, developed the processes and designed the Plant Antisolvent Deashing Unit and the Waste Oil Recovery Unit. HRI and Lummus are supporting Phase III Operations as Subcontractors to ASFI. Badger Plants, Incorporated, Cambridge, Massachusetts, 02142, was the primary construction contractor under Phase II.

The H-Coal Program is a joint Industry/Government project. The Participants are:

Ashland Synthetic Fuels, Inc.
Commonwealth of Kentucky
Conoco Coal Development Company
Electric Power Research Institute
Mobil Oil Company
Standard Oil Company (Indiana)
Ruhrkohle AG (West Germany)
U.S. Department of Energy

H-COAL PILOT PLANT ANNUAL REPORT NO. 3

September 1, 1979 through September 30, 1980

SUMMARY

At the request of DOE Oak Ridge, ASFI agreed to assume responsibility for completion of Plant construction in December, 1979, at which time Badger Plants' on-site work was ended. This construction effort consisted of electric heat tracing in Areas 500 and 600 and insulation of piping and instrumentation in Areas 200, 500 and 600. At the close of the reporting period the work was completed, or was projected to be completed, within the ASFI budgeted amounts and by dates that will not impact Plant operations.

Engineering design solutions were completed for problems encountered with such equipment as the High Pressure Letdown Valves; Slurry Block Valves; Slurry Pumps; the Bowl Mill System; the Dowtherm System; and the Ebullating Pump. A Corrosion Monitoring Program was established.

With the exception of Area 500, the Antisolvent Deashing Unit, all operating units were commissioned and operated during the reporting period. Coal was first introduced into the Plant on May 29, 1980, with coal operations continuing periodically through September 30, 1980. The longest continuous coal run, 119 hours, was achieved during the period July 1 through July 6, 1980. A total of 677 tons of Kentucky No. 11 Coal were processed during the reporting period. The problems encountered during the operating periods were mechanical, not process, in nature.

Various Environmental and Health programs were implemented to assure worker safety and protection and to obtain data from Plant operations for scientific analysis. These comprehensive programs will contribute greatly in determining the acceptability of long term H-Coal Plant operations.

PLANT CONSTRUCTION

M. L. Curnutte - Manager

At the request of DOE Oak Ridge, Modification A035 to Contract DE-AC05-76ET10143 was executed on January 29, 1980. Under this Modification, certain remaining construction activities, mainly subcontract efforts in Areas 500 and 600, were transferred to ASFI from Badger Plants, Inc. More specifically, ASFI assumed the responsibility of issuing subcontracts for insulation of instrumentation and piping and electric heat tracing of piping and equipment in Areas 500 and 600, and the administration of existing subcontracts assigned from Badger Plants for insulation in Areas 100, 200, and 400 and equipment insulation in Areas 500 and 600. The list of subcontract actions and the status is shown in Table 1.

Completion of the insulation subcontracts by Johns-Manville was delayed due to a strike by the local Insulators Union from June 1 to September 16, 1980. As shown, on Table I, the insulation work in Areas 500 and 600 was 26% complete as of September 30, 1980. The projected completion date for Subcontract HC-64 is January 31, 1981. To expedite completion during the strike, a small amount of work remaining in Area 200 under Johns-Manville's Subcontract S-1129 was assigned to Ross Brothers Construction Company under ASFI's Subcontract HC-40. As of September 30, 1980, Area 200 was 92% complete. The projected completion date is December 15, 1980.

TABLE 1

Subcontract Number	Subcontractor	Scope	Award Date	Completion Date	Status as of 9/30/80	Subcontract Derivation
S-1129	Johns-Manville	Insulation, Areas 100, 200 & 400	12/21/78	9/4/80	Complete	Transferred from Badger Plants, Inc.
S-1143	Johns-Manville	Equipment Insulation, Areas 500/600	10/1/79	6/9/80	Complete	Transferred from Badger Plants, Inc.
HC-63	Wente Construction	Electric Heat Tracing, Areas 500/600	1/25/80	6/6/80	Complete	Awarded by ASFI
HC-64	Johns-Manville	Piping & Instrument Insulation, Areas 500/600	2/20/80	1/31/81 (projected)	26%	Awarded by ASFI
HC-40	Ross Brothers Construction Co.	Insulation Area 200	9/4/80	12/15/80 (projected)	92%	Transferred from Johns- Manville (S-1129)

PLANT ENGINEERING

G. E. Tampa - Manager

CAPITAL REVISIONS

Engineering's efforts were directed toward completing design changes required before start of operations for nitrogen purging (February 1, 1980), hydrogen addition (February 26, 1980), fuel oil circulation (March 15, 1980), and coal addition (May 24, 1980). All of the pre-start-up design modifications in engineering as of January 1, 1980 were completed for Sections 100, 200, 400, and 600. Significant design modifications include:

