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CONSPRAY DYNAMIC SLEEVE PISTON COAL FEEDER

Final Technical Report: Phase II,
Verification Tests

January 26, 1984

Work Performed Under Contract No. AC21-80MC14603

For
Morgantown Energy Technology Center
Morgantown, West Virginia

By
Conspray Construction Systems, Inc.
Santa Ana, California

Technical Information Center
Office of Scientific and Technical Information
United States Department of Energy

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FINAL TECHNICAL REPORT:

PHASE II: VERIFICATION TESTS

CONSPRAY DYNAMIC SLEEVE PISTON COAL FEEDER

Performed for the

UNITED STATES DEPARTMENT OF ENERGY

MORGANTOWN ENERGY TECHNOLOGY CENTER

CONTRACT DE-AC21-80MC14603

by

CONSPRAY CONSTRUCTION SYSTEMS, INC.

Santa Ana, California

January 26, 1984

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January 26, 1984

This report details the performance of Phase II: Verification Tests of the Conspray dynamic sleeve piston coal feeder. The machine performed for 200 hours at 700 PSI backpressure, utilizing a 70%-200 mesh Utah bituminous coal as feedstock. All test work was satisfactorily completed.

A post-test inspection was performed. A report of component wear and failures incurred in testing is included as well as suggestions for machine upgrades.

Additional copies of this report as well as Phase I: Proof of Concept Tests may be obtained from the Department of Energy's Morgantown Energy Technology Center, Morgantown, WV; Technical Information Center, Oak Ridge, TN; or from Conspray. Specific questions regarding the feeder and test program may be directed to C. R. Thalken, Test Engineer, or Douglas D. Peterson, Program Manager.

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I. INTRODUCTION

Program Objectives

The primary objective of the Verification Test work was the operation of the feeder for 200 hours under conditions expected to be encountered in a pilot scale coal conversion process. This operation would yield data on wear rates, failure modes and indicate areas requiring improvement prior to gasifier installation.

Summary of Accomplishments

The dynamic sleeve piston feeder successfully completed 200 hours of operation at 700 psi utilizing a Utah bituminous coal of 70%-200 mesh grind. The test plan called for twenty hours per week of feeder testing time, thus requiring ten weeks to complete testing. This schedule was adhered to, with testing completed between early July and mid-September.

The dual train test loop allowed continuous feeder operation. The basic format called for four to five hours per day operation, with the remainder of the time utilized for inspection, maintenance, service of test loop components, and operation of the nitrogen supply system. With approximately 80% of testing accomplished, the lower Everlasting valve in the test loop failed. The post and ring assembly which connects the actuator to the valve sealing discs had broken with the sealing discs in the open position. The same failure had occurred on the upper Everlasting valve during Phase I testing. Due to time and budget constraints, it was decided to complete the remaining Phase II testing using only the Conspray side of the test loop.

Throughput was restricted for two reasons. In order to run continuously, coal could only be pumped into one receiver as quickly as it could be removed from the other receiver and recycled to the top of the loop. Secondly, short feeder strokes were utilized so as to maximize the number of cycles on the two critical feeder components, the discharge valve and the sleeve seal.

The sleeve seal, which had undergone continuous development during Phase I, held up for the entire 200 hours, showing only minimal wear at the completion of testing with 65,000 cycles on it. The valve continues to make a bubble tight seal with over 100,000 cycles on it.

Several areas demonstrated a need for upgrade and improvement. The present electronic control system has an unacceptable level of reliability. The method of actuation of the feeder discharge valve can be improved substantially. A general cleanup of the hydraulic system is in order prior to serious consideration of gasifier installation. Each of these areas is detailed in the body of this report.

The overall conclusion is that the dynamic sleeve piston feeder has proven its ability to operate safely and reliably. When problems have occurred, the machine has demonstrated inherent safety by shutting down without endangering process or personnel. With the recommended improvements incorporated into the feeder, the unit will be ready for installation on a pilot scale coal gasifier.

II. PHASE II: Verification Testing

The purpose of the Verification Test effort was to subject the coal feeder to operation under simulated coal gasification plant conditions. These conditions include a gasifier back pressure of 700 psi, a feedstock grind of 70%-200 mesh coal and operation for 200 hours with coal. By operating with this constant set of conditions and completing the testing in ten weeks, any inherent design weaknesses would be exposed. Testing in a non-critical situation was deemed necessary prior to installation of the feeder on an operating gasifier.

The detailed test plan is included as Appendix A. Briefly, the test format specified feeder operation at reduced throughput in order to maximize machine cycles and thus accelerate any wear that might occur in the specified time span. Throughput reduction may be achieved in two ways. First, feeder cyclic rate is variable from zero to nineteen cycles per minute. The second is volume control by varying the feeder piston stroke from zero to 18". For Phase II testing, the cycle rate was an average of 5 cycles per minute. The feeder stroke setting was varied from 2-1/2" to 6". An initial setting of 5" was utilized. This was gradually reduced to the minimum stroke at which the sleeve would reliably fill, 2-1/2". Late in the program it became necessary to increase the stroke as the recycled pulverized coal picked up moisture from the air and gave difficulty in feeding.

The test procedure involved pressurizing one side of the dual tank test loop to test pressure, 700 psi. The feeder would be started against back pressure, without coal. Once all monitoring systems and instrumentation had been checked for correct

operation and recording, coal feed to the feeder hopper would be started and the test run begun. Operation was continued until the coal storage supply was exhausted.

By using both sides of the dual train test loop (see Facility Diagram, Appendix D) continuous operation was possible. With fresh coal, the material could be removed from the full receiver while feeding into the other receiver. By cycling back and forth between the two sides of the loop, a longest continuous run of 8-1/2 hours was achieved. However, after a few days use, the coal would absorb moisture from the air and become more difficult to remove from the pressure vessels and more erratic to feed from the live bottom hoppers. With this set of conditions, transfer of coal from receiver to storage took longer than a test run, and thus required stopping the feeder. The reduced throughput provided for minimum run times of 1-1/2 hours.

The feeder was operated in this mode for 200 hours. No basic design weaknesses or significant failures were encountered. Continuous monitoring of hydraulic system pressure was recorded via strip chart recorder. Correlation of this data with the electric motor draw provides the horsepower required for feeder operation.

The feeder is powered by a 75 HP electric motor driving a pair of variable volume axial piston hydraulic pumps. These provide the oil flow for actuation of the hydraulic cylinders driving the dynamic sleeve, discharge valve gate and the coal pumping piston. The discharge valve case and loading ring pressure, and sleeve seal pressure, are supplied by a separate circuit so as to allow these functions to be operated independently from the main pumping circuit. This independent operation is necessary so that the discharge valve and sleeve seal can be pressurized

with the feeder turned off. In this way, the feeder may be isolated from the gasifier or pressurized receiver for service without affecting the process. A 3 HP motor drives a 3 GPM hydraulic pump to provide this pressure. An additional 3 HP and 2 GPM pump furnish oil flow for the lubrication of the main hydraulic pumps on start up as well as circulating oil through the heat exchanger and driving the hopper agitator motor.

The Phase II Test Data (Appendix B) list the parameters and recorded data from the individual test runs. As discussed earlier, the feeder was operated at a low throughput rate in order to maximize the number of cycles of operation accumulated during this phase. Both throughput control options were utilized. The pump-stroke was limited to between 2-1/2" and 6". Hydraulic pump output was set at the minimum flow required for reliable machine operation.

Various stroke settings were required due to variations in the flow characteristics of the coal. The stroke is the distance from the open end of the dynamic sleeve to the sleeve seal and is the effective distance over which the sleeve fills.

When fresh, the pulverized coal flowed well enough on dry days to feed a 2-1/2" stroke. The sleeve travels an additional 6" through the seal before the end of its stroke. After accumulating moisture from the air, and especially on damp days, the coal would require up to a 6" stroke for reliable filling. Depending upon the degree of rat-holing of the coal in the feeder hopper, longer stroke lengths were used at the end of a test to completely empty the hopper. As can be seen on the Test Data Summary sheets, various combinations were utilized during the the course of the test runs. Since the objective of Phase II was to accumulate as many machine cycles as possible in 200 hours of operation, the use of varying stroke lengths to accommodate changing feedstock characteristics was consistent with this goal.

With the feeder not cycling and the hydraulic pump output set by loading the motor to 50 amps, all oil output is going over relief (set at 2100 psi) and returning to tank. No work is being done. When the feeder is cycled, a trace of hydraulic system pressure requirements over time is generated. Figure 1 is a copy of a typical Phase II trace. For clarity and discussion, this has been drawn up as Figure 2, representing one machine cycle.

At the beginning of the cycle, the sleeve and piston are retracted and the discharge valve is closed. The following sequence occurs.

1. The sleeve extends through the hopper, charging itself with coal, and seats in the discharge valve. Hydraulic pressure requirement is 450 psi.
2. As soon as the sleeve is seated, a solenoid actuated pneumatic valve opens, releasing the pneumatic pressure that holds the safety latches clear of the sleeve carriage. These latches are spring loaded into position. 0.5 seconds are required for this step.
3. Also, at this step the sleeve seal and sleeve interior are pressurized. The seal is hydraulically actuated. To move the seal into solid contact with the outside of the sleeve, 2 in³ of oil is required. This is supplied by a solenoid actuated valve off an accumulator. The interior of the seal is pressurized with nitrogen gas to equalize pressure with the test loop receiver. The amount of this gas is dependent upon receiver pressure and the void fraction of the feedstock. The receiver pressure was 700 psi. The 70%-200 mesh Utah bituminous coal was estimated by Hazen Research labs to have a void fraction of 45%. This requires 4.65 scf of nitrogen to fill. 0.3 seconds are required.

Note: Steps 2 and 3 are not performed by the main hydraulic circuit. Therefore, during this time, all oil flow is going back to tank through the relief valve, set at 2100 psi.

4. The discharge valve to the coal receiver is now opened, requiring 475 psi.
5. This is the piston extend stroke, the only function effected by gasifier backpressure. For 700 psi backpressure, 1800 psi hydraulic pressure is required to discharge the coal.
6. 500 psi is required to close the discharge valve. This is due to the smaller hydraulic piston area or the rod side of the valve cylinder.
7. The sleeve is depressurized, releasing any residual gas remaining in the sleeve after the discharge valve is closed. The sleeve seal is depressurized, requiring the release of 2 in³ of hydraulic oil. The solenoid actuated pneumatic valve is activated and retracts the safety latches.
8. The sleeve is retracted and withdraws the piston with it as it travels back through the hopper. 450 psi hydraulic pressure is required for this operation.

FIGURE 1:
Strip Chart Trace:
Feeder Hydraulic Pressure
(for ten cycles)

FIGURE 2 : HYDRAULIC VS. TIME TRACE
FOR ONE FEEDER CYCLE

The method of adjusting hydraulic pump output was to gradually increase pump displacement until a specific load was imposed on the main pump drive electric motor. This increase was done with the feeder stopped and all pump output being returned to tank via the hydraulic relief valve.

By running the feeder with coal against a back pressure of 700 psi, it was determined that the maximum required hydraulic pressure was 1,800 psi. The main system relief valve was therefore set at 2,100 psi, or 15% above maximum required pressure. By imposing a load on the motor of 50 amps, enough hydraulic oil was delivered to the system to reliably cycle the machine. At lower load settings, and therefore lower hydraulic flows, insufficient oil was delivered for consistent operation.

Some tests required an initial setting of 52 amps to achieve stable machine cycling. No definite reason for this variation was determined. Possible explanations for this might be temperature differences and ammeter inaccuracy.

The main motor drives the two main pumps through a single input, dual output gearbox. With the pumps at zero displacement, motor draw is 40 amps. The motor manufacturer, Reliance Electric, says the motor will draw 30 amps to run itself at no load.

The following horsepower outputs at the specified amp draws were supplied by Reliance.

30 amps:	3 hp
40 amps:	10 hp
50 amps:	20 hp

Therefore, at the 50 amp setting used during testing, total feeder horsepower was 20 hp for the main drive plus the additional 6 hp consumed by the two 3 hp auxiliary pumps discussed on page 5.

Feeder mechanism:	10 hp
Gearbox & Pumps	7 hp
Main motor:	3 hp
Auxiliary pumps:	<u>6 hp</u>
Total feeder horsepower	26 hp

At this low output rate, variations in stroke setting have a negligible effect on machine cycle time. Sleeve retract, sleeve extend, and piston extend are the functions affected by stroke setting. Most of the total time required for these functions is consumed in control system and hydraulic valve response time and the initial movement of the component. Once actuated, these components move quickly and require very little additional time to travel full stroke over the time required to cover any reduced stroke. Therefore, at the hydraulic pump output provided by a motor loading of 50 amps, the cyclic rate of 5 cycles per minute is applicable regardless of stroke setting.

Since the dynamic sleeve piston feeder delivers material on a volumetric basis, the specific horsepower is a function of the weight per cubic foot of the feedstock, the feeder stroke setting and the number of cycles per minute of operation.

Specific horsepower is calculated by dividing actual throughput into total horsepower consumed by the feeder mechanism, auxiliary systems, motors, pumps, and gearbox.

Cyclic rate:	5 CPM
Bulk density:	41 lbs/ft ³
Power consumption:	26 hp
Back pressure:	700 psi

Stroke	Throughput	HP/TPH
18"	1.35 TPH	19.3
12"	1.05	24.8
6"	.68	38.2
2-1/2"	.48	54.2

These results are shown graphically in the following figure.

FIGURE 3: HORSE POWER REQUIRED PER
TON PER HOUR OF FEED RATE
VS. FEEDER STROKE LENGTH.

Also shown are comparison curves for 0 and 300 PSI back-pressure tests. These test were run with a 110 amp motor draw, giving full hydraulic pump output. This required the entire 75 hp of the main motor plus the 6 hp of the auxiliaries for a total of 81 hp consumed.

Stroke	0 PSI		300 PSI	
	Throughput	HP/TPH	Throughput	HP/TPH
18"	4.9 TPH	16.5	4.4 TPH	18.4
12"	4.3	18.8	3.1	22.1
6"	3.9	20.8	2.4	33.8

The decreasing horsepower requirement with longer stroke shows increasing efficiency with increasing stroke length. As may be expected, increased backpressure requires higher power requirements. It should be noted that at shorter strokes, increased backpressure has a more pronounced effect on horsepower requirement than at longer strokes.

The consistency of operation of the feeder over the 200 hour run time shows that the machine is inherently safe and reliable. The basic construction and operation is sound and trouble-free. With the incorporation of the recommended upgrades, the dynamic sleeve piston feeder will be ready for installation on a pilot scale gasifier.

IIa. Valve Actuation Force and Leakage Tests

As a part of the test program, two experimental valves were supplied by Conspray for use in the test loop. These valves would have application on the let down side of a coal gasifier utilizing the dynamic sleeve piston feeder. On an existing installation using lockhoppers for feeding, this valve could be installed as a replacement part.

These valves are identical to the feeder discharge valve in the method of sealing, consisting of a fixed valve plate, a moving gate containing the valve port, and a floating plate backed up by a loading ring that loads the entire stack. The case is filled with hydraulic oil and pressurized to 10% over conduit pressure to minimize the pressure differential over which the valve makes a seal. Figure 4 shows a cutaway of the valve.

These two valves differ from the feeder discharge valve in the method of actuation. The feeder discharge valve is actuated by an external hydraulic cylinder moving the gate by means of a pivot shaft. The test loop valves have the actuators built in to the moving gate. Thus, no moving parts pass through the pressurized valve case and the actuators are applying the force directly as opposed to the linkage of the feeder valve. Finally, valve gate position is sensed directly and thus a positive indication of gate position is provided. The feeder valve as well as many commercial valves sense position from the actuator. Thus, the potential exists for a failure of either actuator or linkage to result in an incorrect indication of valve position.

The purpose of the present effort was to measure the leakage rates and actuation force requirements of the feeder discharge valve and the two Conspray test loop valves. No attempt was

made to make similar measurements with the Everlasting valves since their performance has been well documented by METC.

The METC valve development program includes the following objectives (excerpted from report DOE/MC-143, "Prototype Lock-hopper Valve Testing and Development Project Test Plan," by John Gardner and Thomas Holtz, April, 1981.):

- . Operating life of 30,000 cycles without internal refurbishment.
- . Internal leakage at end of operating life less than 3.0 scfm per inch of nominal bore size
- . External leakage at end of operating life less than 0.1 scfm
- . Valve Actuation time less than 30 seconds with no shock
- . Valve operating force/torque - repeatable and within the rated limits of the supplied actuator

At the completion of Phase II, the feeder valve had cycled in excess of 100,000 times. The Conspray test loop valves each had less than 1,000 cycles. As detailed in the Wear Results Section, the feeder valve did show wear on the actuation shaft and the seals where the shaft passes through the valve case. The sealing surfaces showed some localized chipping of the tungsten carbide coating. The valve had performed substantially beyond the 30,000 cycle goal listed above without requiring internal refurbishment. The Conspray valves and the feeder valve all continued to make a bubble tight seal when pressurized to 900 psi with nitrogen.

Since the above criteria of leakage and actuating force were considered significant, it was decided to measure these after the completion of Phase II. Initial leakage measurements had been

5 "VALVE CASE PRESSURE RELIEF"
THE RELIEF VALVE ATTACHED TO
THIS PORT SHOULD BE SET SLIGHTLY
(5-10 PSI) BELOW CASE PRESSURE TO
PROVIDE OIL FLOW. THE PORT USED
FOR THIS RELIEF SHOULD BE THE
HIGHEST PORT AVAILABLE IN THE
CASE. ADDITIONAL PORTS ARE
PROVIDED ON THE BLIND FLANGES.
FOR THIS FUNCTION, THE ABOVE
PROVIDED FOR BLEEDING AIR
FROM THE VALVE CASE.

ITEM	PART NO.	QTY	DESCRIPTION	UNIT
1	12000	1	6" VALVE HOUSING	12000
2	12000	1	STATIONARY WEAR PLATE	12000
3	12000	1	ADJUSTABLE WEAR PLATE	12000
4	12000	1	6" VALVE GATE ASSEMBLY	12000
5	12000	1	LOADING RING SCREW	12000
6	12000	1	BLIND FLANGE	12000
7	12000	1	SEAL SLAVE	12000
8	12000	1	6" VALVE HOUSING	12000
9	12000	1	STATIONARY WEAR PLATE	12000
10	12000	1	ADJUSTABLE WEAR PLATE	12000
11	12000	1	6" VALVE GATE ASSEMBLY	12000
12	12000	1	LOADING RING SCREW	12000
13	12000	1	BLIND FLANGE	12000
14	12000	1	SEAL SLAVE	12000
15	12000	1	6" VALVE HOUSING	12000
16	12000	1	STATIONARY WEAR PLATE	12000
17	12000	1	ADJUSTABLE WEAR PLATE	12000
18	12000	1	6" VALVE GATE ASSEMBLY	12000
19	12000	1	LOADING RING SCREW	12000
20	12000	1	BLIND FLANGE	12000
21	12000	1	SEAL SLAVE	12000
22	12000	1	6" VALVE HOUSING	12000
23	12000	1	STATIONARY WEAR PLATE	12000
24	12000	1	ADJUSTABLE WEAR PLATE	12000
25	12000	1	6" VALVE GATE ASSEMBLY	12000
26	12000	1	LOADING RING SCREW	12000
27	12000	1	BLIND FLANGE	12000
28	12000	1	SEAL SLAVE	12000
29	12000	1	6" VALVE HOUSING	12000
30	12000	1	STATIONARY WEAR PLATE	12000
31	12000	1	ADJUSTABLE WEAR PLATE	12000
32	12000	1	6" VALVE GATE ASSEMBLY	12000
33	12000	1	LOADING RING SCREW	12000
34	12000	1	BLIND FLANGE	12000
35	12000	1	SEAL SLAVE	12000
36	12000	1	6" VALVE HOUSING	12000
37	12000	1	STATIONARY WEAR PLATE	12000
38	12000	1	ADJUSTABLE WEAR PLATE	12000
39	12000	1	6" VALVE GATE ASSEMBLY	12000
40	12000	1	LOADING RING SCREW	12000
41	12000	1	BLIND FLANGE	12000
42	12000	1	SEAL SLAVE	12000
43	12000	1	6" VALVE HOUSING	12000
44	12000	1	STATIONARY WEAR PLATE	12000
45	12000	1	ADJUSTABLE WEAR PLATE	12000
46	12000	1	6" VALVE GATE ASSEMBLY	12000
47	12000	1	LOADING RING SCREW	12000
48	12000	1	BLIND FLANGE	12000
49	12000	1	SEAL SLAVE	12000
50	12000	1	6" VALVE HOUSING	12000

1 "LOADING RING PRESSURE"
TO BE MAINTAINED AT
TWICE CASE PRESSURE
OR 1000 PSI HYDRAULIC
PRESSURE WHICHEVER
IS GREATER AT ALL
TIMES

2 "VALVE CLOSE PORTS"
HIGH PRESSURE (1000-1500 PSI)
OIL INTRODUCED INTO
THESE TWO (2) PORTS
IN CONJUNCTION WITH
THE PORTING OF THE
VALVE OPEN PORTS (NOTE
3) TO TANK WILL
RESULT IN THE VALVE
CLOSING. ACTUATING
TIME CONTROLLED BY OIL
AVAILABILITY

3 "VALVE OPEN PORTS"
SERVE THE INVERSE
FUNCTION OF NOTE 2

4 "VALVE CASE PRESSURE"
HYDRAULIC PRESSURE IS
TO BE MAINTAINED AT
A MINIMUM OF 50 PSI
ABOVE CONDUIT PRESSURE
AND A MAXIMUM OF
100 PSI ABOVE CONDUIT
PRESSURE. LOCATION
USED FOR THIS FUNCTION
SHOULD BE AT THE
LOWEST AVAILABLE CASE
PORT. ADDITIONAL PORTS
ARE PROVIDED ON
BLIND FLANGES (TIME 6)

DATE 12/1/83	LTR MATERIAL	REVISION DESCRIPTION	DATE	BY
QTY	WEAT TREAT	TITLE 6" VALVE ASSEMBLY WITH FUNCTION NOTES		
REVISION				
CONSPRAY CONSTRUCTION SYSTEMS INC.		DRIVE NO. 2874C	REV. 38	GAL.
Bakersfield, California 93311		(714) 540-1234		

taken when the valves were assembled. Pressurized to 900 psi with nitrogen, neither the feeder valve nor the two test loop valves showed any pressure decay over a 30 minute period.

