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HIGH TEMPERATURE GAS TURBINE ENGINE COMPONENT MATERIALS TESTING PROGRAM.

TASK I

MASTER

MONTHLY TECHNICAL PROGRESS REPORT NO. 5, PERIOD: NOVEMBER 1 - NOVEMBER 29, 1975

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16. Abstracts

Work continued to slip this month in those Subtasks (3.1, 3.3 and 7.2) that are directly affected by the lack of the COED fuel needed for Initial Testing. The limited amount of COED fuel to be made available, the need to resolve logistics for its delivery and the need to develop a synthetic COED fuel for the balance of Initial Testing and for Confirmation Testing have combined to create delays in the Initial Test Program, which would otherwise have been initiated on October 20. As a result of the lack of--and/or delays involving--the above information/data requested from ERDA, the new start date of the Initial COED Testing appears to be late December. (This delayed start in Initial Testing, work scheduled to start in January in other Subtasks (7.3 and 8 in toto)on the basis of having Initial COED fuel test results available, will have to be deferred.)

Other work is continuing on schedule. The selection of materials to be tested, identification of coal feedstocks to be used, selection of a specific COED fuel to be used, and preparations for Initial COED Fuel Testing have all been completed on schedule. Preparations for the Initial Low-BTU Gas Tests at ERDA/MERC and also, for the Screening Tests are proceeding in accordance with schedule. The absence of Initial COED Testing results needed to establish test conditions for the Screening Tests, however, may cause their initiation to be deferred.

17b. Identifiers/Open-Ended Terms Fireside Corrosion Task 1, COED fuel, component life

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3

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November 15, 1075

III OPEN ITEMS

A. Subtask 6 - Program Management

Applicability of ERDA Administrative Orders No. 3 and No. 4 pertaining to the distribution of monthly, quarterly, annual and final reports requires resolution. Following previous correspondance requesting resolution (e.g., letter of October 16, for which there was no formal reply) and discussions of this matter with ERDA on November 5, General Electric has formally proposed four (4) alternative approaches in their letter of November 12. Advantages and disadvantages of each alternative were delineated therein. ERDA was requested to select that alternative most acceptable to it and then direct GE to proceed accordingly. This direction has not as yet been forthcoming.

In the interim, GE has received ERDA's comments on the draft of Quarterly Technical Progress Report No. 1, and is ready to reproduce this report upon receipt of ERDA's directive.

B. Subtask 6 - Program Management

In ERDA's letter of November 5 authorizing GE to provide for the transportation of 6000 gallons of Government-owned COED fuel oil and to derive 80,000 gallons of a "synthetic coal-derived (COED) fuel oil" for use in program testing, authorization was granted for the funding required to accomplish this; however, this letter of November 5 stated that the contract was not increased by the added costs associated with this additional work. As a result, General Electric, in their letter of November 10, requested a formal contract change which will change the Statement of Work (Appendix A), and will increase the estimated cost, the fixed fee and the total contract amount to reflect the change in the statement of work. GE has not as yet received a response to their letter of November 10 (which was prepared at ERDA's request).

In the interim, GE is proceding with Initial Testing plans while awaiting resolution of this matter. This action is being taken to preclude accrual of additional schedule slips.

FIGURE I - FIRESIDE CORROSION TASK I - WORK BREAKDOWN STRUCTURE AND MASTER SCHEDULE (SHEET 1 OF 4)