- SO₂ Emission Abatement Modifications (including a propane pipeline from AOI's Catlettsburg Refinery to the Plant)
- Changes to Hydroclone Instrumentation
- Modifications to Seal Oil System
- Cooling Coil for Product Streams
- Revisions to J-219 Slurry Pumps for Better Control
- Repair of 2" XXS Piping
- Dust Control Scrubber on the Slurry Mix Drum
- Skin Thermocouples for Slurry Heaters
- Explosion Panel Covers for Dry Coal Bins
- Addition of Weigh Belts to Flakers
- Revisions to Catalyst Withdrawal System
- Revision to Dowtherm Heater Inlet Piping
- Addition of Bypass on M-220 for better Slurry Mix Drum Temperature Control
- Addition of Steam Disengaging Drums for Steam Generator Equipment Blowdown
- Revision to Reactor Effluent Product Tube per latest PDU information
- Elimination of Rupture Discs on High Pressure Coolers
- Revise, relocate, or add control or monitoring instrumentation

ENGINEERING AND TECHNICAL SERVICE

Significant design problems were identified during the year. Engineering programs were instituted to resolve these equipment problems which included the following:

A. High Pressure Letdown Valves - (LV-202A/B and LV-204A/B)

Problems with the Willis letdown valves included severe erosion of both stationary and rotating discs, failure of silver solder joints which hold the discs to the carrier rings, cracking of tungsten carbide diffusers, and failure of some downstream orifices. Failure of the silver solder joint was resolved by substituting a bolted clamp ring design to hold discs in place for both the front and back discs. Failure (cracking) of the downstream tungsten carbide diffusers, chokes, and orifices were resolved with the substitution of 17-4 PH cones weld overlayed with Stellite 6. Disc life of various materials evaluated at H-Coal include the following:

17-4 PH Stainless Steel (Annealed) 2½ hours
17-4 PH Stainless Steel (Heat Hardened) 12 hours
VC-19 Tungsten Carbide (6% binder) 2-3 days
TMT-5 Coating on VC-19 - 3-4 Days

To date, the TMT-5 coating by Turbine Metals Technology on VC-19 tungsten carbide has shown the best life. Plans are underway to evaluate Kennametal K-701, 702 and 703 tungsten carbides with or without TMT-5, TMT-5 on molybdenum, TMT-5 on TiB₂ on 431SS and silicon carbide on carbide for extending disc life.

While trim life of the Willis valves has been poor, inspection of the valve bodies has revealed no erosion at all, upstream of the discs. This success is attributed to designing these valves to hold velocities below 7 fps for all operations.

Despite some progress in improving trim, a letdown valve replacement program, using valves with more streamlined plugs and seats, has been instituted. Valve replacements include two from Kieley and Mueller, two from Masoneilan, and one from Cameron. New trim was designed to convert one of the Willis valves to a plug and seat type valve. A Paul valve which employs a caged ball to provide fluid throttling has also been ordered.

B. Slurry Block Valves

The Plant design specified over 400 Gulf and Western EPG ball valves for large slurry valves and hundreds of Rockwell plug valves for smaller slurry valves. Both types of valves have given good service, except for the 6 inch and 10 inch EPG block valves around the high pressure letdown valves. Problems with these block valves included stem and spool packing leaks, failure of the tungsten carbide (plasma spray), ball coatings and resultant leak through, and difficulty in disassembling valves because of solids accumulation in the seat spring cavities. Die-formed John Crane 1625 GF inner rings with Crane 187I top and bottom rings has solved the stem leakage problem. A change to die-formed Crane 187I rings for spool packing has also been successful. The problem with poor sealing of the valves initially was found to be due to flaking of the tungsten carbide coating on the balls. The balls are made from 316SS with a weld overlay of Haynes 25 (similar to Stellite). The interim solution was to remove the carbide and rebuild the balls with a Stellite surface. The Stellite to Stellite sealing has so far provided an order of magnitude of better life. Problems with plugging of the seat (coil) spring cavity was resolved with the addition of gasketed spring covers and injection of Loctite nickel anti-sieze grease in the spring cavities. Plans to test a new Union Carbide diffusion coating (LW-33 Tungsten Carbide, D-Gun applied) and TMT-5 coating on the G&W balls have been formulated.

It is also planned to use other valves in letdown block valve service. Mogas C-1 ball valves, Kamyr ball valves, and WKM Pow-R-Seal gate valves will be tested. A double block system to guarantee shut off and a high pressure oil flush for each letdown train to improve block valve life is being designed.

C. Lawrence Pumps

Preoperation activities included change out of pump O-Rings from Viton to Kalrez or Grafoil. All Lawrence pump clearances were checked and reset prior to operation.