Two test setups were required. Internal and external leakage were measured with the setup as shown in Figure 5 . Actuation force was measured by instrumenting the valves as illustrated in Figure 6 . Actuation times had been measured during operation in the test loop and were consistently 1.8 to 2.2 seconds for all three valves. The hydraulic shifting of the valves provides excellent control, and thus rapid valve actuation with no discernible shock.

Identification of the three valves under discussion is as follows:

Feeder valve: the discharge valve of the dynamic sleeve coal feeder. In the test loop diagram, this is located between the feeder hopper and the elbow

Valve A: the upper Conspray valve in the test loop

Valve B: the lower Conspray valve in the test loop

Valves A and B are identical.

For clarity, the following items will be discussed separately.

1. Valve internal leakage: the leakage from the valve inlet to outlet
2. Valve external leakage: leakage to the outside of valve from inside.
3. Actuating force: In the case of the hydraulically actuated Conspray valves, the maximum force required is the initial

VALVE LEAKAGE TEST SETUP

VALVE ACTUATION FORCE REQUIREMENT TEST SETUP

or breakaway pressure. Once the valve is shifting, hydraulic pressure rapidly drops to under 300 psi and remains at that level for the rest of the cycle, regardless of the other operating parameters.

Valve internal leakage

The sealing capability of any of the valves (either feeder or A and B) is dependent upon the hydraulically actuated loading ring forcing the valve plates together. The valve case pressure is also maintained hydraulically. The proper operation of the valve requires case pressure to be balanced with or slightly higher than conduit pressure, and never lower. This prevents the valved material from getting between the valve plates. By maintaining case pressure 50 psi higher than conduit pressure, the pressure differential will cause any flow to go into the conduit rather than into the valve case.

The test matrix called for four tests at each conduit pressure level of 0, 200, 400, 600 and 800 psi. Valve case pressure was always set 50 psi over conduit pressure. Loading ring pressures of 1000, 1300, 1600 and 1900 psi were tested at each pressure level. The purpose of this was to determine the minimum loading pressure required to maintain the valve plates in solid contact and thus prevent leakage.

The valves were removed from the test loop, a flange installed on both the upstream and downstream side and torqued down on a stainless steel and asbestos crush gasket. A 2-20 scfm (Air) Dwyer Rotometer was attached to the downstream flange and a N₂ pressure regulator/gauge/valve assembly as shown in Figure attached to the upstream flange. The test conductor actuated the valve under test to the closed position. The test conductor opened Valve 1, closed Valve 2 (shown in Figure 5), set loading ring pressure, case pressure, and conduit pressure to the

pressures called for in the test matrix. The pressure indicated by the upstream gauge was noted, a stop watch started and Valve 1 closed simultaneously. The test operator noted any upstream pressure decay and monitored the downstream rotometer for any signs of gas flow. These readings were recorded every one minute for a period of five minutes.

During all the tests no nitrogen flow was detected by the rotometer on the outlet side, and the maximum pressure loss on the inlet was 3 psi over a 5 minute time period. The pressure was measured by using a pressure transducer sending a signal to highly sensitive pressure recorder. Thus, readings accurate within ± 3 psi were available at pressures to 800 psi.

All three valves, feeder, A and B, show no internal leakage of nitrogen gas from inlet to outlet, and thus meet the internal leakage specification. The feeder valve has over 100,000 cycles on it and has far exceeded the 30,000 cycle goal of the METC Prototype Valve Development Project.

At certain combinations of internal case pressure and loading ring pressure, the valve case pressurization fluid can be lost into the conduit. At a 600 psi conduit pressure, the 650 psi case pressure is sufficient to separate the valve plates and cause a loss of pressurization fluid into the conduit. The feeder valve was tested first and this loss occurred at an 800 psi loading ring pressure. Increasing the loading ring pressure to 1200 psi stopped the flow. When valves A and B were tested, an initial loading ring setting of 1000 psi was used. This was insufficient to maintain the seal at the 600 psi conduit pressure. As with the feeder valve, 1200 psi was sufficient to regain the seal. Therefore, for conduit pressures to 800 psi, a loading ring pressure of 1200 psi should be considered the lowest setting required to maintain valve sealing.

Valve external leakage

Since the Conspray valve design consists of a sealed case filled with hydraulic fluid, any external leakage will be visible or will flow through the hydraulic pressurization hoses. The valve case pressure is maintained by a hydraulic pump and controlled by a relief valve. Therefore, any loss of fluid will be through the relief valve and back to tank. Replacement fluid for such a loss would be supplied by the pressurization source.

In order to measure any fluid loss, a hydraulic cylinder was piped into the case pressurization supply circuit. In Figure 5, this is labeled "Valve Case Oil Leakage Indicating Cylinder." With the case pressurized, Valve 3 is closed. Any oil from the hydraulic supply must now pass through Valve 4, moving the hydraulic cylinder as oil is transferred from the rod end of the cylinder through Valve 5 to the test valve case to maintain case pressure. Should any external leakage occur, the amount of cylinder rod extension would furnish a measurement of fluid loss.

The only tests where oil was lost were the previously mentioned tests involving low loading pressures. In these situations, the case pressure was high enough to overcome the loading ring pressure and force oil out of the valve into the conduit. No other set of test conditions caused loss of pressurization fluid either external to the valve or internally through the hydraulic system.

The same leakage tests were performed on the feeder valve. This valve is actuated by an external actuator operating the valve gate by means of a shaft passing from the pressurized valve case to the outside. This shaft has seals where it passes through the valve case. During the course of testing, the actuating forces on this shaft had caused damage to the seal retaining areas of the valve case. The Parker Poly Pak

style of seal was used in this application due to its self energizing action and its superiority to an O-ring in making a rotary seal. The damage to the seal retaining area allowed the seal to fit loosely and thus to leak at low case pressures (under 200 psi). Thus, no leakage tests were run at pressures under 200 psi with the valve in this damaged condition. At 250 psi, sufficient pressure was available to energize the lip of the Poly Pak and thus make an oil tight external seal. Therefore, the feeder valve tests were all run with a case pressure of at least 250 psi. It should be noted that during Phase I, no leakage had occurred during the atmospheric pressure portion of the test program. The resulting loss of sealing capability over the 100,000 cycles achieved by the valve does indicate the need for an upgraded seal in this area.

Valve Actuating Force

The Conspray valve design requires the greatest force to begin actuation. Once the moving gate has been started, the hydraulic pressure required to maintain movement drops to 200 to 300 psi for any of the three valves tested. Therefore, the breakaway (movement initiating) force requirement was the variable to be measured.

The loading ring of the Conspray valve design plays a key role in making the seal. The loading forces the three valve sealing elements (fixed plate, floating plate and moving gate) into tight contact, preventing the loss of case pressurization fluid into the conduit. As loading ring pressure is increased, a higher loading is applied to the valve plates and a higher breakaway pressure is required to actuate the valve. Conversely, as case pressure is increased while holding a constant loading ring pressure, a decrease occurs in pressure required for breakaway. The valve is adjusted for various

conduit pressure levels by setting case pressure 50 psi over conduit pressure, and selecting a loading ring pressure sufficient to make a reliable seal at the required conduit pressure. A conservative setting is a loading pressure twice that of the conduit pressure. For the actuation force tests, settings lower than this were also tested.

The test procedure was to test each valve at several conduit pressure levels and loading pressure levels and to record the breakaway pressure required for each conduit/loading ring pressure combination. The test set-up is shown in Figure 6 . The conduit, valve case and loading ring were pressurized to test pressure. A pressure control valve supplying oil to the valve actuators was gradually increased until valve actuation occurred. The required pressure for breakaway was recorded. Pressure transducers in the hydraulic lines to each side of the valve actuator sent a signal to a strip chart recorder recording the pressure.

The actuation force test results are shown graphically in Figure 7 . As expected, the force requirement decreased with increasing conduit pressure and constant loading ring pressure. This is because case pressure counteracts the loading ring. As case pressure is increased, it is decreasing the loading on the valve plates and thus reduces the force required for actuation. Continuing to increase case pressure with a constant loading ring pressure ultimately will unload the valve plate stack and result in loss of case pressurization fluid into the conduit. This was discussed earlier under "Valve Internal Leakage."

The force to actuate the valve is calculated by multiplying the area of the hydraulic valve actuator by the hydraulic pressure. The two Conspray valves A and B are actuated by a pair of 3-1/4" bore cylinders with 1-3/4" diameter cylinder rods. The feeder valve is actuated by a single 5" bore

cylinder with a 1-1/2" rod. The A and B valves have the actuators mounted directly to the valve gate and all of the force is applied to the gate. The feeder valve has the actuator mounted external to the valve, and operates the gate through a pivot shaft and lever.

As may be seen graphically in Figure 7 , the force required to actuate the feeder valve is substantially greater than that of the A and B valves. This shows that the pivot shaft and linkage arrangement is absorbing a considerable amount of the actuating power, and that the direct actuators are more efficient.

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VALVE ACTUATING FORCE TEST RESULTS

FIGURE 7

I Ib. 700 psi Maximum Throughput Repeat Tests

Following the completion of the 200 hours of Phase II testing at reduced throughput, it was decided to retest the feeder at full stroke and maximum hydraulic pump displacement. The purpose of this test series would be to determine if feeder performance had deteriorated during the 200 hour test series.

Five hours of operation were performed at a 700 psi backpressure. Pulverized Texas lignite and Utah bituminous coal were tested, approximately 2-1/2 hours running time each. The feeder was set at the full 18" stroke and the 110 amp motor draw (full hydraulic pump output) as used in Phase I.

A summary of the results are presented in Figure 8. As indicated, points L₁, L₂, and B₁-B₂ show the area where throughputs would be expected to fall at pressure levels between 600 and 900 psi. These are approximations because the actual weight of material pumped will be a function of bulk density, which varies with moisture content. Points L₃ and B₃ are the average results of the post Phase II repeat tests. Point L₃ is average maximum throughput for Texas lignite and point B₃ for Utah bituminous coal.

The test results, 5554 lbs/hr for lignite and 6107 lbs/hr for bituminous coal, fall within the expected ranges. Therefore, no decrease in feeder throughput performance has occurred.

FIGURE 8

700 PSI MAXIMUM THROUGHPUT TEST RESULTS

IIc. 0 and 300 psi Rerun Tests

During the Phase I: Proof of Concept tests, it was noted that the throughput rate increased when the feeder was set up for the 600 psi tests following the 300 psi tests. The cause of this increase was due to much more rapid reaction of the sleeve seal at higher hydraulic pressures. The seal reached pressurization more quickly at 600 psi than at 300 psi.

The original feeder specification called for a sleeve seal hydraulic pressure level 50 psi above reactor pressure. A pressure transducer in the seal circuit signals the machine controller when this predetermined pressure level is achieved. The pressure setting of this seal is controlled by a hydraulic pressure reducing valve. For the 300 psi tests, this valve was set to limit seal pressure to 350 psi. During 600 psi tests, the seal was pressurized to 650 psi.

Increasing the pressure level setting of the seal reduced the time to pressurize. In the seal pressurization circuit, the controlling component is the pressure reducing valve. Discussions with the valve supplier revealed that higher oil flow rates at higher pressures are to be expected.

The net result of this more rapid seal response was an increase in throughput rates at 600 psi over those achieved at 300 psi. As may be expected, this increase was most noticeable at the shorter stroke settings where the machine operates at a higher cyclic rate. For all feedstocks tested, the average throughput increase was 10% at a 6" stroke, 7.5% at a 12" stroke, and a 1% decrease at the full 18" stroke.

During set up for the 300 psi tests, it had been noted that the sleeve seal depressurized more quickly than it had during the zero psi baseline tests. The control system

requires the sleeve seal to exhaust prior to the retraction of the sleeve. In order to determine that the seal has exhausted, it is necessary to pressurize it so that a pressure drop occurs upon opening the exhaust valve. This pressure drop generates the signal that tells the controller that the seal has exhausted.

Time and budget constraints prevented a complete rerun of the zero and 300 psi tests. However, the 70%-200 mesh lignite feedstock was run through the entire test matrix of zero, 300, 600 and 900 psi tests at 6", 12" and 18" strokes. The 600 and 900 psi tests produced the expected results. However, the zero and 300 psi throughputs were greater than the average throughputs of the other feedstocks by the amounts shown below.

	0 psi	300 psi
6" stroke	32%	15%
12" stroke	16%	15%
18" stroke	18%	5%

Following the completion of Phase II, it was decided to rerun the zero and 300 psi tests to establish the throughput rates with seal pressurization controls set for optimal operation. The seal pressurization pressure level was set at 650 psi for the 300 psi runs. A 200 psi setting provided the absolute minimum total time to both pressurize and depressurize, so that was the level selected for the zero psi baseline runs.

The results are shown in Figure 9. As expected, machine performance has now been improved. These hydraulic functions are independent of backpressure provided they are higher. Therefore, the feeder may be adjusted for optimal performance at any backpressure from zero up to design limit.

IIId. Vertical and Horizontal Pumping Tests

The final series of tests run with the dynamic sleeve piston feeder were conducted at atmospheric pressure to test the machine's ability to convey coal vertically and horizontally. Vertical feeding would have application to fluid bed processes calling for bottom feeding of coal. Horizontal pumping over a distance would have application to a process requiring injection of the feedstock into the side of the producer. For fluid bed processes, the advantage of the dynamic sleeve piston feeder over conventional pneumatic transport systems would be minimization or elimination of transport gas requirement, thus lowering both capital and operating cost of the fluid bed feed system.

In a fixed bed producer, the dynamic sleeve piston feeder would eliminate the need for lockhoppers, rotary metering devices, and reduce the compressed gas requirement.

Vertical Conduit Tests

Two conduit configurations were tested. The first was a straight vertical conduit of 8" diameter, while the second was a gradually increasing taper from 8" to 11". Vertical lift was 10'. An elbow was attached to the feeder discharge. To minimize packing in the elbow, it was a 6" to 8" adapter.

Granular Feedstock

Initial tests were conducted utilizing a 1/4" x 0 feedstock typical of that used in fluid bed combustors. The test goal was the elimination of transport gas. Therefore, the first tests were conducted using no fluidizing gas. With the straight conduit installed, the material pumped around the elbow and vertically approximately one foot. With the taper

conduit installed, the vertical pumping distance increases to 16". Clearly, some form of fluidizing was required in order to reach a significant lift.

A single 1/4" pipe port was installed at the bottom of the elbow to provide for fluidization. Gaseous nitrogen was metered through a Rotometer flow meter. An additional nitrogen line, directly off the source, was piped into the bottom of elbow. This line was controlled with a ball valve and was used to break loose any packs or plugs.

The test sequence involved starting up with a nitrogen flow of over 20 SCFM. The feeder was operated at an 8" stroke and 10.5 cycles per minute (55 amp motor draw). As stable operation was achieved, the flow of nitrogen was gradually reduced until packing or plugging occurred. Attempts to dislodge the plug with the feeder proved useless. The second nitrogen line proved effective in dislodging the plug.

Successful tests resulted in a true nitrogen flow rate of 9.4 - 9.6 SCFM with the straight conduit, and 11.75 - 12.5 SCFM with the tapered conduit. Coal throughput was a nominal 2,500 lbs./hr. These parameters were maintained for one hour of steady state operation with no changes occurring or any additional gas requirement.

After correcting the nitrogen flow rate for the backpressure on the Rotometer, actual gas consumption rates averaged 56.91 pounds of nitrogen per hour for the tapered conduit, and 44.58 pounds per hour for the straight conduit. This yielded average ratios of feedstock to gas of 44.06 pounds of coal per pound of gas for the taper and 55.48 pounds of coal per pound of nitrogen for the straight conduit.

Attempts to further reduce the nitrogen flow resulted in plugging of the conduit. Runs as long as 40 minutes were achieved at reduced flows, but inevitably the conduit would pack and require a high volume blast of nitrogen for clearance. The hydraulic pressure required for steady state operation was 250 - 275 psi. A packing situation in the vertical conduit, either tapered or straight, could be seen to develop by a rapid increase in hydraulic pumping pressure. This pressure would come up to the relief valve setting at which point the feeder would stall. Increasing the relief valve setting had no effect on dislodging the plug. Only a rapid, high volume blast of nitrogen would clear the conduit and allow a resumption of pumping.

Pulverized Feedstock

In order to determine the effect of particle size on nitrogen flow requirements, tests were conducted using a Utah bituminous coal, ground to 70%-200 mesh, and having a bulk density of 37 lbs per ft³.

The same test procedure was used for the pulverized coal as that described above for the granular material. When stable operation was achieved, hydraulic pumping pressure was 250 - 275 psi. The nitrogen flow was gradually reduced until hydraulic pressure began to climb, signalling impending packing of the conduit. Nitrogen delivery was increased slightly to regain the steady state operation and the gas flow requirements determined.

The nitrogen gas requirement was under 8 SCFM for the straight pipe and about 9.5 SCFM for the tapered unit. Throughput of coal in pounds per hour was substantially less than with the previously tested granular coal, due to the lower bulk density (37 lbs/ft³ vs. 53.5 lbs/ft³). The lower fluidizing

gas requirement would be expected due to the lower bulk density. Similarly, the number of pounds of coal pumped versus the number of pounds of nitrogen consumed showed a corresponding decrease.

After correcting the nitrogen flow rate for the backpressure on the Rotometer, actual gas consumption rates with pulverized coal average 36.66 pounds of nitrogen per hour for the straight conduit, and 39.78 pounds per hour for the taper. This yielded average ratios of coal conveyed to nitrogen consumed of 47.33 pounds of coal per pound of nitrogen for the straight conduit, and 39.78 pounds of coal per pound of nitrogen for the taper.

All runs were for a minimum of one hour in a steady state condition with a piston extend pressure of 250 to 275 psi. Throughput rate average 1743 lbs/hr.

The variation in gas consumption between the tapered and straight conduits is in line with expectations based on the previous effort. The ratio of gas consumption rates between the two conduits was 1.20 with the pulverized feedstock as against 1.26 with the granular coal.

Pulsed Flow Tests

The nitrogen supply system was modified to allow a rapid increase of gas flow during the time when the feeder discharge valve was open. This valve is open approximately 30% of the operating cycle time. By providing a high rate of flow during the time the valve is open, and reducing the flow during other portions of the feeder cycle, it was considered possible to reduce overall nitrogen consumption.

The actual test set up provided for a constant, fixed flow of fluidizing gas. This flow was then increased by opening

a solenoid actuated valve when the feeder discharge valve was open, thereby approximately doubling the flow during that time. Initially, a continuous flow of two-thirds the previous continuous flow, with the pulsed flow of the same amount, were attempted. This series of tests was run with the straight conduit in place.

The average continuous flow with granular coal was 5.65 SCFM (versus 9.47 SCFM previously). During the time the feeder discharge valve was open, this rate was increased to a total flow of 12.03 SCFM. The discharge valve is open 28% of the machine cycle. This yields total overall average flow of 7.44 SCFM. This is significantly less than the average of 9.47 SCFM for the continuous flow tests. The increase in throughput was from a previous average of 55.48 pounds of coal per pound of nitrogen to 71.28.

Switching the feedstock to 70%-200 mesh pulverized coal confirmed these results. The average continuous flow rate was reduced to 4.88 SCFM from 8 SCFM. During the discharge valve open portion of the feeder cycle, the flow was increased to 10.75 SCFM, yielding an overall average gas consumption of 6.60 SCFM. This improved the coal to gas ratio to 80.78 pounds of coal per pound of nitrogen from 36.66 for the continuous flow.

Due to program time constraints, no tests were run with the tapered conduit and pulsed flow.

Conclusions

The purpose of the taper was to test the possibility of pumping with little or no fluidizing gas. Theoretically, a conduit of gradually increasing taper should be capable of transporting a material provided the angle of taper is greater than the angle of repose of the material. Since

this angle if fairly flat (20° - 30°) for coal, it was not practical to consider a taper of that magnitude. However, the use of some taper may have been helpful in minimizing the tendency of the material to pack and, therefore, lower the fluidizing gas requirement.

With a steady flow of gas, the fluidizing gas was maintaining the column of coal in the conduit in a fluid state, but not actually conveying the material. The feeder was transporting the material up the conduit with the piston stroke. When gas flow was reduced below the requirement for stable continuous operation, the fluid column would settle gradually over time and finally pack.

The gas consumption differential between the straight and taper conduits is a function of volume. The tapered conduit has a volume of $4 \frac{1}{2} \text{ ft}^3$ (4.431 ft^3 actual) versus 3 ft^3 (2.967 ft^3 actual) for the straight conduit. The fluidizing gas flow requirement is nominally $9 \frac{1}{2}$ SCFM for the straight conduit in this test configuration and 12 SCFM for the taper. Therefore, more gas is required to maintain the tapered conduit in a fluid condition. The ratio of gas consumption is 1.26 compared to the ratio of volumes of 1.5. Therefore, it appears that the taper does contribute to coal flow and prevention of bridging.

