15/05/019/002

Minutes of Second Meeting
of the

SHALE OIL TECHNICAL ADVISORY COMMITTEE

held at
Anvil Points Oil Shale Research Center
Rifle, Colorado
on
Thursday, September 3, 1964

The second meeting of the Technical Advisory Committee was held at the Anvil Points Oil Shale Research Center near Rifle, Colorado, on Thursday, September 3, 1964. Those present full time were:

S. L. Meisel, Chairman, Socony Mobil Oil Company, Inc.
R. H. Cramer, Program Manager, Socony Mobil Oil Company, Inc.
K. M. Elliott, Socony Mobil Oil Company, Inc.
J. R. Felix, Esso Research and Engineering
C. D. Geiger, Humble Oil and Refining Company

All of the Program personnel and J. M. Petty, Administrative Manager for the Colorado School of Mines Research Foundation, Inc., were present part time to report on their activities.

The meeting opened at 9:20 a.m., with Chairman S. L. Meisel distributing the agenda (Attachment No. 1).

OLD BUSINESS

A. Approval of Minutes

The minutes of the first meeting of the Technical Advisory Committee were approved as sent to the members.

B. Discussion of Duties of Permanent Secretary

S. L. Meisel presented a suggested list of duties for the Permanent Secretary. These duties were discussed and the Committee approved the following duties for the Permanent Secretary:

1. Serve as central contact for the Advisory Committee.
2. Assist Chairman in making meeting arrangements.
3. Arrange for editing, typing, and distribution of minutes of meeting.
4. Prepare official policy statements by Committee for signature by Chairman and Committee Members.

5. Serve as parliamentarian; prove reference to Contract and the previous policy decisions during Committee deliberations.

6. Maintain official files for the Committee to include:
   1. Technical Advisory Committee minutes.
   2. Technical Advisory Committee correspondence.
   3. Monthly Progress and other memoranda.
   4. Final reports.

C. Audit of August 24 and 25 (Preliminary)

R. H. Cramer reported on the visit of Mr. B. P. Pierce (Humble) and Mr. E. H. Wurster (Socony) to audit the accounts and records. These auditors concluded the systems and records were satisfactory. They did suggest a few minor changes which are being implemented. Their official audit report will be sent to Humble and Socony Mobil within a week or two.

C. D. Geiger commented that Mr. Pierce was most complimentary of the controls and the system set-up. C. D. Geiger also reported that the auditors critically reviewed the system since it was just being put into effect and now was the time to make any changes.

D. 1964 Budget

R. H. Cramer presented the 1964 Budget for approval which had been reviewed at the June meeting of the Technical Advisory Committee. After a brief discussion on amounts allocated for housing and staffing, this budget was approved as presented in the minutes of the June 29 Advisory Committee meeting.

The Chairman recommended, and the Advisory Committee concurred, that the Program Manager should give them reasonable notice as to when Stage I will be completed. The responsibilities of the Project Manager and the Participating Parties for notice of their intent to continue in the Program were discussed. As spelled out on page 10 of the Research Contract, the Project Manager has the responsibility to notify the Research Foundation of termination of the Contract in the event all the parties do not want to

continue into Stage II. The Participating Parties have the responsibility to give a 15-day notice of their intent not to continue into Stage II as discussed in detail on page 6 of the Research Agreement. If the Research Foundation cannot find other parties to continue research at the facilities, it has the responsibility to give a 30-day notice to the Department of Interior of intent to return facilities to them as covered on page 23 of the Lease Agreement, and the responsibility to conclude this transfer at an estimated total cost of $60,000 to be paid by the parties involved.

E. 1964 Program

The Committee approved the 1964 Program as presented in the minutes of the June 29 meeting recognizing that mining evaluations may not be started until January, 1965. The Committee decided, after a detailed discussion of the pros and cons of hiring a mining engineer early in Stage I, to let the Program Manager bring the mining engineers into the Program when they can be used best to carry out the program objectives as spelled out in the Contracts. It was the current opinion of the Program Manager that the mining engineer would not be needed until January or February, 1965 instead of October, 1964 as shown in the 1964 Program.

F. Other

1. Status of Additional Participating Parties

The Chairman reported that no other companies have indicated intent to become a participating party. Sinclair has not followed up on its initial interest. Pan American has requested a meeting with the Project Manager to discuss the program.

2. October Meeting of Technical Advisory Committee

The Chairman recommended that the next meeting of the Technical Advisory Committee be held at the Socony Mobil New York Offices on October 30, 1964 and that K. M. Elliott make the necessary arrangements. The Committee agreed with this recommendation and concurred with C. D. Geiger's

suggestion that the Chairmanship be held for three meetings even if the third meeting went beyond the six months' chairmanship term.

3. Safety Program

J. R. Felix inquired into the over-all medical assistance available to the plant and families of the employees. R. H. Cramer reported that two excellent doctors were available in Rifle and safety program including fire fighting training was under way. The safety program is outlined in Attachment No. 2.

C. D. Geiger reported that two physicians in the Humble Medical Department would like to visit the Anvil Points facilities. R. H. Cramer replied that members of the Socony Mobil Medical Department would also like to visit the facilities and suggested that the Humble physicians get in touch with the Socony Mobil physicians and make a joint visit to Anvil Points.

NEW BUSINESS

The Program personnel reported on their individual technical activities. Copies of the handouts presented with each of these reports have been sent under separate cover. A list of these handouts is attached (Attachment No. 3).

A. General Review

R. H. Cramer reported that the staff was essentially complete. Two mining engineers would be brought in when needed and another crew of retort operators would be hired near the end of 1964 to permit 7-day-around-the-clock operation of the retorts. The current crews are operating 5-day-around-the-clock. The No. 1 Retort (6 T/D) has been taken through cold shakedown with shale rates up to 750 lbs/(Hr)(Ft^2) or (24 T/D). This retort is currently going through a hot shakedown test at the Bureau of Mines Demonstration Run rate of 230 lbs/(Hr)(Ft^2). The usual number of mechanical problems developed but appear to be corrected now.

The Program is only about two weeks behind the rehabilitation time estimated last fall, primarily due to poor equipment delivery by vendors. The Analytical Laboratory is completely staffed and trained to handle the tests for retort run analyses. Although the Colorado School of Mines Laboratory at Golden is available to us we do not plan to use it to any great extent. Infrequent tests such as mass spec or special tests on the shale oil will be run by the Socony Mobil or Humble Laboratories, under the terms indicated in the Research Agreement.

C. D. Geiger expressed some concern over the Bureau of Mines asking for tests which we would not be staffed to handle along with our own tests. R. H. Cramer pointed out that the Bureau's Laramie Laboratory was better equipped and staffed, and therefore the Bureau would most likely have the tests done there instead of by us.

J. R. Felix asked how well the non-professional and professional people worked together. R. H. Cramer reported that not only was the cooperation between non-professional and professional excellent but the non-professional workers were capable and willing to do many jobs which weren't necessarily what their job title called for.

B. Rehabilitation and Staffing

1. Staffing and Rehabilitation of Facilities

J. M. Petty reviewed the organization chart (Handout No. 1) and described the responsibility of the key Research Foundation supervisory personnel. He also commented on the fact he was able to assemble a fairly highly skilled work force because of the large number of applications he received.

2. Rehabilitation of Pilot Retorts

W. S. Bergen described the rehabilitation of the No. 1 Retort and the planned rehabilitation of the No. 2 Retort. He pointed out that PERT-type preplanning had assisted greatly in getting the rehabilitation completed on schedule and for the estimated cost. The current PERT schedule is shown in Handout 2. Daily and more detailed weekly meetings with the supervisory people involved in the rehabilitation also assisted in meeting the deadlines on the PERT schedule.

The major policies followed in the revamping of the retorts were:

1. The retort solids and gas handling equipment was to be capable of operating at 750 lbs/(Hr)(Ft^2).

2. All product recovery equipment was to be of commercially available types easily scaled to higher rates.

3. The raw and spent shale handling system was to be automated.

4. Equipment was to be as reliable as possible in operation.

The old retort was stripped down to the retort shell and a new Victaulic pipe system was installed capable of handling the larger gas rates. The Victaulic piping is easily installed or modified since it requires no welding. The revised process flow for Retort No. 1 is shown in Handout No. 3.

C. D. Geiger asked what the accuracy of the raw shale and product weighing systems were. W. S. Bergen indicated that the accuracy was as follows:

Raw shale ± 1%

Spent Shale ± 0.1%

Liquid produce ± 0.1%

Gas produce ± 0.1%

C. Engineering Analysts

1. Engineering Studies

P. W. Snyder discussed the computer communications available and the status of the mathematical model of the Gas Combustion retort.

a. Computer Communications

The material balance calculation has been programed and put into Socony Mobil's "Real Time" system. This permits us to send raw retort data, via teletype, to a 1410 IBM computer located in New York City and receive back immediately the results of the material balance calculation. Other more detailed engineering calculations can be made on Socony Mobil's 7040 IBM computer located in Princeton if needed. The use of this system was illustrated later by sending in the raw data from Bureau of Mines Run Number 222D. The results are shown in Handout No. 25.

b. Math Model

The objectives of the Math Model are to:

a. Reduce the experimental runs required to define the limitations of the Gas Combustion Retort. There are about ten process variables for this process. In order to precisely define these interactions at only two levels it would require about 1,000 experimental runs. The Math Model can do this more rapidly, at less expense than the pilot retort, and indicate the variables which do not interact.

b. Establish sensitive variables for experimental study.

c. Establish critical internal conditions such as the overlapping of the retorting and combustion zones.

d. Establish optimum operating conditions.

This model is programed on Socony Mobil's 7040 IBM computer located at Princeton, New Jersey.

P. W. Snyder presented a brief description of the Gas Combustion process as shown in Handout No. 4 and described the theoretical bases of the Math Model as outlined in Handout 5. He reviewed the printout information as shown in Handouts 6 and 7; and the correlations being developed from the results as shown in Handouts 8, 9, and 10. Quantitative conclusions from these initial math model studies should be viewed with caution as the model is still being debugged and modified.

It was pointed out that the model does not include oil impingement on the shale, refluxing of oil, or thermal cracking since not enough information is available on these processes at this time. However, as the experimental program progresses we hope to be able to include these processes in the model.

2. Economic Studies

J. E. Burchfield reviewed the bases for economic evaluations as follows:

1. A mining - crushing - retorting complex would be used to develop a cost of producing oil shale at the 50,000 B/D level as shown in Handout No. 11

2. The individual cost bases as shown in Handout No. 12 were developed as much as possible from published information.

With those bases we plan to develop economic guidelines to define the most economic improvements to make in retorting and define relative cost of yield loss and other process variations. An example of this type of guidelines is presented as Handout No. 13 which shows the effect of shale mass rate through the retort and yield loss on the cost of producing 50,000 B/D of raw shale oil.

After a detailed discussion of the cost bases the Committee recommended that:

1. Economic studies be limited to the cost of producing raw shale oil from the retorts and be presented as differential costs rather than as absolute costs. A nomograph to interrelate the effect of variables on costs may be the best way to show the final results.

2. The bases and sources of information used to establish mining and shale preparation costs be obtained from published information or developed from the program and be well documented for use by the Participating Parties in any subsequent studies that they may conduct.

3. The values of retort by-products be obtained from published information.

4. Crushing equipment manufacturers be contacted to develop crushing costs, with consideration of supplying them with shale to develop the data needed to estimate these costs.

D. Retort Program

1. Overall Program

J. E. Lawson reported on the experimental operating program for the two pilot retorts as shown in Handout 14. Mr. Lawson pointed out that this program was his goal and the timing of each objective was dependent on solving unforeseen mechanical and process problems which will certainly arise. The typical temperature profile obtained by the Bureau of Mines in Retort No. 1 as shown in Handout 15 is not very uniform. We plan to develop an air distributor which will produce a more uniform temperature profile and make this retort more ideal and permit us to analyze the effect of process variables without superimposed gas distribution effects. Current thinking is along the lines of a peripheral air distributor.

K. M. Elliott concurred with the maximizing ideal temperature distribution in the No. 1 Retort and then the testing of commercial distributor designs against the optimum achieved with this ideal pilot retort.

2. Shale Supply

C. W. Tyson reviewed the results of a study of the quantity and quality of oil shale supply as shown in Handout 16. The overall conclusion is that the amount of mined shale available for Stage I will closely approximate Program requirements. However, R. H. Cramer reported that additional shale could be obtained by blasting from two easily accesable benches in the mine if necessary.