D. Bowl Mill System

In January, 1980, the gear box and grinding system were returned to the manufacturer for replacement of bearings and gaskets. Field support was provided for the bowl mill system repairs and modifications. Significant contributions included trouble-shooting system interlocks in the early operation, redesign of the bowl mill motor mount to avoid future problems with the input shaft thrust bearing, and redesign of the water spray system for the inert gas heater. An extensive test to check out the bowl mill, heater, weigh feeders and all 100 Section equipment up to the slurry mix drum was completed in April and May. In this test, pulverized and dried coal was off-loaded into sealed trucks. Coal weigh feeders were also calibrated.

E. Reciprocating Equipment Vibration

Many of the reciprocating pumps and compressors showed excessive vibration before start-up. These problems were solved by the addition of discharge dampeners, additional pipe bracing, or ground stabilization with concrete grout. Equipment modified with success include the J-219 high pressure slurry feed pumps, R-202 hydrogen compressors, J-204 lean oil absorber pumps and J-231 high pressure flush pumps. Additional modifications to install larger flywheels on the R-201 compressors are planned to smooth the transition from 50% to 100% load.

F. Dowtherm System

Early operation of the Dowtherm system showed leaks in several vents and drains in the jacketed pipe. Connections to the process pipe had cracked due to differential thermal expansion. Vent and drain taps were redesigned and modified in June. Light catalytic cycle oil (LCC) is currently being used with success as heat transfer media.

G. Ebullating Pump

Initial problems with the J-201 Reactor Ebullating Pump included loose diffuser vanes and spalled diffuser coating. Engineering solutions have been developed to provide a sleeved bolting system with Belleville washers to keep the vanes tight. The spalled tungsten carbide coating will be replaced by Colmonoy 75, the same coating used with success on the impeller.

H. Separator Impingement Baffles

During September 1980, a failure of the ceramic impingement baffles in the Q-202 1200 psig flash and Q-203 50 psig flash drums was encountered. Baffle posts were washed downstream and plugged the letdown valves. The baffles were redesigned to include a monolithic layer of AA-22 refractory supported by hex mesh welded to the steel supports. Bottoms lines of the flash drums were also provided with a bar screen strainer to avoid future pluggage of the letdown valves.

I. J-219 High Pressure Slurry Pumps

Packing failure of the J-219 pumps occurred in July and both A and B pumps were overhauled. Engineering modifications included retiming the high pressure flush pumps to inject flush oil on the discharge stroke. The flush pump discharge piping was replaced to withstand higher pressure. Check valves and relief valves were also replaced. A water flush capability was added above the flushing section of each cylinder. Finally, seal rings were changed to Kalrez in the flush oil pumps as O-Rings made of ethylene propylene rubber had softened and failed. After these modifications were made, the pumps operated with a higher degree of success. Suction dampeners and screens have not caused problems with slurry plugging the suction system. This equipment will be left in place.

MATERIALS EVALUATION AND INSPECTION, QUALITY ASSURANCE

A. M-209 Failure

On September 20, 1980, a failure of the M-209 reactor separator effluent/steam exchanger terminated Plant operations. Inspection revealed three Incoloy 800 tubes had failed in the bottom outlet (cold) portion of this two pass thermosyphon reboiler. Metallurgical analysis by the Institute for Mining and Minerals Research (IMMR) and the Oak Ridge National Laboratory (ORNL) indicated failure was the result of chloride stress corrosion cracking from the water side. Chloride concentration in the crevice between the tube O.D. and tube sheet was evident since the tubes were rolled only $2\frac{1}{2}$ " into the $9\frac{1}{2}$ " thick tube sheet. Cracks in 40% of the other tubes were evident just outside each tube roll. Since tubes away from the tube sheet were serviceable, the tubes will be reused to make a shorter bundle.

B. Equipment Corrosion Test Program

Details of the corrosion test program were developed at the beginning of the reporting period. The Institute for Mining and Minerals Research, University of Kentucky, prepared and will evaluate the corrosion coupons. Thirty-one racks prepared by IMMR and 13 by ORNL were installed in Section 200. Racks for Section 500 were installed in February. Coupons will be removed and analyzed during the first turnaround to evaluate problem areas for the break in mode using Kentucky No. 11 Coal and to provide a base point before start of operations using Illinois No. 6 Coal.

C. Fractionator Corrosion

Following the coal run in early July, the N-202 fractionator was washed, opened, and inspected. No corrosion was found at this time. To detect any change in the future, additional corrosion coupons were installed in the tower.

D. UT Monitoring Program

An extensive data base was developed during construction and is being monitored during operation. Using ultrasonics (D-Meter) equipment, key piping and other components are being monitored to detect corrosion or erosion. All such readings to date indicate no problem areas.

E. QUALITY ASSURANCE

On September 22, 1980 a full time Quality Assurance Supervisor was hired to strengthen the quality assurance effort.