Pulsed nitrogen flow was used for a number of trials with both granular and pulverized coal. However, only one test lasted more than an hour, and it began exhibiting instability and increased piston extend pressure prior to one hours operation. All tests with the pulsed flow ended in a packing of the vertical conduit. Therefore, the reduced nitrogen flow rates, despite running forty to fifty minutes, cannot be considered to be steady state operation. Due to program

time constraints, no additional test series were attempted at higher flow rates. However, the length of running time before plugging occurred would indicate that only a moderate flow increase would be required to achieve steady state operation.

The increase in throughput achieved with pulsed nitrogen flow on pulverized coal is not in line with the other results. The increase, from 36.66 pounds of coal per pound of nitrogen to over 80, indicates that the gas flow is contributing to transfer of the coal. Apparently, a combination of pneumatic transport from the fluidizing gas and mechanical transport from the feeder is taking place.

The pulsed flow concept appears to have potential for further reduction of fluidizing gas requirements over continuous flow. However, more experimentation would have to be carried out to achieve the required steady state operation and to optimize the nitrogen feed system and flow control.

Horizontal Conduit Pumping Tests

Tests were conducted with the straight pipe attached directly to the feeder discharge valve, giving a horizontal pumping direction. The purpose of this effort was to determine the limits of pumping coal without fluidizing gas. Such an installation may be required should the feeder be installed on a pilot scale gasifier.

All three types of coal were tested, 1-1/2" chunk, 1/4" granular and 200 mesh pulverized. The feeder was operated at an 18" piston stroke. Initially, piston discharge pressures of 250 - 275 psi were sufficient to convey material. However, shortly before the hydraulic pressure would reach relief valve setting (2150 psi), the pressure requirement

would climb to 500 - 550 psi, indicating an impending plug. As may be expected, the chunk coal traveled the furthest, about five feet prior to jamming, and the pulverized coal was conveyed approximately three feet. The initial pressure increase, from 250 psi to 500 psi, occurs at a distance approximately $\frac{3}{4}$ that required to stall the feeder. Therefore, these distances should be considered as safe maximums to convey coal horizontally.

1-1/2" chunk coal:	59"
1/4" granular coal:	43"
200 mesh pulverized coal:	38"

These tests were only conducted one run with each type of coal and so cannot be considered definitive results. Differences in moisture content, particle size distribution and type of coal may affect pumping distance.

III. BASELINE MEASUREMENTS: WEAR PARTS

P. N.	Description	Measurements		Remarks
		Initial	Final	
2612C	Sleeve	OD: 4.998 ID: 4.500	4.998 4.500	Localized chipping of chrome plate on tip; .030 chamfer on tip where chrome plate missing; approx. .010 eccentricity at tip
2652B	Piston Cup	Ø: 4 5/8"	4 5/8"	This is a flexible urethane U-cup fitting the ID of the sleeve with 1/8" diametrical interference. Sealing is effected by a clean, sharp edge on the O.D. This sealing edge is energized by the presence of pressure, i.e., higher back pressures yield greater loading of the lip
2620C	Sleeve Seal	ID 5.100	5.100	Difficult to accurately measure ID of neoprene sealing surface. Wear patterns evident on previous seals during development not present on inspection of this part.
2622D	Fixed Valve Plate	Thickness: .75	.75	Chipping of tungsten carbide coating around edge of valve port; approx. .010 erosion of coating evident where sleeve pressurization gas contacts plate.
2623D	Valve Gate	Thickness: .75	.75	Chipping of tungsten carbide coating around edge of valve port; 3/8" x 3/8" indentation approx. .060 deep on hopper side of gate; sleeve pressurization path worn approx. 3/8" long x .090 deep, with discharge end of path work beyond original point at 45° angle x 3/8"; severe wear on gate actuating splines.

P. N.	Description	Measurements		Remarks
		Initial	Final	
2625D	Floating Valve Plate	Thickness: 1.00	1.00	Chipping of tungsten carbide
2624C	Pivot Shaft	OD: 3.937	-	Severe wear to splines, evidence of eccentric loads; some deformation of splines evident; damage to sealing surfaces indicating contact with valve housing
2628D	Actuator Lever	ID: 3.937	-	Localized damage to splines indicating side loads

See Assembly Drawing No. P342-2600R for identification of parts.

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IV. FAILURE ANALYSIS AND WEAR RESULTS

The feeder performed reliably as evidenced by the accumulation of the required 200 hours of operation in ten weeks. All components of the pump mechanism and valve held up well. The two critical components, the sleeve seal and the discharge valve wear plates, required no service due to wear or failure. Some minor deburring of the feeder valve gate was required after the piston partially unscrewed and contacted the gate. A new sleeve seal was installed at the beginning of Phase II and lasted the entire 200 hours. No detectable wear was evident upon post test inspection.

Most of the failures involved purchased components. Selection of more appropriate replacements has eliminated recurrence of most failures. The feeder control system should be replaced in its entirety to eliminate this source of trouble. The present control system has proven to be marginally adequate for testing purposes. The signal demodulator unit suffered several failures, which are discussed later in this section. In addition, the programmable machine controller has proven to have insufficient capacity to handle the required inputs and outputs for plant installation. The feeder as it is presently configured must be operated manually by the operator. An upgraded industrial quality controller would allow for remote operation. No actual failure of the programmable controller occurred. However, it does occasionally fail to start, stop in mid step, or skip a step, especially in damp weather.

COMPONENT FAILURES DURING PHASE II

<u>DATE</u>	<u>RUN NUMBER (a)</u>	<u>REFERENCE NUMBER (b)</u>	<u>NATURE OF FAILURE</u>
7/01/82	-	6	SLEEVE EXHAUST HOSE ERODED
7/02/82	-	1	HIGH SLEEVE XDUCER HOSE PLUGGED
7/06/82	10	7	ADJUSTMENT OF PROXIMITY SWITCH REQUIRED
7/08/82	-	1	DEMULATOR CARD BAD (DYNECO)
7/09/82	-	3	PISTON HEAD CAME LOOSE
7/14/82	24	1	LOW SLEEVE CALIBRATION DRIFTED (DYNECO)
7/20/82	35	1	HIGH SLEEVE XDUCER HOSE PLUGGED (DYNECO)
7/21/82	39	8	FRACTURED 1/2" FITTING ACC. #1
7/22/82	42	9	BLOWN HOSE ON PRIMARY PISTON CYLINDER
8/03/82	-	1	DEMULATOR CARD BAD (DYNECO)
8/09/82	49	7	ADJUSTMENT OF PROXIMITY SWITCH REQUIRED
8/11/82	-	1	SET POINT CARD BAD (DYNECO)
8/12/82	-	1	DEMULATOR CARD BAD (DYNECO)
8/12/82	56	2	SLEEVE SEAL HOUSING LOOSE BOLTS
8/16/82	58	1	LOW SLEEVE XDUCER HOSE PLUGGED (DYNECO)
8/17/82	60	10	VALVE HOUSING GASKET LEAKING A.T.F.
8/24/82	67	4	SLEEVE EXHAUST BALL VALVE LEAKING
8/26/82	-	5	PISTON CUP OVER HEATED
9/07/82	-	1	REACTOR TRANSDUCER BAD (DYNECO)
9/08/82	79	11	BLOWN FUSE DUE TO PINCHED WIRE

(a) REFER TO TEST RUN SUMMARIES FOR TESTING CONDITIONS.

(b) REFER TO DETAILED FAILURE ANALYSIS IN FOLLOWING PAGES.

TABLE 1

DETAILED FAILURE ANALYSIS

1. Pressure Transducer System: The pressure transducer system presently installed in the feeder has proven itself to be inadequate in terms of reliability. This system translates pressure signals from the sleeve pressurize/exhaust manifold and the sleeve seal pressurize/exhaust manifold into usable signals sent to the feeder programmable controller. In addition, this system provides the strip chart recorder and the Apple II computer with reactor pressure and feeder hydraulic pressure information.

During Phase I of the test program, several modular cards in this system failed and were sent to the manufacturer for repair. This trend continued throughout Phase II. As spare cards were kept on hand, very little testing time was lost due to this problem, although several test runs were aborted due to failures in this system. Due to system redundancy, these failures caused no safety or equipment damage problems. It is recommended that this system be replaced with a more reliable system better suited to industrial applications and limited to machine control functions rather than including the monitoring devices required by the rest of the test loop.

2. Sleeve Seal Housing: During run #56, sleeve seal pressure was lost suddenly. The machine automatically shut down without any loss of reactor pressure. An investigation into the source of the problem was initiated. Since a blown sleeve seal was the most likely cause, indicated by these symptoms, this was checked first. The seal was found to be intact; however, the washers under the hold down screws securing the sleeve seal housing were found to be cracked, and some washer segments had fallen out. This meant the housing was no longer tight against the counterbored seat.

This caused the sealing O ring to extrude allowing a loss of seal pressurization oil into the feeder hopper. This failure was corrected by the installation of heavy duty washers used in high speed manufacturing processes where shock loads are continuous and frequent. The cause of this failure was the continuous pressurization and depressurization of the seal stressing these washers. Now that sleeve seals are lasting a substantial amount of time, these washers are experiencing more prolonged service than previously. Close monitoring detected no noticeable tendency towards a reoccurrence of this failure.

3. Piston and Cup: During morning checkout on July 9, some piston cup cooling fluid was discovered in the feeder hopper. This would indicate that the piston cup was worn or damaged. However, upon inspection, it was found that the piston head itself had begun to unscrew from its threaded seat. Further inspection revealed that the piston head had unscrewed far enough to make contact with the feeder valve moving gate. The valve was disassembled for inspection. Some minor damage to the hopper side of the valve swinging gate was noted. The finish was restored by hand stoning and the valve was reassembled. The piston assembly was removed for inspection. The piston cup had been severely damaged, but the rest of the piston assembly was found to be undamaged. The piston cup was replaced, and the piston assembly installed using a high strength Loc-Tite thread locking compound and primer rather than the medium strength, no primer combination previously used. Inspection of the piston position was added to the morning checkout procedures. No tendency towards a repetition of this occurrence has been noted.

4. Sleeve Exhaust Ball Valve Wear: As the system accumulated more hours of operation, it was noted that the ball valve controlling the sleeve exhaust function was wearing rapidly.

This was caused by the sleeve pressurize ball valve being closed simultaneously with the opening of the exhaust valve. During the valve overlap period, the extra flow (over the residual gas remaining in the sleeve after discharge valve closure) of gas was causing this rapid wear. With this valve leaking, the time to pressurize the sleeve gradually increased, thereby slowing down the feeder cyclic rate. Without replacement, the valve would eventually have leaked at a high enough rate to prevent the sleeve from being pressurized.

Only one signal is generated by the control system for control of sleeve pressure. Therefore, to correct the problem it was necessary to install a time delay relay circuit for sleeve pressure control. Once the signal for sleeve pressure is dropped, approximately one-half second is required for the pressurize valve to close. The exhaust valve is then opened. This addition provided acceptable life for the ball valve for testing.

For continuous, long term operation a valve more resistant to erosion by coal fines would be preferable. Even with the time delay relay circuit installed, sleeve exhaust ball valve life was limited to approximately 50 hours. At that time, the stainless balls, teflon trim, and carbon steel bodies were all worn.

5. Cup Problems: Late in August, it was again noted that an unusual amount of piston cup cooling fluid was present in the feeder hopper. An inspection of the piston cup revealed heavy wear and some tearing on the heel of the cup. A thorough analysis of the problem was initiated. A modular bearing is used on the piston to support and guide the assembly. Since the cup was damaged beyond any capability to seal, and as no leakage was apparent during the previous afternoon 700 psi testing, this modular bearing was apparently providing a gas tight seal. This means that little cup coolant was passing the modular bearing to cool the cup during short stroke testing. Also, an analysis of the piston assembly showed the cup to be squeezed in its installed position approximately .070". This squeeze should be .015-.020". Therefore, the cup had an extremely high lip loading in addition to severe limitations to cooling provided. Upon investigation, it was found that the cup design had been changed by the manufacturer, and that this was the source of the excess squeeze. These problems have been solved by reducing the cup squeeze by fabricating a new cup retainer to reduce the lip loading to the original design point, and by modifying the modular bearing to provide for improved flow of coolant to the cup.

6. Exhaust Hose Eroded: During Run Number 2, it was noted that the sleeve pressurization function was taking an abnormally long time. The run was shut down to investigate this phenomenon after 66 minutes of run time. It was discovered that a hose used to conduct sleeve pressurization gas to the feeder valve assembly was leaking while the sleeve was being pressurized. Upon its removal from the system, it became apparent that the hose had been eroded from the inside. The hose was replaced with a length of high pressure 1/2" I.D. pipe. No further problems have been experienced in this circuit.

7. Loose Proximity Switch: During Run Number 10, the proximity switch indicating that the primary piston is fully extended failed to do so. Upon investigation, it was noted that the bolts holding the proximity switch bracket were not tightened sufficiently to prevent the bracket from moving due to machine vibration. These bolts were retightened and checked periodically during the remainder of Phase II testing. No tendency for these bolts to come loose again has been noted.

During Run Number 49, an occurrence of the same nature as the above was noted concerning the feeder valve opened proximity switch. Again the bolts displayed no tendency to allow a repetition of this event after being retightened.

8. Fractured 1/4" Fitting: During Run Number 39, a hydraulic fluid leak of approximately one quart per minute was noted from beneath the feeder. The completion of the test was expedited by increasing the stroke length to 12". Upon the accomplishment of a normal test shut down, a fractured nut on a 1/4" hose fitting was found to be the source of the leak. Apparently, the fitting had been over tightened during installation. A new fitting was installed, and testing resumed.

9. Blown Hydraulic Hose: Run Number 42 was aborted 167 minutes into the test due to a blown hydraulic hose on the blind (extend) end of the cylinder for the primary piston. It was found that the hose had been chafing against a sharp corner of the feeder frame, and this corner had abraded the cover and wire braids of the hose causing it to fail. The hose was replaced, and testing resumed.

10. Feeder Valve Housing Leak: During Run Number 60, the feeder valve housing began leaking at the gasket line. Upon investigation, the splined shaft hold back bolt was found to be loose; and that the shaft was pressing out on the valve case cover. The additional force thus applied to the valve cover caused the valve gasket to leak. The gasket was replaced, the valve reassembled, and testing continued.

The feeder valve actuation method as discussed in the recommendations section of this report deals in detail with the solution to the problem pointed out by this incident.

11. Blown Fuse: Run Number 79 was aborted 25 minutes into the test after the feeder valve failed to open. Investigation revealed that the sleeve seal pressurize valve was not getting a signal to activate. Further investigation found a blown fuse on the output of the machine controller. The cause of this blown fuse was found to be a pinched wire in the feeder caused by the frequent removal and replacement of the Dynesco pressure transducer system for repairs. The wire was repaired, rerouted, the effected fuse replaced, and testing resumed.

WEAR INSPECTION RESULTS

Feeder Valve Assembly

(A) Fixed Plate. After accumulating 70,369 cycles, the fixed plate displayed slight chipping of the carbide coating on the shearing edge of the discharge hole. This chipping should be eliminated by the addition of the shearing inserts discussed in the Recommendations Section of this report. The cause of this chipping has been determined to be the introduction of foreign material between the fixed plate and the hopper side of the swinging gate during testing on 9-9-82 when the piston contacted the swinging gates and separated the plates. The only other point of wear found on the fixed plate, was an area where the sleeve pressurization gas contacts the fixed plate surface. The erosive wear resulting at this point is minimal and is not deemed to be a major problem as the gas path is not in an area of the plate where valve sealing occurs. However, as is also noted in the Recommendations Section, it is planned to devise an alternate path for this gas to facilitate pressurizing and exhausting the sleeve more rapidly and also reducing the complexity of machine work required to fabricate the fixed plate and moving gate. This action would also tend to eliminate the possibility of contamination by the sleeve pressurization gas by reducing the number of seals internal to the valve.

(B) Floating Plate. After accumulating 72,167 cycles, the floating plate was inspected and showed no measurable signs of deterioration or damage other than some slight chipping of the carbide coating around the discharge hole caused by the shearing of hard foreign material contaminating the feedstock. This chipping is confined to within 1/16"

radially from the shearing edge of the discharge hole of this plate. As explained in the Recommendations section of this report, a shearing insert should be incorporated in this plate to prevent the occurrence of this damage.

(C) Swinging Gate. The Hopper Side of the swinging gate exhibits some damage to the shearing edge of the discharge hole suffered on 9/9/82 when the piston head loosened, and this shearing edge was required to shave the head of the cup retainer bolt. The damage to this side of the gate is confined to a 3/8" by 3/8" indentation on the shearing edge 1/16" deep. This damage in no way affects the sealing capability of the valve. This side of the gate has accumulated 102,186 cycles during the course of testing. The Discharge Side of the swinging gate exhibits no measurable wear and damage to the shearing edge of the discharge hole is limited to very slight chipping of the carbide coating. Limited to within 1/32" radially from the edge of the discharge hole. This side of the swinging gate has accumulated 108,330 cycles during testing.

(D) Feeder Valve Actuation Assembly. This assembly consists of a splined shaft, riding on two bearings rotated by an arm extending radially from the shaft outside the valve housing. This splined shaft also moves a swinging gate inside the valve housing. This actuation assembly has exhibited excess wear at several points. The bearings which support the splined shaft are badly worn in localized spots, indicating that the side loads induced upon the shaft greatly exceed the design side load capabilities of these bearings. In addition, the splined shaft itself exhibits deformation in the area where the shifting arm attaches to the shaft, indicating a potential failure point in the shifting mechanism.

The support bearing in the housing cover (shifting arm end) of the splined shaft, has been contacting the housing itself, and has worn 1/16" of material from the housing itself. This wear is caused by the shaft being forced against the housing cover by case pressure.

The hopper end of the splined shaft due to the movement caused by the side load has caused the shaft tail piece to damage the tail piece sealing bore. Although the seals in this bore have not as yet failed, their failure is expected in a very short time. The failure of these seals would not in itself be catastrophic, but would increase the load on the valve housing cover, and would probably cause the failure of the valve housing gasket.

(E) Valve Housing Face and Frame. The sealing surface area provided on the valve housing cover has proven to be inadequate. Several times during Phase I and II testing, the housing gasket failed due both to movement of the housing cover induced by the shifting mechanism and by the lack of sufficient gasket squeeze area on the housing cover.

(F) Piston Rod. Striations up to 1/64" deep were noted on the lower half of the piston rod early on in the Phase I testing. These striations are caused by the tube contacting the interior of the sleeve carriage both during the sleeve and primary extend steps of the machine cycle, this contact is due to the lack of adequate provisions for piston tube support at the rear of the sleeve carriage. This wear although not approaching the point where it would cause a machine failure, is allowing an increasing loss of cup cooling fluid past the seal in the sleeve carriage around the tube. Over an extended period of machine operation, this wear could possibly penetrate the tube allowing a total loss of cup cooling fluid.

(G) Sleeve Seal Housing. The sleeve seal housing shows some signs of deformation (indentation) in the housing material in the area of the housing clamping bolt washers. This deformation has been determined to be the result of the cyclic loading of this part by the pressurizing and exhausting of this housing during each machine cycle. This deformation was not noted prior to the failure of the washers under the clamping bolts on 8/12/82, and appears not to have worsened since that time.

(H) Sleeve Seal. After nearly 70,000 cycles accumulated on this seal, no measurable wear can be detected.

(I) Sleeve Exhaust and Pressurize Ball Valves. Wear rates on the sleeve pressurize and exhaust ball valves have been reduced to negligible proportions since the installation of a time delay relay circuit which assures the complete closure of one valve prior to allowing the other valve to open. This could be corrected by reprogramming the process controller if another output was available. Unfortunately, this controller cannot be expanded due to parts being unavailable for this unit.

(J) Sleeve and Sleeve Carriage. The end of the sleeve which penetrates the hopper and sleeve seal was inspected and found to have incurred minimal abrasive wear. This end of the sleeve was damaged in November of 1981 when the sleeve contacted the moving gate. At that time, the chrome plated surface of the sleeve end was stripped off by the action of the gate. Since that time, the abrasive action of the coal in the feeder hopper has rounded the square edge of the end of the sleeve to an even 1/32" smooth radius. The wear in this area is deemed to be acceptable, due to the large amount of material which would have to be removed to affect machine operation.

The sleeve carriage support guide rods were inspected and no wear could be found.

Leakage of the cup cooling fluid from the sleeve carriage seals has been determined to be due to the motion of the fluid in the tank causing the seals to cock slightly off center. These seals were originally pressed in place, but should be retained in place with retaining "C" clips in the future.

(K) Hydraulic System. The large (2") directional spool valves which control the main feeder functions (i.e., sleeve, piston, discharge valve) extend and retract functions, were checked for internal leakage and found to have internal leakage rates of from six to eight times that in the specifications. This leakage apparently was the cause of several persistent control function problems experienced during the initial shakedown of the feeder, resulting in the addition of several electrical circuits to accomplish actions more simply controlled directly by hydraulic pilot lines.

A visual inspection of the hydraulic hosing of the feeder disclosed the need for the replacement of several large diameter hydraulic hoses due to external wear of the hoses caused by contact with other hoses, and portions of the feeder frame.

V. TECHNICAL EVALUATION AND UPGRADES

During the course of testing, several areas of the feeder demonstrated a need for upgrading to assure more acceptable limits of reliability and performance prior to gasifier installation. The general areas requiring upgrades are: feeder discharge valve, control system, sleeve carriage assembly, hydraulic system, and the piston assembly.

FEEDER DISCHARGE VALVE. As noted in the Inspection Section, the feeder valve actuation assembly is experiencing very high rates of wear at several points in the mechanism. The loads induced on the various parts of this assembly are clearly excessive as demonstrated by: valve housing gasket failure, splined shaft deformation, seal bore damage, and excessive localized bearing wear patterns.

To alleviate this problem, it is recommended that a new valve actuation mechanism be designed.