3. Operator Training and Shakedown

P. H. Gifford reviewed the operator training program, data

recording, and shakedown of Retort No. 1. He reported the training program was successful and that the operators motivation is excellent. The data taken has been organized into a series of 14 forms from raw data through interpretive results. These forms are included in Handouts 17 through 30. OSRC Forms No. 1 to 4, 12, and 13 are raw data and will be available to the Bureau of Mines; the remaining forms are summaries of interpretives and will be available only to the Participating Parties. Retort No. 1 has been taken through a cold shakedown and the necessary mechanical changes made to provide smooth shale handling. The unit is now under hot shakedown tests. The line burner has been very successful for startup; however, temperature control and shale clinkering have presented a few problems. Both high and low temperature clinkers have been encountered. The low temperature clinkers are soft and do not appear to present any problem.

4. Mist Formation and Recovery

K. I. Jagel discussed the mist formation problem and stated the following objective of this program:

1. Define process conditions which insure that a stable oil mist is formed.

2. Define the conditions and equipment required to recover the oil mist.

A cascade jet impactor system for sampling the gas streams and measuring mist droplet size is being built to assist in these studies.

K. M. Elliott asked if consideration has been given to getting mist formation information from a small fixed bed unit. K. I. Jagel replied that the Bureau of Mines had designed a small moving bed unit to get this type of information. We are planning to find out what kind of information can be developed from the pilot unit first.

5. Flow Studies - Retort No. 1

I. A. Jefcoat reported on the shale flow studies on the No. 1 Retort. In these studies 50 pounds of red shale were fed through the star feeder along with the normal shale feed and time of withdrawal was measured. As shown in Handout No. 31 about 80 percent of this red shale came out with about 150 pounds of total shale indicating very little mixing of shale through the entire system. The effect was true for high as well as low shale rate indicating that most of the little mixing that did occur was probably in the feed system.

6. Mechanical Models

a. Shale Flow Studies

T. C. Lyons reported on the objective of the mechanical model studies as outlined in Handout 32. K. M. Elliott asked whether we thought variation of particle shape would be important. T. C. Lyons said we intend to observe this effect of long particles versus short particles in the mix and if there appears to be an effect a study of the effect of shape would be carried out. After further discussion it was decided that the study would not be necessary since we have no control over shape which is primarily a function of shale richness.

b. Mechanical Feasibility Study

L. J. Skowronek reported on the mechanical feasibility studies being carried out to guide the experimental studies toward designs which can be scaled to commercial size. His preliminary conclusion was that commercial units will be restricted to maximum spans of about 15 feet in order to provide support for the intervals required. In order to achieve the large crossectional areas needed for economic design it will be necessary to unitize the commercial design.

E. Analytical Laboratory Program

B. L. Beck reported on the rehabilitation and staffing of the analytical facilities. Although the Analytical Building was large enough the equipment was in poor condition. The building has been cleaned, the utility put into shape and new equipment purchased. A few pieces of equipment still remain to be received. The four technicians obtained appear to be competent. They have been trained to run all the tests needed for retort material balances. B. L. Beck also reviewed the method of requesting and reporting analytical tests as shown in Handout No. 33.

D. Liederman reviewed in detail the tests which will be taken and the reporting mechanisms as shown in Handouts 28 and 29.

The Committee recommended that periodic detailed quality tests on the shale oil should be run to permit detection of any significant quality change as a function of retorting operating conditions. These detailed tests should include sulfur content, boiling range distribution, and carbon residue. If a significant variation occurs the stored product samples from previous runs should be reanalyzed and the program should be re-examined with a view to changes that would assist in defining the relation between retort variables and shale oil quality.

F. 1965 Preliminary Budget and Accounting Controls

R. H. Cramer reviewed the accounting controls, and in particular the system of variance control on accrued expense. At the end of each month the outstanding bills are added to the expenditures in the proper account to give an exact accrued expense to compare with the budgeted expense. The variance from the budget shows immediately the status of any particular account.

C. J. Verdeur presented the 1965 preliminary budget (Attachment No. 4) for review and approval at the next meeting.

Letter of Appreciation to Technical Staff

The Committee decided to send a letter of appreciation to the home of each of the members of the technical staff as an indication of their satisfaction with the progress of the Program and adjustment of the families to the new surroundings.

S. L. Meisel
Permanent Secretary

PWSnyder:rl

Attachments

September 16, 1964

Attachment No. 1

AGENDA

SECOND SHALE OIL TECHNICAL ADVISORY COMMITTEE
Anvil Points, Rifle, Colorado
September 3 & 4, 1964

September 3

I. Old Business — 9:15 a.m.

A. Approval of Minutes

B. Discussion of Duties of Permanent Secretary

C. Audit of August 24 & 25 (preliminary)

D. 1964 Budget

E. 1964 Program

F. Other

II. New Business - Report of Program Personnel — 11:15 a.m.

A. General Review
Program Manager

B. Rehabilitation and Staffing (20)(1)
Program Manager
Administrative Manager
Staff Mechanical Engineer
Describe No. 1 Retort Revision

Lunch — 12:00 noon

C. Engineering Analysis (15)(1) — 12:30 p.m.
Program Manager
Engineering Analyses (FWS)
Economic Analyses (JEB)

D. Retort Program (40)(1)
Program Manager
Supervising Engineer (JEL) (Retort Program)
Shale Supply (CWT)
Operator Training and Shakedown (PHG)
Mist Formation and Recovery (KIJ)
Flow Studies - Retort No. 1 (IAJ)
Mechanical Models
Shale Flow Studies (TCL)
Mechanical Feasibility Studies (LJS)

(1) Time in minutes

E. Analytical Laboratory Program (10)(1)
   Program Manager
   Supervising Chemist (BLB)
   Analytical Chemist (DL)

F. 1965 Budget (Preliminary) and Accounting Controls (10)(1)
   Program Manager
   Administrative Assistant

G. Other

III. Executive Session

September 14

I. Tour Ground Level Facilities — 8:15 to 9:45 a.m.

II. Tour Mine — 9:45 to 11:00 a.m.

Attachment No. 2

ANVIL POINTS OIL SHALE RESEARCH CENTER
Rifle, Colorado
August 17, 1964

Yearly Program of the Safety Department

It is the policy of the Colorado School of Mines Research Foundation, Inc., Safety Department to develop and promote safety throughout all phases of the Shale Oil Research program.

Our program will consist of "Accident Prevention", by training, by observing conditions and acts. We feel that corrective safety is an attempt to correct a condition or unsafe act after an incident has occurred which has drawn our attention to one or both factors.

Through the media of Safe Operating Procedures, Foreman Training, Safety Meetings, Demonstrations, Engineered Safety and any other media that is available from the Oil Companies, Colorado School of Mines Research Foundation, Inc., U. S. Bureau of Mines, National Safety Council, and our employees and engineering staff at this operation.

The Yearly Safety Program will cover the following:

Hazardous Materials - training will start immediately
- High Boiling Fractions
- Dust Control
- Gases
- Fumes and Vapors
- Chemicals

Materials Handling - each safety session, if necessary
- Maintenance Materials
- Production Materials

Housekeeping - each safety session, if necessary

Fire Prevention - training will start August 17

First Aid - training will start approximately November 1

Moving Machinery and Equipment - each safety session, if necessary
- Automobiles
- Dozers
- Trucks
- Loaders

Maintenance - each safety session, if necessary

Safety Guidance

Since the safety program covers many phases of the activities in this plant, it will be presented in approximately the following percentages.

Fire Prevention and Training	20%
First Aid Training	20%
Hazardous Materials	10%
Moving Machinery and Equipment	10%
Materials Handling	10%
Maintenance, Housekeeping and Safety Guidance	30%

We feel that emphasis should be stressed during the first weeks of this program on Fire Prevention, First Aid Training and Employee Training. Materials Handling, Housekeeping, Moving Equipment, Maintenance, First Aid, and Hazardous Materials will be covered at each safety session, if necessary. Most of the time one subject will be covered but others may be included from time to time.

We have made arrangements to have the doctors conduct several of the safety meetings. We will also have several general fire prevention training sessions to acquaint everyone in the plant with the use of fire extinguishers.

R. W. Wamsley

R. W. Wamsley
Safety Engineer

Attachment No. 3

LISTING OF TECHNICAL HANDOUTS

	Handout No.
Organization Chart for Stage I	1
Rehabilitation Schedule	2
Process Flow Diagram Gas Combustion Process Retort No. 1	3
Gas Combustion Retort Diagram	4
Bases for Math Model of Gas Combustion Retort	5
Summary Printout from Math Model	6
Temperature Profile Printout from Math Model	7
Effects of Process Variables on Conditions in the Mist Forming Zone	8
Effects of Process Variables on Conditions in the Combustion Zone	9
Effect of Process Variables on Conditions in the Shale Cooling Zone	10
Proposed Economic Base Case	11
Economic Bases for Evaluation of Shale Oil Recovery in Retorting	12
Cost of Shale Oil as a Function of Retort Space Velocity and Yield	13
Proposed Retort Operating Schedule	14
Temperature Profile for Bureau of Mines Run 331A	15
Shale Analyses and Preparation	16
Gas Combustion No. 1 Operations Sheet "A"	17
Gas Combustion No. 1 Operation Sheet "B"	18
Temperature Probes	19
Screen Analysis Data Sheet	20
Gas Analysis	21
Liquid Product Analysis	22
Raw and Spent Shale Analysis	23
Program Objective and Conclusions Summary Report	24

	Handout No.
Material Balance Calculation Via Prototype	25
Detailed Test Sheet	26
Test Summary Sheet	27
Laboratory Analysis Request	28
Fischer Retort Assay	29
Run Purpose Sheet	30
Breakout Curves for Red-marked One-Inch Shale Flowing Through the No. 1 Retort	31
Program of Initial Mechanical Model Studies	32
Analytical Laboratory Operations	33

Attachment No. 4

ANVIL POINTS OIL SHALE RESEARCH CENTER
1965 ADMINISTRATIVE EXPENSE BUDGET
January 1, 1965 to November 30, 1965

Manpower Quota (End of November)		
Participating Parties	18	
Research Foundation	77	
Total	95	
Salaries and Wages		
Participating Parties		230,400
Research Foundation		396,700
Total		627,100
Employee Benefits		
Participating Parties		57,700
Research Foundation		74,100
Total		131,800
Employee Expenses		
Participating Parties		53,600
Research Foundation		2,200
Total		55,800
Materials and Supplies		50,600
Facilities and Equipment		79,200
Professional Fees and Services		57,200
Other Operating Services		17,600
Other Direct Expenses		88,300
Lease Expense		4,400
Rent Revenues		(22,000)
Net Expenses		1,090,000

ANVIL POINTS OIL SHALE RESEARCH CENTER
1965 ADMINISTRATIVE EXPENSE BUDGET
January 1, 1965 to November 30, 1965

Account Number	Description	Total 11 Months	Total 1st Quarter	Total 2nd Quarter	Total 3rd Quarter	Total 4th Quarter
	Expense Accounts					
	Salaries & Wages-Research Foundation					
500	Administration Personnel & Accounts	47,900	12,800	12,800	12,800	9,500
502	Purchasing & Warehousing	22,600	6,100	6,100	6,000	4,400
504	Safety	21,700	5,800	5,800	5,800	4,300
505	Eng. - Electrical - Rehabilitation	--	--	--	--	--
506	Operating	34,900	9,300	9,300	9,300	7,000
507	Mechanical - Rehabilitation	--	--	--	--	--
508	Operating	54,400	14,600	14,500	14,500	10,800
509	Civil - Rehabilitation	--	--	--	--	--
510	Operating	115,600	30,900	31,000	31,000	22,700
512	Housing	--	--	--	--	--
	Technical Development					
520	Tech.Dev. - Mining - Rehabilitation	--	--	--	--	--
521	Operating	--	--	--	--	--
522	Retorting - Rehabilitation	--	--	--	--	--
523	Operating	78,800	21,100	21,100	21,200	15,400
5[illegible]	Analytical - Rehabilitation	--	--	--	--	--
5[illegible]	Operating	20,800	5,500	5,500	5,500	4,300
	Sub-Total Research Foundation	396,700	106,100	106,100	106,100	78,400
	Salaries & Wages-Participating Parties					
530	Administrative	88,800	23,800	23,800	23,800	17,400
	Technical Development					
532	Technical Development - Mining	29,100	7,800	7,800	7,800	5,700
533	Retorting	90,100	24,100	24,100	24,100	17,800
534	Analytical	22,400	6,000	6,000	6,000	4,400
	Sub-Total Participating Parties	230,400	61,700	61,700	61,700	45,300
	TOTAL - Salaries & Wages	627,100	167,800	167,800	167,800	123,700
	Employee Benefits					
540	Research Foundation	74,100	16,300	16,900	22,400	18,500
541	Participating Parties	57,700	15,400	15,500	15,400	11,400
	TOTAL Employee Benefits	131,800	31,700	32,400	37,800	29,900