PLANT OPERATIONS

H. B. Chadwick - Plant Manager
H. H. Stotler - Technical Manager

Operation of the H-Coal Pilot Plant at Catlettsburg, Kentucky followed a planned program for breaking in the operating units.

All utility systems were commissioned and placed into service as required to carry out the operations of Section 100 (Coal Preparation) and Section 200 (Coal Liquefaction). These systems are:

- (a) Steam System
- (b) Cooling Water System
- (c) Sour Water Stripping System
- (d) Sour Gas Scrubbing System
- (e) Wastewater Treatment System
- (f) Tank Farm
- (g) Fuel Supply System
- (h) Dowtherm System
- (i) Nitrogen Supply System
- (j) Sewage Treatment System
- (k) Flare System

Section 100 (Coal Preparation) was commissioned and tested in preparation for supplying coal to the Coal Liquefaction System (Section 200). Initial testing was carried out by using quench water to simulate the heat load with coal in the Coal Pulverizing and Drying Bowl Mill. Section 100 was ready to supply coal to Section 200 as needed.

The operating plan carried out in Section 200 (Coal Liquefaction) was as follows:

During February 1980, the gas circulating loops were operated, pressure tested at full operating pressures, and debugged. These operations were conducted with nitrogen and then with hydrogen. Also during February, tests were performed with the Fractionation System using a mixture of petroleum derived gasoline, No. 2 fuel oil, and heavy gas oil as the feedstock to debug this system.

During March and April 1980, the system was operated with a No. 2 fuel oil and then a blend of No. 2 fuel oil and heavy gas oil to debug the liquid circulating loops in the system.

The reactor was loaded with catalyst during the latter part of March and the Catalyst Withdrawal System was tested. The Withdrawal System performed satisfactorily throughout the operating period.

In May 1980, oil operations were continued. The concentration of heavy gas oil in the feedstock was gradually increased to 100 percent. The feedstock was then shifted to a blend of 67 percent heavy gas oil and 33 percent No. 6 fuel oil. The concentration of No. 6 fuel oil was gradually increased to 100 percent in the feedstock. The system was operated for eight days in this manner. During these oil operations, the reactor temperature was increased to conform to desulfurizing conditions. Satisfactory desulfurization was achieved.

During the latter part of May, 8,000 barrels of anthracene oil were hydrotreated. The hydrotreated anthracene oil was used to slurry the coal feed during initial coal operations.

Coal was first introduced to Section 200 on May 29, 1980.

Four short runs were made with Kentucky No. 11 coal during the remainder of the reporting period. The longest run, a period of 119 hours, was achieved in July, 1980.

From a process standpoint, Section 200 has performed well at established operating conditions.

The system for providing a homogeneous mixture of feed slurry to the reactor operated quite satisfactorily. In this system, recycle oil is mixed with prepared coal in a slurry mix tank, pumped to reactor pressure, preheated, and fed to the reactor. Evidence of lumps of powdered coal in the feed slurry has not been found. Visual observations always indicated a homogeneous slurry.

The Ebullated Bed Reactor System operated quite satisfactorily, even during Plant upset conditions such as short term power outages and rapid system depressurization due to a heat exchanger tube failure. Maintaining proper ebullation during normal operations has been satisfactory, except for an operation in August which was attributed to pluggage in the ebullating recycle flow.

Initially there was concern that solids could build-up on the trays in the Atomospheric Stripper and Vacuum Towers. During normal operations, there has been no evidence of this occurring.

The problems encountered with coal operations to date are primarily associated with equipment failure, malfunction of instrument controllers, and the need to refine operating procedures to prevent the plugging of downstream equipment with solids during Plant upset conditions.

The major mechanical problem has been with the valves in the Slurry Letdown System. Downstream of the reactor, the slurry, consisting of oil, unconverted coal and ash, is released in pressure from 3000 psig to 1200 psig and then passes to a 1200 psig vapor-slurry separator. From this separator, the slurry is let down from 1200 psig to 70 psig. It was originally recognized that the wear on the internals of these letdown valves would be significant due to the high velocity through the valves caused by vapor flashing. Therefore, two parallel letdown systems were installed with EPG block valves so that one system could be taken out of service while operating with the other system. These block valves have not performed as expected. There were also problems with the Willis valve used in the slurry letdown system. These valves have a rotating and a stationary disc with holes. In operation, the rotating disc is turned and the flow through the valve is set by the matching of holes in the two discs. Several Modifications have been made to the Willis valves to extend valve life.

In September, 1980, three tubes in exchanger M-209 failed which caused a depressurization and Plant shutdown. This exchanger partially cools the 3000 psig hydrogen from the reactor effluent separator by generating steam. The tube failure was the result of chloride stress corrosion on the steam generating side. This system was modified to provide steam condensate rather than boiler feed water to the exchanger. The exchanger tubes were rerolled using a different procedure and reinstalled in the exchanger.