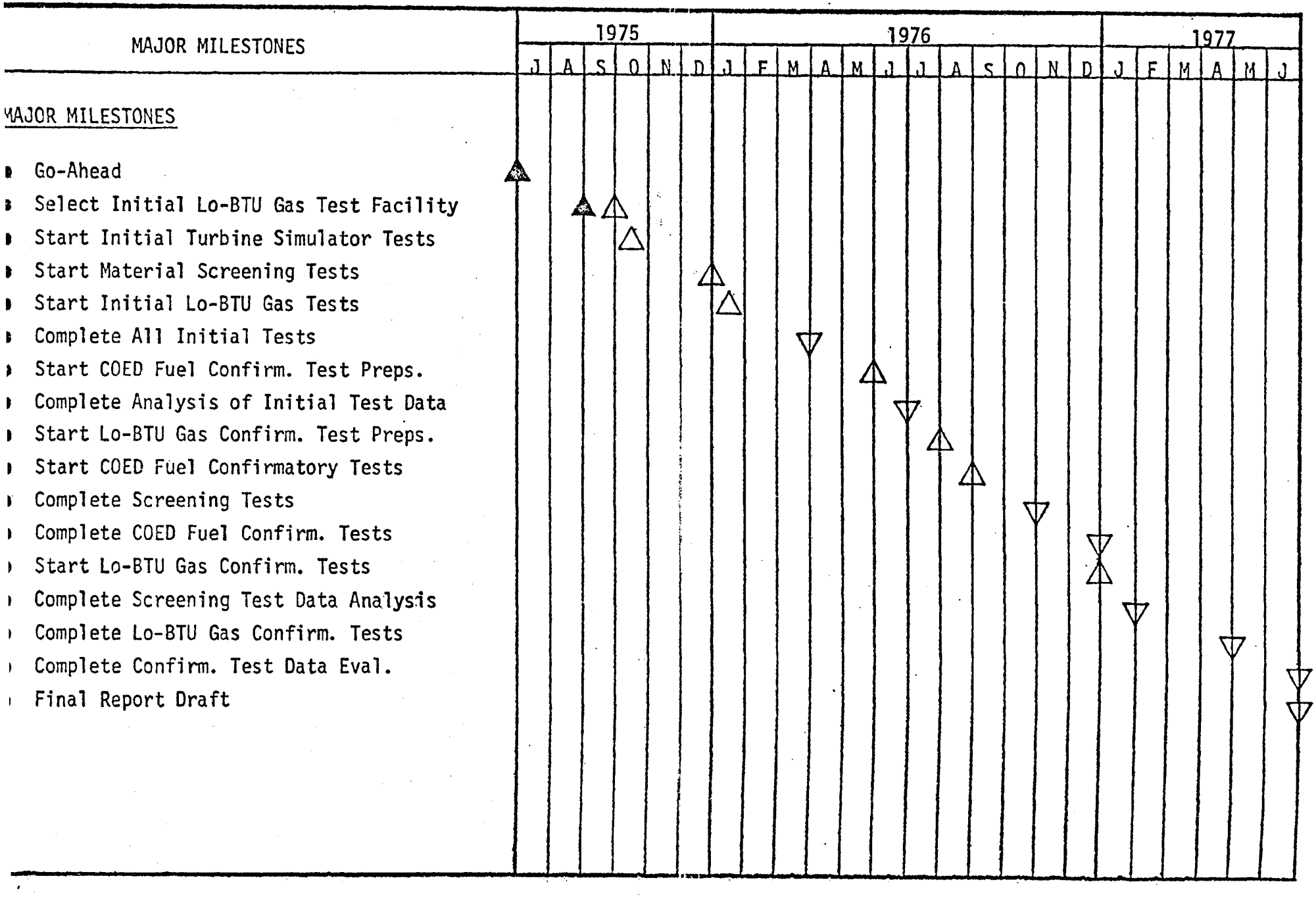

FIGURE I - FIRESIDE CORROSION TASK I - WORK BREAKDOWN STRUCTURE AND MASTER SCHEDULE (SHEET 2 OF 4)