The original concrete pump valve from which this valve design was patterned, utilized a hydraulic cylinder directly attached to the moving gate. This method of valve actuation was considered excessively bulky for use with the pressurized case valve. However, since the pivot shaft actuator has not proven satisfactory, the direct actuation design should be incorporated into the feeder valve design.

Additional valve upgrades should include:

- (1) Inserts on the shearing edges of all valve plates to prevent indentation of the base material of the plates if the valve is required to shear any hard foreign materials contaminating the feedstock.

- (2) Rerouting the sleeve pressurize/exhaust gas path behind the fixed plate to eliminate the requirement for additional machining work on the fixed plate, prevent erosion of the fixed plate surface and eliminate the need for several gas path seals inside the valve housing.
- (3) Generally heavier construction of the valve casing to prevent flexing of the housing cover.
- (4) Increasing the gasket sealing area of the valve housing to assure more positive seating of the gasket material.

CONTROL SYSTEM. The programmable controller currently installed in the feeder has several drawbacks to be seriously considered in any program involving feeder upgrades. The most potentially serious drawback to the existing controller is that replacement parts for this unit are no longer available due to the manufacturer going out of business. This, should a failure occur in the controller, would cause the feeder to be out of service for several weeks while a replacement unit is being specified, procured, installed, programmed, and checked out. Other drawbacks include excessively long time delays built into the controller which require the feeder to wait while the controller checks all inputs and outputs. This time delay also effectively prohibits this unit from being reprogrammed with more sophisticated subcheck routines that would allow the controller to check the various feeder functions and monitor several ancillary feeder subsystems concurrently.

A state of the art industrial controller could, with the selection of appropriate modules, eliminate the requirement for separate electronics section for the pressure transducer

system. This would eliminate a section of the present feeder control system which has been a source of many problems during all phases of testing.

Mechanical Improvements

The mechanical elements of the feeder have held up quite well in testing. However, several areas can be improved for ease of service and general improvement of coal handling.

A new larger feeder hopper should be designed. The areas requiring improvement are access to the sleeve seal. A larger, wider hopper would improve access as well as provide more coal storage at the machine. If the discharge valve is upgraded, hopper modifications can be carried out with only moderate additional effort.

A further improvement may be made by designing the hopper for mass flow of the feedstock utilized by the targeted process. The present design is a compromise to accommodate all sizes, and can be improved upon substantially.

The pumping piston should be redesigned to improve accessibility to the piston cup. Presently, the cup must be removed through the coal hopper. A better approach would be to allow the piston assembly to be removed from the back of the sleeve carriage assembly.

Modification of the sleeve carriage assembly is also required to provide additional bearing support for the piston rod. This rod has evidence of wear from contact with the carriage assembly after approximately 500 hours operation. With proper support, it will operate many thousands of hours with no measureable wear.

The sleeve carriage also carries the reservoir for the cooling oil for the piston cup. This is currently an atmospheric system. Upgrading the tank to withstand system pressure would provide additional blow back protection in the event of piston cup failure.

Hydraulic Improvements

The hydraulic system for the feeder was originally adapted from a concrete pump circuit. Therefore, several improvements in performance are possible now that the requirements of coal feed service are evident. Some components have proven to be marginal and should be replaced.

As reported in the Phase I Final Report, the main hydraulic pumps have apparently suffered damage during the power failure under load tests. They continue to function; however, they are becoming increasingly noisy and are giving further evidence of impending failure by gradually losing pressure as they heat up. It is not possible to determine the time to failure. Should a pump fail, it will discharge metal into the hydraulic system, no doubt causing further damage to other components.

An additional shortcoming of the present pumps is the inability to control the displacement to as fine a degree as desirable. Pump displacement determines feeder cycle rate. A Vernier-type throttle control is required to activate the displacement control on these limits. This is a cable device, and prone to sticking and stretching, thereby affecting the repeatability of throughputs. It requires manual operation and is not readily adaptable to remote control.

Several of the larger diameter hydraulic hoses in the system as well as many of the smaller ones should be replaced with

hard piping. This action would effectively prevent hose failures due to chaffing or other mechanical damage.

The sleeve seal housing should be redesigned to allow the alignment of the seal to the sleeve. Also, the shearing edge of the seal housing should be hard faced to assure long wear life. In addition, the depth of the seal housing should be minimized to increase the fill ratio of the sleeve.

The dynamic sleeve should be redesigned to allow the tip to be replaced. Although the wear experienced to date has been slight, in the long term this part must be expected to wear out.

VI. APPENDICES

A. PHASE II TEST PLAN

Targeted Process:	Texaco Gasification
Test Pressure:	700 psi
Coal Type:	Western Bituminous
Grind:	70% - 200 mesh nominal
Additives:	None
Moisture:	As received
Operational Goal:	200 hours by September 17, 1982

The objective of Phase II is a demonstration of the Conspray dynamic sleeve piston coal feeder's continued ability to safely and reliably feed pulverized coal into a pressurized environment. This demonstration will be considered successful if the feeder completes this test phase with no major failures attributable to defective design.

Changes and modifications to the facility and feeder include installation of the second reactor and feeder adjustments for verification testing. To install the second reactor, the two experimental Conspray 6" valves, the pressure vessel, and related hydraulic and nitrogen pressurization piping were installed in the pit and connected to the feeder discharge manifold. A 1/2" air actuated ball valve added to the pressurization piping allows selection of reactor #1 or #2 for sleeve pressurization. The motor driving the auger carrying material from reactor discharge to the bucket elevator will have to be replaced. It was the motor originally driving the belt conveyor. The distance from reactor #2 to the elevator is greater than #1, so the motor will not reliably convey material that extra distance. During loading of loop, the motor occasionally stalls out and the auger has to be broken loose by hand.

To run the feeder in the verification test mode, the high sleeve pressure transducer demodulator will be recalibrated and the main hydraulic relief valve set at 2,000 p.s.i. Due to the lower Everlasting valve leakage, a regulator will be installed to maintain reactor #1 pressure when testing. A series of check valves was installed on the hydraulic pressure control circuit for the case and loading ring pressures on the feeder valve and the Conspray valves. An additional accumulator was also added to that circuit. This maintains loading ring and case pressures when either Everlasting or Conspray valves are shifted, which causes a momentary drop in system pressure.

The Texaco gasification process is known to utilize a powdered coal at pressures up to 500 p.s.i. Both the coal grind and the process details are proprietary information. The feeder's ability to feed -200 mesh material at 700 p.s.i. is considered by the contractor to exceed the requirements of the Texaco process.

The test coal will be a nominal 70% - 200 mesh and will be ground by an independent coal grinder. Screen analysis and Ohaus moisture determination are performed by the contractor. It is not known how closely this size distribution conforms to the specific requirements of the Texaco process. The Texaco process has been tested with a wide variety of coal types, including Western bituminous.

The test format will consist of feeding nominal 750 lb. batches of coal from the live bottom storage hoppers through the feeder into the reactor which is pressurized to 700 p.s.i. with nitrogen. Due to the coal grind, the feeder will be run at reduced throughput so as to ensure reliable flow from the live bottom hoppers which discharge powdered coal rather slowly.

This will increase the running time for each test. Several options exist for reducing feeder throughput. The stroke can be shortened, the hydraulic pump output decreased to slow the cyclic rate, the step-time increased on the Versatyme process controller, or some combination of these three. During the set-up procedure between completion of Phase I and commencement of Phase II, tests will be run to determine the optimum combination of adjustments. METC will be notified when this throughput is determined. Each test is expected to last approximately 30 minutes. However, this test duration may be increased pending the results of the tests to reduce throughput.

The coal will be recycled. A sample will be taken each 10 running hours and analyzed by screen analysis. Based on experience gained in Phase I: Proof of Concept Tests, no significant size distribution alteration is expected to the specific grind size. Screen analyses will be reported.

It is scheduled to begin testing on or about June 28, 1982. Assuming 50% operational time, ten weeks will be required to complete the 200 hours of testing. Should this 200 hours be accumulated significantly prior to the September 17 target date, such additional testing as possible will be performed.

The test crew will consist of a test engineer, a test technician, and a general laborer. These are the same manpower requirements as utilized in Phase I.

B. PHASE II TEST DATA

A total of 93 test runs were accomplished during Phase II with a total run time of 200 hours, 23 minutes accumulated.

For all tests, the feedstock was a Utah bituminous coal, ground to 70%-200 mesh size. A back pressure of 700 psi was utilized. These parameters simulate the requirements of an entrained gasification process. Coal was used for all test runs, with the machine started against pressure, run until the coal supply was exhausted, and stopped if required to transfer coal from storage to feed.

The nomenclature is used in the test run summary sheets:

Column title	Description
Run number	Identification of individual test runs
Piston extends (psi)	The hydraulic pressure in pounds per square inch required to extend the piston and thereby discharge the coal. This function requires the greatest pressure and is the determining factor in the relief valve setting.
Stroke set (inches)	The effective stroke of the dynamic sleeve; the distance it travels to fill. Listings such as "5/18" indicate the test was run at a 5" stroke with an 18" stroke used at the end for complete emptying of the feeder hopper.

Amps	The amount of current drawn by the main pump drive electric motor. This is a function of the displacement of the variable volume hydraulic pumps.
Test cycles	Number of cycles in the test run.
Elapsed time	Total amount of time of a test run
Roll number	The data on hydraulic pressure of the feeder functions is recorded on strip chart rolls. These rolls are numbered and annotated and are included in the Test Data Package, a separate set of raw data.
Test date	The date of the test run

Table 2: Phase II Test Run Summary (Sheet 1)

RUN NUMBER	EXTEND P.S.I.	STROKE SET INCHES	AMPS ON	TEST CYCLES	ELAPSED TIME	ROLL NUMBER	TEST DATE
1	1800	5/18	50/80	164	48 MIN.	1	6/30/82
2	1800	5	50	345	66 MIN.	1	7/01/82
3	1800	5	50	373	90 MIN.	1	7/01/82
4	1800	4/18	50	354	105 MIN.	1	7/01/82
5	1800	6	50	183	60 MIN.	1	7/02/82
6	1800	4	50	346	93 MIN.	1	7/02/82
7	1800	4/18	50	346	97 MIN.	1	7/02/82
8	1800	4/18	50	386	103 MIN.	1	7/06/82
9	1800	4/18	50	376	70 MIN.	1	7/06/82
10 *	1800	4	50	71	17 MIN.	1	7/06/82
11	1800	4	50/65	199	50 MIN.	1	7/06/82
12	1800	3	50	615	194 MIN.	1/2	7/07/82
13	1800	3	50/55	614	170 MIN.	2	7/07/82
14	1800	3/18	50/55	954	310 MIN.	2	7/08/82
15	1800	3	55	855	110 MIN.	2	7/08/82
16	1800	3/18	50/52	596	113 MIN.	2	7/12/82
17	1800	3/18	52	598	133 MIN.	2	7/12/82
18	1750	3/18	52	572	122 MIN.	2	7/12/82
19	1700	3	52	510	90 MIN.	2	7/13/82
20	1700	3/18	52	537	113 MIN.	2	7/13/82
21	1750	3/18	52	567	105 MIN.	3	7/13/82
22	1725	3	52	588	120 MIN.	3	7/14/82
23	1700	3/18	52	571	101 MIN.	3	7/14/82
24 *	1750	3	52	97	20 MIN.	3	7/14/82
25	1750	3/18	52	735	150 MIN.	3	7/14/82
26	1700	3	52	734	140 MIN.	3	7/15/82
27	1725	2½	52	798	163 MIN.	3	7/15/82
28	1700	5/18	52	354	62 MIN.	3	7/15/82

Table 2 : Phase II Test Run Summary (Sheet 2)

RUN NUMBER	EXTEND P.S.I.	STROKE SET INCHES	AMPS	TEST CYCLES	ELAPSED TIME	ROLL NUMBER	TEST DATE
29	1700	2½	52	679	123 MIN.	3	7/16/82
30	1725	2½	52	625	120 MIN.	3	7/16/82
31	1725	2½	52	512	100 MIN.	4	7/16/82
32	1725	2½	50	592	171 MIN.	4	7/17/82
33	1750	2½	50	1232	210 MIN.	4	7/19/82
34	1700	2½	50	500	110 MIN.	4	7/19/82
35 *	1700	2½	50	78	14 MIN.	4	7/20/82
36	1725	2½	50	1024	250 MIN.	4	7/20/82
37	1725	2½/18	50/52	411	101 MIN.	4	7/20/82
38	1750	2½	50	1059	240 MIN.	4	7/21/82
39	1725	2½/12	50	316	80 MIN.	5	7/21/82
40	1725	2½	50	691	180 MIN.	5	7/22/82
41	1800	4/18	52	612	118 MIN.	5	7/22/82
42 *	1725	2½	52	794	167 MIN.	5	7/22/82
43	1775	2½/6	52	454	90 MIN.	5	8/04/82
44	1775	2½	50	1124	254 MIN.	5	8/05/82
45	1750	3/18	50	535	110 MIN.	5	8/05/82
46	1775	3	50	654	198 MIN.	6	8/06/82
47	1725	3/18	50	309	101 MIN.	6	8/06/82
48	1725	3/18	50	819	180 MIN.	6	8/07/82
49 *	1750	3	50	580	126 MIN.	6	8/09/82
50	1750	3	50	705	154 MIN.	6	8/09/82
51	1750	3	50	639	141 MIN.	6	8/09/82
52	1725	3/12/18	50	404	90 MIN.	6	8/09/82
53	1725	3	50	714	159 MIN.	7	8/11/82
54	1750	3	50	601	144 MIN.	7	8/11/82
55	1750	3/12	50	416	106 MIN.	7	8/11/82
56 *	1750	2½/12/18	50	702	130 MIN.	7	8/13/82

Table 2: Phase II Test Run Summary (Sheet 3)

RUN NUMBER	EXTEND P.S.I.	STROKE SET INCHES	AMPS	TEST CYCLES	ELAPSED TIME	ROLL NUMBER	TEST DATE
57	1725	3	50	1114	180 MIN.	7	8/14/82
58	1750	2½	50	788	200 MIN.	7	8/16/82
59	1750	2½	50	880	211 MIN.	7/8	8/17/82
60	1750	2½	50	712	179 MIN.	8	8/17/82
61	1750	2½	50	803	200 MIN.	8	8/19/82
62	1850	2½	50	845	240 MIN.	8	8/20/82
63	1800	2½/12	50	534	120 MIN.	8	8/20/82
64	1800	2½	50	989	240 MIN.	8	8/21/82
65	1750	2½	50	1210	300 MIN.	8/9	8/23/82
66	1775	2½/18	50/52	522	123 MIN.	9	8/23/82
67	1825	3/12	50	761	206 MIN.	9	8/24/82
68	1800	2½	50	779	189 MIN.	9	8/25/82
69	1800	2½/12	50	859	210 MIN.	9	8/25/82
70	1725	6	50	364	76 MIN.	9	9/02/82
71	1650	6	50	542	118 MIN.	9	9/02/82
72	1650	6	50	423	94 MIN.	9	9/02/82
73	1725	6	50	412	90 MIN.	10	9/03/82
74	1775	6	50	459	90 MIN.	10	9/03/82
75	1750	6	50	512	100 MIN.	10	9/03/82
76	1725	6	50	417	90 MIN.	10	9/07/82
77	1700	6	50	606	153 MIN.	10	9/07/82
78	1700	6	50	492	110 MIN.	10	9/07/82
79	1725	6	50	121	25 MIN.	10	9/08/92
80	1725	6	50	523	105 MIN.	10	9/08/82
81	1700	6	50	572	125 MIN.	10	9/08/82
82	1725	6	50	481	110 MIN.	10	9/08/82
83	1750	6	50	445	90 MIN.	10	9/08/82
84	1725	6	50	561	110 MIN.	10	9/08/82

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DATE Marcj 18, 1982
HRI PROJECT 002-52E
HRI SERIES NO. 23394-4
DATE RECD 3/10/1982
CUST P.O.# 82049

REPORT OF ANALYSIS
PREPARED FOR:

SAMPLE IDENTIFICATION:
WESTERN BITUMINOUS

CONSPRAY CONSTRUCTION
MR BOB THALAKEN
111 WEST DYER ROAD
SANTA ANA CALIFORNIA 92707

TABLE 3 : FEEDSTOCK ANALYSIS

REPORTING BASIS >	AS RECD	DRY	EQM	AIR DRY
PROXIMATE (%)				
MOISTURE	3.27	0.00		3.27
ASH	5.37	5.55		5.37
VOLATILE	41.31	42.71		41.31
FIXED C	50.05	51.74		50.05
	-----	-----	-----	-----
TOTAL	100.00	100.00	100.00	100.00
SULFUR	0.52	0.54		0.52
BTU/LB	12958	13397		12958
MMF BTU/LB		14268		
AIR DRY LOSS (%)				
ULTIMATE (%)				
MOISTURE	3.27	0.00		3.27
CARBON	72.62	75.08		72.62
HYDROGEN	5.25	5.43		5.25
NITROGEN	1.23	1.27		1.23
SULFUR	0.52	0.54		0.52
ASH	5.37	5.55		5.37
OXYGEN*	11.74	12.13		11.74
	-----	-----	-----	-----
TOTAL	100.00	100.00	100.00	100.00
CHLORINE**				

FORMS OF SULFUR (AS S,%)

SULFATE		
PYRITIC		
ORGANIC		
	-----	-----
TOTAL	0.52	0.54

WATER SOLUBLE ALKALIES

NA2O
K2O

HGI= @ % MOISTURE
AS REC'D SP.GR. (G/CC)
FREE SWELLING INDEX

REPORT PREPARED BY:

Charles E. Balsam

CHARLES E. BALSAM
COAL LABORATORY MANAGER

* OXYGEN BY DIFFERENCE.

** NOT USUALLY REPORTED AS PART OF THE ULTIMATE ANALYSIS

GILSON SCREEN/SIEVE TEST REPORT

RETAINED							PASSING			NOTES		
WEIGHTS in: g kg lbs				PERCENT			SCREEN/SIEVE		WEIGHT		PERCENT	
Sample + Screen	- Screen	= Sample	Cumulative	Incremental	Cumulative	Spec	SIZE OR RANGE		Cumulative		Cumulative	Spec
Ø	479.8	—	—	—	—		# 8		—	—		1
596.1	577.0	19.1	19.1	9.28	9.28		# 16		186.5	90.68		2
419.7	419.2	0.5	19.6	0.24	9.52		# 30		186.0	90.44		3
389.85	386.1	3.75	23.35	1.82	11.34		# 50		182.25	88.62		4
309.35	282.8	26.55	49.9	12.41	24.25		# 100		155.7	75.71		5
911.15	355.25	55.9	105.8	27.18	51.43		# 200		99.8	48.53		6
338.9	321.7	17.2	123.0	8.36	59.79		# 230		82.6	40.17		7
463.5	380.9	82.6	205.6	40.11	99.96		# Pan		Ø	Ø		8
												9
												10
												11
												12
												13
												14
												15
												16
												17
												18
												19
												20

NOTES:

Utah BIT

Sample ID: Phase II Pre-Test Sample

Date: 7-5-82

Test # Operator: Pat Cron

Book #: Page #:

REORDER AS TSA-260

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TABLE 4 : SIEVE ANALYSIS

C. RECOMMENDED SPARE PARTS

The following spare parts should be kept on hand during gasifier operation.

Quantity	Part Number	Description
1	2754C	Adjustable wear plate
1	2756C	Stationary wear plate
1	2761D	Valve gate
1	2652B	Piston cup
1	2620C	Sleeve seal

CONSPRAY
COAL FEEDER TEST SITE

APPENDIX H:
Valve Actuation Force
and Leak Tests

Valve Actuation Force Test Procedure

- 1) Calibrate the strip chart recorder and annotate test information on the strip chart paper and the valve test sheet.
- 2) Set in this order; according to the test matrix.
 - a) loading ring pressure
 - b) valve case pressure
 - c) conduit pressure
- 3) Actuate the valve once and leave valve in the open position.
- 4) Reduce the actuation pressure to less than 100 psi. Switch the actuation control switch to the closed position.
- 5) Turn the strip chart recorder paper feed control to 125/mm/sec.
- 6) Increase the valve actuation pressure slowly until "break-away." This will be indicated by the left event marker on the strip chart recorder. Upon "breakaway," stop increasing the actuation pressure.
- 7) When the left event marker returns to the on position, the valve has closed, stop the strip chart recorder, and reduce valve actuation pressure to less than 100 psi.
- 8) Verify that the loading ring pressure, housing pressure and conduit pressure coincide with the test matrix.
- 9) Annotate test information on recorder paper.
- 10) Turn on strip chart recorder paper to feed to 125/mm/sec.
- 11) Increase the valve actuation pressure gradually using the pressure reducing valve until breakaway occurs. The break-away point will be indicated by the left event marker on the strip chart recorder.
- 12) When breakaway occurs, stop increasing actuation pressure.
- 13) When the left event marker on strip chart recorder has indicated full valve open, stop the strip chart recorder and reduce valve actuation pressure to less than 100 psi.
- 14) Annotate test information onto strip chart recording paper and test sheet for the next test to be run.