Table 2 gives a summary of the Plant operations during the reporting period.

SECTION 100 - Coal Receiving and Preparation

Section 100 was commissioned, and on December 19, 1979, the coal pulverizing and drying Bowl Mill was started. After a short time, the mill automatically shut down due to a failure of the ball bearings around the main bowl rotating shaft. The mill was disassembled and the bowl and gear housing were returned to the manufacturer for repairs. The Bowl Mill was reinstalled on February 21, 1980.

A series of test runs were then performed without coal to debug the operating system. In these tests, quench water was injected into the mill to simulate a heat load with coal. Principal modifications made as a result of those tests were:

1. Installation of a regulator for proper regulation of the atomizing air rate used for fuel oil atomization.
2. Improved burner flame stability by the installation of a ring of refractory brick inside the gas generator firebox to increase the combustion gas velocity at the burner tip.

Operation of the mill with coal began on April 14, 1980. Early in these operations corrections were made to the electrical interlock controls. It was also necessary to steam trace and insulate the scavenging screw conveyor in the baghouse system to prevent moisture condensation. Calibration of the weigh feeders which feed the prepared coal to the Slurry Mix Tank, Q-236, was made. The coal preparation system was then operated when needed to provide prepared coal to the Coal Liquefaction Section 200.

SECTION 200 - Coal Liquefaction

Commissioning activities in Section 200 were completed and nitrogen circulation was established on February 1, 1980. Commissioning activities included:

1. Resetting of pressure relief valves
2. Installation of corrosion test racks in equipment throughout the system
3. Installation of orifice plates
4. Calibration and checkout of instrument loops
5. Leak testing with plant air
6. Checkout of all pumps and compressors
7. Acidizing of the suction drums and piping for the hydrogen compressors

TABLE 2

H-COAL PILOT PLANT OPERATIONS

Type Operation:	From		To		Hours Onstream	Max. Rate	Total Processed	Remarks
	Hour	Date	Hour	Date				
Initial Oil Operations								
No. 2 Fuel Oil	1000	3/11	0600	4/17	884	70 gpm	--	Leaking block valve.
No. 2 Fuel Oil	0140	5/1	1600	5/1	14	40 gpm	--	Leaking block valve.
No. 2 Fuel Oil	1000	5/4	0730	5/5	21	40 gpm	--	Leaking relief valve.
No. 2 Fuel Oil	0100	5/6	1400	5/6	13	40 gpm	--	Started heavy gas oil operation.
Heavy Gas Oil	1400	5/6	1540	5/9	74	40 gpm	--	Started No. 6 Fuel Oil Operation.
No. 6 Fuel Oil	1540	5/9	0910	5/24	353	70 gpm	--	Started to hydrotreat anthracene oil.
Hydrotreat Anthracene	0910	5/24	1210	5/29	123	80 gpm	8000 bbls	Started coal feed.
Coal Operations								
Run 1								
Coal Feed	1210	5/29	0800	5/30	20	128 T/D	91 Tons	Slurry letdown valve failure.
Circulating Oil	0800	5/30	2114	5/30	13	--	--	Shutting down plant.
Run 2								
Starting up with oil	0135	5/31	1710	6/2	63	--	--	Slurry letdown valve failure.
Starting up with oil	1545	6/5	0630	6/6	15	--	--	Started feeding coal.
Coal Feed	0630	6/6	1530	6/6	9	200 T/D	51 Tons	Lost ebullation of catalyst bed.
Circulating Oil	1530	6/6	0500	6/16	229	--	--	Oil leak at ebullating pump.
Run 3								
Starting up with oil	1000	6/24	0155	7/1	160	--	--	Started feeding coal.
Coal Feed	0155	7/1	0050	7/6	119	180 T/D	518 Tons	Packing leaks on slurry feed pumps.
Circulating Oil	0050	7/6	0430	7/6	5	--	--	Shutting down to fix pumps.
Reprocessing slurry to recover start- up oil	1130	7/6	1800	7/14	198	--	--	Slurry block and letdown valve failure.
Run 4								
Starting up with oil	0110	8/16	0855	8/20	104	--	--	Started feeding coal.
Coal Feed	0855	8/20	1630	8/20	8	79 T/D	17 Tons	Lost recycle ebullating flow.
Circulating Oil	1630	8/20	1400	8/28	189	--	--	Pump failure - lost recycle flow.
Run 5								
Starting up with oil	1500	9/20	1505	9/20	0	--	--	Tube rupture of 3000 psig H ₂ exchanger.

From February 1 to February 26, 1980, nitrogen was circulated through the 3000 psig and 1200 psig systems. Both systems were satisfactorily leak tested up to a pressure of 1200 psig. The reactor was heated to 500°F and maintained at this temperature. Debugging of the circulating gas circuits was also carried out.