Account Number	Description	Total 11 Months	Total 1st Quarter	Total 2nd Quarter	Total 3rd Quarter	Total 4th Quarter
	Employee Expenses					
550	Travel - Research Foundation	2,200	600	600	600	400
551	Travel - Participating Parties	5,500	1,500	1,500	1,500	1,000
552	Moving - Research Foundation	--	--	--	--	--
553	Moving - Participating Parties	--	--	--	--	--
554	Living Expenses - Participating Parties	45,900	12,500	12,500	12,500	8,400
555	Miscellaneous	2,200	600	600	600	400
	TOTAL Employee Expenses	55,800	15,200	15,200	15,200	10,200
560	Consult. Auditors & Attorneys	2,200	600	600	600	400
570	Project Manager's Expenses	9,800	8,200	600	600	400
571	Other Participating Parties Expenses	--	--	--	--	--
575	Contractors Fee	55,000	15,000	15,000	15,000	10,000
576	Precontract Expenses	--	--	--	--	--
	Materials & Supplies					
58[illegible]	Rehabilitation	--	--	--	--	--
58[illegible]	Operating	44,000	12,000	12,000	12,000	8,000
582	Stationery & Office Supplies	6,600	1,800	1,800	1,800	1,200
583	Housing	--	--	--	--	--
	TOTAL Materials & Supplies	50,600	13,800	13,800	13,800	9,200
	Equipment					
590	Rehabilitation	--	--	--	--	--
591	Operating	79,200	21,600	21,600	21,600	14,400
	TOTAL Equipment	79,200	21,600	21,600	21,600	14,400
595	Rents on Leased Equipment	--	--	--	--	--
596	Operating	4,400	1,200	1,200	1,200	800
	TOTAL Rents on Leased Equipment	4,400	1,200	1,200	1,200	800
	Subcontracts					
600	Rehabilitation	--	--	--	--	--
601	Operating	5,500	1,500	1,500	1,500	1,000
602	Maintenance	2,200	600	600	600	400
603	Laboratory Service	5,500	1,500	1,500	1,500	1,000
604	Machine Accounting	4,400	1,200	1,200	1,200	800
605	Dismantlement	--	--	--	--	--
	TOTAL Subcontracts	17,600	4,800	4,800	4,800	3,200

Account Number	Description	Total 11 Months	Total 1st Quarter	Total 2nd Quarter	Total 3rd Quarter	Total 4th Quarter
610	Freight & Postage	4,400	1,200	1,200	1,200	800
	Utilities					
620	Fuel	22,700	12,000	5,000	1,400	4,300
621	Electricity	23,000	7,500	5,500	5,000	5,000
622	Government Services	--	--	--	--	--
623	Telephone & Telegraph	11,000	3,000	3,000	3,000	2,000
624	Other	5,700	1,200	1,600	2,000	900
	TOTAL Utilities	62,400	23,700	15,100	11,400	12,200
	Insurance & Operating Taxes					
630	Insurance - By Major Type	8,600	1,700	4,100	1,700	1,100
640	State & Local Taxes	--	--	--	--	--
650	Permits or Licenses	200	100	100	--	--
	TOTAL Insurance & Operating Taxes	8,800	1,800	4,200	1,700	1,100
660	Personnel Procurement	400	100	100	100	100
670	Labor Relations & Negotiations	600	200	200	100	100
6[illegible]	Other Miscellaneous Expenses	1,900	500	500	500	400
GRAND TOTAL EXPENSE ACCOUNTS		1,112,000	307,400	294,300	293,400	216,900

SCHEDULE OF ESTIMATED REVENUES
January 1, 1965 to November 30, 1965

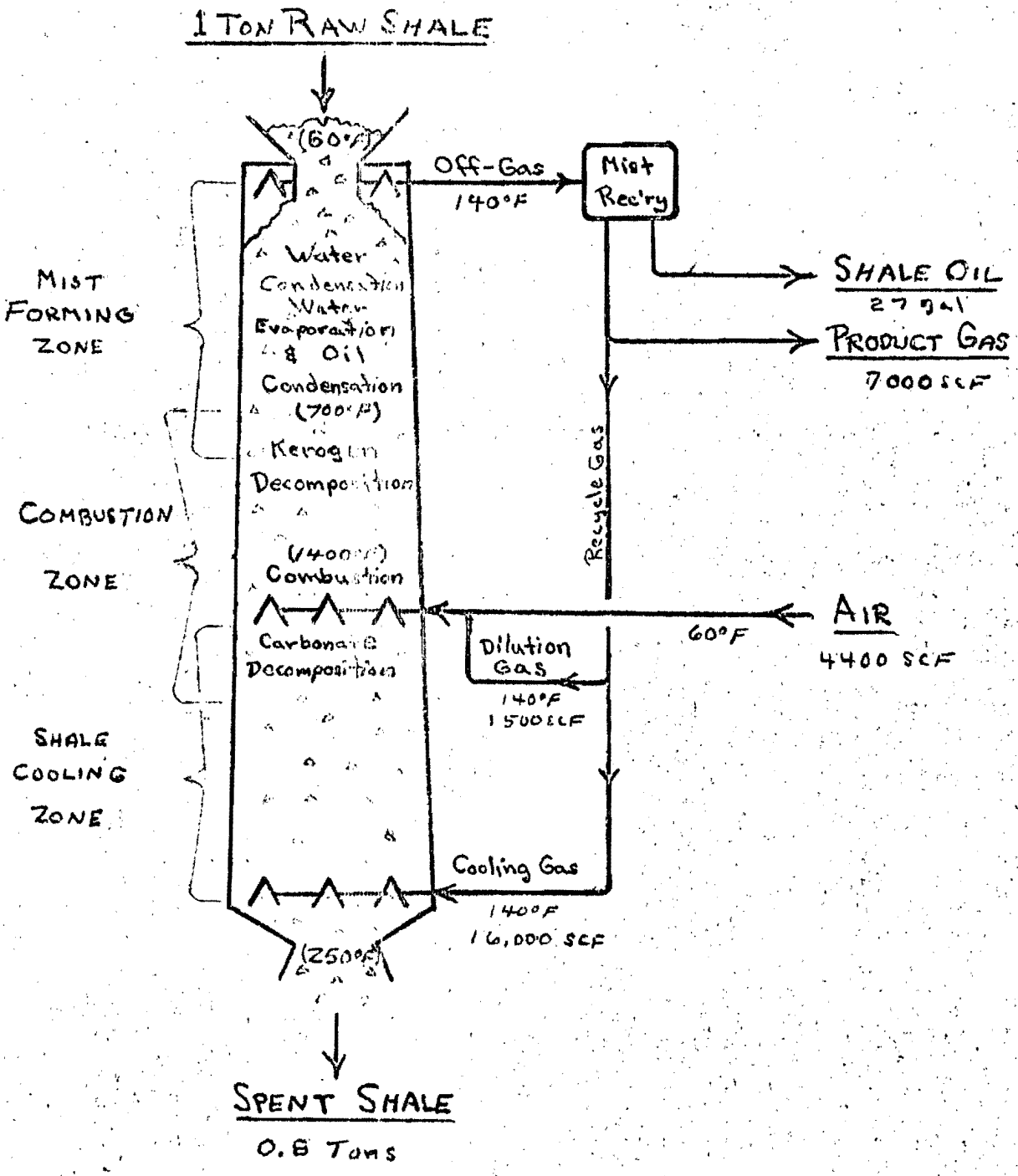
Account Number	Description	Total 11 Months	Total 1st Quarter	Total 2nd Quarter	Total 3rd Quarter	Total 4th Quarter
700	Revenue - House Rent	16,400	4,500	4,500	4,400	3,000
701	Revenue - Electricity	3,400	1,000	800	900	700
702	Revenue-Bureau of Mines Payments	2,200	600	600	600	400
710	Other Miscellaneous Income	--	--	--	--	--
	TOTAL Revenues	22,000	6,100	5,900	5,900	4,100

1965 ADMINISTRATIVE BUDGET OF ESTIMATED COSTS & EXPENSES LESS REVENUES
January 1, 1965 to November 30, 1965

Total Expense Accounts	1,112,000
Less: Total Revenues	22,000
TOTAL Net Administrative Budget	1,090,000

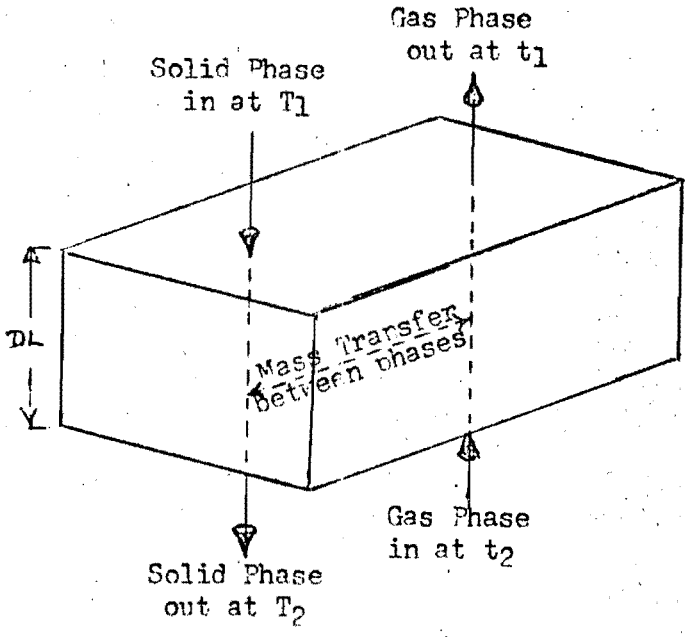
Handout No 4

GAS-COMBUSTION RETORT



Handout No. 5

BASES FOR MATH MODEL OF GAS COMBUSTION RETORT



A. Heat Transfer

Gas to Solid and conduction through Solid

B. Mass Transfer and Heat Effects

Mass in Solid Phase		Mass In Gas Phase	Heat Effect
(H_2O) adsorbed	$\xrightarrow{*}$	(H_2O) vapor	- Heat
(H_2O) surface	$\xrightarrow{*}$	(H_2O) vapor	- Heat
(H_2O) surface	$\longleftarrow$	(H_2O) Mist $\xleftarrow{*}$ (H_2O) vapor	+ Heat
(Oil) surface	$\longleftarrow$	(Oil) mist $\xleftarrow{*}$ (Oil) vapor	+ Heat
Kerogen	$\xrightarrow{*}$	(Oil) vapor + Gas	- Heat
Carbonates	$\xrightarrow{*}$	CO_2	- Heat
Coke + O_2	$\xrightarrow{*}$	CO_2 + (H_2O) vapor	+ Heat
		Gas + $O_2 \xrightarrow{*} CO_2$ + (H_2O) vapor	+ Heat
Kerogen + O_2	$\xrightarrow{*}$	CO_2 + H_2O	+ Heat
Oil	$\longrightarrow$	Coke + Gas	- Heat

* processes currently in math model (9/3/64).

model accounts for mass and heat transfer between gross phases and across the individual particles of shale.