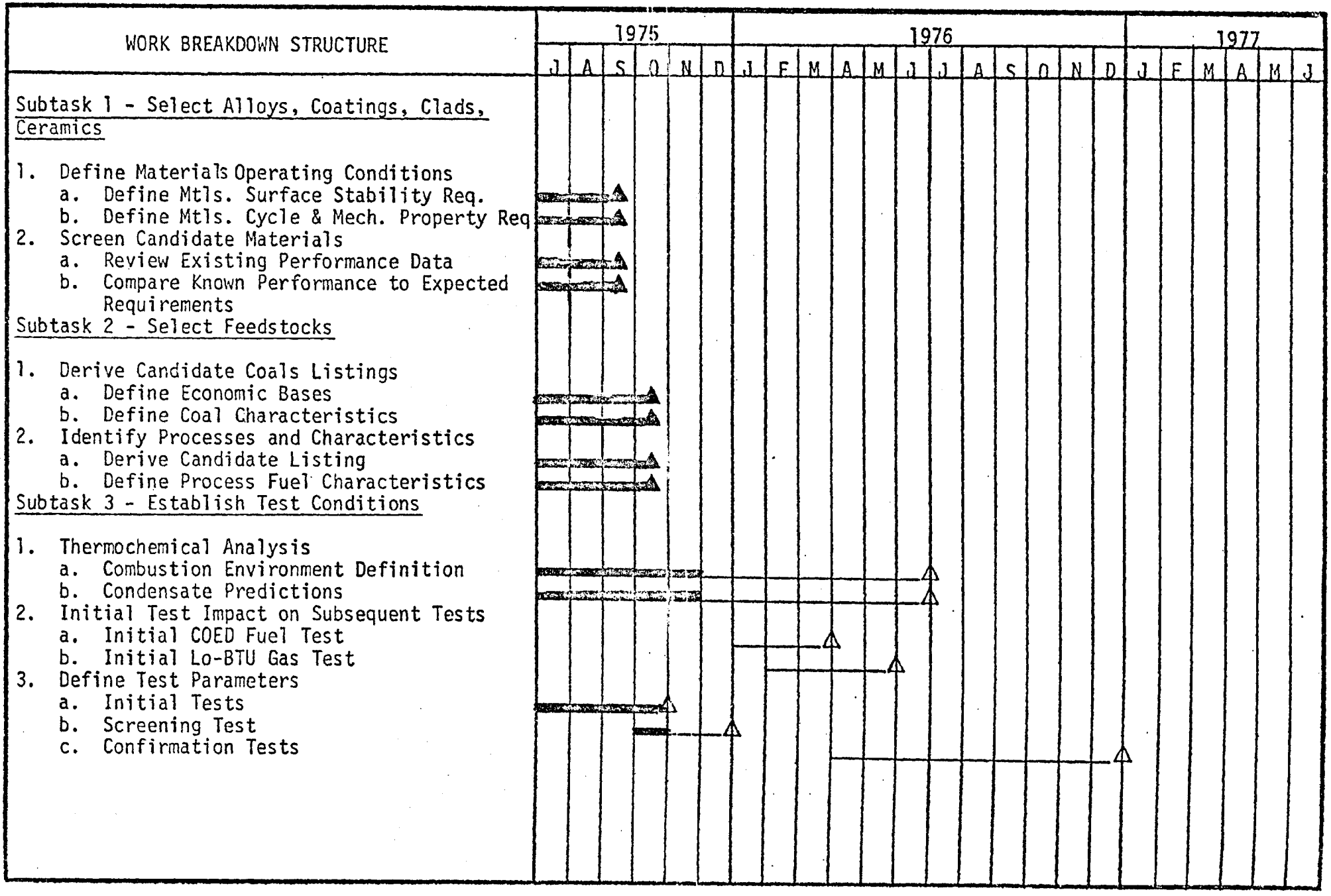

FIGURE I - FIRESIDE CORROSION TASK I - WORK BREAKDOWN STRUCTURE AND MASTER SCHEDULE (SHEET 3 OF 4)