On February 26, 1980, hydrogen was introduced and the 3000 and 1200 psig systems were satisfactorily leak tested up to their normal operating pressures.

From February 20 through February 25, 1980, the fractionation system was tested using a mixture of petroleum derived gasoline, No. 2 fuel oil, and heavy gas oil as the feedstock. Test results show that satisfactory separation was achieved.

On March 11, 1980, No. 2 fuel oil was introduced into the system and circulation of this oil on total recycle was established. The oil circulating systems were then debugged.

On March 19, 1980, a blend of No. 2 fuel oil and heavy gas oil was circulated throughout the system while operating the reactor at 480°F and 2500 psig.

The reactor was loaded with catalyst during March 19 through March 21, 1980, with the system in operation.

During April 4 through April 7, a series of catalyst withdrawals were made to test the catalyst withdrawal system and to give the operators experience with the withdrawal procedures.

Operations with a blend of No. 2 fuel oil and heavy gas oil on total recycle continued until May 8 when operations with 100% heavy gas oil were achieved.

On May 9, 1980, No. 6 fuel oil was introduced, feeding a blend of 33 percent No. 6 fuel oil and 67 percent heavy gas oil. The concentration of No. 6 fuel oil was increased each day and by May 14, 1980, the system was operating with 100 percent No. 6 fuel oil. The system was operated with No. 6 fuel oil until May 21.

During these heavy gas oil and No. 6 fuel oil operations, the Plant was operated at conditions necessary to desulfurize the feedstock. Test results confirmed the expected desulfurization levels.

From May 21 until May 23, 1980, the system was operated with heavy gas oil to flush the system of No. 6 fuel oil.

From May 23 through May 29, 1980, 8,000 barrels of anthracene oil was hydro-treated and stored. The hydrotreated anthracene oil was then used as start-up oil for the initial coal operations.

Coal was first introduced into the system at 1210 hours on May 29, 1980. Coal feed was stopped at 0800 hours on May 30, 1980, when the slurry letdown valves, which release the pressure from 3000 psig to 1200 psig, failed. A block valve was then used to control the slurry flow while solids were flushed from the system.

The system was restarted and oil circulation was established at 0135 hours on May 31, 1980. On June 2, the same slurry letdown valves failed and oil circulation was stopped to repair the valves.

Oil circulation was reestablished on June 5. Coal feed was introduced at 0630 hours on June 6. At 1530 hours on June 6, the coal feed was halted because of a loss of catalyst bed ebullation. After flushing the system of solids by circulating oil, a leak developed at the ebullating pump and the Plant was shut down.

The system was restarted and oil circulation was established on June 24, 1980. Coal feed was introduced at 0155 hours on July 1, 1980, and operations with coal continued until 0050 hours on July 6 with only occasional interruptions of the coal feed. A total of 517 tons of dry coal was processed during the 119 hours of coal operations. Coal feed interruptions were caused by power outages, electrical storms, and a failure with the slurry heater controls. In each case, recovery to operating conditions was smooth with no disruption of the reactor system.

The coal feed was eventually terminated because of excessive leakage through the packing in the high pressure slurry charge pumps. Emergency repairs were made and operation of the system was maintained in order to process heavy slop oil for the recovery of start-up oil. The system was shut down on July 14, 1980 to repair the high pressure slurry charge pumps and the slurry letdown valves in the 3000 and 1200 psig systems.

The Plant was restarted and oil circulation was established on August 16, 1980. Coal feed was introduced at 0855 hours on August 20 and stopped at 1630 hours when it became evident that there was poor ebullation of the catalyst bed. Efforts were made to re-ebullate the bed by circulating oil but without success. On August 28, oil circulation was stopped and the system was shut down. Inspection showed that the poor ebullation was due to inadequate recycle ebullating flow because of solids blockage in the recycle ebullating flow system.

The system was restarted and oil circulation was reestablished on September 20 when high pressure hydrogen exchanger M-209 failed. Three tubes in the exchanger ruptured. It was determined that the tube failures were due to chloride stress corrosion on the steam generating side of the exchanger. At the end of the reporting period, the exchanger M-209 was being repaired.

SECTION 400 - Offsites

A. Steam System (Area 400.1)

The steam system was put into service in December, 1979. A steam supply line from AOI's Catlettsburg refinery was installed and placed in service in March, 1980, to provide backup steam supply when the onsite steam boiler is taken out of service and to supplement the steam supply from the onsite boiler. The steam system provided reliable service through the reporting period.

The Plant steam boiler was taken out of service on September 29, 1980, for the annual boiler inspection. The system was found to be in good condition.

B. Cooling Water System (Area 400.2)

The cooling water system was placed in service in December, 1979, and has provided reliable service throughout the reporting period.