CALCULATION NUMBER 1 (ef Process Variable Study) Handout No. 6

REMARKS

INPUT

RETORT LENGTH,FT		FLOW RATES	
TOTAL	12.0	SHALE,LB/(HR)(FT2)	300.0
TOP COMB ZONE, FROM TOP	3.9	TOT RECYCLE GAS,SCF/T	16000.0
AIR INLET, FROM TOP	6.0	DILUTION GAS,SCF/T	1600.0
SHALE PARTICLE SIZE,INCHES	1.00	AIR,SCF/T	4000.0
		WATER,LB/T	15.0
TEMPERATURES,F			
RAW SHALE	60.0		
AIR-DIL GAS	216.8		

SUMMARY OF RESULTS

TEMPERATURES,F		KERO DECOMP,FRAC		COMBUSTION	
OFF-GAS	132.5	ENTER COMB ZONE	0.000	GAS BURNED	0.123
SPENT SHALE	284.7	SPENT SHALE,CALC	1.000	COKE BURNED	0.166
PEAK GAS	1175	,EST	1.000	OIL BURNED	0.005
PEAK SHALE	1138	CO2 DECOMP,FRAC		LENGTH,FT	2.107
MIX GAS AIR IN	853.1	MAGNESIUM	1.000		
REC GAS AIR IN	1029.9	CALCIUM	0.094	GAS MAKE	
		TOTAL,CALCULATED	0.094	DRY,SCF/T	5086.9
PRESS DROP,PSI	0.8	,ESTIMATED	0.200	HC,BTU/SCF	139.0
				H2OV,SCF/T	1282.3
				H2OL, LB/T	26.7

TEMPERATURE PROFILE

X,FT	0.0	1.1	1.3	1.5	1.7	1.9	2.1	2.3	2.5	2.7	2.9	3.1	3.3	3.4
SHALE	60	177	185	193	200	206	214	224	238	255	277	305	341	363
GAS	133	190	197	204	211	220	231	247	266	291	322	362	413	444
X,FT	3.5	3.6	3.6	3.7	3.8	3.9	4.0	4.1	4.2	4.3	4.3	4.3	4.3	4.4
SHALE	388	400	405	437	472	509	535	569	605	643	650	650	665	711
GAS	478	494	500	536	574	613	640	680	723	770	778	778	791	832
X,FT	4.5	4.6	4.7	4.8	4.9	5.0	5.1	5.1	5.2	5.3	5.3	5.3	5.5	5.6
SHALE	756	798	833	861	887	913	939	970	1013	1059	1090	1102	1135	1138
GAS	870	906	942	979	1021	1063	1097	1127	1153	1171	1175	1173	1143	1087
X,FT	5.8	5.9	5.9	6.0	6.0	6.0	6.1	6.3	6.5	6.7	6.9	7.1	7.3	7.5
SHALE	1114	1095	1075	1061	1048	1048	1038	1022	1009	996	985	975	966	957
GAS	999	952	910	879	853	1030	1022	1008	996	985	975	965	956	948
X,FT	7.7	7.9	8.1	8.3	8.5	8.7	8.9	9.1	9.3	9.5	9.7	9.9	10.1	10.3
SHALE	949	940	932	924	915	906	896	886	874	861	846	828	807	783
GAS	939	931	923	914	905	895	884	872	858	842	823	801	776	745
X,FT	10.5	10.7	10.9	11.0	11.1	11.2	11.3	11.4	11.5	11.6	11.7	11.8	11.9	12.0
SHALE	754	719	678	641	614	585	553	519	483	444	404	364	324	285
GAS	708	664	611	566	532	495	456	414	368	320	272	223	174	126

Handout No. 7

TEMPERATURE PROFILES FOR GAS COMBUSTION RETORT

RUN: No 1 of Process Variable Study

SHALE RATE: 300 lb/(hr)(sq ft)

AIR RATE: 9000 SCFH

RECYCLE GAS RATE: 16,000 SCFH

+ = Gas Temperature

Δ = Mean Shale Temperature

6/12/64

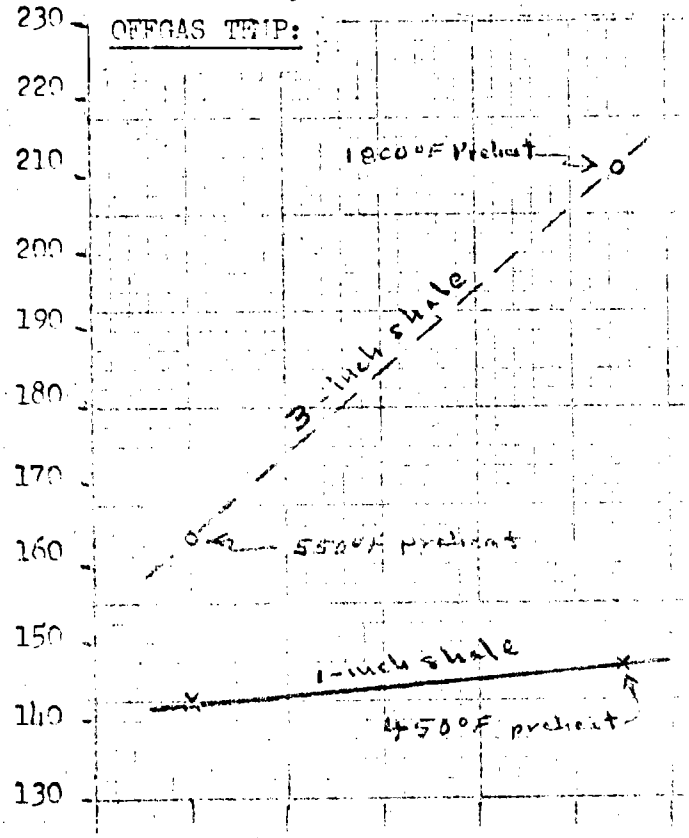
Handout No. 8

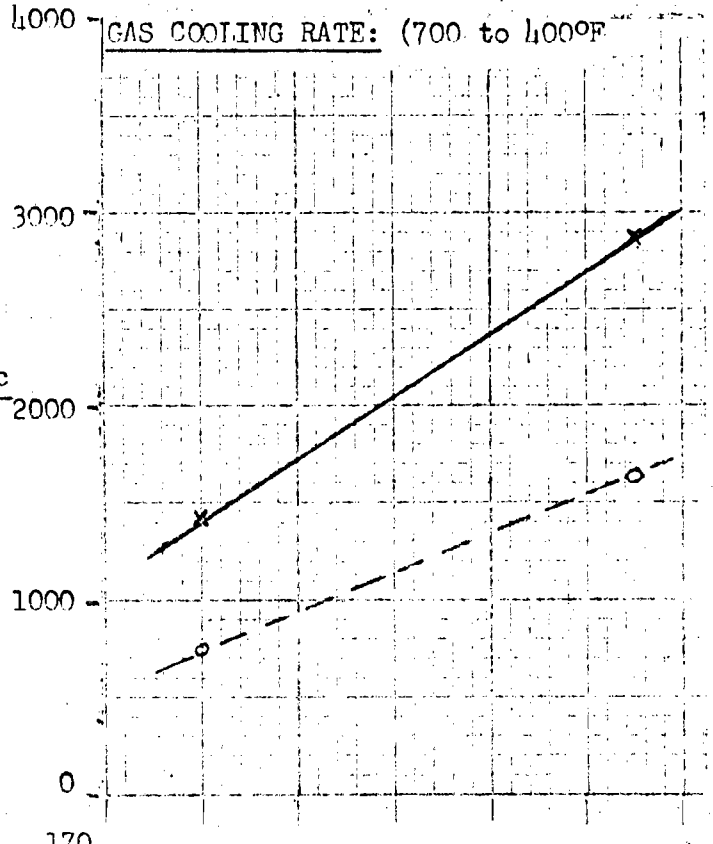
EFFECTS OF PROCESS VARIABLES ON CONDITIONS IN THE MIST FORMING ZONE

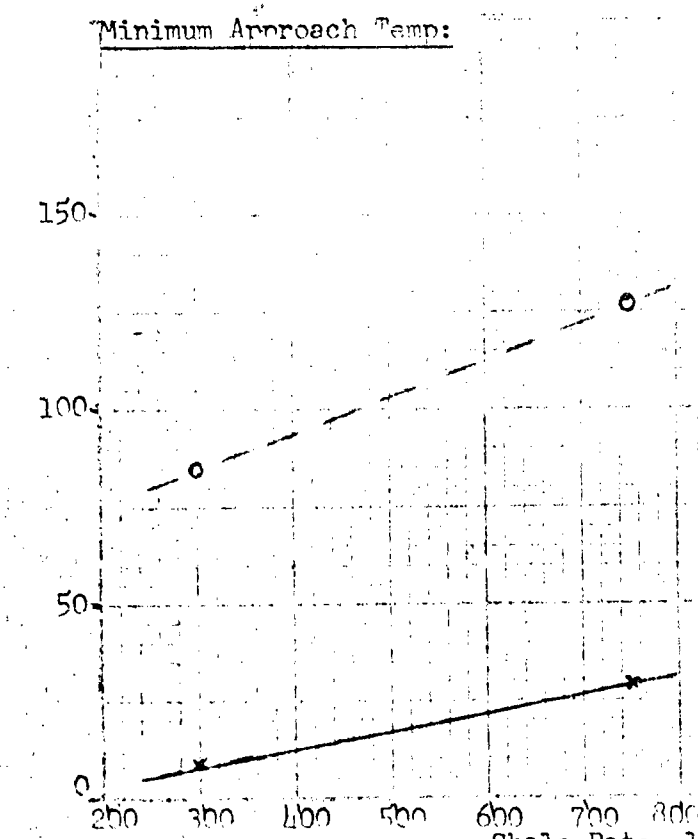
Retort Height - 12-16 Ft. | Shale Part. Size - 1-3 inches | Tot Recycle Gas-16,000 SCF/T
Air Inlet to Top - 6-10 Ft. | Shale Rate - 300-750 lbs/(Hr)(Ft^2) | Air Rate - 4000 SCF/T
Water Add. & Reflux - 45-90 lbs/T | Raw Shale Temp. - 60°F | Dil. Gas/Air - 0.4 V/V

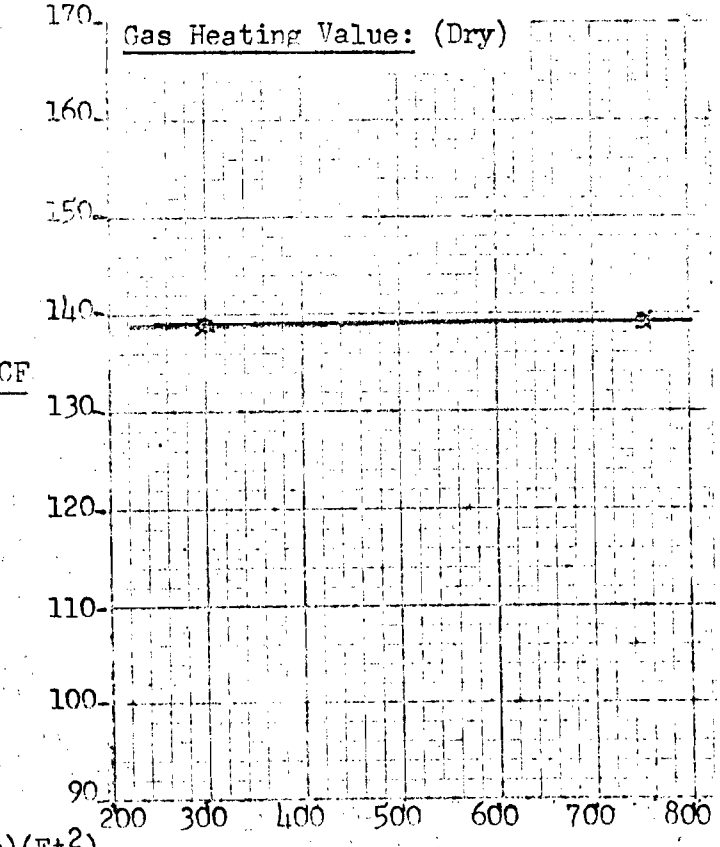
Air-Dilution Gas Temp - 120-1800°F

x———x 1-inch shale (6 feet from air inlet to top @ 45 lbs water/T)
o- - - -o 3-inch shale (10 feet from air inlet to top @ 90 lbs water/T)