TEST NUMBER	LOADING RING PRESSURE	CONDUIT PRESSURE	CASE PRESSURE	BREAKAWAY PRESSURE	NOTES
10a	800	0	50	325	GOOD TEST
20a	1200	0	50	500	GOOD TEST
30a	1600	0	50	735	GOOD TEST
40a	1900	0	50	830	GOOD TEST
50a	800	100	150	365	GOOD TEST
60a	1200	100	150	515	GOOD TEST
*70a	1600	100	150	770	GOOD TEST
80a	1900	100	150	860	GOOD TEST
90a	800	200	250	305	GOOD TEST
100a	1200	200	250	485	GOOD TEST
110a	1600	200	250	655	GOOD TEST
120a	1900	200	250	770	GOOD TEST
130a	800	300	350	275	GOOD TEST
140a	1200	300	350	445	GOOD TEST
150a	1600	300	350	605	GOOD TEST
160a	1900	300	350	730	GOOD TEST
170a	800	400	450	210	GOOD TEST
180a	1200	400	450	390	GOOD TEST
190a	1600	400	450	510	GOOD TEST
200a	1900	400	450	610	GOOD TEST
210a	800	500	550	180	GOOD TEST
220a	1200	500	550	295	GOOD TEST
230a	1600	500	550	455	GOOD TEST
240a	1900	500	550	520	GOOD TEST
250a	800	600	650	*	*
260a	1200	600	650	275	GOOD TEST
270a	1600	600	650	430	GOOD TEST
280a	1900	600	650	510	GOOD TEST
290a	800	700	750	*	*
300a	1200	700	750	230	GOOD TEST
310a	1600	700	750	360	GOOD TEST
320a	1900	700	750	405	GOOD TEST
410a	800	0	250	590	GOOD TEST
420a	1200	0	250	770	GOOD TEST
430a	1600	0	250	895	GOOD TEST
440a	1900	0	250	915	GOOD TEST

* TEST WAS NOT RUN DUE TO CASE LEAKAGE INTO CONDUIT.

OPEN TO CLOSE TEST DATA

TEST NUMBER	LOADING RING PRESSURE	CONDUIT PRESSURE	CASE PRESSURE	BREAKAWAY PRESSURE	NOTES
1cb	800	0	50	365	GOOD TEST
2cb	1200	0	50	500	GOOD TEST
3cb	1600	0	50	680	GOOD TEST
4cb	1900	0	50	780	GOOD TEST
5cb	800	100	150	320	GOOD TEST
6cb	1200	100	150	460	GOOD TEST
7cb	1600	100	150	760	GOOD TEST
8cb	1900	100	150	880	GOOD TEST
9cb	800	200	250	380	GOOD TEST
10cb	1200	200	250	420	GOOD TEST
11cb	1600	200	250	580	GOOD TEST
12cb	1900	200	250	720	GOOD TEST
13cb	800	300	350	200	GOOD TEST
14cb	1200	300	350	380	GOOD TEST
15cb	1600	300	350	520	GOOD TEST
16cb	1900	300	350	680	GOOD TEST
17cb	800	400	450	180	GOOD TEST
18cb	1200	400	450	320	GOOD TEST
19cb	1600	400	450	480	GOOD TEST
20cb	1900	400	450	580	GOOD TEST
21cb	800	500	550	120	GOOD TEST
22cb	1200	500	550	240	GOOD TEST
23cb	1600	500	550	410	GOOD TEST
24cb	1900	500	550	480	GOOD TEST
25cb	800	600	650	*	*
26cb	1200	600	650	220	GOOD TEST
27cb	1600	600	650	380	GOOD TEST
28cb	1900	600	650	480	GOOD TEST
29cb	800	700	750	*	*
30cb	1200	700	750	220	GOOD TEST
31cb	1600	700	750	320	GOOD TEST
32cb	1900	700	750	420	GOOD TEST
41cb	800	0	250	380	GOOD TEST
42cb	1200	0	250	510	GOOD TEST
43cb	1600	0	250	660	GOOD TEST
44cb	1900	0	250	740	GOOD TEST

*TEST WAS NOT RUN DUE TO CASE LEAKAGE INTO CONDUIT

TABLE5, SHEET 2

CLOSE TO OPEN TEST DATA

TEST NUMBER	LOADING RING PRESSURE	CONDUIT PRESSURE	CASE PRESSURE	BREAKAWAY PRESSURE	NOTES
1ob	800	0	50	315	GOOD TEST
2ob	1200	0	50	500	GOOD TEST
3ob	1600	0	50	740	GOOD TEST
4ob	1900	0	50	860	GOOD TEST
5ob	800	100	150	340	GOOD TEST
6ob	1200	100	150	510	GOOD TEST
7ob	1600	100	150	760	GOOD TEST
8ob	1900	100	150	860	GOOD TEST
9ob	800	200	250	310	GOOD TEST
10ob	1200	200	250	480	GOOD TEST
11ob	1600	200	250	640	GOOD TEST
12ob	1900	200	250	720	GOOD TEST
13ob	800	300	350	280	GOOD TEST
14ob	1200	300	350	440	GOOD TEST
15ob	1600	300	350	620	GOOD TEST
16ob	1900	300	350	740	GOOD TEST
17ob	800	400	450	220	GOOD TEST
18ob	1200	400	450	370	GOOD TEST
19ob	1600	400	450	510	GOOD TEST
20ob	1900	400	450	620	GOOD TEST
21ob	800	500	550	165	GOOD TEST
22ob	1200	500	550	300	GOOD TEST
23ob	1600	500	550	460	GOOD TEST
24ob	1900	500	550	540	GOOD TEST
25ob	800	600	650	*	*
26ob	1200	600	650	270	GOOD TEST
27ob	1600	600	650	480	GOOD TEST
28ob	1900	600	650	560	GOOD TEST
29ob	800	700	750	*	*
30ob	1200	700	750	260	GOOD TEST
31ob	1600	700	750	360	GOOD TEST
32ob	1900	700	750	460	GOOD TEST
41ob	800	0	250	620	GOOD TEST
42ob	1200	0	250	780	GOOD TEST
43ob	1600	0	250	920	GOOD TEST
44ob	1900	0	250	990	GOOD TEST

* TEST WAS NOT RUN DUE TO CASE LEAKAGE INTO CONDUIT

TEST NUMBER	LOADING RING PRESSURE	CONDUIT PRESSURE	CASE PRESSURE	BREAKAWAY PRESSURE	NOTES
1ca	800	0	50	345	GOOD TEST
2ca	1200	0	50	510	GOOD TEST
3ca	1600	0	50	690	GOOD TEST
4ca	1900	0	50	785	GOOD TEST
5ca	800	100	150	300	GOOD TEST
6ca	1200	100	150	460	GOOD TEST
7ca	1600	100	150	650	GOOD TEST
8ca	1900	100	150	755	GOOD TEST
9ca	800	200	250	245	GOOD TEST
10ca	1200	200	250	420	GOOD TEST
11ca	1600	200	250	580	GOOD TEST
12ca	1900	200	250	715	GOOD TEST
13ca	800	300	350	210	GOOD TEST
14ca	1200	300	350	400	GOOD TEST
15ca	1600	300	350	510	GOOD TEST
16ca	1900	300	350	665	GOOD TEST
17ca	800	400	450	185	GOOD TEST
18ca	1200	400	450	315	GOOD TEST
19ca	1600	400	450	400	GOOD TEST
20ca	1900	400	450	620	GOOD TEST
21ca	800	500	550	135	GOOD TEST
22ca	1200	500	550	245	GOOD TEST
23ca	1600	500	550	425	GOOD TEST
24ca	1900	500	550	515	GOOD TEST
25ca	800	600	650	*	*
26ca	1200	600	650	215	GOOD TEST
27ca	1600	600	650	390	GOOD TEST
28ca	1900	600	650	485	GOOD TEST
29ca	800	700	750	*	*
30ca	1200	700	750	200	GOOD TEST
31ca	1600	700	750	320	GOOD TEST
32ca	1900	700	750	465	GOOD TEST
41ca	800	0	250	375	GOOD TEST
42ca	1200	0	250	535	GOOD TEST
43ca	1600	0	250	630	GOOD TEST
44ca	1900	0	250	705	GOOD TEST

* TEST WAS NOT RUN DUE TO CASE LEAKAGE INTO CONDUIT.

COAL FEEDER VALVE ACTUATION FORCE

TEST DATA

CLOSE TO OPEN

TEST NUMBER	LOADING RING PRESSURE	CONDUIT PRESSURE	CASE PRESSURE	BREAKAWAY PRESSURE	NOTES
1of	1000	0	50 *	795	GOOD TEST
2of	1300	0	50 *	920	GOOD TEST
3of	1600	0	50 *	1130	GOOD TEST
4of	1900	0	50 *	1280	GOOD TEST
5of	1000	200	250	600	GOOD TEST
6of	1300	200	250	720	GOOD TEST
7of	1600	200	250	880	GOOD TEST
8of	1900	200	250	980	GOOD TEST
9of	1000	400	450	470	GOOD TEST
10of	1300	400	450	615	GOOD TEST
11of	1600	400	450	820	GOOD TEST
12of	1900	400	450	840	GOOD TEST
13of	1000	600	650	360	GOOD TEST
14of	1300	600	650	520	GOOD TEST
15of	1600	600	650	730	GOOD TEST
16of	1900	600	650	800	GOOD TEST
17of	1000	800	850	285	GOOD TEST
18of	1300	800	850	400	GOOD TEST
19of	1600	800	850	570	GOOD TEST
20of	1900	800	850	640	GOOD TEST

* THESE TESTS WERE ACCOMPLISHED WITH 200 F.S.I. CASE PRESSURE DUE TO SPLINED SHAFT LEAKAGE AT 50 F.S.I.

TABLE 5, SHEET 5

COAL FEEDER VALVE ACTUATION FORCE
TEST DATA OPEN TO CLOSE

TEST NUMBER	LOADING RING PRESSURE	CONDUIT PRESSURE	CASE PRESSURE	BREAKAWAY PRESSURE	NOTES
1cf	1000	0	50 *	760	GOOD TEST
2cf	1300	0	50 *	960	GOOD TEST
3cf	1600	0	50 *	1160	GOOD TEST
4cf	1900	0	50 *	1240	GOOD TEST
5cf	1000	200	250	685	GOOD TEST
6cf	1300	200	250	800	GOOD TEST
7cf	1600	200	250	980	GOOD TEST
8cf	1900	200	250	1120	GOOD TEST
9cf	1000	400	450	530	GOOD TEST
10cf	13000	400	450	640	GOOD TEST
11cf	1600	400	450	850	GOOD TEST
12cf	1900	400	450	985	GOOD TEST
13cf	1000	600	650	440	GOOD TEST
14cf	1300	600	650	520	GOOD TEST
15cf	1600	600	650	725	GOOD TEST
16cf	1900	600	650	880	GOOD TEST
17cf	1000	800	850	355	GOOD TEST
18cf	1300	800	850	330	GOOD TEST
19cf	1600	800	850	520	GOOD TEST
20cf	1900	800	850	680	GOOD TEST

* THESE TESTS WERE ACCOMPLISHED WITH 200 F.S.I. CASE PRESSURE
DUE TO SPLINED SHAFT LEAKAGE AT 50 F.S.I.

TABLE 5 , SHEET 6

LOADING RING PRESSURE	CASE PRESSURE	CONDUIT PRESSURE	PRESSURE DECAY	NOTES
1000	50	0	0	DETECTED NO LEAKAGE
1300	50	0	0	DETECTED NO LEAKAGE
1600	50	0	0	DETECTED NO LEAKAGE
1900	50	0	0	DETECTED NO LEAKAGE
1000	250	200	0	DETECTED NO LEAKAGE
1300	250	200	0	DETECTED NO LEAKAGE
1600	250	200	0	DETECTED NO LEAKAGE
1900	250	200	0	DETECTED NO LEAKAGE
1000	450	400	0	DETECTED NO LEAKAGE
1300	450	400	0	DETECTED NO LEAKAGE
1600	450	400	0	DETECTED NO LEAKAGE
1900	450	400	0	DETECTED NO LEAKAGE
1000	650	600		OIL FLOW INTO CONDUIT DETECTED
1300	650	600	0	DETECTED NO LEAKAGE
1600	650	600	0	DETECTED NO LEAKAGE
1900	650	600	0	DETECTED NO LEAKAGE
1000	850	800		OIL FLOW INTO CONDUIT DETECTED
1300	850	800	0	DETECTED NO LEAKAGE
1600	850	800	0	DETECTED NO LEAKAGE
1900	850	800	0	DETECTED NO LEAKAGE

TABLE 5, SHEET 7

LOADING RING PRESSURE	CASE PRESSURE	CONDUIT PRESSURE	UPSTREAM PRESSURE DECAY	NOTES
1000	50	0	0	DETECTED NO LEAKAGE
1300	50	0	0	DETECTED NO LEAKAGE
1600	50	0	0	DETECTED NO LEAKAGE
1900	50	0	0	DETECTED NO LEAKAGE
1000	250	200	0	DETECTED NO LEAKAGE
1300	250	200	0	DETECTED NO LEAKAGE
1600	250	200	0	DETECTED NO LEAKAGE
1900	250	200	0	DETECTED NO LEAKAGE
1000	450	400	0	DETECTED NO LEAKAGE
1300	450	400	0	DETECTED NO LEAKAGE
1600	450	400	0	DETECTED NO LEAKAGE
1900	450	400	0	DETECTED NO LEAKAGE
1000	650	600		OIL FLOW INTO CONDUIT DETECTED
1300	650	600	0	DETECTED NO LEAKAGE
1600	650	600	0	DETECTED NO LEAKAGE
1900	650	600	0	DETECTED NO LEAKAGE
1000	850	800		OIL FLOW INTO CONDUIT DETECTED
1300	850	800	0	DETECTED NO LEAKAGE
1600	850	800	0	DETECTED NO LEAKAGE
1900	850	800	0	DETECTED NO LEAKAGE

TABLE 5, SHEET 8

FEEDER VALVE LEAKAGE RATE TEST DATA

LOADING RING PRESSURE	CASE PRESSURE	CONDUIT PRESSURE	UPSTREAM PRESSURE DECAY	NOTES
800	250	200	0	NO LEAKAGE DETECTED
1200	250	200	0	NO LEAKAGE DETECTED
1600	250	200	0	NO LEAKAGE DETECTED
1900	250	200	0	NO LEAKAGE DETECTED
800	450	400	0	NO LEAKAGE DETECTED
1200	450	400	0	NO LEAKAGE DETECTED
1600	450	400	0	NO LEAKAGE DETECTED
1900	450	400	0	NO LEAKAGE DETECTED
800	650	600		OIL FLOW INTO CONDUIT DETECTED
1200	650	600	0	NO LEAKAGE DETECTED
1600	650	600	0	NO LEAKAGE DETECTED
1900	650	600	0	NO LEAKAGE DETECTED
800	850	800		OIL FLOW INTO CONDUIT DETECTED
1200	850	800	0	NO LEAKAGE DETECTED
1600	850	800	0	NO LEAKAGE DETECTED
1900	850	800	0	NO LEAKAGE DETECTED

TABLE 5, SHEET 9

APPENDIX I:700 PSI
Maximum Throughput Tests
Data Sheets

COAL FEEDER TEST RESULTS:
700 psi maximum throughput

TEST NUMBER	I	II	III	IV	V
REACTOR PRESSURE PSI	700	700	700	700	700
MOISTURE %	10.2	10.2	10.2	10.2	10.2
STROKE SET INCHES	18	18	18	18	18
THROUGHPUT RATE LBS/HR	5905	5947	5888	5981	6181
ELAPSED TIME/SEC.	185.3	184.0	185.8	182.9	177.0
LOADING RING PRESSURE PSI	1000	1000	1000	1000	1000
HOUSING PRESSURE PSI	750	750	750	750	750
SLEEVE SEAL PRESSURE PSI	750	750	750	750	750
PISTON EXTEND PRESSURE PSI	1775	1750	1750	1800	1775
TEST CYCLES	27	27	27	27	26
AMPS SET	110	110	110	110	110
WEIGHT OF FUEL PUMPED	304LBS.	304LBS.	304LBS.	304LBS.	304LBS.
CYCLES PER/MIN	8.73	8.81	8.70	8.86	9.10
FUEL TYPE & ADDITIVES	WEST BIT.	WEST BIT.	WEST BIT.	WEST BIT.	WEST BIT.
FUEL SIZE	70%-#200	70%-#200	70%-#200	70%-#200	70%-#200
HIGH SLEEVE PRESSURE PSI	650	650	650	650	650
LOW SLEEVE PRESSURE PSI	150	150	150	150	150
TEST DATE	11/18/82	11/18/82	11/18/82	11/18/82	11/19/82

TABLE 6, SHEET 1

COAL FEEDER TEST RESULTS :
700 psi maximum throughput

TEST NUMBER	VI	VII	VIII	IX	X
REACTOR PRESSURE PSI	700	700	700	700	700
MOISTURE %	10.2	10.2	10.2	10.2	10.2
STROKE SET INCHES	18	18	18	18	18
THROUGHPUT RATE LBS/HR	6148	6205	6281	6360	6243
ELAPSED TIME/SEC.	178.0	176.3	174.2	172.0	175.3
LOADING RING PRESSURE PSI	1000	1000	1000	1000	1000
HOUSING PRESSURE PSI	750	750	750	750	750
SLEEVE SEAL PRESSURE PSI	750	750	750	750	750
PISTON EXTEND PRESSURE PSI	1750	1800	1775	1800	1775
TEST CYCLES	27	27	27	27	27
AMPS SET	110	110	110	110	110
WEIGHT OF FUEL PUMPED	304LBS.	304LBS.	304LBS.	304LBS.	304LBS.
CYCLES PER/MIN	9.05	9.11	9.23	9.30	9.16
FUEL TYPE & ADDITIVES	WEST BIT.	WEST BIT.	WEST BIT.	WEST BIT.	WEST BIT.
FUEL SIZE	70%-#200	70%-#200	70%-#200	70%-#200	70%-#200
HIGH SLEEVE PRESSURE PSI	650	650	650	650	650
LOW SLEEVE PRESSURE PSI	150	150	150	150	150
TEST DATE	11/19/82	11/19/82	11/22/82	11/22/82	11/22/82

COAL FEEDER TEST RESULTS:-
700 psi maximum throughput

TEST NUMBER	XI	XII	XIII	XIV	XV
REACTOR PRESSURE PSI	700	700	700	700	700
MOISTURE %	10.2	10.2	10.2	10.2	10.2
STROKE SET INCHES	18	18	18	18	18
THROUGHPUT RATE LBS/HR	6163	6064	6042	6442	5981
ELAPSED TIME/SEC.	177.5	180.4	181.1	169.8	182.9
LOADING RING PRESSURE PSI	1000	1000	1000	1000	1000
HOUSING PRESSURE PSI	750	750	750	750	750
SLEEVE SEAL PRESSURE PSI	750	750	750	750	750
PISTON EXTEND PRESSURE PSI	1800	1775	1775	1775	1800
TEST CYCLES	27	27	27	28	27
AMPS SET	110	110	110	110	110
WEIGHT OF FUEL PUMPED	304LBS.	304LBS.	304LBS.	304LBS.	304LBS.
CYCLES PER/MIN	9.09	8.93	8.91	9.80	8.86
FUEL TYPE & ADDITIVES	WEST BIT.	WEST BIT.	WEST BIT.	WEST BIT.	WEST BIT.
FUEL SIZE	70% - #200	70% - #200	70% - #200	70% - #200	70% - #200
HIGH SLEEVE PRESSURE PSI	650	650	650	650	560
LOW SLEEVE PRESSURE PSI	150	150	150	150	150
TEST DATE	11/23/82	11/23/82	11/23/82	11/24/82	11/24/82

COAL FEEDER TEST RESULTS:
700 psi maximum throughput

TEST NUMBER	XVI	XVII	XVIII	XIX	XX
REACTOR PRESSURE PSI	700	700	700	700	700
MOISTURE %	10.2	10.2	10.2	10.2	10.2
STROKE SET INCHES	18	18	18	18	18
THROUGHPUT RATE LBS/HR	5905	5981	6129	6316	6266
ELAPSED TIME/SEC.	185.3	182.9	178.5	173.2	174.6
LOADING RING PRESSURE PSI	1000	1000	1000	1000	1000
HOUSING PRESSURE PSI	750	750	750	750	750
SLEEVE SEAL PRESSURE PSI	750	750	750	750	750
PISTON EXTEND PRESSURE PSI	1750	1800	1775	1800	1800
TEST CYCLES	27	27	27	27	27
AMPS SET	110	110	110	110	110
WEIGHT OF FUEL PUMPED	304LBS.	304LBS.	304LBS.	304LBS.	304LBS.
CYCLES PER/MIN	8.73	8.86	9.04	9.27	9.17
FUEL TYPE & ADDITIVES	WEST BIT.	WEST BIT.	WEST BIT.	WEST BIT.	WEST BIT.
FUEL SIZE	70%-#200	70%-#200	70%-#200	70%-#200	70%-#200
HIGH SLEEVE PRESSURE PSI	650	650	650	650	650
LOW SLEEVE PRESSURE PSI	150	150	150	150	150
TEST DATE	11/24/82	11/29/82	11/29/82	11/29/82	11/30/82

TABLE 6, SHEET 4

COAL FEEDER TEST RESULTS :
700 psi maximum throughput

TEST NUMBER	XXI	XXII	XXIII	XXIV	XXV
REACTOR PRESSURE PSI	700	700	700	700	700
MOISTURE %	10.2	10.2	10.2	10.2	10.2
STROKE SET INCHES	18	18	18	18	18
THROUGHPUT RATE LBS/HR	6093	6042	5984	6067	5990
ELAPSED TIME/SEC.	179.6	181.1	182.9	180.4	182.7
LOADING RING PRESSURE PSI	1000	1000	1000	1000	1000
HOUSING PRESSURE PSI	750	750	750	750	750
SLEEVE SEAL PRESSURE PSI	750	750	750	750	750
PISTON EXTEND PRESSURE PSI	1750	1750	1775	1750	1775
TEST CYCLES	27	27	27	27	27
AMPS SET	110	110	110	110	110
WEIGHT OF FUEL PUMPED	304LBS.	304LBS.	304LBS	304LBS	304LBS
CYCLES PER/MIN	9.02	8.91	8.86	8.98	8.87
FUEL TYPE & ADDITIVES	WEST BIT.	WEST BIT.	WEST BIT.	WEST BIT.	WEST BIT.
FUEL SIZE	70%-#200	70%-#200	70%-#200	70%-#200	70%-#200
HIGH SLEEVE PRESSURE PSI	650	650	650	650	650
LOW SLEEVE PRESSURE PSI	150	150	150	150	150
TEST DATE	11/30/82	11/30/82	11/30/82	11/30/82	11/30/82