In July, 1980, during a Plant shutdown, a number of cooling water exchangers were water jet cleaned on the cooling water side to remove an accumulation of iron scale. Significant pitting of carbon steel tubes was noted. An iron dispersant, Betz 492, was added to the cooling water and the blowdown rate was increased. The phosphate residual level was also increased. The system was operated in this manner until the iron levels were reduced to an acceptable level.

C. Sour Water Stripping System (Area 400.3)

The Sour Water Stripping System was placed in service in December, 1979.

The hydrogen sulfide and ammonia concentrations in the feedwater to this system increase significantly when coal is processed in the Plant because of the formation of these compounds from the coal. During the reporting period, the periods of operation with coal were of too short a duration to adequately test this system.

D. Sour Gas Scrubbing System (Area 400.4)

The Sour Gas Scrubbing System was placed in service, circulating DEA, in March, 1980, when desulfurization operations with heavy gas oil were started. The system operated satisfactorily during the remainder of the reporting period. Occasionally, the system would upset due to oil carryover with the feed gas thus contaminating the DEA solution. This problem is being rectified by the installation of additional knockout drums for the feed gases to the system.

E. Wastewater Treatment System (Area 400.5)

The Wastewater Treatment System was operated on total recycle until March, 1980. It was then placed in service with the overall Plant.

F. Tank Farm (Area 400.6)

The Tank Farm serviced the Plant as required through the reporting period.

G. Fuel Supply System (Area 400.7)

The Plant was originally designed to use refinery gas produced during operations, supplemented with low sulfur No. 2 fuel oil, as Plant fuel. Due to a change in environmental regulations, it was necessary to modify the system to substitute propane as the supplemental fuel. These modifications were made in January and February, 1980, and included revisions to the heater burners and the installation of a propane pipeline between AOI's Catlettsburg Refinery and the Plant.

H. Dowtherm System (Area 400.8)

The Dowtherm System was placed in service in May, 1980. During operations in May and June, a number of leaks developed between the Dowtherm pipe jackets and the process streams. The system has a number of short nipples used for vents and drains during hydrostatic testing. A number of these nipples broke loose during operation of the system due to thermal stress. The leaks were repaired and, in July, 1980, heavy cycle oil was used for hot oil rather than Dowtherm. In July, the hot oil was switched to the use of light cycle oil to permit operation at a higher temperature level.

I. Nitrogen Supply System (Area 400.9)

The low pressure Nitrogen Supply System was placed in service in December, 1979. The high pressure system was placed in service in February, 1980, and adequately serviced the Plant through the reporting period.

J. Sewage Treatment Plant (Area 400.10)

The Sewage Treatment Plant was placed in service in December, 1979. After the installation of a new sewage surge tank in January, 1980, the system operated normally for the remainder of the reporting period.

K. Flare System (Area 400.11)

The Flare System was placed in service in early February, 1980, and operated quite adequately even during Plant upsets.

SECTION 500 - Deashing System

During the latter part of the reporting period, the following commissioning activities of the system were carried out:

1. Water flushing of process lines
2. Checkout and instrument calibration
3. Commissioning of utility systems such as potable water, utility water, fire water, cooling water, plant and instrument air, and nitrogen.

SECTION 600 - Waste Oil Recovery System

After completing the commissioning of the Waste Oil Recovery System, it was placed in operation on July 11, 1980, processing light slop oil. The system was utilized during the remainder of the reporting period processing light, heavy and pitch slop oils. The system operated at or above design rates, processing 4950 barrels of light slop, 3300 barrels of heavy slop, and 1400 barrels of pitch slop.

ENVIRONMENTAL AND HEALTH PROGRAMS

J. H. Gray - Manager

A significant portion of the Plant operating objectives are related to environmental and health evaluations. During the reporting period the following accomplishments were achieved in these areas.

Wastewater Treatment Plant

Bacteria were fed to the Plant in order to "seed" it for initial operations. A methanol feed system was installed in order to avoid underfeeding of the biomass during periods when the Plant is not operating on coal. The bacteria were acclimated to the Plant wastewater and the Treatment Plant is in full operation.

Although the biological treatment of Plant wastewater performed satisfactorily, the rate of treatment was not sufficient to meet demand. The Treatment Plant has been redesigned to treat 350 GPM maximum instead of the original 100 GPM rate. The process design is in the detailed engineering phase.

Oily Water Collection Pond

The Oily Water Collection Pond was lined with a chlorinated polyethylene material which degraded when it came in contact with H-Coal oils. The pond was drained, isolated from the sewer system, lined with concrete, and returned to service in October, 1980. Two Calgon Activated Carbon Units were temporarily installed to operate in parallel with the Treatment Plant while the pond was repaired.

Stack Testing

In order to comply with the terms of the Air Permit issued by Kentucky in December, 1979, platforms were installed to provide access to certain air emission points within the Plant.