FWS 9/2/64

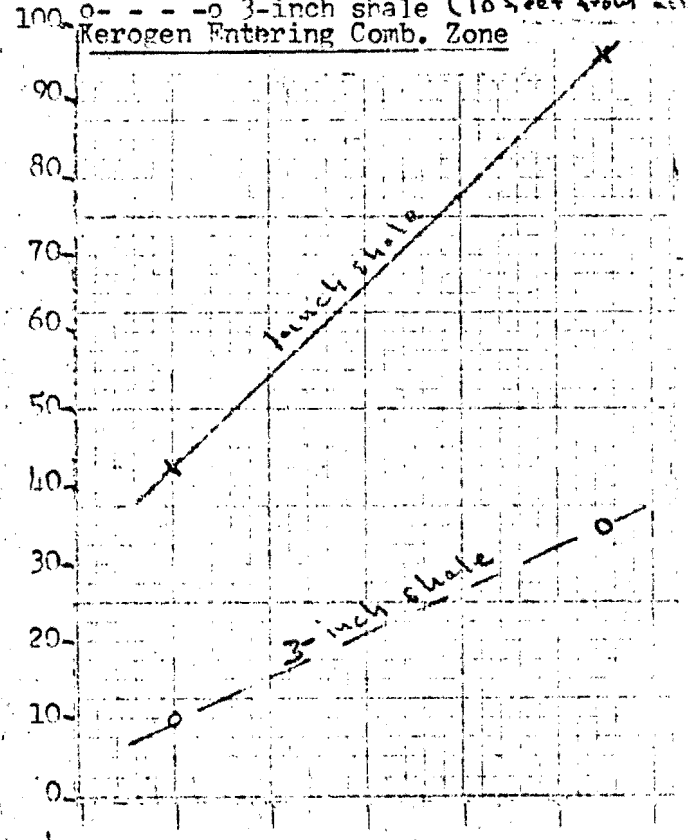
Handout No. 9

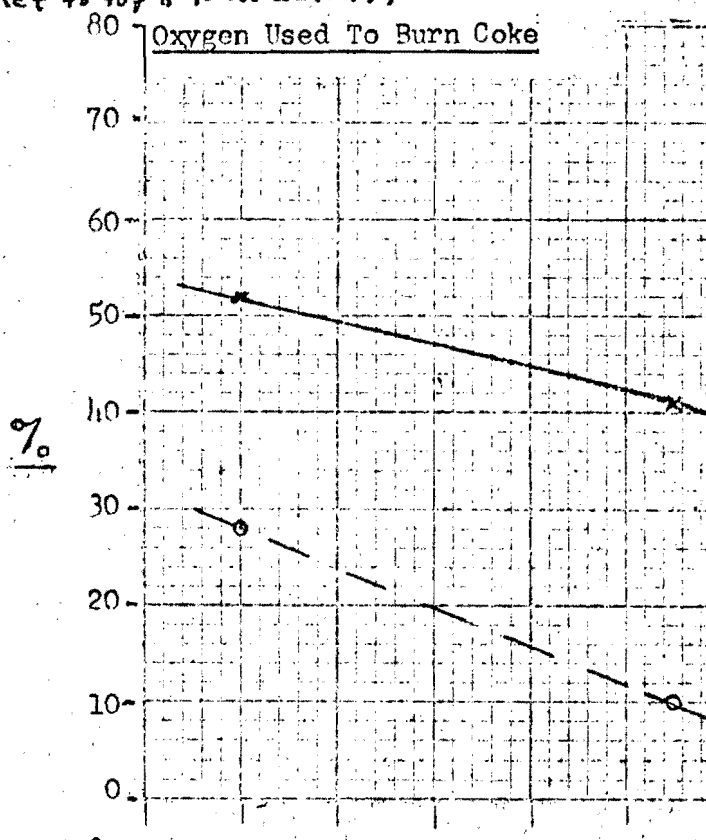
EFFECT OF PROCESS VARIABLES ON CONDITIONS IN COMBUSTION ZONE

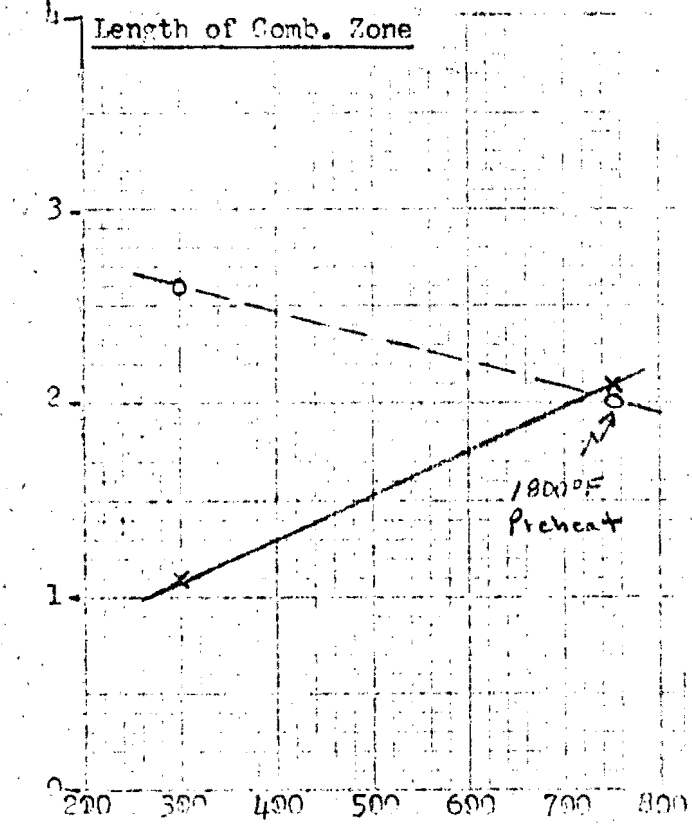
Retort Height - 12-16 Ft.
Air Inlet to Top - 6-10 Ft.
Water Add. & Reflux - 45-90 lbs/T
Shale Part. Size - 1-3 inches
Shale Rate - 300-750 lbs/(Hr)(Ft^2)
Raw Shale Temp. - 60°F
Tot Recycle Gas-16,000 SCF
Air Rate - 4000 SCF/T
Dil. Gas/Air - 0.4 V/V

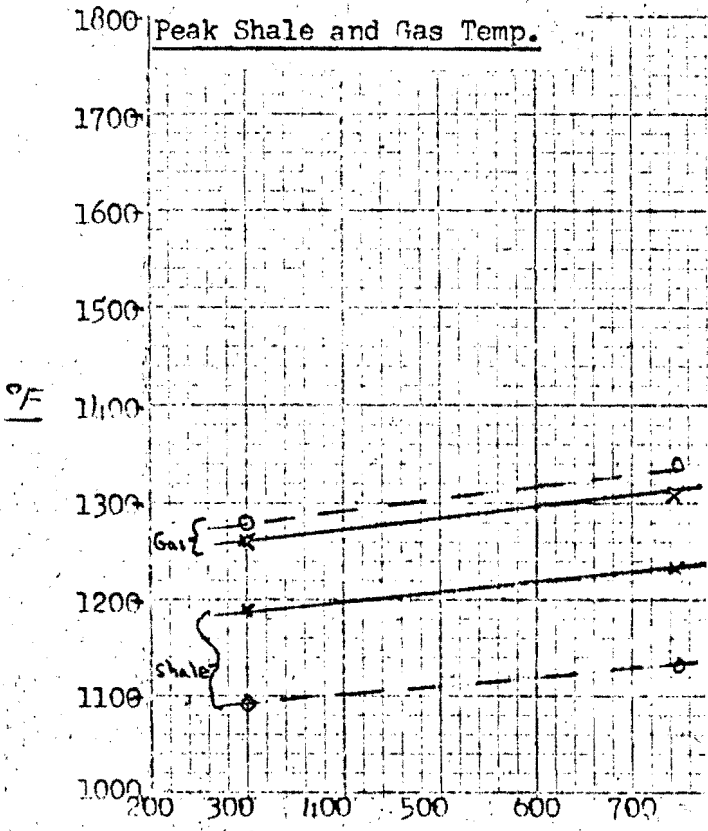
Air-Dilution Gas Temp - 120-1800°F

x———x 1-inch shale (6 feet from air inlet to top @ 45 lbs water/T)
o- - - -o 3-inch shale (10 feet from air inlet to top @ 90 lbs water/T)









Shale Rate, lbs/(Hr)(Ft^2)

Handout No. 10

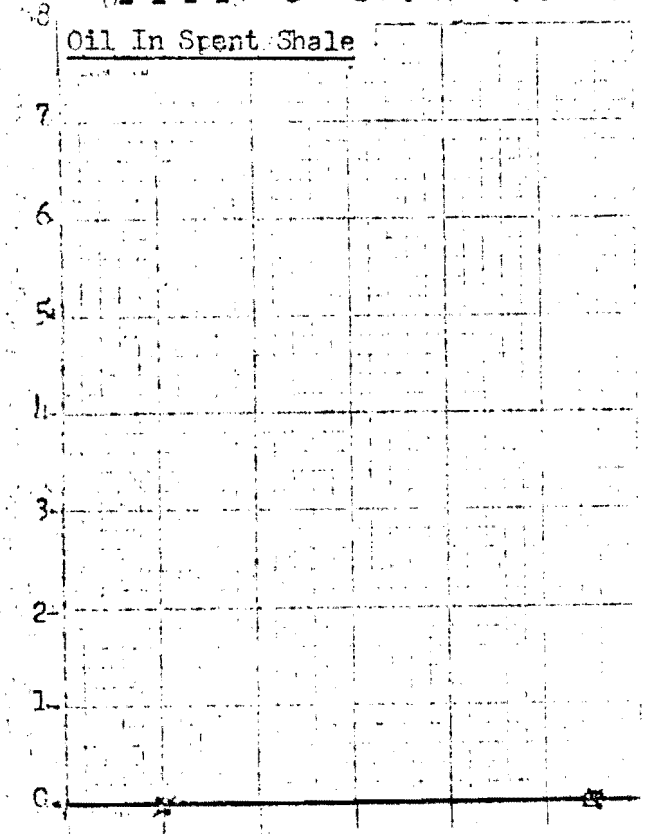
EFFECTS OF PROCESS VARIABLES ON CONDITIONS IN THE SHALE COOLING ZONE

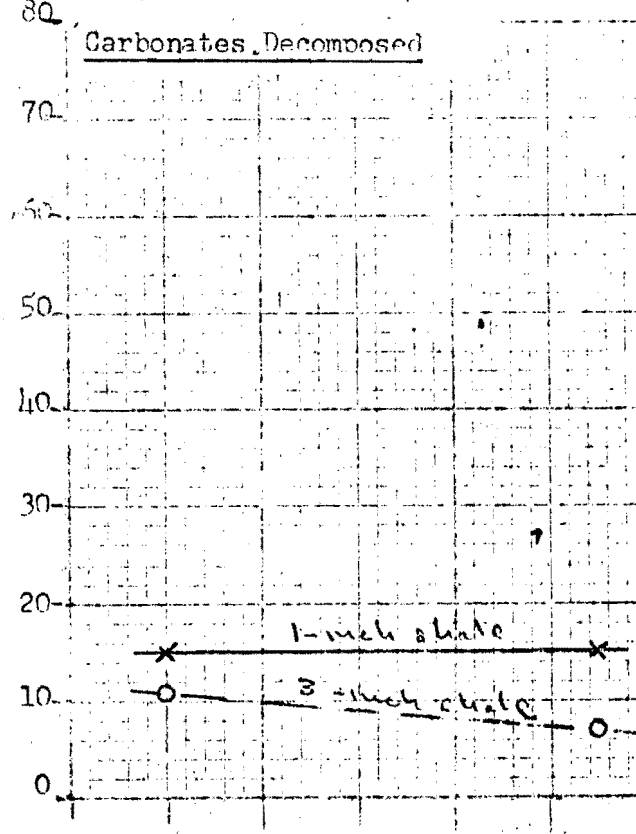
Retort Height - 12-16 Ft. | Shale Part. Size - 1-3 Inches | Tot Recycle Gas-16,000 SCF
Air Inlet to Top - 6-10 Ft. | Shale Rate - 300-750 lbs/(Hr)(Ft^2) | Air Rate - 4000 SCF/T
Wat. Add. & Reflux - 45-90 lbs/T | Raw Shale Temp. - 60°F | Dil. Gas/Air - 0.4 V/V

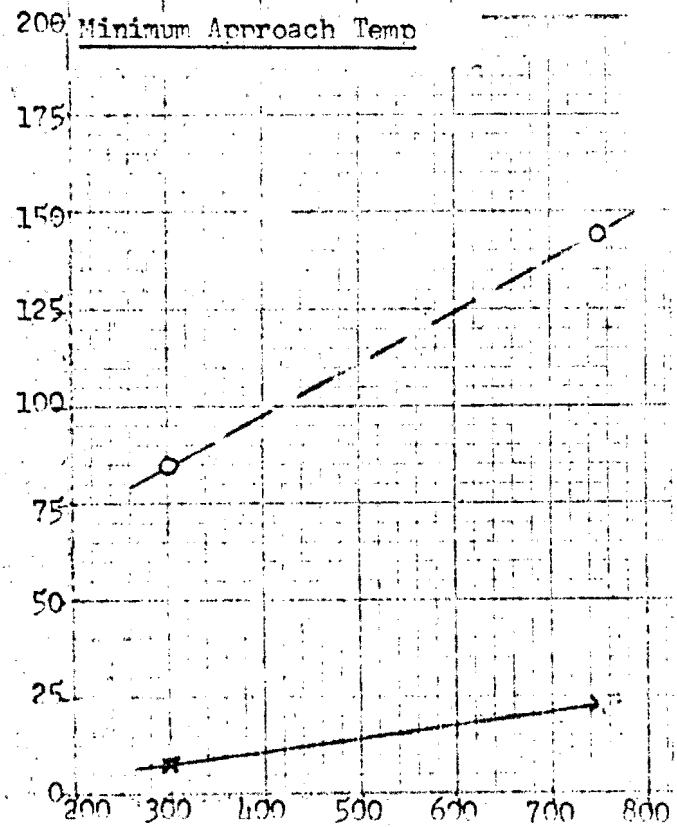
Air-Dilution Gas Temp - 120-1800°F

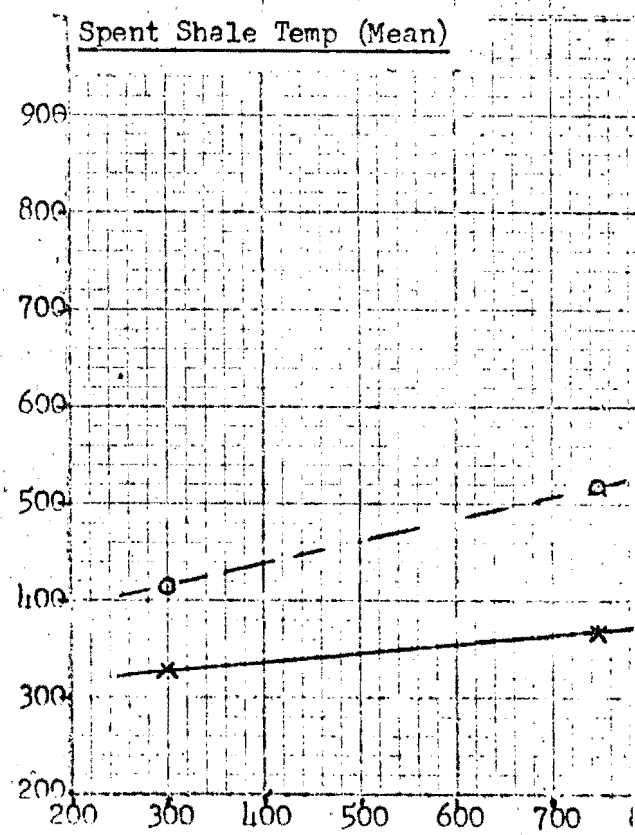
x——x - 1-inch shale (6 feet from air inlet to top @ 45 lbs water/T)

o- - - -o - 3-inch shale (10 feet from air inlet to top @ 90 lbs water/T)