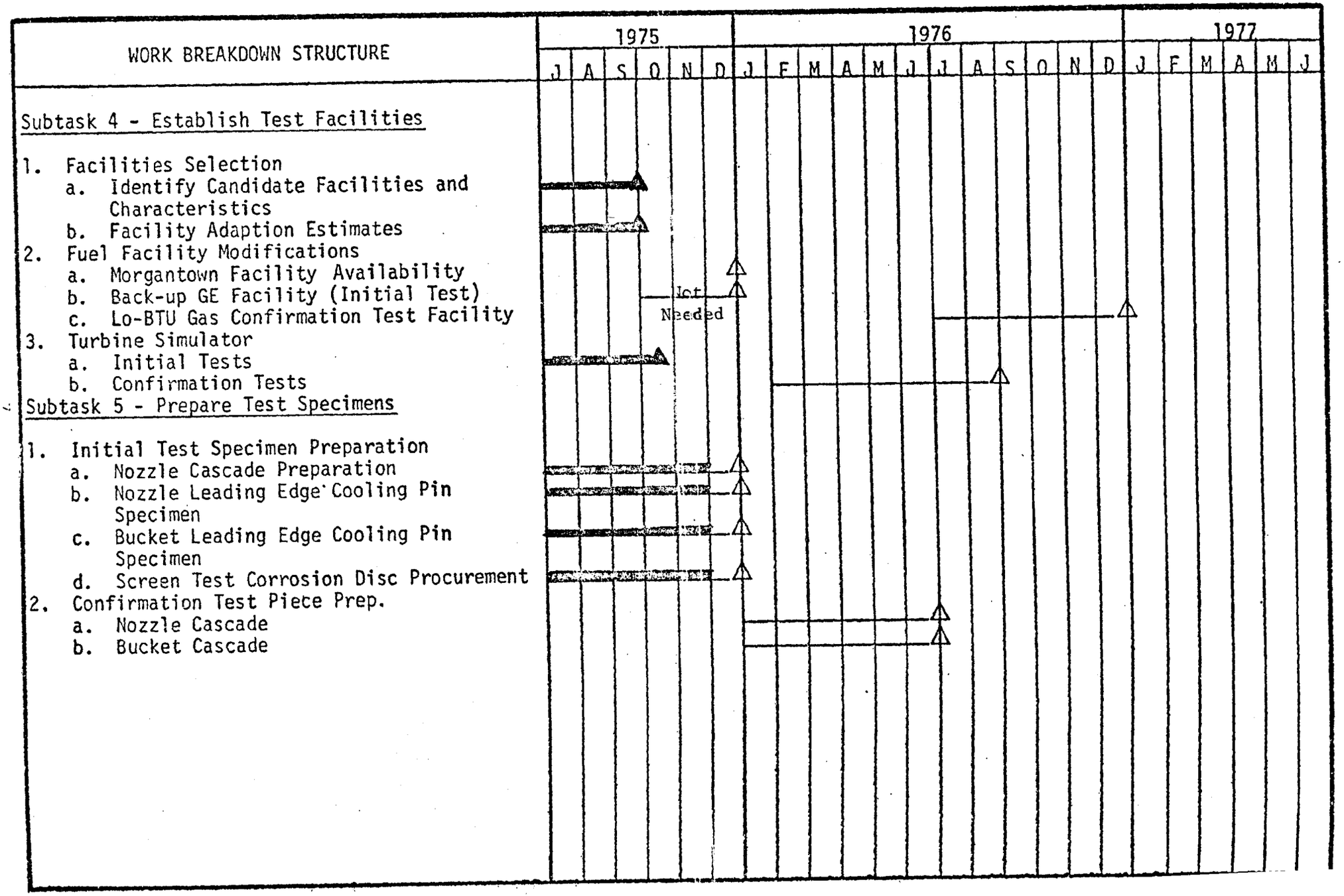

FIGURE I - FIRESIDE CORROSION TASK I - WORK BREAKDOWN STRUCTURE AND MASTER SCHEDULE (SHEET 4 OF 4)