COAL FEEDER TEST RESULTS
700 psi maximum throughput

TEST NUMBER	XXVI	XXVII	XXVIII	XXIX	XXX
REACTOR PRESSURE PSI	700	700	700	700	700
MOISTURE %	10.2	10.2	10.2	10.2	10.2
STROKE SET INCHES	18	18	18	18	18
THROUGHPUT RATE LBS/HR	6264	5906	5903	6060	6135
ELAPSED TIME/SEC.	174.7	185.3	185.4	180.6	178.4
LOADING RING PRESSURE PSI	1000	1000	1000	1000	1000
HOUSING PRESSURE PSI	750	750	750	750	750
SLEEVE SEAL PRESSURE PSI	750	750	750	750	750
PISTON EXTEND PRESSURE P.S.I.	1750	1725	1775	1750	1750
TEST CYCLES	27	27	27	27	27
AMPS SET	110	110	110	110	110
WEIGHT OF FUEL PUMPED	304LBS	304LBS	304LBS	304LBS	304LBS
CYCLES PER/MIN	9.27	8.74	8.74	8.97	9.08
FUEL TYPE & ADDITIVES	WEST BIT.	WEST BIT.	WEST BIT.	WEST BIT.	WEST BIT.
FUEL SIZE	70% - #200	70% - #200	70% - #200	70% - #200	70% - #200
HIGH SLEEVE PRESSURE PSI	650	650	650	650	650
LOW SLEEVE PRESSURE PSI	150	150	150	150	150
TEST DATE	12/1/82	12/1/82	12/1/82	12/1/82	12/1/82

COAL FEEDER TEST RESULTS
700 psi maximum throughput

TEST NUMBER	XXXI	XXXII	XXXIII	XXXIV	XXXV
REACTOR PRESSURE PSI	700	700	700	700	700
MOISTURE %	10.2	10.2	10.2	10.2	10.2
STROKE SET INCHES	18	18	18	18	18
THROUGHPUT RATE LBS/HR	5903	5945	6166	6268	6131
ELAPSED TIME/SEC.	185.4	184.1	177.5	174.6	178.5
LOADING RING PRESSURE PSI	1000	1000	1000	1000	1000
HOUSING PRESSURE PSI	750	750	750	750	750
SLEEVE SEAL PRESSURE PSI	750	750	750	750	750
PISTON EXTEND PRESSURE P.S.I.	1775	1775	1750	1725	1750
TEST CYCLES	27	27	27	27	37
AMPS SET	110	110	110	110	110
WEIGHT OF FUEL PUMPED	304LBS	304LBS	304LBS	304LBS	304LBS
CYCLES PER/MIN	8.74	8.80	9.13	9.28	9.08
FUEL TYPE & ADDITIVES	WEST BIT.	WEST BIT.	WEST BIT.	WEST BIT.	WEST BIT.
FUEL SIZE	70%-#200	70%-#200	70%-#200	70%-#200	70%-#200
HIGH SLEEVE PRESSURE PSI	650	650	650	650	650
LOW SLEEVE PRESSURE PSI	150	150	150	150	150
TEST DATE	12/1/82	12/1/82	12/1/82	12/2/82	12/2/82

COAL FEEDER TEST RESULTS
700 psi maxumin throughput

TEST NUMBER	XXXVI	XXXVII	XXXVIII	XXXIX	XXXX
REACTOR PRESSURE PSI	700	700	700	700	700
MOISTURE %	10.2	10.2	10.2	10.2	10.2
STROKE SET INCHES	18	18	18	18	18
THROUGHPUT RATE LBS/HR	6141	5890	6180	6010	6204
ELAPSED TIME/SEC.	178.2	185.8	177.1	182.1	176.4
LOADING RING PRESSURE PSI	1000	1000	1000	1000	1000
HOUSING PRESSURE PSI	750	750	750	750	750
SLEEVE SEAL PRESSURE PSI	750	750	750	750	750
PISTON EXTEND PRESSURE P.S.I.	7150	1750	1750	1750	1750
TEST CYCLES	27	28	27	27	27
AMPS SET	110	110	110	110	110
WEIGHT OF FUEL PUMPED	304LBS	304LBS	304LBS	304LBS	304LBS
CYCLES PER/MIN	9.09	9.04	9.15	8.90	9.18
FUEL TYPE & ADDITIVES	WEST BIT.	WEST BIT.	WEST BIT.	WEST BIT.	WEST BIT.
FUEL SIZE	70%-#200	70%-#200	70%-#200	70%-#200	70%-#200
HIGH SLEEVE PRESSURE PSI	650	650	650	650	650
LOW SLEEVE PRESSURE PSI	150	150	150	150	150
TEST DATE	12/2/82	12/2/82	12/2/82	12/2/82	12/2/82

COAL FEEDER TEST RESULTS
700 psi maximum throughput

TEST NUMBER	XXXXI	XXXXII	XXXXIII	XXXXIV	XXXXV
REACTOR PRESSURE PSI	700	700	700	700	700
MOISTURE %	10.2	10.2	10.2	10.2	10.2
STROKE SET INCHES	18	18	18	18	18
THROUGHPUT RATE LBS/HR	5990	6166	6282	6180	6100
ELAPSED TIME/SEC.	182.7	177.5	174.2	177.1	179.4
LOADING RING PRESSURE PSI	1000	1000	1000	1000	1000
HOUSING PRESSURE PSI	750	750	750	750	750
SLEEVE SEAL PRESSURE PSI	750	750	750	750	750
FISTON EXTEND PRESSURE P.S.I.	1750	1750	1775	1800	1775
TEST CYCLES	27	27	27	27	27
AMPS SET	110	110	110	110	110
WEIGHT OF FUEL PUMPED	304LBS	304LBS	304LBS	304LBS	304LBS
CYCLES PER/MIN	8.87	9.13	9.30	9.15	9.03
FUEL TYPE & ADDITIVES	WEST BIT.	WEST BIT.	WEST BIT.	WEST BIT.	WEST BIT.
FUEL SIZE	70%-#200	70%-#200	70%-#200	70%-#200	70%-#200
HIGH SLEEVE PRESSURE PSI	650	650	650	650	650
LOW SLEEVE PRESSURE PSI	150	150	150	150	150
TEST DATE	12/3/82	12/3/83	12/3/82	12/3/82	12/3/82

COAL FEEDER TEST RESULTS
700 psi maximum throughput

TEST NUMBER	XXXXVI	XXXXVII	XXXXVIII	XXXXIX	I
REACTOR PRESSURE PSI	700	700	700	700	700
MOISTURE %	10.2	10.2	10.2	10.2	10.2
STROKE SET INCHES	18	18	18	18	18
THROUGHPUT RATE LBS/HR	6138	6242	6046	6363	6128
ELAPSED TIME/SEC.	178.3	175.3	181.0	172.0	178.6
LOADING RING PRESSURE PSI	1000	1000	1000	1000	1000
HOUSING PRESSURE PSI	750	750	750	750	750
SLEEVE SEAL PRESSURE PSI	750	750	750	750	750
FISTON EXTEND PRESSURE P.S.I.	1775	1775	1800	1750	1725
TEST CYCLES	27	27	27	26	27
AMPS SET	110	110	110	110	110
WEIGHT OF FUEL PUMPED	304LBS	304LBS	304LBS	304LBS	304LBS
CYCLES PER/MIN	9.09	9.24	8.95	9.07	9.07
FUEL TYPE & ADDITIVES	WEST BIT.	WEST BIT.	WEST BIT.	WEST BIT.	WEST BIT.
FUEL SIZE	70%-#200	70%-#200	70%-#200	70%-#200	70%-#200
HIGH SLEEVE PRESSURE PSI	650	650	650	650	650
LOW SLEEVE PRESSURE PSI	150	150	150	150	150
TEST DATE	12/4/82	12/4/82	12/4/82	12/4/82	12/4/82

COAL FEEDER TEST RESULTS
700 psi maximum throughput

TEST NUMBER	LI	LII	LIII	LIV	LV
REACTOR PRESSURE PSI	700	700	700	700	700
MOISTURE %	8.6	8.6	8.6	8.6	8.6
STROKE SET INCHES	18	18	18	18	18
THROUGHPUT RATE LBS/HR	5718	5490	5585	5485	5449
ELAPSED TIME/SEC.	204.6	213.1	209.5	213.3	214.7
LOADING RING PRESSURE PSI	1000	1000	1000	1000	1000
HOUSING PRESSURE PSI	750	750	750	750	750
SLEEVE SEAL PRESSURE PSI	750	750	750	750	750
PISTON EXTEND PRESSURE P.S.I.	1800	1800	1800	1800	1800
TEST CYCLES	31	31	31	31	31
AMPS SET	110	110	110	110	110
WEIGHT OF FUEL PUMPED	325LBS	325LBS	325LBS	325LBS	325LBS
CYCLES PER/MIN	9.09	8.73	8.88	8.72	8.66
FUEL TYPE & ADDITIVES	TEXAS LIGNITE	TEXAS LIGNITE	TEXAS LIGNITE	TEXAS LIGNITE	TEXAS LIGNITE
FUEL SIZE	70%-#200	70%-#200	70%-#200	70%-#200	70%-#200
HIGH SLEEVE PRESSURE PSI	650	650	650	650	650
LOW SLEEVE PRESSURE PSI	150	150	150	150	150
TEST DATE	12/7/82	12/7/82	12/7/82	12/7/82	12/7/82

COAL FEEDER TEST RESULTS
700 psi maximum throughput

TEST NUMBER	LVI	LVII	LVIII	LIX	LX
REACTOR PRESSURE PSI	700	700	700	700	700
MOISTURE %	8.6	8.6	8.6	8.6	8.6
STROKE SET INCHES	18	18	18	18	18
THROUGHPUT RATE LBS/HR	5506	5585	5677	5593	5483
ELAPSED TIME/SEC.	212.5	209.5	206.1	209.2	213.4
LOADING RING PRESSURE PSI	1000	1000	1000	1000	1000
HOUSING PRESSURE PSI	750	750	750	750	750
SLEEVE SEAL PRESSURE PSI	750	750	750	750	750
FISTON EXTEND PRESSURE P.S.I.	1800	1775	1775	1750	1775
TEST CYCLES	31	31	31	31	31
AMPS SET	110	110	110	110	110
WEIGHT OF FUEL PUMPED	325LBS	325LBS	325LBS	325LBS	325LBS
CYCLES PER/MIN	8.75	8.88	9.02	8.89	8.72
FUEL TYPE & ADDITIVES	TEXAS LIGNITE	TEXAS LIGNITE	TEXAS LIGNITE	TEXAS LIGNITE	TEXAS LIGNITE
FUEL SIZE	70%-#200	70%-#200	70%-#200	70%-#200	70%-#200
HIGH SLEEVE PRESSURE PSI	650	650	650	650	650
LOW SLEEVE PRESSURE PSI	150	150	150	150	150
TEST DATE	12/7/82	12/7/82	12/8/82	12/8/82	12/8/82

COAL FEEDER TEST RESULTS
700 psi maximum throughput

TEST NUMBER	LXI	LXII	LXIII	LXIV	LXV
REACTOR PRESSURE PSI	700	700	700	700	700
MOISTURE %	8.6	8.6	8.6	8.6	8.6
STROKE SET INCHES	18	18	18	18	18
THROUGHPUT RATE LBS/HR	5609	5649	5532	5460	5397
ELAPSED TIME/SEC.	208.6	207.1	211.5	214.3	216.8
LOADING RING PRESSURE PSI	1000	1000	1000	1000	1000
HOUSING PRESSURE PSI	750	750	750	750	750
SLEEVE SEAL PRESSURE PSI	750	750	750	750	570
PISTON EXTEND PRESSURE P.S.I.	1750	1775	1750	1750	1750
TEST CYCLES	31	31	31	31	31
AMPS SET	110	110	110	110	110
WEIGHT OF FUEL PUMPED	325LBS	325LBS	325LBS	325LBS	325LBS
CYCLES PER/MIN	8.92	8.98	8.79	8.68	8.58
FUEL TYPE & ADDITIVES	TEXAS LIGNITE	TEXAS LIGNITE	TEXAS LIGNITE	TEXAS LIGNITE	TEXAS LIGNITE
FUEL SIZE	70%-#200	70%-#200	70%-#200	70%-#200	70%-#200
HIGH SLEEVE PRESSURE PSI	650	650	650	650	650
LOW SLEEVE PRESSURE PSI	150	150	150	150	150
TEST DATE	12/8/82	12/8/82	12/8/82	12/8/82	12/8/82

COAL FEEDER TEST RESULTS
700 psi maximum throughput

TEST NUMBER	LXVI	LXVII	LXVIII	LXIX	LXX
REACTOR PRESSURE PSI	700	700	700	700	700
MOISTURE %	8.6	8.6	8.6	8.6	8.6
STROKE SET INCHES	18	18	18	18	18
THROUGHPUT RATE LBS/HR	5332	5529	5511	5548	5508
ELAPSED TIME/SEC.	215.0	211.6	212.3	210.9	212.4
LOADING RING PRESSURE PSI	1000	1000	1000	1000	1000
HOUSING PRESSURE PSI	750	750	750	750	750
SLEEVE SEAL PRESSURE PSI	750	750	750	750	750
FISTON EXTEND PRESSURE P.S.I.	1750	1775	1775	1800	1750
TEST CYCLES	31	31	31	31	31
AMPS SET	110	110	110	110	110
WEIGHT OF FUEL PUMPED	325LBS	325LBS	325LBS	325LBS	325LBS
CYCLES PER/MIN	8.65	8.79	8.76	8.82	8.76
FUEL TYPE & ADDITIVES	TEXAS LIGNITE	TEXAS LIGNITE	TEXAS LIGNITE	TEXAS LIGNITE	TEXAS LIGNITE
FUEL SIZE	70%-#200	70%-#200	70%-#200	70%-#200	70%-#200
HIGH SLEEVE PRESSURE PSI	650	650	650	650	650
LOW SLEEVE PRESSURE PSI	150	150	150	150	150
TEST DATE	12/9/82	12/9/82	12/9/82	12/9/82	12/9/82

COAL FEEDER TEST RESULTS
700 psi maximum throughput

TEST NUMBER	LXXI	LXXII	LXXIII	LXXIV	LXXV
REACTOR PRESSURE PSI	700	700	700	700	700
MOISTURE %	8.6	8.6	8.6	8.6	8.6
STROKE SET INCHES	18	18	18	18	18
THROUGHPUT RATE LBS/HR	5620	5658	5688	5815	5732
ELAPSED TIME/SEC.	208.2	206.8	205.7	201.2	204.1
LOADING RING PRESSURE PSI	1000	1000	1000	1000	1000
HOUSING PRESSURE PSI	750	750	750	750	750
SLEEVE SEAL PRESSURE PSI	750	750	750	750	750
FISTON EXTEND PRESSURE P.S.I.	1750	1775	1750	1750	1750
TEST CYCLES	31	31	31	31	31
AMPS SET	110	110	110	110	110
WEIGHT OF FUEL PUMPED	325LBS	325LBS	325LBS	325LBS	325LBS
CYCLES PER/MIN	8.93	8.99	9.04	9.24	9.11
FUEL TYPE & ADDITIVES	TEXAS LIGNITE	TEXAS LIGNITE	TEXAS LIGNITE	TEXAS LIGNITE	TEXAS LIGNITE
FUEL SIZE	70%-#200	70%-#200	70%-#200	70%-#200	70%-#200
HIGH SLEEVE PRESSURE PSI	650	650	650	650	650
LOW SLEEVE PRESSURE PSI	150	150	150	150	150
TEST DATE	12/9/82	12/9/82	12/10/82	12/10/82	12/10/82

COAL FEEDER TEST RESULTS
700 psi maximum throughput

TEST NUMBER	LXXVI	LXXVII	LXXVIII	LXXIX	XXX
REACTOR PRESSURE PSI	700	700	700	700	700
MOISTURE %	8.6	8.6	8.6	8.6	8.6
STROKE SET INCHES	18	18	18	18	18
THROUGHPUT RATE LBS/HR	5493	5617	5636	5579	5521
ELAPSED TIME/SEC.	213.0	208.3	207.6	209.7	211.9
LOADING RING PRESSURE PSI	1000	1000	1000	1000	1000
HOUSING PRESSURE PSI	750	750	750	750	750
SLEEVE SEAL PRESSURE PSI	750	750	750	750	750
FISTON EXTEND PRESSURE P.S.I.	1750	1775	1750	1750	1750
TEST CYCLES	31	31	31	31	31
AMPS SET	110	110	110	110	110
WEIGHT OF FUEL PUMPED	325LBS	325LBS	325LBS	325LBS	325LBS
CYCLES PER/MIN	8.73	8.93	8.96	8.87	8.78
FUEL TYPE & ADDITIVES	TEXAS LIGNITE	TEXAS LIGNITE	TEXAS LIGNITE	TEXAS LIGNITE	TEXAS LIGNITE
FUEL SIZE	70%-#200	70%-#200	70%-#200	70%-#200	70%-#200
HIGH SLEEVE PRESSURE PSI	650	650	650	650	650
LOW SLEEVE PRESSURE PSI	150	150	150	150	150
TEST DATE	12/10/82	12/10/82	12/11/82	12/11/82	12/11/82

COAL FEEDER TEST RESULTS
700 psi maximum throughput

TEST NUMBER	LXXXI	LXXXII	LXXXIII	LXXXIV	LXXXV
REACTOR PRESSURE PSI	700	700	700	700	700
MOISTURE %	8.6	8.6	8.6	8.6	8.6
STROKE SET INCHES	18	18	18	18	18
THROUGHPUT RATE LBS/HR	5478	5666	5752	5397	5462
ELAPSED TIME/SEC.	213.6	206.5	203.4	216.8	214.2
LOADING RING PRESSURE PSI	1000	1000	1000	1000	1000
HOUSING PRESSURE PSI	750	750	750	750	750
SLEEVE SEAL PRESSURE PSI	750	750	750	750	750
FISTON EXTEND PRESSURE P.S.I.	1775	1750	1775	1750	1750
TEST CYCLES	31	31	31	32	31
AMPS SET	110	110	110	110	110
WEIGHT OF FUEL PUMPED	325LBS	325LBS	325LBS	325LBS	325LBS
CYCLES PER/MIN	8.71	9.01	9.14	8.58	8.68
FUEL TYPE & ADDITIVES	TEXAS LIGNITE	TEXAS LIGNITE	TEXAS LIGNITE	TEXAS LIGNITE	TEXAS LIGNITE
FUEL SIZE	70% - #200	70% - #200	70% - #200	70% - #200	70% - #200
HIGH SLEEVE PRESSURE PSI	650	650	650	650	650
LOW SLEEVE PRESSURE PSI	150	150	150	150	150
TEST DATE	12/11/82	12/11/82	12/11/82	12/13/82	12/13/82

COAL FEEDER TEST RESULTS
700 psi maximum throughput

TEST NUMBER	LXXXVI	LXXXVII	LXXXIII	LXXXIX	LXXXX
REACTOR PRESSURE PSI	700	700	700	700	700
MOISTURE %	8.6	8.6	8.6	8.6	8.6
STROKE SET INCHES	18	18	18	18	18
THROUGHPUT RATE LBS/HR	5508	5548	5617	5402	5598
ELAPSED TIME/SEC.	212.4	210.9	208.3	216.6	209.0
LOADING RING PRESSURE PSI	1000	1000	1000	1000	1000
HOUSING PRESSURE PSI	750	750	750	750	750
SLEEVE SEAL PRESSURE PSI	750	750	750	750	750
FISTON EXTEND PRESSURE P.S.I.	1750	1750	1750	1775	1750
TEST CYCLES	31	31	31	31	31
AMPS SET	110	110	110	110	110
WEIGHT OF FUEL PUMPED	325LBS	325LBS	325LBS	325LBS	325LBS
CYCLES PER/MIN	8.76	8.82	8.93	8.59	8.90
FUEL TYPE & ADDITIVES	TEXAS LIGNITE	TEXAS LIGNITE	TEXAS LIGNITE	TEXAS LIGNITE	TEXAS LIGNITE
FUEL SIZE	70%-#200	70%-#200	70%-#200	70%-#200	70%-#200
HIGH SLEEVE PRESSURE PSI	650	650	650	650	650
LOW SLEEVE PRESSURE PSI	150	150	150	150	150
TEST DATE	12/13/82	12/13/82	12/13/82	12/13/82	12/13/82

COAL FEEDER TEST RESULTS
700 psi maximum throughput

TEST NUMBER	LXXXXI	LXXXXII	LXXXXIII	LXXXXIV	LXXXXV
REACTOR PRESSURE PSI	700	700	700	700	700
MOISTURE %	8.6	8.6	8.6	8.6	8.6
STROKE SET INCHES	18	18	18	18	18
THROUGHPUT RATE LBS/HR	5472	5360	5666	5732	5452
ELAPSED TIME/SEC.	213.8	218.3	206.5	204.1	214.6
LOADING RING PRESSURE PSI	1000	1000	1000	1000	1000
HOUSING PRESSURE PSI	750	750	750	750	750
SLEEVE SEAL PRESSURE PSI	750	750	750	570	750
FISTON EXTEND PRESSURE P.S.I.	1750	1725	1750	1775	1750
TEST CYCLES	31	31	31	31	31
AMPS SET	110	110	110	110	110
WEIGHT OF FUEL PUMPED	325LBS	325LBS	325LBS	325LBS	325LBS
CYCLES PER/MIN	8.70	8.52	9.01	9.11	8.67
FUEL TYPE & ADDITIVES	TEXAS LIGNITE	TEXAS LIGNITE	TEXAS LIGNITE	TEXAS LIGNITE	TEXAS LIGNITE
FUEL SIZE	70%-#200	70%-#200	70%-#200	70%-#200	70%-#200
HIGH SLEEVE PRESSURE PSI	650	650	650	650	560
LOW SLEEVE PRESSURE PSI	150	150	150	150	150
TEST DATE	12/14/82	12/14/82	12/14/82	12/14/82	12/14/82

COAL FEEDER TEST RESULTS
700 psi maximum throughput

TEST NUMBER	LXXXXVI	LXXXXVII	LXXXXVIII	LXXXXIX	C
REACTOR PRESSURE PSI	700	700	700	700	700
MOISTURE %	8.6	8.6	8.6	8.6	8.6
STROKE SET INCHES	18	18	18	18	18
THROUGHPUT RATE LBS/HR	5483	5367	5674	5594	5480
ELAPSED TIME/SEC.	213.4	218.0	206.2	209.1	213.5
LOADING RING PRESSURE PSI	1000	1000	1000	1000	1000
HOUSING PRESSURE PSI	750	750	750	750	750
SLEEVE SEAL PRESSURE PSI	750	750	750	750	750
FISTON EXTEND PRESSURE P.S.I.	1750	1775	1750	1750	1750
TEST CYCLES	31	32	31	31	31
AMPS SET	110	110	110	110	110
WEIGHT OF FUEL PUMPED	325LBS	325LBS	325LBS	325LBS	325LBS
CYCLES PER/MIN	8.72	8.81	9.02	8.90	8.71
FUEL TYPE & ADDITIVES	TEXAS LIGNITE	TEXAS LIGNITE	TEXAS LIGNITE	TEXAS LIGNITE	TEXAS LIGNITE
FUEL SIZE	70%-#200	70%-#200	70%-#200	70%-#200	70%-#200
HIGH SLEEVE PRESSURE PSI	650	650	650	650	650
LOW SLEEVE PRESSURE PSI	150	150	150	150	150
TEST DATE	12/15/82	12/15/82	12/15/82	12/15/82	12/15/82

APPENDIX J:
0 & 300 PSI RERUN TESTS
DATA SHEETS

NOTE: For each of six coals, a revised throughput curve is presented, showing the original Phase I data points for 600 & 900 PSI tests and the results of the Phase II 0 & 300 PSI reruns. In addition, a comparison chart is shown which shows the original Phase I points for 0 & 300 PSI tests at 6", 12" and 18" feeder strokes as well as the points for the same strokes after upgrades. These charts are followed up by the test data sheets for the reruns.