Solid Waste Storage and Landfill

The design of the H-Coal Solid Waste Storage and Landfill site was approved by Kentucky. Site preparation is essentially complete with several storage cells and the landfill area ready to accept vacuum tower bottoms and dewatered wastewater sludge.

Nuclear Instruments

The 38 nuclear level indicating instruments were placed in service, wipe tested, surveyed with a Geiger-counter, and certified safe to operate. A comprehensive Nuclear Safety Manual was distributed to all Plant employees for use and reference.

Medical Surveillance Program

The H-Coal Medical Surveillance Program was initiated with physical examinations of workers commencing in November, 1979. In addition to annual physical examinations, periodic skin examinations will be made.

Personal Hygiene Program

A Personal Hygiene Program was developed and implemented. Work clothing was obtained and issued to the workers. Instruction in health and hygiene procedures was given to appropriate personnel.

Other Environmental and Health Accomplishments

In conjunction with the Kentucky Department of Energy, an experimental biological monitoring program was implemented. The program uses urine samples from Test and Control groups, comprised of ASFI volunteers, to experiment with the AMES procedures in an attempt to scientifically test this screening method for determining biological results from exposure to synthetic fuel processes, such as H-Coal.

A hydrogen sulfide area monitoring system was installed.

A Hazardous Materials Handbook was issued to operations and maintenance personnel.

An Industrial Hygiene Air Sampling Program was implemented.

A Respirator Program was implemented. Respiratory protection devices were obtained, respirators for emergency use were located throughout the Plant, and workers were trained in the proper use of this respirator equipment.

ASFI assisted the Oak Ridge National Laboratory (ORNL) in making preliminary plans for implementation of a proposed ORNL Environmental and Health Research Program.

TABLE 3

H-COAL PILOT PLANT SUBCONTRACTING ACTIVITY

A. Subcontract Awards - September 1, 1979 - September 30, 1980

<u>ASFI Subcontract No.</u>	<u>Subcontractor</u>	<u>Description</u>	<u>Effective Date</u>	<u>Subcontract Amount</u>
HC-44	Roe Creek Development	Solid Waste Storage	8-13-80	\$2,629,393
HC-46	Mobilhealth Detection Office	Mobil Medical Facility	10-11-79	\$ 80,000
HC-49	Betz Laboratories	Boiler Feed Water Treatment	9-12-79	\$ 11,000
HC-50	Betz Laboratories	Cooling Water Treatment	9-12-79	\$ 20,000
HC-51	Hydrocarbon Research Inc.	Catalyst Testing	10-19-79	\$ 53,100
HC-53	F. W. Means	Clothing and Laundry	2-18-80	\$1,066,900
HC-54	Gray Serv	Grayloc Maintenance	4-14-80	\$ 275,000
HC-56	Allen Refractories	Refractories Repair	7-17-80	\$ 100,000
HC-58	American Cyanamid	Catalyst	7-31-79	\$ 689,700
HC-59	University of Kentucky Research Foundation	Materials Testing	7-16-79	\$ 94,245
HC-63	Wente Construction Co.	Electric Tracing Areas 500/600	1-25-80	\$ 162,073
HC-64	Johns-Manville Sales Corporation	Insulation Areas 500/600	2-25-80	\$ 751,172

B. Pending Procurement Actions as of September 30, 1980

<u>ASFI Subcontract No.</u>	<u>Subcontractor</u>	<u>Description</u>	<u>Estimated Award Date</u>	<u>Estimated Value</u>
HC-57	Ashland Oil, Inc.	Propane	Dec., 1980	\$7,000,000
HC-60	Ashland Oil, Inc.	Service Agreement	Dec., 1980	\$9,514,700
HC-61	Ashland Oil, Inc.	South Point Warehouse	Dec., 1980	\$ 62,000
HC-62	Consolidation Coal Co.	Illinois #6 Coal	Dec., 1980	\$3,063,300
HC-65	Wyodak	Wyodak Coal	June, 1981	\$1,325,000
HC-66	Davison Specialty Chemical Company	Amocat 1A Catalyst	Nov., 1980	\$ 210,000

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<u>Title</u>	<u>Author(s)</u>	<u>Date</u>
Reactor Heatup and Pressuring Operation No. T-1	Richard F. Bernard	April 25, 1980
Fractionator Testing No. T-2	M. J. Dabkowski, D. P. Malone, P. S. Sheth	April 29, 1980
Operating Results with No. 6 Fuel Oil No. T-3	R. F. Bernard, J. A. Morrison, M. J. Dabkowski, C. L. Chen	July 15, 1980
Anthracene Oil Operation No. T-4	R. F. Bernard	July 15, 1980
Coal Preparation Test No. T-5	D. C. McCoy, E. R. Smith	July 15, 1980

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