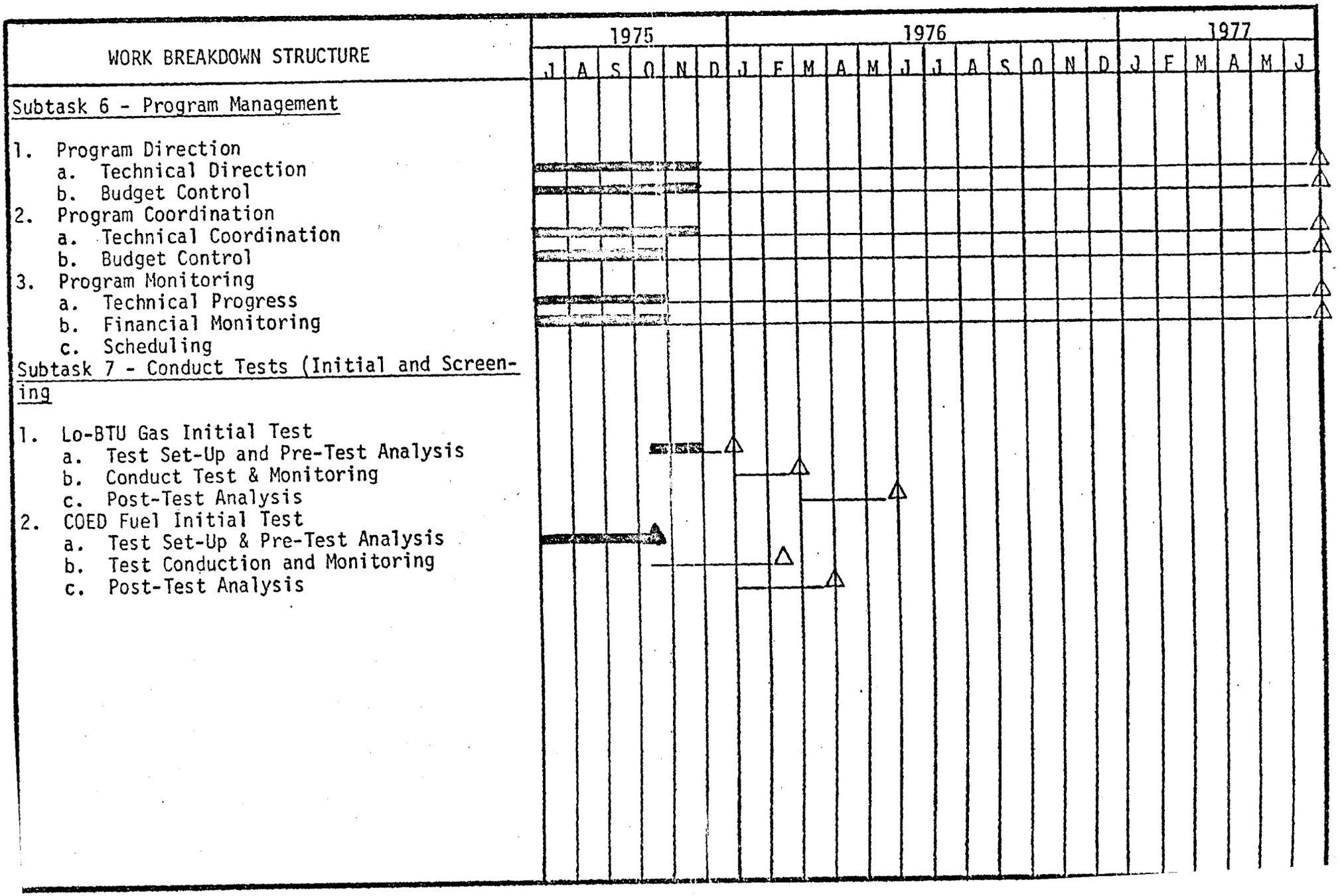

TABLE 1

ALTERNATIVE TEST PLANS – INITIAL COAL OIL TESTS, CONSIDERING POSSIBLE CONTINGENCIES

Alternative 1 – Basic Plan Considering No Test Complications (6,000 gallons COED – 40,000 gallons No. 2)		
Test 1* (Successful)	T_F = 1950°F	Pittsburgh COED (35 hours duration)
Test 2	T_F ≥1950°F	Pittsburgh COED (35 hours duration)
Test 3 (Successful)	T_F = 1950	Synthetic Pittsburgh COED (100 hours duration)
Test 4	T_F ≥1950°F	Synthetic Pittsburgh COED (100 hours duration)
Test 5	T_F = 1950	"Cleaner" or "dirtier" synthetic COED (100 hours duration)
Test 6	T_F ≥1950°F	"Cleaner" or "dirtier" synthetic COED (100 hours duration)
Alternative 2 – Contingency Plan to be Used if Ash Deposits Create Cooling Hole Plugging Situation (6,000 gallons COED – 40,000 gallons No. 2)		
Test 1* (Plugging Problem)	T_F = 1950°F	Pittsburgh COED (35 hours duration)
Test 2	T_F ≥1950°F	Pittsburgh COED (35 hours duration)
Test 3 (Successful)	T_F = 1950°F	Synthetic Pittsburgh COED (100 hours duration)
Test 4	T_F ≤1950°F	Synthetic Pittsburgh COED (100 hours duration)
Test 5	T_F = 1950°F	"Cleaner" synthetic COED (100 hours duration)
Test 6	T_F ≥1950°F	"Cleaner" synthetic COED (100 hours duration)
Alternative 3 – Contingency Plan to be Used if Initial Test Run Yields Inconclusive Results (6,000 gallons COED – 40,000 gallons No. 2)		
Test 1* Inconclusive results	T_F = 1950°F	Pittsburgh COED (35 hours duration)
Test 2	T_F = 1950°F	Pittsburgh COED (35 hours duration)
Test 3 (Successful)	T_F = 1950°F	Synthetic Pittsburgh COED (100 hours duration)
Test 4	T_F >1950°F For < 1950°F	Synthetic Pittsburgh COED (100 hours duration)
Test 5	T_F = 1950°F	"Cleaner" or "dirtier" synthetic COED (100 hours duration)
Test 6	T_F ≥1950°F or ≤1950°F	"Cleaner" or "dirtier" synthetic COED (100 hours duration)