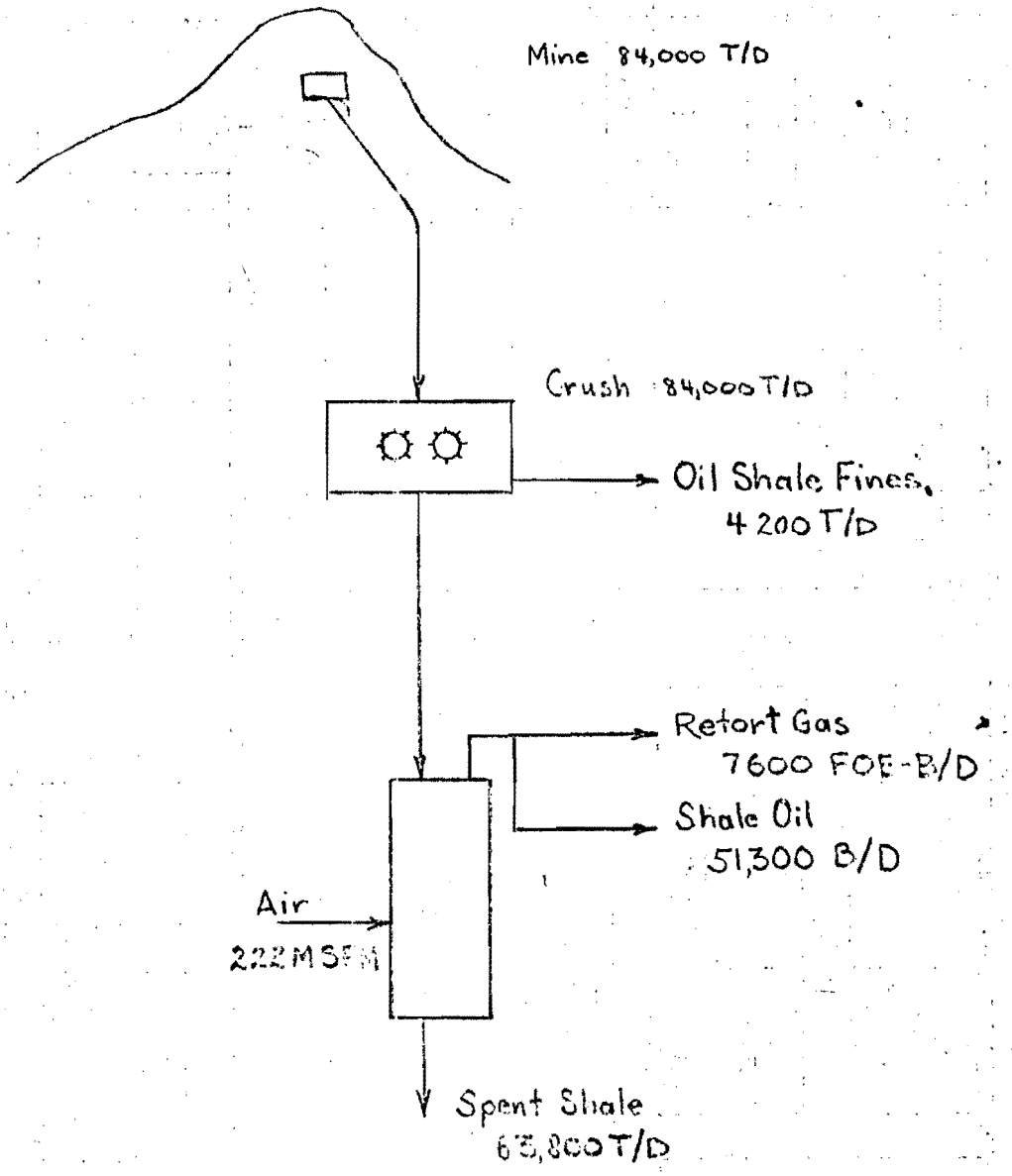
Shale Rate, lbs/(Hr)(Ft^2)

Handout No. 11

9/2/64

Proposed Economic Base Case

MINING



CRUSHING

RETORTING

9/2/64 JGB

Handout No. 12

Economic Evaluation of Shale Oil Recovery By Retorting

$$\text{Cost of Shale Oil} = \frac{\text{Cost of Capital + Operating Cost - By Product Value}}{\text{Barrels of Recovered Shale Oil}}$$

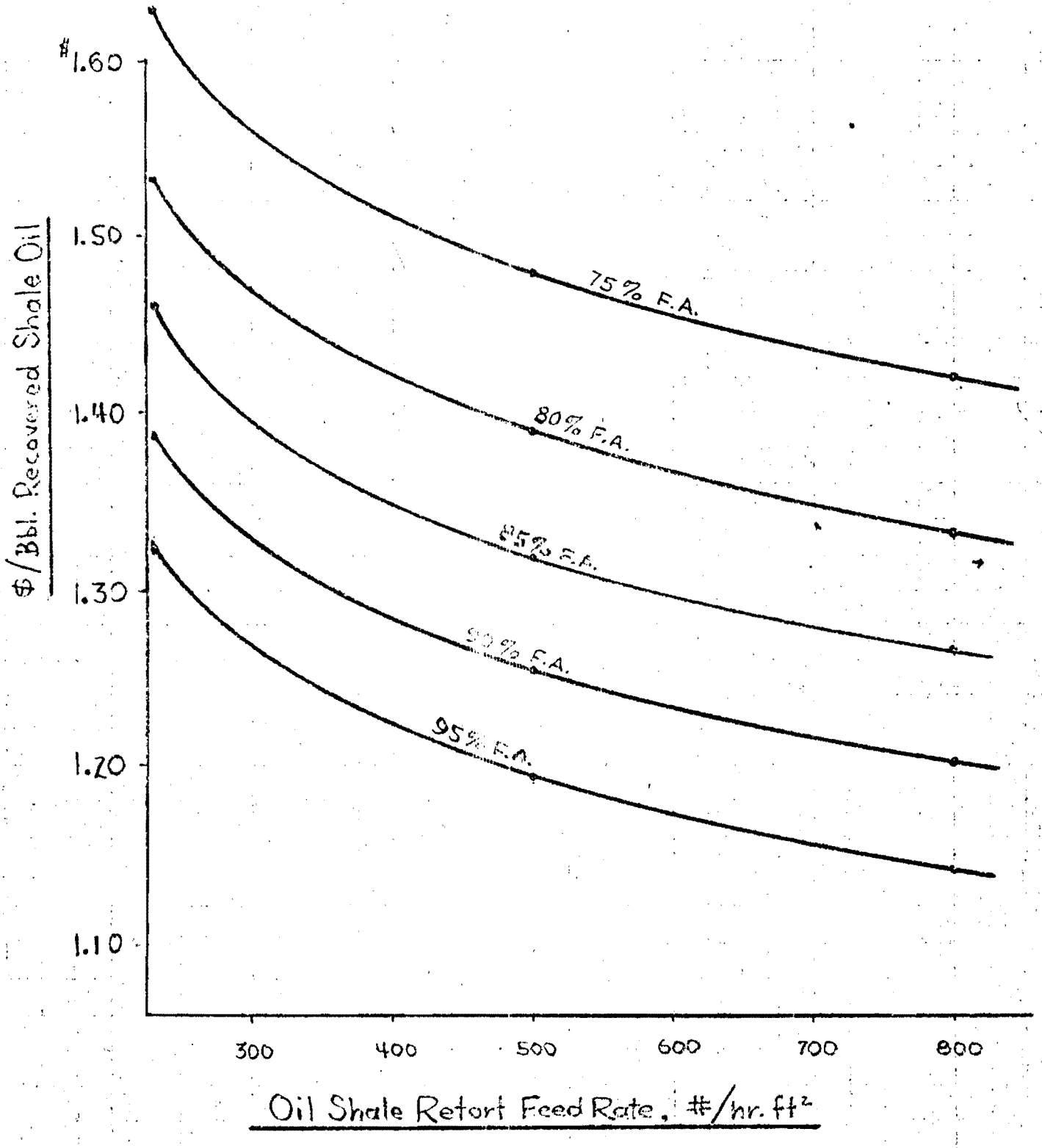
Operating Costs	Utilities	- Air - Steam - Power - Water - Fuel
	Wages	- Operating - Maintenance - Supervision - Plant Overhead - Benefits
	Material	- Maintenance - Miscellaneous - Explosives
	Yield	- Shale Oil Recovery - Losses
	Other Factors	- Escalation of Wages and Material - Federal Income Tax - Local Taxes - Insurance
Cost of Capital	10% D.C.F. 15 Year Project Life 15 Year Depreciation S.Y.D.	
By Product Values	Undersized Oil Shale	No Value
	Retort Gas	Discounted 20% Relative to Natural Gas (after considering lower efficiency)

Factors Not Included in Current Economic Analyses

Depletion Allowance
Other Political Factors - Imports Quotas
Housing
Land

Handout No. 13

Cost Of Shale Oil As A Function Of Retort Space Velocity And Yield



9/2/64 JEB

Handout No. 14

PROPOSED RETORT OPERATING SCHEDULE

Approximate Timing	Unit	Objective
August 28	Retort No. 1	Unit fired initially.
September	Retort No. 1	Hot shakedown.
September	Retort No. 1	Demonstration runs.
September	Retort No. 1	Installation of new air distributor and new raw shale feeder.
September	Retort No. 1	Determine maximum rate capability with new air distributor and shale feed system.
October	Retort No. 1	Test series to determine effect of nucleating agents and gas cooling rate.
October	Retort No. 1	Test series to determine effect of air preheat.
November	Retort No. 2	Operator training and cold shakedown.
November	Retort No. 2	Hot shakedown and demonstration runs.
November	Retort No. 2	Determine maximum rate capability of unit.
December	Retorts 1 & 2	Process variable study.

Retorts to be operated on five day per week basis throughout this period until process variable study is initiated at which time it will be desirable to start seven day per week operation.

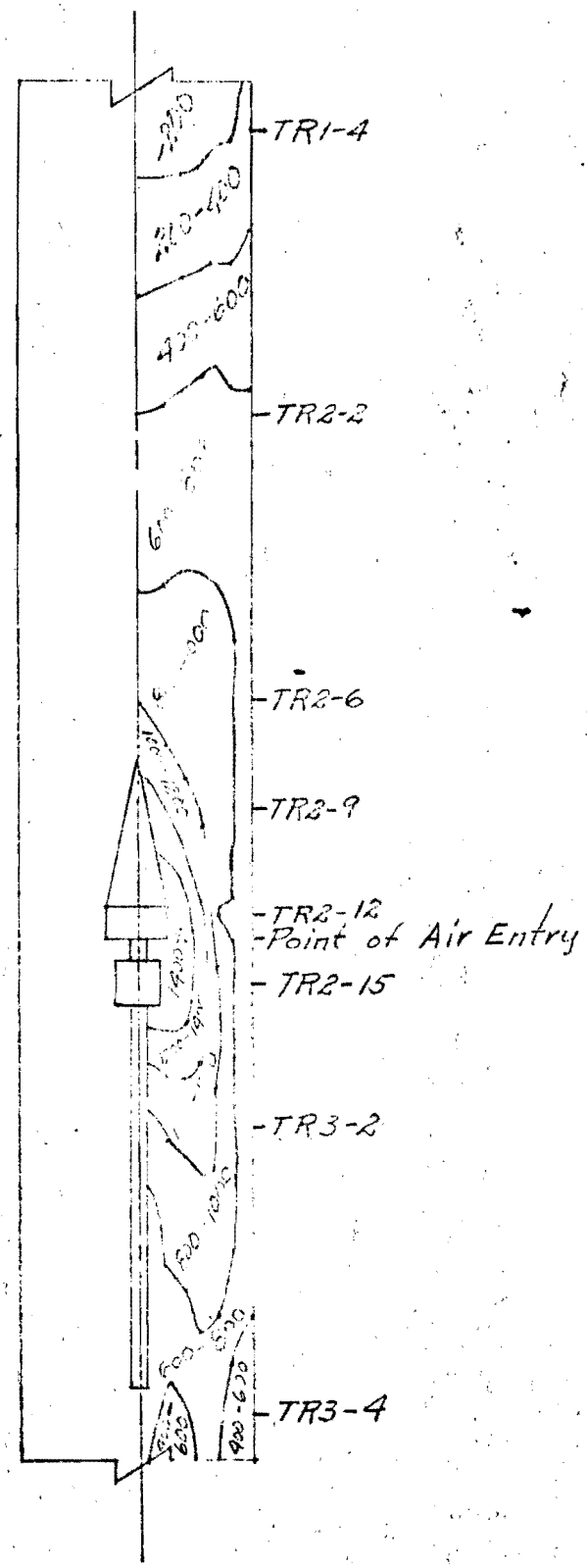
BY ..... DATE .....
CHKD. BY ..... DATE .....