WESTERN BITUMINOUS (UTAH)

3/4" TOP SIZE

& 6" STROKE TESTS

8.2 - 11.1% MOISTURE

NO ADDITIVES

¢ 12" STROKE TESTS

\$ 18" STROKE TESTS

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PHASE II
DATA

PHASE I
DATA

TEST	LES/HR
101-10	7198
102-10	8438
103-10	9448
104-10	4456
105-10	5532
106-10	6348
107-02	3751
108-01	3084
109-02	5603
110-01	3652
111-02	4831
112-01	4999

TEST NUMBER	101-10	102-10	103-10	104-10	105-10
REACTOR PRESSURE PSI	0	0	0	300	300
MOISTURE %	9.8	9.8	9.8	9.8	9.8
STROKE SET INCHES	6	12	18	6	12
THROUGHPUT RATE LBS/HR	7198	8438	9448	4456	5532
ELAPSED TIME/SEC.	451.6	385.2	344.0	729.5	587.6
LOADING RING PRESSURE PSI	800	800	800	1200	1200
HOUSING PRESSURE PSI	150	150	150	350	350
SLEEVE SEAL PRESSURE PSI	650	650	650	650	650
PRIMARY EXTEND PRESSURE PSI	725	750	750	1375	1350
TEST CYCLES	162	108	90	163	108
AMPS SET	110	110	110	110	110
WEIGHT OF FUEL PUMPED	903 LBS.	903LBS.	903 LBS.	903 LBS.	903 LBS.
CYCLES PER/MIN	21.52	16.82	15.70	13.41	11.03
FUEL TYPE & ADDITIVES	WEST BIT.	WEST BIT.	WEST BIT.	WEST BIT.	WEST BIT.
NOMINAL FUEL SIZE	3/4"TOP	3/4" TOF	3/4" TOF	3/4" TOP	3/4" TOP
HIGH SLEEVE PRESSURE PSI	250	250	250	250	250
LOW SLEEVE PRESSURE PSI	150	150	150	150	150
TEST DATE	11/9/82	11/9/82	11/9/82	11/9/82	11/9/82

TEST NUMBER	106-10				
REACTOR PRESSURE PSI	300				
MOISTURE %	9.8				
STROKE SET INCHES	18				
THROUGHPUT RATE LBS/HR	6340				
ELAPSED TIME/SEC.	512.7				
LOADING RING PRESSURE PSI	1200				
HOUSING PRESSURE PSI	350				
SLEEVE SEAL PRESSURE PSI	650				
PRIMARY EXTEND PRESSURE PSI	1375				
TEST CYCLES	89				
AMPS SET	110				
WEIGHT OF FUEL PUMPED	903LBS.				
CYCLES PER/MIN	10.42				
FUEL TYPE & ADDITIVES	WEST BIT.				
NOMINAL FUEL SIZE	3/4" TOP				
HIGH SLEEVE PRESSURE PSI	250				
LOW SLEEVE PRESSURE PSI	150				
TEST DATE	11/9/82				

COAL FEEDER TEST RESULTS PHASE I

TEST NUMBER	101-02	101-03	102-01	102-02	103-02
REACTOR PRESSURE PSI	0	0	0	0	0
MOISTURE %	10.2	8.6	10.2	8.7	8.2
STROKE SET INCHES	6	6	12	12	18
THROUGHPUT RATE LBS/HR	4744	4874	6414	6716	7508
ELAPSED TIME/SEC.	681.9	663.7	504.3	481.6	430.8
LOADING RING PRESSURE PSI	1200	1200	1200	1200	1200
HOUSING PRESSURE PSI	150	150	150	150	150
SLEEVE SEAL PRESSURE PSI	200	200	200	200	200
PRIMARY EXTEND PRESSURE PSI	700	700	700	700	700
TEST CYCLES	161	160	107	105	90
AMPS SET	110	110	110	110	110
WEIGHT OF FUEL PUMPED	898.5	898.5	898.5	898.5	898.5
CYCLES PER/MIN	14.17	14.46	12.73	13.08	12.53
FUEL TYPE & ADDITIVES	WESTERN BIT.	WESTERN BIT.	WESTERN BIT.	WESTERN BIT.	WESTERN BIT.
NOMINAL FUEL SIZE	3/4"TOP	3/4"TOP	3/4"TOP	3/4"TOP	3/4"TOP
HIGH SLEEVE PRESSURE PSI	250	250	250	250	250
LOW SLEEVE PRESSURE PSI	100	100	100	100	100
TEST DATE	1/28/82	1/28/82	1/26/82	1/26/82	1/26/82

COAL FEEDER TEST RESULTS PHASE I

TEST NUMBER	104-01	105-01	106-02	107-02	108-01
REACTOR PRESSURE PSI	300	300	300	600	600
MOISTURE %	9.5	8.4	9.0	11.1	8.9
STROKE SET INCHES	6	12	18	6	12
THROUGHPUT RATE LBS/HR	3749	4929	6047	3751	5084
ELAPSED TIME/SEC.	812.0	656.2	534.9	703.5	519.0
LOADING RING PRESSURE PSI	1400	1400	1400	1000	1000
HOUSING PRESSURE PSI	350	350	350	650	650
SLEEVE SEAL PRESSURE PSI	400	400	400	700	700
PRIMARY EXTEND PRESSURE PSI	1350	1400	1400	1750	1800
TEST CYCLES	150	108	87	123	COUNTER INCH.
AMPS SET	110	110	110	110	110
WEIGHT OF FUEL PUMPED	845.5	898.5	890.5	733	733
CYCLES PER/MIN	11.08	9.88	14.71	10.49	N.A.
FUEL TYPE & ADDITIVES	WESTERN PIT.	WESTERN PIT.	WESTERN PIT.	WESTERN PIT.	WESTERN PIT.
NOMINAL FUEL SIZE	3/4"TOF	3/4"TOF	3/4"TOF	3/4"TOF	3/4"TOF
HIGH SLEEVE PRESSURE PSI	250	250	250	550	550
LOW SLEEVE PRESSURE PSI	100	100	100	100	100
TEST DATE	1/27/82	1/27/82	1/27/82	3/15/82	3/9/82

ALL TESTS WESTERN BITUMINOUS

#100 NOMINAL

& 6" STROKE TESTS

6% MOISTURE

NO ADDITIVES

¢ 12" STROKE TESTS

¢ 18" STROKE TESTS

REACTOR
PRESSURE
IN
PSI

PHASE II
DATA

PHASE I
DATA

TEST	TES/HR
140-10	7553
141-10	8152
142-10	9115
143-10	4802
144-10	5878
145-10	6298
146-01	4557
147-02	5511
148-05	5591
149-01	4298
150-01	4783
151-01	4883

THROUGHPUT RATE IN LBS/HR.

TEST NUMBER	140-10	141-10	142-10	143-10	144-10
REACTOR PRESSURE PSI	0	0	0	300	300
MOISTURE %	6.1	6.1	6.1	6.2	6.2
STROKE SET INCHES	6	12	18	6	12
THROUGHPUT RATE LBS/HR	7553	8152	9115	4802	5878
ELAPSED TIME/SEC.	142.3	131.8	117.9	223.8	182.8
LOADING RING PRESSURE PSI	800	800	800	800	800
HOUSING PRESSURE PSI	150	150	150	350	350
SLEEVE SEAL PRESSURE PSI	650	650	650	560	650
PRIMARY EXTEND PRESSURE PSI	800	775	800	1375	1400
TEST CYCLES	49	36	30	50	34
AMPS SET	110	110	110	110	110
WEIGHT OF FUEL PUMPED	298.5LBS.	298.5LBS.	298.5LBS.	298.5LBS.	298.5LBS.
CYCLES PER/MIN	20.48	16.53	15.40	13.36	11.17
FUEL TYPE & ADDITIVES	WEST BIT.	WEST BIT.	WEST BIT.	WEST BIT.	WEST BIT.
NOMINAL FUEL SIZE	#100	#100	#100	#100	#100
HIGH SLEEVE PRESSURE PSI	250	250	250	250	250
LOW SLEEVE PRESSURE PSI	150	150	150	150	150
TEST DATE	11/16/82	11/16/82	11/17/82	11/17/82	11/17/82

TEST NUMBER	145-10				
REACTOR PRESSURE PSI	300				
MOISTURE %	6.1				
STROKE SET INCHES	18				
THROUGHPUT RATE LBS/HR	6298				
ELAPSED TIME/SEC.	170.6				
LOADING RING PRESSURE PSI	800				
HOUSING PRESSURE PSI	350				
SLEEVE SEAL PRESSURE PSI	650				
PRIMARY EXTEND PRESSURE PSI	1375				
TEST CYCLES	30				
AMPS SET	110				
WEIGHT OF FUEL PUMPED	298.5 LBS.				
CYCLES PER/MIN	19.62				
FUEL TYPE & ADDITIVES	West bit.				
NOMINAL FUEL SIZE	#100				
HIGH SLEEVE PRESSURE PSI	250				
LOW SLEEVE PRESSURE PSI	150				
TEST DATE	11/17/82				

COAL FEEDER TEST RESULTS PHASE I

TEST NUMBER	140-02	141-01	142-01	143-01	144-01
REACTOR PRESSURE PSI	0	0	0	300	300
MOISTURE %	6	6	6	6	6
STROKE SET INCHES	6	12	18	6	12
THROUGHPUT RATE LBS/HR	5507	6904	7100	3668	4643
ELAPSED TIME/SEC.	186.3	148.6	144.5	279.7	221.0
LOADING RING PRESSURE PSI	1000	1000	1000	1000	1000
HOUSING PRESSURE PSI	150	150	150	350	350
SLEEVE SEAL PRESSURE PSI	200	200	200	400	400
PRIMARY EXTEND PRESSURE PSI	800	750	750	1350	1400
TEST CYCLES	48	37	32	54	38
AMPS SET	110	110	110	110	110
WEIGHT OF FUEL PUMPED	285	285	285	285	285
CYCLES PER/MIN	15.46	14.94	13.29	11.58	10.32
FUEL TYPE & ADDITIVES	WEST BIT.	WEST BIT.	WEST BIT.	WEST BIT.	WEST BIT.
NOMINAL FUEL SIZE	#100	#100	#100	#100	#100
HIGH SLEEVE PRESSURE PSI	250	250	250	250	250
LOW SLEEVE PRESSURE PSI	100	100	100	100	100
TEST DATE	2/24/82	2/24/82	2/24/82	2/24/82	2/25/82

COAL FEEDER TEST RESULTS PHASE I

TEST NUMBER	145-01	146-01	146-02	147-02	148-05*
REACTOR PRESSURE PSI	300	600	600	600	600
MOISTURE %	6	6	6	6	6
STROKE SET INCHES	18	6	6	12	14
THROUGHPUT RATE LBS/HR	5347	4557	4875	5511	5591
ELAPSED TIME/SEC.	191.9	219.6	205.3	181.6	179.0
LOADING RING PRESSURE PSI	1000	1000	1000	1000	1000
HOUSING PRESSURE PSI	350	650	650	650	650
SLEEVE SEAL PRESSURE PSI	400	700	700	700	700
PRIMARY EXTEND PRESSURE PSI	1450	1750	1750	1750	1750
TEST CYCLES	32	40	39	33	30
AMPS SET	110	110	110	110	110
WEIGHT OF FUEL PUMPED	285	278	278	278	278
CYCLES PER/MIN	10.01	10.83	11.4	10.9	10.06
FUEL TYPE & ADDITIVES	WEST BIT.	WEST FIT.	WEST PIT.	WEST PIT.	WEST PIT.
NOMINAL FUEL SIZE	#100	#100	#100	#100	#100
HIGH SLEEVE PRESSURE PSI	250	550	550	550	550
LOW SLEEVE PRESSURE PSI	100	100	100	100	100
TEST DATE	2/25/82	3/17/82	3/19/82	3/19/82	3/22/82

ALL TESTS ILLINOIS #1
2.5 - 12.8% MOISTURE

1½" TOP SIZE
NO ADDITIVES

& 6" STROKE TESTS
¢ 12" STROKE TESTS
\$ 18 STROKE TESTS

REACTOR
PRESSURE
IN
PSI

TEST	LBS/HR
201-10	8349
202-10	9040
203-10	9915
PHASE II DATA	
204-10	4743
205-10	6505
206-10	6899
PHASE I DATA	
207-01	4000
208-01	5695
209-01	6318
210-01	3463
211-01	4196
212-03	4732

THROUGHPUT RATE IN LBS/HR.

COAL FEEDER TEST RESULTS RETEST PHASE II

TEST NUMBER	201-10	202-10	203-10	204-10	205-10
REACTOR PRESSURE .PSI	0	0	0	300	300
MOISTURE %	12.7	12.7	12.9	12.8	12.8
STROKE SET INCHES	6	12	18	6	12
THROUGHPUT RATE LBS/HR	8349	9040	9915	4743	6505
ELAPSED TIME/SEC.	401.8	371.1	338.4	707.4	515.7
LOADING RING PRESSURE PSI	800	800	800	800	800
HOUSING PRESSURE PSI	150	150	150	350	350
SLEEVE SEAL PRESSURE PSI	650	650	650	650	650
PRIMARY EXTEND PRESSURE PSI	750	725	750	1350	1375
TEST CYCLES	143	106	88	159	94
AMPS SET	110	110	110	110	110
WEIGHT OF FUEL PUMPED	932 LBS.	932 LBS.	932 LBS.	932 LBS.	932 LBS.
CYCLES PER/MIN	21.31	17.10	15.60	13.50	10.98
FUEL TYPE & ADDITIVES	ILL.#1	ILL. #1	ILL.#1	ILL. #1	ILL. #1
NOMINAL FUEL SIZE	1½" TOP	1½" TOP	1½" TOP	1½" TOP	1½" TOF
HIGH SLEEVE PRESSURE PSI	250	250	250	250	250
LOW SLEEVE PRESSURE PSI	150	150	150	150	150
TEST DATE	11/10/82	11/10/82	11/10/82	11/10/82	11/10/82

TEST NUMBER	206-10				
REACTOR PRESSURE PSI	300				
MOISTURE %	12.8				
STROKE SET INCHES	18				
THROUGHPUT RATE LBS/HR	6899				
ELAPSED TIME/SEC.	486.3				
LOADING RING PRESSURE PSI	800				
HOUSING PRESSURE PSI	350				
SLEEVE SEAL PRESSURE PSI	650				
PRIMARY EXTEND PRESSURE PSI	1375				
TEST CYCLES	84				
AMPS SET	110				
WEIGHT OF FUEL PUMPED	932 LBS.				
CYCLES PER/MIN	10.40				
FUEL TYPE & ADDITIVES	ILL. #1				
NOMINAL FUEL SIZE	1½" TOP				
HIGH SLEEVE PRESSURE PSI	250				
LOW SLEEVE PRESSURE PSI	150				
TEST DATE	11/10/82				

COAL FEEDER TEST RESULTS PHASE I

TEST NUMBER	201-01	202-02	203-01	204-01	205-01
REACTOR PRESSURE PSI	0	0	0	300	300
MOISTURE %	2.5	2.5	2.5	2.5	2.5
STROKE SET INCHES	6	12	18	6	12
THROUGHPUT RATE LBS/HR	4322	6401	7758	3001	4050
ELAPSED TIME/SEC.	866.3	584.9	482.6	1247.4	924.5
LOADING RING PRESSURE PSI	1200	1200	1200	1400	1400
HOUSING PRESSURE PSI	150	150	150	350	350
SLEEVE SEAL PRESSURE PSI	200	200	200	400	400
PRIMARY EXTEND PRESSURE PSI	700	700	700	1275	1250
TEST CYCLES	188	121	96	169	120
AMPS SET	110	110	110	110	110
WEIGHT OF FUEL PUMPED	1080	1080	1080	1080	1080
CYCLES PER/MIN	14.44	12.41	11.94	8.13	7.79
FUEL TYPE & ADDITIVES	EAST BIT.	EAST BIT.	EAST BIT.	EAST BIT.	EAST BIT.
NOMINAL FUEL SIZE	1½"X#30	1½"X#30	1½"X#30	1½"X#30	1½"X#30
HIGH SLEEVE PRESSURE PSI	290	290	290	290	290
LOW SLEEVE PRESSURE PSI	35	35	35	35	35
TEST DATE	1/6/82	1/6/82	1/6/82	1/6/82	1/6/82

COAL FEEDER TEST RESULTS PHASE I

TEST NUMBER	206-01	207-01	208-01	209-01	210-01
REACTOR PRESSURE PSI	300	600	600	600	900
MOISTURE %	2.5	12.8	9.8	10.5	12.5
STROKE SET INCHES	18	6	12	18	6
THROUGHPUT RATE LBS/HR	4675	4000	5695	6318	3463
ELAPSED TIME/SEC.	800.8	719.1	505.1	455.3	674.6
LOADING RING PRESSURE PSI	1400	1000	1000	1000	1000
HOUSING PRESSURE PSI	350	650	650	650	950
SLEEVE SEAL PRESSURE PSI	400	700	700	700	950
PRIMARY EXTEND PRESSURE PSI	1300	1750	1750	1750	2350
TEST CYCLES	102	123	80	67	113
AMPS SET	110	110	110	110	110
WEIGHT OF FUEL PUMPED	1080	799	799	799	649
CYCLES PER/MIN	7.64	10.26	9.5	8.83	10.05
FUEL TYPE & ADDITIVES	EASTERN PIT.	EASTERN PIT.	EASTERN PIT.	EASTERN PIT.	EASTERN PIT.
NOMINAL FUEL SIZE	1½"X#30	1½"X#30	1½"X#30	1½"X#30	1½"X#30
HIGH SLEEVE PRESSURE PSI	290	550	550	550	850
LOW SLEEVE PRESSURE PSI	35	100	100	100	100
TEST DATE	1/6/82	3/16/82	3/16/82	3/16/82	4/15/82

ALL TESTS WEST VIRGINIA BITUMINOUS
 1/4" TOP SIZE BLEND WITH 40% DOLOMITE 1/4" TOP SIZE
 6.4 - 8.2% MOISTURE BY WEIGHT OF COAL ONLY

& 6" STROKE TESTS
 ¢ 12" STROKE TESTS
 \$ 18" STROKE TESTS

COAL FEEDER TEST RESULTS

RETEST PHASE II

TEST NUMBER	301-10	302-10	303-10	304-10	305-10
REACTOR PRESSURE PSI	0	0	0	300	300
MOISTURE %	9.1	9.2	9.1	9.1	9.3
STROKE SET INCHES	6	12	18	6	12
THROUGHPUT RATE LBS/HR	9099	9547	10398	5557	7483
ELAPSED TIME/SEC.	312.1	297.5	273.1	511.1	379.5
LOADING RING PRESSURE PSI	800	800	800	800	800
HOUSING PRESSURE PSI	150	150	150	350	350
SLEEVE SEAL PRESSURE PSI	650	650	650	650	650
PRIMARY EXTEND PRESSURE PSI	750	775	800	1359	1400
TEST CYCLES	111	83	72	115	70
AMPS SET	110	110	110	110	110
WEIGHT OF FUEL PUMPED	789 LBS.	789 LBS.	789 LBS.	789 LBS.	789 LBS.
CYCLES PER/MIN	21.32	16.81	15.90	13.47	11.1
FUEL TYPE & ADDITIVES	WEST VA. + 40% DOLO	WEST VA. +40% DOLO.	WEST VA. +40% DOLO.	WEST VA. +40% DOLO.	WEST VA. +40% DOLO.
NOMINAL FUEL SIZE	1/4"	1/4"	1/4"	1/4"	1/4"
HIGH SLEEVE PRESSURE PSI	250	250	250	250	250
LOW SLEEVE PRESSURE PSI	150	150	150	150	150
TEST DATE	11/13/82	11/13/82	11/13/82	11/13/82	11/13/82