*Same test run for all alternatives

C. Subtask 6 - Program Management

As a result of the COED fuel situation (6,000 gallons to be supplied by the Government, versus 28,800 requested),the need to develop synthetic COED fuel, and delays in obtaining of ERDA approval to initiate discussions with their Pittsburgh Research Center regarding acquisition of the Government-owned COED fuel, the program has already fallen behind schedule. As indicated in General Electric's letter of August 29, GE needed the COED fuel in Schenectady by October 1, in order to perform Initial Tests in accordance with the original program plans and schedule presented in Figure 1. Since two months have elapsed beyond this October 1 need date, the Initial Testing program has slipped by a nominal two months. Because of the sequential "building block" nature of the test phases - - Initial Testing, followed by Screening Tests, which in turn lead to Confirmation Tests - - this delay gets reflected back into these future testing phases.

Matters got further complicated by the need to develop and verify synthetic COED fuel, a matter that was not considered at contract inception, i.e., all COED fuel was to be furnished by the Government. This testing and verification will require additional time.

Indeed, the total amount of program schedule slippage cannot be explicitly determined until the results of Initial Test Run No. 4 (Table 1), the second test run involving "synthetic COED fuel",have been analyzed. (This is presently not expected to occur until some time in March.) Since these Initial Test results form the basis for establishing test conditions for the Screening Tests, the latter must of needs have their initiation date postponed from January 1 to some as yet indeterminant date. Likewise, the Confirmation Tests cannot be initiated until adequate data has been obtained from the Screening Tests.

This situation can be summed up as follows:

(1) The original schedule presented in Figure 1 has slipped as a result of the COED fuel situation. The degree to which it has slipped cannot be explicitly determined until March.

(2) An explicit revised schedule will be established, and employed in place of that given in Figure 1, only when it can be developed on the basis of factual data. (Any interim schedule revisions would be based on pure conjecture, and would be subject to month-to-month fluctuations, without any real basis or substantiation for same.) In the interim, The Schedule given in Figure 1 will be used, with slips in same duly noted.

(3) While General Electric will make every possible effort to attempt to minimize the impact of these schedule slips, it appears to be highly improbable that the final report draft can be completed by the contract end date (June 30, 1977). The revised schedule will reflect a projected revision in the date for final report submittal.

(4) In addition, the COED fuel situation outlined in Open Item B - also created a cost-related situation. As regards cost and schedule, there are essentially two options:

(a) Increase contract performance period.

(b) Reduce scope of Confirmation Testing.

These were pointed out in General Electric's letter of November 10 to the ERDA Program Manager.

D. Subtask 6 - Conduct Tests

While ERDA's letter of November 5 authorized GE to proceed with the acquisition of 6000 gallons of Government-owned COED fuel oil and to develop 80,000 gallons of "synthetic COED fuel oil", complications immediately arose regarding: (1) the availability of the selected COED fuel (derived from Pittsburgh coal); and (2) authorization to contact ERDA's Pittsburgh Research Center (where the fuel is being stored) to arrange for the logistics of its transport. These matters were not resolved until November 17. GE and its fuel transporter have since initiated discussions with ERDA's Pittsburgh Research Center regarding the logistics of acquiring this COED fuel; these involve means for transferring the fuel from the Government tank cars to tanker trucks. These arrangements regarding logistics were incomplete at the end of this month.