SUBJECT .....

SHEET NO. ..... OF .....
JOB NO. .....

Handout No. I5

Run 33/A.



C. Shale Analysis and Preparation (C. W. T[illegible])

Objective: To determine the quantity and quality of raw shale stockpiles available for the first phase of retorting research.

1. Background

a. Raw Shale Inventory and Sampling

Seven piles of raw shale have been located at the Anvil Points facilities. The location and description of each pile are shown in Table 1 along with the available Fischer Assay results. All mine run shale piles have to be or will have to be crushed to three-inch minus before representative samples can be obtained. Pile "A", therefore, is the only pile which does not have to be run completely through the crushing and screening facilities.

TABLE 1

Location, Description and Analyses of Raw Shale Stockpiles

Pile	Location	Shale Size	Estimated Amount, Tons	Fischer Assay gal/ton	Fischer Assay 95% Conf. Limits	Sampling Procedure
A	West of mine road gate	-3", +¼"	ca. 1000	27.8	±2.1	Perimeter & 2 diagonal trenches 4 assays run
B	Above Crusher Bldg.	-3", +¼"	225	26.3	±2.7	Total pile through Crusher 4 assays run
C	Above Crusher Bldg. next to pile "B"	Mine Run	ca. 1400	24.8	±0.8	Total pile through Crusher 14 assays run
D	East of mine road gate	Mine Run	ca. 1000	40 to 50	--	Total pile through Crusher
E	Behind pile "D" and probably part of it originally	-3", +¼"	60	50.8	--	Total pile through Crusher 1 assay run
L	East of mine road gate next to pile "D"	Mine Run	ca. 1000(1)	10 to 15	--	Total pile through Crusher if required
M	In 7th cross cut of mine	Mine Run	ca. 2000	28 to 30	--	Total pile through Crusher
			ca. 6700(1)			

(1) Use of Pile "L" may not be feasible except for solids flow studies.

TEMPERATURE PROBES

NUMBER ONE RETORT

RUN & TEST NO. _____ DATE _____

TIME PROBES START _____ END _____

OPERATOR _____

THERMOCOUPLE NUMBER	TEMPERATURE, °F IMMERSION INTO BED						
	0"	1½"	3"	4½"	6"	7½"	10"
TR- 2-4							
TR- 2-6							
TR- 2-10							
TR- 2-13							
TR- 2-16							
TR- 3-3							
TR- 3-6							
TR- 3-10							

SKIN TEMPERATURE °F

TI-1	_____ °F	TI-11	_____ °F
2	_____ °F	12	_____ °F
3	_____ °F	13	_____ °F
4	_____ °F	14	_____ °F
5	_____ °F	15	_____ °F
6	_____ °F	16	_____ °F
7	_____ °F	17	_____ °F
8	_____ °F	18	_____ °F
9	_____ °F	19	_____ °F
10	_____ °F	20	_____ °F

SCREEN ANALYSIS DATA SHEET
(TY-LAB TESTER)

Sample No. _____ Date _____ Run No. _____

Unit _____ Description _____

Approx. Shale Size _____ Required Shaking Time _____

Date Analyzed _____ Analyzed By _____

Total Sample Wt. Gross _____ -Tare _____ =Net _____

Harrison No. 20

Screen Size			Weights				Percentages			
Screens Required	Opening Inches	Mesh	Gross Lbs. Oz.	Gross Lbs.	Tare Lbs.	Net Wt. Retained	Screen Size	% Retained	Cum. %	Remarks
	4.25						4.25			
	3.00						3.00			
	2.00						2.00			
	1.50						1.50			
	1.050						1.050			
	0.742						0.742			
	0.525						0.525			
	0.371						0.371			
	0.263	3					0.263			
	0.185	4					0.185			
	0.131	6					0.131			
	0.093	8					0.093			
	0.065	10					0.065			
	PAN						PAN			
			Total on Screens and Pan				LOSS			
			Loss (By Difference)				TOTAL			
			Total Sample Weight							

Handout No. 21

GAS ANALYSIS

RUN & TEST NO. _____ DATE _____

UNIT NO. _____ OPERATOR _____

	I	II	III	IV	AVG.
Water, lbs./M SCF of dry gas					
Liquid, lbs./M SCF of dry gas					
Composition, dry basis					
H_2 Vol. %					
C_2 Vol. %					
N_2 Vol. %					
CH_4+ Vol. %					
CO Vol. %					
CO_2 Vol. %					
H_2S Vol. %					
Carbon (Total) lbs./M SCF dry gas					
Hydrogen (Total) lbs./M SCF dry gas					
Heating Value, BTU/MSCF					

LIQUID PRODUCT ANALYSIS

RUN & TEST NO. _____ DATE _____

UNIT NO. _____ OPERATOR _____

	I	II	III	IV	AVG.
Oil, wt. %					
Water, wt. %					
Carbon, wt. % of oil					
Hydrogen, wt. % of oil					
Dry Oil Properties					
API Gravity					
Density, g/cc					
Viscosity, SUS @ 130 °F					
Viscosity, SUS @ 210 °F					
Ramsbottom Carbon, wt. %					
Sediment, Volume %					
Pour Point °F					
Sulfur, wt. %					
Ash, wt. %					
Nitrogen, wt. %					
Distillation, wt. %					
1 (50°C, 760 mm)					
2 (75, ")					
3 (100, ")					
4 (125, ")					
5 (150, ")					
6 (175, ")					
7 (200, ")					
8 (150, ")					
9 (175, ")					
10 (200, ")					
11 (225, ")					
12 (250, ")					
13 (275, ")					
14 (300, ")					
BTMS.					

RAW & SPENT SHALE ANALYSIS

RUN & TEST NO. _____ DATE _____

UNIT NO. _____ OPERATOR _____

	I		II		III		IV		AVG.	
	RS	SS	RS	SS	RS	SS	RS	SS	RS	SS
Fischer Assay, gal/ton										
Oil, wt. %										
Water, wt. %										
Spent Shale, wt. %										
Gas + Loss, wt. %										
Specific Gravity										
CO_2 (Mineral), wt. %										
Ash, wt. %										
Carbon (Total), wt. %										
Carbon (Organic) wt. %										
Hydrogen (Total), wt. %										
Nitrogen, wt. %										
Moisture, wt. %										

Handout No. 23

PROGRAM OBJECTIVE AND CONCLUSION SUMMARY REPORT

(Not completely developed at this time)

HANDOUT No. 25 MATERIAL BAL CALC VIA TELETYPE

029, RUN NO 222D DATE JA 0, 1952

INPUT DATA

A. RUN TIME 2.4000000E&01

B. CHARGE MATERIALS

RS	1.2215000E&04	URS	1.5000000E-02	OLRS	1.1000000E-01
FA	2.9000000E&01	GRS	2.1000000E-02	CORS	1.6700000E-01
ASRS	6.7600000E-01	CRS	1.7100000E-01	HRS	1.7500000E-02
W	0.0000000E 00				
A	1.5900000E&01	UA	3.0000000E-02		

C. PRODUCTS

SS	9.5370000E&03	USS	5.5000000E-03		
OLSS	5.0000000E-02	GSS	1.0000000E-03	COSS	1.5900000E-01
ASSS	8.2400000E-01	CSS	5.0800000E-02	HSS	1.9000000E-03
L	1.5160000E&03	WL	1.4900000E-01	OLL	8.9100000E-01
COL	8.3700000E-01	HOL	1.1200000E-01	DOL	7.7600000E&00
G	2.1300000E&01	WG	6.7000000E&00	OG	1.0000000E-01
HHG	4.2000000E&00	COG	4.0000000E&00	CHG	4.6000000E&00
COOG	8.7400000E&01	NG	5.6900000E&01	CG	1.2800000E&01
HG	7.5200000E-01				

CALCULATIONS

A. MATERIALS IN

WI	2.2055688E&02	CI	2.0887650E&03	HI	2.1383874E&02
OI	2.0880327E&03	ASI	8.2573400E&03	HI	1.3963415E&04

B. MATERIALS OUT

DG	3.0709406E&01	WO	4.6409052E&02		
CO	1.9573871E&03	HO	2.3562601E&02	OO	2.2308892E&03
ASO	7.0584880E&03	HO	1.3769903E&04		

C. YIELDS

FAY	9.3865407E-01	GY	5.0281467E&03	CD	2.7534125E&01
WY	8.4807925E&00	GL	6.1246000E&00		

D. MATERIAL BALANCES

OVMB	9.8614150E-01	CMB	9.3710259E-01	HMB	1.1018864E&00
ASMB	9.5169728E-01	OMB	1.0684168E&00		

END OF RUN
SYSTEM CLOSED

Handout No. 26

OIL SHALE RETORT NO. 1

DETAILED TEST SHEET Date _____

Purpose:

1. General	
Run & Test No.	
Date Started	
Length, hours	
2. Rates & Quantities	
Air, scfm	
Propane, scfm	
Recycle, scfm	
Dilution, scfm	
Vent, scfm	
Total, scfm	
Raw Shale, lbs/hr	
Spent Shale, lbs/hr	
Liquid Product, lbs/hr	
Air, SCF/ton RS	
Recycle, SCF/ton RS	
Dilution, SCF/ton RS	
Propane, SCF/ton RS	
3. Temperature, °F	
Product Outlet	
Spent Shale Outlet	
Raw Shale Inlet	
Recycle Gas Inlet	
Dilution Gas Inlet	
Air Inlet	
Line Burner Outlet	
Retort Maximum	
4. Yields & Balances	
Oil Collected, Vol. % FA	
Oil Collected, gal/ton RS	
Gas Vented, SCF/ton RS	
Spent Shale, wt.% RS	
Carbonate Decomp. %	
Water Recovered, gal/ton RS	
Gas Losses, SCF	
Overall Balance %	
Carbon Balance %	
Hydrogen Balance, %	
Ash Balance, %	
Oxygen Balance, %	
Nitrogen Balance, %	
Heat Balance, %	
5. Raw Shale Properties	
Fischer Assay, gal/ton	
Oil, wt. % (FA)	
Water, wt. % (FA)	
Mineral CO_2, wt. %	
Ignition Loss, wt. %	
Moisture, wt. %	
Carbon (Total), wt. %	
Carbon (Organic), wt. %	
Hydrogen (Total), we. %	
Nominal Particle Size, in.	