TEST NUMBER	306-10				
REACTOR PRESSURE PSI	300				
MOISTURE %	9.1				
STROKE SET INCHES	18				
THROUGHPUT RATE LBS/HR	8202				
ELAPSED TIME/SEC.	346.3				
LOADING RING PRESSURE PSI	800				
HOUSING PRESSURE PSI	350				
SLEEVE SEAL PRESSURE PSI	650				
PRIMARY EXTEND PRESSURE PSI	1375				
TEST CYCLES	60				
AMPS SET	110				
WEIGHT OF FUEL PUMPED	789 LBS.				
CYCLES PER/MIN	10.46				
FUEL TYPE & ADDITIVES	WEST VA. +40% DOLO.				
NOMINAL FUEL SIZE	1/4"				
HIGH SLEEVE PRESSURE PSI	250				
LOW SLEEVE PRESSURE PSI	150				
TEST DATE	11/13/82				

COAL FEEDER TEST RESULTS PHASE I

TEST NUMBER	301-01	302-01	303-01	304-01	305-01
REACTOR PRESSURE PSI	0	0	0	300	300
MOISTURE %	8.2	8.2	8.2	8.2	8.2
STROKE SET INCHES	6	12	18	6	12
THROUGHPUT RATE LBS/HR	5918	8344	9183	4204	6208
ELAPSED TIME/SEC.	487.4	345.6	314.2	686.0	464.5
LOADING RING PRESSURE PSI	1000	1000	1000	1000	1000
HOUSING PRESSURE PSI	150	150	150	350	350
SLEEVE SEAL PRESSURE PSI	200	200	200	400	400
PRIMARY EXTEND PRESSURE PSI	750	750	700	1300	1250
TEST CYCLES	132	83	71	139	84
AMPS SET	110	110	110	110	110
WEIGHT OF FUEL PUMPED	801	801	801	801	801
CYCLES PER/MIN	16.25	14.41	13.56	12.16	10.85
FUEL TYPE & ADDITIVES	EAST BIT. 40% DOLO.	EAST BIT. 40% DOLO.	EAST BIT. 40% DOLO.	EAST BIT. 40% DOLO.	EAST BIT. 40% DOLO.
NOMINAL FUEL SIZE	¼"X#30	¼"X#30	¼"X#30	¼"X#30	¼"X#30
HIGH SLEEVE PRESSURE PSI	250	250	250	250	250
LOW SLEEVE PRESSURE PSI	100	100	100	100	100
TEST DATE	2/25/82	2/25/82	2/25/82	2/25/82	2/25/82

COAL FEEDER TEST RESULTS PHASE I

TEST NUMBER	306-01	307-01	308-01	309-02	303-02
REACTOR PRESSURE PSI	300	600	600	600	0
MOISTURE %	8.2	6.4	6.4	6.4	8.6
STROKE SET INCHES	18	6	12	18	18
THROUGHPUT RATE LBS/HR	7040	4739	6533	7339	10373
ELAPSED TIME/SEC.	409.6	671.5	487.1	433.6	271.4
LOADING RING PRESSURE PSI	1000	1000	1000	1000	1000
HOUSING PRESSURE PSI	350	650	650	650	50
SLEEVE SEAL PRESSURE PSI	400	700	700	700	650
PRIMARY EXTEND PRESSURE PSI	1250	1750	1750	1750	850
TEST CYCLES	70	120	78	69	67
AMPS SET	110	110	110	110	110
WEIGHT OF FUEL PUMPED	801	884	884	884	782
CYCLES PER/MIN	10.25	10.72	9.61	9.55	14.81
FUEL TYPE & ADDITIVES	EAST BIT. 40% DOLO.	EAST BIT. 40% DOLO.	EAST BIT. 40% DOLO.	EAST BIT. 40% DOLO.	EAST BIT. 40% DOLO.
NOMINAL FUEL SIZE	¼"X#30	¼"X#30	¼"X#30	¼"X#30	¼"X#30
HIGH SLEEVE PRESSURE PSI	250	550	550	550	850
LOW SLEEVE PRESSURE PSI	100	100	100	100	150
TEST DATE	2/25/82	3/16/82	3/16/82	3/15/82.	6/1/82

ALL TESTS TEXAS ILLINOIS
12.9 - 14.5% MOISTURE

3/4" TOP SIZE
NO ADDITIVES

6" STROKE TESTS
12" STROKE TESTS
18" STROKE TESTS

TEST NUMBER	501-10	502-10	503-10	504-10	505-10
REACTOR PRESSURE PSI	0	0	0	300	300
MOISTURE %	18.2	18.4	18.4	18.5	18.6
STROKE SET INCHES	6	12	18	6	12
THROUGHPUT RATE LBS/HR	6798	8315	9878	4302	5803
ELAPSED TIME/SEC.	396.6	324.2	272.9	626.7	4646
LOADING RING PRESSURE PSI	800	800	800	800	800
HOUSING PRESSURE PSI	150	150	150	350	350
SLEEVE SEAL PRESSURE PSI	650	650	650	650	650
PRIMARY EXTEND PRESSURE PSI	725	750	750	1350	1375
TEST CYCLES	142	91	71	140	85
AMPS SET	110	110	110	110	110
WEIGHT OF FUEL PUMPED	749 LBS.	749 LBS.	749 LBS.	749 LBS.	749 LBS.
CYCLES PER/MIN	21.50	16.84	15.69	13.43	11.1
FUEL TYPE & ADDITIVES	TEXAS LIGNITE	TEXAS LIGNITE	TEXAS LIGNITE	TEXAS LIGNITE	TEXAS LIGNITE
NOMINAL FUEL SIZE	3/4"	3/4"	3/4"	3/4"	3/4"
HIGH SLEEVE PRESSURE PSI	250	250	250	250	250
LOW SLEEVE PRESSURE PSI	150	150	150	150	150
TEST DATE	11/11/82	11/11/82	11/11/82	11/11/82	11/11/82

COAL FEEDER TEST RESULTS

RETEST PHASE II

TEST NUMBER	506-10	507-10	508-10	509-10	
REACTOR PRESSURE PSI	300	600	600	600	
MOISTURE %	18.4	18.5	18.6	18.4	
STROKE SET INCHES	18	6	12	18	
THROUGHPUT RATE LBS/HR	6797	3902	5063	6002	
ELAPSED TIME/SEC.	396.7	691.0	532.5	449.2	
LOADING RING PRESSURE PSI	800	1000	1000	1000	
HOUSING PRESSURE PSI	350	650	650	650	
SLEEVE SEAL PRESSURE PSI	650	650	650	650	
PRIMARY EXTEND PRESSURE PSI	1400	1775	1775	1750	
TEST CYCLES	69	122	84	63	
AMPS SET	110	110	110	110	
WEIGHT OF FUEL PUMPED	749 LBS.	749 LBS.	749 LBS.	749 LBS.	
CYCLES PER/MIN	10.44	10.62	9.54	8.46	
FUEL TYPE & ADDITIVES	TEXAS LIGNITE	TEXAS LIGNITE	TEXAS LIGNITE	TEXAS LIGNITE	
NOMINAL FUEL SIZE	3/4" TOP	3/4" TOP	3/4" TOP	3/4" TOP	
HIGH SLEEVE PRESSURE PSI	250	550	550	550	
LOW SLEEVE PRESSURE PSI	150	150	150	150	
TEST DATE	11/11/82	11/12/82	11/12/82	11/12/82	

COAL FEEDER TEST RESULTS PHASE I

TEST NUMBER	501-01	502-01	503-01	503-02	504-01
REACTOR PRESSURE PSI	0	0	0	0	300
MOISTURE %	14.1	14.3	14.1	14.1	14.1
STROKE SET INCHES	6	12	18	18	6
THROUGHPUT RATE LBS/HR	5735	7589	9003	8963	3822
ELAPSED TIME/SEC.	457.6	347.7	291.5	288.0	675.3
LOADING RING PRESSURE PSI	1000	1000	1000	1400	1000
HOUSING PRESSURE PSI	150	150	150	150	350
SLEEVE SEAL PRESSURE PSI	200 OFF @ FAIL VAIVE	200 OFF @ FAIL VAIVE	200 OFF @ FAIL VAIVE	200 OFF @ FAIL VAIVE	400 OFF @ FAIL VAIVE
PRIMARY EXTEND PRESSURE PSI	800	650	750	700	1300
TEST CYCLES	129	81	65	65	133
AMPS SET	110	110	110	110	110
WEIGHT OF FUEL PUMPED	729	733	729	717	717
CYCLES PER/MIN	16.19	13.98	13.38	13.54	11.82
FUEL TYPE & ADDITIVES	TEXAS LIGNITE	TEXAS LIGNITE	TEXAS LIGNITE	TEXAS LIGNITE	TEXAS LIGNITE
NOMINAL FUEL SIZE	1" TOP	1" TOP	1" TOP	1" TOP	1" TOP
HIGH SLEEVE PRESSURE PSI	250	250	250	250	250
LOW SLEEVE PRESSURE PSI	100	100	100	100	100
TEST DATE	2/11/82	2/11/82	2/11/82	2/15/82	2/15/82

COAL FEEDER TEST RESULTS PHASE I

TEST NUMBER	505-01	506-01	507-01	508-01	509-01
REACTOR PRESSURE PSI	300	300	600	600	600
MOISTURE %	14.1	12.9	14.5	14.7	14.5
STROKE SET INCHES	12	18	6	12	18
THROUGHPUT RATE LBS/HR	5408	6699	3641	4831	5755
ELAPSED TIME/SEC.	477.3	393.9	706.9	532.8	447.3
LOADING RING PRESSURE PSI	1000	1000	1000	1000	1000
HOUSING PRESSURE PSI	350	350	650	650	650
SLEEVE SEAL PRESSURE PSI	400	400	700	700	700
PRIMARY EXTEND PRESSURE PSI	1300	1450	1750	1800	1800
TEST CYCLES	85	80	126	85	64
AMPS. SET	110	110	110	110	110
WEIGHT OF FUEL PUMPED	717	733	715	715	715
CYCLES PER/MIN	10.69	12.19	10.69	9.57	8.58
FUEL TYPE & ADDITIVES	TEXAS LIGNITE	TEXAS LIGNITE	TEXAS LIGNITE	TEXAS LIGNITE	TEXAS LIGNITE
NOMINAL FUEL SIZE	1" TOP	1" TOP	1" TOP	1" TOP	1" TOP
HIGH SLEEVE PRESSURE PSI	250	250	540	540	540
LOW SLEEVE PRESSURE PSI	100	100	100	100	100
TEST DATE	2/15/82	2/11/82	3/4/82	3/3/82	3/3/82

TEXAS LIGNITE
7.5% MOISTURE

NOMINAL #200
NO ADDITIVES

8 6" STROKE TESTS
4 12" STROKE TESTS
4 18" STROKE TESTS

TEST NUMBER	540-10	541-10	542-10	543-10	544-10
REACTOR PRESSURE PSI	0	0	0	300	300
MOISTURE %	9.2	9.4	9.4	9.3	9.3
STROKE SET INCHES	6	12	18	6	12
THROUGHPUT RATE LBS/HR	7821	8298	10,103	4902	5998
ELAPSED TIME/SEC.	131.6	124.0	101.9	210.0	171.6
LOADING RING PRESSURE PSI	800	800	800	800	800
HOUSING PRESSURE PSI	150	150	150	350	350
SLEEVE SEAL PRESSURE PSI	650	650	650	650	650
PRIMARY EXTEND PRESSURE PSI	750	750	750	1375	1400
TEST CYCLES	47	35	26	47	32
AMPS SET	110	110	110	110	110
WEIGHT OF FUEL PUMPED	286 LBS.	286 LBS.	286 LBS.	286 LBS.	286 LBS.
CYCLES PER/MIN	21.31	16.79	15.65	13.47	11.02
FUEL TYPE & ADDITIVES	TEXAS LIGNITE	TEXAS LIGNITE	TEXAS LIGNITE	TEXAS LIGNITE	TEXAS LIGNITE
NOMINAL FUEL SIZE	#200	#200	#200	#200	#200
HIGH SLEEVE PRESSURE PSI	250	250	250	250	250
LOW SLEEVE PRESSURE PSI	150	150	150	150	150
TEST DATE	11/15/82	11/15/82	11/15/82	11/15/82	11/16/82

TEST NUMBER	545-10				
REACTOR PRESSURE PSI	300				
MOISTURE %	9.4				
STROKE SET INCHES	18				
THROUGHPUT RATE LBS/HR	6497				
ELAPSED TIME/SEC.	158.4				
LOADING RING PRESSURE PSI	800				
HOUSING PRESSURE PSI	350				
SLEEVE SEAL PRESSURE PSI	650				
PRIMARY EXTEND PRESSURE PSI	1400				
TEST CYCLES	27				
AMPS SET	110				
WEIGHT OF FUEL PUMPED	286 LBS.				
CYCLES PER/MIN	10.46				
FUEL TYPE & ADDITIVES	TEXAS LIGNITE				
NOMINAL FUEL SIZE	#200				
HIGH SLEEVE PRESSURE PSI	250				
LOW SLEEVE PRESSURE PSI	150				
TEST DATE	11/16/82				

COAL FEEDER TEST RESULTS PHASE I

TEST NUMBER	540-01	541-01	541-02	542-01	543-01
REACTOR PRESSURE PSI	0	0	0	0	300
MOISTURE %	7.5	7.5	7.5	7.5	7.5
STROKE SET INCHES	6	12	12	18	6
THROUGHPUT RATE LBS/HR	7628	8513	8498	10027	5031
ELAPSED TIME/SEC.	127.9	114.6	114.8	97.3	193.9
LOADING RING PRESSURE PSI	1000	1000	1000	1000	1000
HOUSING PRESSURE PSI	100	100	100	100	350
SLEEVE SEAL PRESSURE PSI	650	650	650	650	650
PRIMARY EXTEND PRESSURE PSI	950	950	950	950	1250
TEST CYCLES	37	30	30	27	39
AMPS SET	110	110	110	110	110
WEIGHT OF FUEL PUMPED	2711PS	2711PS	2711PS	2711PS	2711PS
CYCLES PER/MIN	17.36	15.71	15.68	16.65	12.07
FUEL TYPE & ADDITIVES	TEXAS LIGNITE	TEXAS LIGNITE	TEXAS LIGNITE	TEXAS LIGNITE	TEXAS LIGNITE
NOMINAL FUEL SIZE	-#200	-#200	-#200	-#200	-#200
HIGH SLEEVE PRESSURE PSI	250	250	250	250	250
LOW SLEEVE PRESSURE PSI	150	150	150	150	150
TEST DATE	5/27/82	5/27/82	5/27/82	5/27/82	5/27/82

COAL FEEDER TEST RESULTS PHASE I

TEST NUMBER	544-01	545-01	546-01	547-01	548-01
REACTOR PRESSURE PSI	300	300	600	600	600
MOISTURE %	7.5	7.5	7.5	7.5	7.5
STROKE SET INCHES	12	18	6	12	18
THROUGHPUT RATE LBS/HR	5891	6238	4441	5198	5669
ELAPSED TIME/SEC.	165.6	156.4	219.7	187.7	172.1
LOADING RING PRESSURE PSI	1000	1000	1000	1000	1000
HOUSING PRESSURE PSI	350	350	650	650	650
SLEEVE SEAL PRESSURE PSI	650	650	650	650	650
PRIMARY EXTEND PRESSURE PSI	1250	1250	1750	1750	1750
TEST CYCLES	30	27	30	30	27
AMPS SET	110	110	110	110	110
WEIGHT OF FUEL PUMPED	2711PS	2711PS	2711PS	2711PS	2711PS
CYCLES PER/MIN	10.87	10.36	10.38	9.59	9.41
FUEL TYPE & ADDITIVES	TEXAS IGNITE	TEXAS IGNITE	TEXAS IGNITE	TEXAS IGNITE	TEXAS IGNITE
NOMINAL FUEL SIZE	-#200	-#200	-#200	-#200	-#200
HIGH SLEEVE PRESSURE PSI	250	250	650	650	650
LOW SLEEVE PRESSURE PSI	150	150	150	150	150
TEST DATE	5/27/82	5/27/82	5/27/82	5/27/82	5/27/82

APPENDIX K:
VERTICAL AND HORIZONTAL CONDUIT TEST
PARAMETERS AND RESULTS

VERTICAL CONDUIT TEST PARAMETERS

Feedstocks:

Granular	1/4" x 0 Utah bituminous coal, 53.5 lbs./ft ³
Pulverized	70%-200 mesh Utah bituminous coal, 37 lbs/ft ³
Feeder stroke	8"
Feeder amperage setting	55 amps
Feeder cycle rate	10.4 - 10.7
Time of test	60 minutes
Straight conduit	8" ID x 8'6" height
Volume	2.967 ft ³
Tapered conduit	8 1/2" ID (bottom) to 11" ID (top) x 8'6" height
Volume	4.431 ft ³
Elbow	6" to 8", 90°
Volume	.422 ft ³

TABLE 8

VERTICAL CONDUIT PUMPING TEST RESULTS:
CONTINUOUS NITROGEN FLOW

TEST #	THROUGHPUT/HR. LBS	FT ³	CPM	INDICATED FLOW N ₂ /MIN	CORRECTED FLOW N ₂ /MIN	N ₂ BACKPRESS PSI G	LBS/HR N ₂	FT ³ /(COAL) PER FT ³ (N ₂)	LBS (COAL) PER LB (N ₂)	# OF STROKES IN TEST
SP 1	2458	45.94	10.4	7	9.4	10	44.27	.0814	55.52	624
SP 2	2505	46.82	10.6	7	9.6	12	45.21	.0813	55.41	636
SP 3	2458	45.94	10.4	7	9.4	10	44.27	.0815	55.52	624
TP 1	2482	46.39	10.5	8.5	12.5	14	58.87	.0618	42.16	630
TP 2	2529	47.27	10.7	8.5	12.0	13	56.51	.0657	44.75	642
TP 3	2505	46.82	10.6	8.5	11.75	12	55.34	.0664	45.26	636
SP 4	1754	47.4	10.6	6	7.85	10	36.97	.1006	47.68	636
SP 5	1721	46.5	10.4	6	7.75	9	36.50	.1000	47.15	623
SP 6	1721	46.5	10.4	6	7.75	9	36.50	.1000	47.15	625
TP 4	1770	47.8	10.7	7	9.6	12	39.15	.0837	39.15	643
TP 5	1754	47.4	10.6	7	9.0	9.5	41.38	.0878	41.38	635
TP 6	1737	46.9	10.5	7	9.5	11.5	38.82	.0823	38.82	631

Notes: Tests 1 - 3 utilized granular coal, 4 - 6 pulverized coal.
"SP" indicates straight conduit test; "TP" tapered conduit.

TABLE 9

VERTICAL CONDUIT PUMPING TEST RESULTS:

Pulsed Nitrogen Flow

GRANULAR COAL (1/4" x #0)

Test #	Steady State Time (Min)	Through- put lbs/hr.	Through- Coal put Ft ³ /hr	N ₂ Pulse	Backpress. psi Cont.	% of Pulse On Time	Pulse Corrected Flow, SCFM	Continuous Corrected Flow, SCFM	Total Corrected Flow, SCFM	lbs/hr N ₂	Ft ³ /hr N ₂	Ft ³ 5ft ³	Coal N ₂	lbs (coal) Per lb N ₂	CPM
SPP1	52	2482	46.39	15	16	26.7	12.3	5.7	7.46	35.14	447.74	.1036	70.63	5	
SPP2	65	2458	45.94	15	16	28.4	11.5	5.1	6.92	32.58	415.06	.1107	75.45	10.4	
SPP3	41	2529	47.27	15	17	28.9	12.3	6.15	7.93	37.33	475.64	.0994	67.75	10.7	

PULVERIZED COAL (70% - #200)

SPP4	49	2505	46.82	17	14	29.8	11.25	4.25	6.34	29.84	380.16	.1232	83.95	10.6	
SPP5	38	2553	47.72	17	13	30.1	10.5	4.9	6.59	31.02	395.14	.1208	82.30	10.8	
SPP6	45	2458	45.94	17	13	27.3	10.5	5.5	6.87	32.33	411.9	.1115	76.09	10.4	

TABLE 10

HORIZONTAL PUMPING TEST PARAMETERS

Feedstocks (a) 70% - 200 mesh Utah bituminous, 6% moisture
 (b) 1/4" x 0 West Virginia bituminous, 14% moisture
 (c) 1-1/2" topsize Utah bituminous, 12% moisture

Feeder stroke 18"
 Feeder amperage setting 55 amps
 Feeder cycle rate 7.3 - 7.5 CPM
 Piston extend pressure 250 - 275 psi

Conduit 8" ID x 8'6" OAL

RESULTS

Pumping distance @ stall (2150 psi)	# of strokes	Pumping distance @ 500 psi*	# of strokes
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Feedstock:

(a)	49"	9	38"	7
(b)	55"	11	43"	8
(c)	73"	16	59"	12

*Piston extend pressure rises gradually from 250 psi to 500 psi. After 500 psi, packing is imminent. Therefore, these should be considered maximum reliable distances.

TABLE 11