Based on the above, delivery of COED fuel to Schenectady before early December is not expected. As a result, it is expected that only one test run (No. 1 in Table 1) can be run in December. This in turn impacts the schedule situation outlined in Open Item C.

IV DETAILED DESCRIPTION OF MONTHLY PROGRESS

A. Summary

Work continued to slip this month in those Subtasks (3.1, 3.3 and 7.2) that are directly affected by the lack of the COED fuel needed for Initial Testing. The limited amount of COED fuel (6,000 gallons), past delays created by the need for verification of its availability, the need to resolve logistics for its delivery, and the need to develop a synthetic COED fuel oil for use in the balance of Initial Testing and for Confirmation Testing have combined to create delays in the Initial Test Program, which would otherwise have been initiated on October 20. As a result of the lack of -- and/or delays involving -- the above information/data requested from ERDA, the new start date of the Initial COED fuel tests appears to be late December. (As a result of this delayed start in initial testing, work originally scheduled to start in January in other Subtasks (7.3, 8.1, 8.2, 8.3, 8.4 and 8.5), on the basis of having Initial COED fuel Test results available, will have to be deferred.)

Other work is continuing on schedule. The selection of materials to be tested, the identification of the coal feedstocks to be used, plus the selection of a specific COED fuel oil as the liquid coal oil to be used, have all been completed on schedule. Preparations for the Initial COED fuel testing in Schenectady have been completed, along with detailed test plans that cover the three (3) probable testing contingencies. Preparations for Initial Low-BTU Testing at ERDA/MERC are proceeding in accordance with schedule with a GE-ERDA meeting on this subject held on November 6 at Morgantown serving to clarify interfaces between both parties. Based on the results of this meeting, GE-GTPD has since specified coal feedstock sampling requirements and also, requirements for the sampling and analysis of solid and gaseous phases entering the turbine simulator skid during these tests at ERDA/MERC.

A meeting between ERDA and GE program management in Washington on November 5 also served to clarify several program management-related matters and led to a better understanding between both parties on programmatic situations.

ERDA's comments on the draft of Quarterly Technical Progress Report No. 1 have been received and incorporated. (This document will be reproduced as soon as ERDA direction on its distribution has been received.)

B. Work Accomplished During the Month

Subtask 1 - Select Alloys, Coatings, Claddings and Ceramics

Work in this subtask is complete and was reported in Monthly Progress Report No. 1.

Subtask 2 - Select Feedstocks

Work in this subtask is complete and was reported in Monthly Progress Reports No. 1 through No. 4.

Subtask 3 - Establish Test Conditions

(a) Thermochemical Analyses

No efforts were performed this month, as a result of (1) unavailability of Government-furnished COED fuel oil and hence, Initial Test results based on same; and (2) unavailability to date of the coal feedstock samples to be used by ERDA/MERC for Initial Low-BTU Gas Testing. Arrangements are in process to obtain the latter, following the analysis of which, thermochemical analyses of Low-BTU gas test conditions will be performed.

(b) Test Parameter Definition-Initial Liquid Coal Tests

These were defined in Monthly Progress Report No. 4. Test condition alternatives are summarized in Table 1. Arrangements were made on November 17 to have GE and its transportation source contact ERDA's Pittsburgh Research Center regarding the acquisition of 6000 gallons of COED fuel derived from Pittsburgh coal. Logistics-related situations, including means of transferring this fuel from a tank car into tanker trucks utilizing facilities available at ERDA's Pittsburgh Research Center, are in process of being worked out. It is expected that this

fuel will arrive in Schenectady during early to mid-December.