6. Liquid Product Prop.	
1. Water, wt. %	
2. Oil, wt. %	
a. Carbon Content, wt. %	
b. Hydrogen, wt. %	
c. Density, g/cc	
d. Gravity, API	
e. Viscosity, SUS @130°F	
f. Viscosity, SUS @210°F	
g. Ramsbottom Carbon, wt. %	
h. Pour Point, °F	
i. Ash, wt. %	
7. Product Gas Properties	
Water Vapor, lbs/MSCF dry	
Dry Analysis	
O_2 Vol. %	
H_2 Vol. %	
CO Vol. %	
CO_2 Vol. %	
CH_4 Vol. %	
N_2 Vol. %	
H_2S Vol. %	
Carbon (Total) lbs/MSCF dry	
Hydrogen (Total) lbs/MSCF dry	
Liquid, lbs/MSCF dry	
8. Spent Shale Properties	
Fischer Assay, gal/ton	
Mineral CO_2, wt. %	
Water, wt. %	
Oil, wt. %	
Gas, wt. %	
Ash, wt. %	
Carbon (Total), wt. %	
Hydrogen (Total), wt. %	
9. Miscellaneous	
Bed Height, ft.-in.	
Pressure Drop, in. H_2O/ft.	
Dist. Back Press., psi	
NaCl Solution, wt. %	
NaCl Rate gal/ton RS	

REMARKS:

10. Operational Analysis	Specified	% of Spec.	Degree of Control
Shale Rate, lbs/hr			
Air Rate, scfm			
Recycle Gas Rate			
Dilution Gas Rate			
Propane Rate			

Handout No. 27

TEST SUMMARY SHEET

Run No. ----------
Date ----------
Duration ----------hr.----------
Retort type No.----------
Oil recovery system type No.----------
Raw material flows:
  Raw shale-lb./hr. x sq.ft. bed area---
  Recycle gas-std.c.f./ton raw shale---
  Air----------do-----
  Dilution gas ----------do-----
  Propane gas ----------do-----
  Brine-gal/ton----------raw shale----
Products recovered:
  Shale oil----vol.-pct. Fischer assay---
  Shale oil-----gal./ton raw shale----
  Gas vented-std.c.f./ton raw shale----
  Spent shale-----lb./ton raw shale----
  Water condensed----------
  Material output---wt.-pct. of input---
Raw shale properties:
  Fischer assay----------gal./ton----
  Mineral CO_2----------wt.-pct.----
  Particle size range---------inch----
Shale oil properties:
  Gravity----------°API---
  Viscosity--------S.S.U. at 130° F.---
  S.S.U. at 210° F.---
  Ramsbottom carbon--------wt.-pct.----
  Pour point----------° F.---
  Sulfur----------wt.-pct.----
  Nitrogen----------do-----
Gas Properties:
  Moisture----------vol.-pct.----
  Analysis, dry:
    CO_2----------vol.-pct.----
    H_2S----------do-----
    O_2----------do-----
    CO----------do-----
    H_2----------do-----
    Hydrocarbons----------do-----
    N_2----------do-----
  Heating value, gross (calc.)
  B.t.u./std.c.f.---
Spent shale properties:
  Fischer assay----------gal./ton---
  Mineral CO_2----------do-----
Operating data:
  Press. drop/ft. bed height--in. H_2O---
  Retort gas outlet temp.---------° F.---
  Recycle gas temp.----------do---
  Air preheat temp.----------do---
  Spent shale temp.----------do---
Operating characteristics:
  Degree of clinkering or coking-------
  Other troubles----------See note No.---

Handout No. 28

LAB. NO. _____

LABORATORY ANALYSIS REQUEST

ANVIL POINTS OIL SHALE RESEARCH CENTER

SAMPLE NO. _____ DATE _____

SAMPLE DESCRIPTION _____

SUBMITTED BY _____ RESULTS TO _____

☐ RETAIN ☐ DISCARD ☐ RETURN ☐ BY PHONE

TYPE OF SAMPLE

☐ RAW SHALE ☐ OIL ☐ GAS

☐ SPENT SHALE ☐ OTHER _____

	ANAL.
◯ FISCHER ASSAY	___
___ GAL/TON	
0. ___ S.G. OIL	
___ OIL WT. %	
___ WATER WT. %	
___ SPENT SHALE WT. %	
___ GAS+LOSS WT. %	
◯ MINERAL CO_2 ___ WT. %	___
◯ ASH (SHALE) ___ WT. %	___
◯ IGNITION LOSS ___ WT. %	___
◯ MOISTURE ___ WT. %	___
◯ CARBON (TOTAL) ___ WT. %	___
◯ CARBON (ORGANIC) ___ WT. %	___
◯ HYDROGEN ___ WT. %	___
◯ NITROGEN ___ WT. %	___
◯ API GRAVITY ___ °	___
◯ VISCOSITY ___ SUS@130°F.	___
◯ VISCOSITY ___ SUS@210°F.	___

	ANAL.
◯ RAM. CARBON ___ WT. %	___
◯ WATER IN OIL ___ WT. %	___
◯ SEDIMENT IN OIL ___ VOL. %	___
◯ POUR POINT ___ °F.	___
◯ ASH (OIL) ___ WT. %	___
◯ DISTILLATION (14 FRACTIONS)	___
◯ GAS CHROMATOGRAPHY	___
H_2 ___ VOL. %	
O_2 ___ VOL. %	
N_2 ___ VOL. %	
CH_4 ___ VOL. %	
CO ___ VOL. %	
CO_2 ___ VOL. %	
H_2S ___ VOL. %	
OTHER ___ VOL. %	
◯ WATER IN GAS ___	___
◯ ___	___
◯ ___	___

SPECIAL INSTRUCTIONS AND OTHER TESTS _____

DATE COMPLETED ___ CHECKED BY _____

OSRC-13

Handout No. 29

FISCHER RETORT ASSAY

ANVIL POINTS OIL SHALE RESEARCH CENTER

Sample No. _____ Date - -

Sample Description _____

Retort No. _____ Receiver No. _____ Adapter No. _____

Retort + Sample	gm.	Retort + Spent Shale	gm.
Retort (-)		Retort (-)	
Sample Weight	gm.	Spent Shale	gm.
Dist. + Spent Shale (-)		Distillate Weight (+)	
Gas + Loss	gm.	Dist + Spent Shale	gm.

Rec. + Adp. + Dist.		gm
Rec. + Adp.	(-)	
Distillate Weight		gm.
Water Vol. (Wt.)	(-)	
Oil Weight		gm.

OIL	gm		Wt % OIL
WATER	gm.		Wt.% WATER
SPENT SHALE	gm		Wt.% SPENT SHALE
GAS + LOSS	gm.		Wt.% GAS + LOSS
SAMPLE WEIGHT	gm	100.0	%

SPECIFIC GRAVITY OF OIL

Pipet No. _____

Weight (Pipet + Oil) _____ gm.

S.G. 100°/100° F. 0.

Correction 0.

S.G. 60°/60° F. 0.

$$\frac{(\text{Oil Weight})\,(2.396\times10^{-2})}{(\text{S.G. } 60°/60°)\,(\text{Sample Weight})}$$

$$\frac{(\quad)\,(2.396\times10^{-2})}{(0.\quad)\,(\quad)}$$

_____ GALLONS/TON

COMMENTS _____

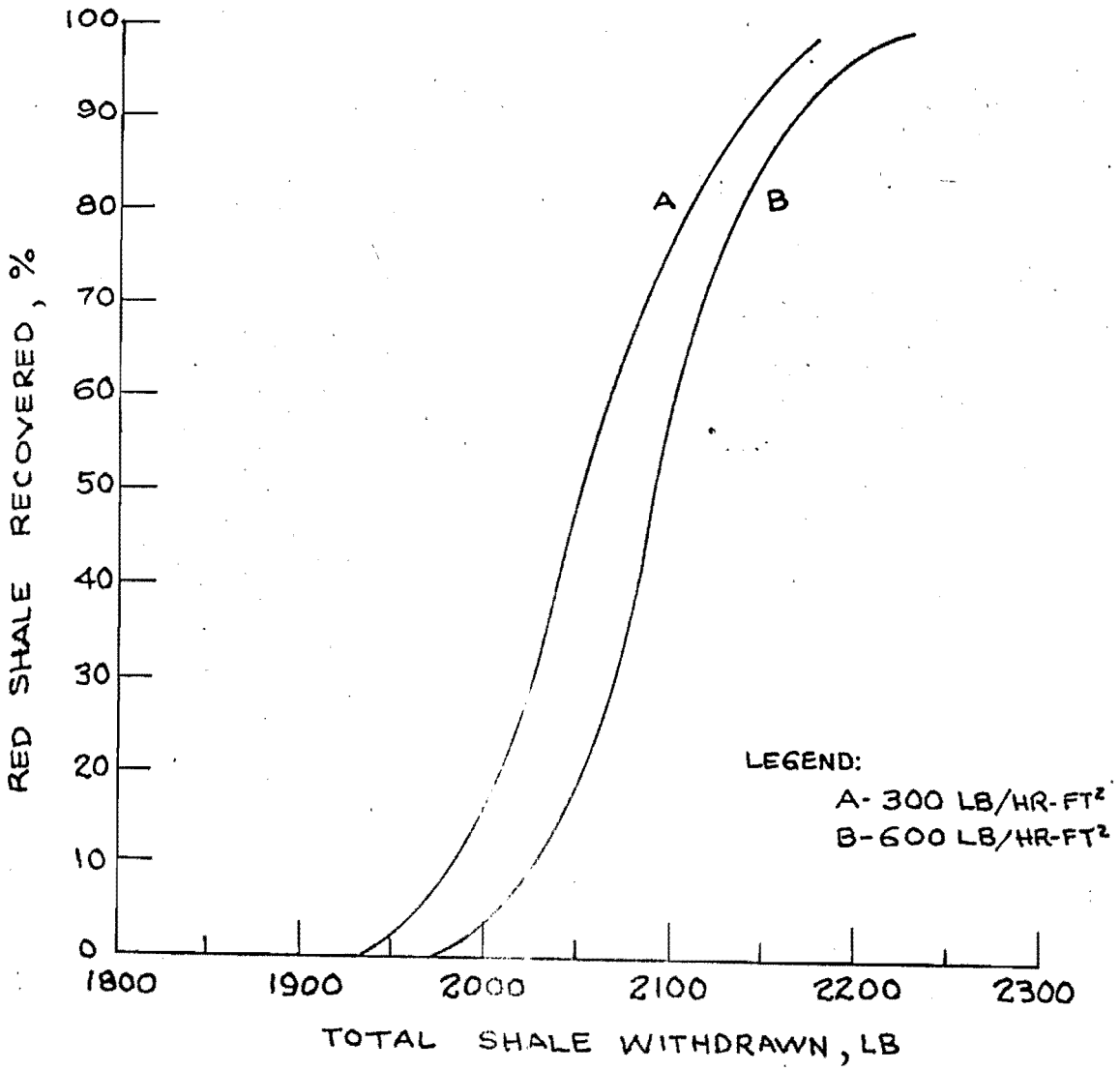
ANALYST _____ CHECKED BY _____

OSRC-13

Handout No. 30

RUN PURPOSE SHEET

RUN	PURPOSE



BREAKOUT CURVES FOR RED-MARKED ONE-INCH SHALE FLOWING THROUGH THE No. 1 RETORT AT RATES OF 300 AND 600 LB/HR-FT²

Handout No. 32

July 22, 1964

PROGRAM OF INITIAL MATHEMATICAL MODEL STUDIES

Shale Flow Studies

The initial shale flow studies will be carried out with two particle size ranges: a "uniform" size of 1/2 - 1 inch and a "desired" range of 1/4 - 3 inch. In addition a comparison of the flow characteristics of spent and raw shale will be made.

A. Determine Basic Flow Characteristics of Oil Shale

1. Flow capacity of pipes.

2. Flow characteristics through:

   a. Tire Nipples

   b. Orifice plates

   c. Rectangular slots

   (Includes the effect of inlet geometry on flow)

3. Angles of flow and repose.

4. Doning heights in moving shale beds.

B. Develop Drawoff Schemes which will Provide Uniform Shale Flow Through Large Vessels

1. Multi-level drawoff schemes.

2. Baffle drawoff schemes.

3. Other schemes which are available commercially.

C. Carry Out Shale Flow Studies to Supplement Design of "Ideal" Air Distributor for Retort No. 1

Air Distributor Studies

A. Investigate Various Air Distributor Designs with Respect To:

1. Degree of mixing of air-dilution gas and recycle gas.

2. Degree of mixing of gas streams and shale.

TCLyons:rl

Handout No. 33

ANALYTICAL LABORATORY OPERATIONS

This memo is to summarize the initial operation of the analytical laboratory with regard to incoming samples, analysis request sheets, result reporting, and log books.

A person submitting a sample should identify it with a Sample Number; he also should fill out a Laboratory Analysis Request form, OSRC-12, (attached). This will show the same Sample Number, a Sample Description, and all other pertinent information. All analyses requested for that sample should be indicated by putting an "X" in the circle preceeding the test.

The laboratory will assign a Laboratory Number to each sample and will stamp this number (1)on the sample tag, (2)on the Laboratory Analysis Request form, and (3)in the Analytical Laboratory Log Book. With each Laboratory Number, the following information will be recorded in the Analytical Laboratory Log Bock -

Date sample received
Sample No.
Sample Description
Analyses requested
Date all analyses completed

The requested analyses will then be performed on the sample, and the results written in the appropriate blanks of the Laboratory Analysis Request form. This form will be checked, dated, and then sent to the person indicated.

A separate notebook will be used for each test listed on the Laboratory Analysis Request form. For each sample, a summary line, containing Laboratory Number, date, results, and the analyst's name, will be recorded. This will be followed by the raw data obtained, such as weights, temperature, pressure, time, calculations, etc.

Supplies of Laboratory Analysis Request forms and sample tags will be available at the Laboratory. Also available are yellow warning tags to be attached to samples that are skin irritants, such as crude shale oil.

B. L. Beck
D. Liederman

7/28/64