(c) Test Parameter Definition-Initial Low-BTU Gas Tests

An ERDA-GE interface meeting to discuss Initial Low-BTU Gas Testing was held at ERDA/MERC on November 6. Most of the interfaces discussed at this meeting covered matters encompassed by GE-CR&D's separate contract with ERDA/MERC for testing at the Morgantown facility. Nevertheless, two key items involving the Fireside Corrosion Task 1 program's needs arose; as a result, GE-GTPD promptly forwarded the following information to The ERDA Program Manager (L.M. Raring) for transmittal to ERDA/MERC for action:

(1) GE Requirements for Samples of Coal Feedstocks

(a) Feedstocks: Two separate coals are involved:

(i) Illinois #6 (or equivalent)

(ii) Montana Rosebud

Samples of each of these are required.

(b) Sampling Method: Each coal is to be sampled as it is unloaded from the car. Samples from the beginning, middle and end of the load are to be combined to make up one ten (10) pound sample of each of the two different coals.

(c) Crushing Requirements: The entire ten (10) pound samples of each of the two different coals should be crushed to 200 mesh or finer by ERDA/MERC before forwarding to GE.

(d) Shipping Condition: The crushed ten-pound samples should be shipped in a dry container to GE.

(2) Requirements for Sampling and Analysis of Low-BTU Gas

(a) Sampling

(i) Sampling is to be made of the cleaned producer gas.

(ii) Sampling Locations-Samples are to be taken from two locations: (i) the GE probe located just ahead of the turbine simulator skid's nozzle; and (ii) the ERDA/MERC probe located ahead of the combustor.

(iii) Scope-Samples of both solid and gaseous phases are required.

(iv) Means of Obtaining Samples

(I) Gaseous Phase-Sampling line leading directly to appropriate analyzers (per GE's understanding of ERDA/MERC's test arrangements)

(II) Solid Phase/Particulate Matter-Passing withdrawn gas through an appropriate filter

(b) Analysis

(i) Scope- Samples taken from both sampling locations shall be analyzed

(ii) Elements/Consituents to be Analyzed

.Gaseous Phase-CO, CO_2, N_2, H_2O, H_2, H_2S, SO_2

.Contaminants (Solid Phase)-Na, K, Pb and V (to determine if any or all of these are present)

(iii) Means of Analyses

.Particulate Matter- Size distribution analyses followed by a spectro-qualitative analysis, both to be performed on the entire sample.

.Quantitative Analyses- To be performed for Na, K, Pb and V, if any or all of these are present in the qualitative analysis.

.X-Ray Determination of Chemical Compounds Involving Na, K, PV and V- This analysis would be desirable.

.Sulfate and Chloride Ions in Particulate Matter- Analyses for these is desired.

Subtask 4-Establish Test Facilities

(a) Initial Coal-Derived Liquid Fuel Tests

As indicated in Monthly Technical Report No. 4, modifications of the turbine simulator in Schenectady for the Initial Tests on COED oil were completed in mid-October per schedule. These modified facilities are sitting dormant while awaiting the establishment of firm delivery dates for the COED oil. A shakedown of these test arrangements will be performed using #2 fuel oil, just prior to the delivery of the COED fuel. (In the interim, the basic turbine simulator proper has been used to perform GE-sponsored testing outside of the Fireside Corrosion Task 1 program.)

During this Company-sponsored testing, a partial shakedown of one hour duration was performed on the exhaust system.

This partial shakedown was run "piggy-backed" on the Company-sponsored testing. The need for a minor adjustment in the exhaust system arrangements was uncovered and quickly corrected.

(b) Initial Low-BTU Gas Testing

Fabrication of the turbine simulator for Low BTU Gas Initial Tests is continuing.

The introduction of the air-film cooled nozzle simulation pins ahead of the nozzle have recently been found to place a constraint on the combustor, that had not been considered in its design for testing at ERDA/MERC. (This combustor had originally been designed without reflecting the needs and arrangements unique to the Fireside Task 1 Program.) Thus, a reevaluation of the combustion liner and end cap configuration was deemed necessary to allow attainment of the 4% pressure drop required to satisfy the cooling pin requirments.

It was found that the pressure drop required for the "air film cooled nozzle simulation" pins, when combined with the high fuel/air ratio associated with low BTU fuel, would result in a somewhat marginal combustor cooling situation.

Several candidate combustor configuration and combustor configuration modifications to rectify this situation were investigated. A combustion test performed in late November on the most promising of these configurations was successful; an additional test will be performed in early December to verify these results. (Note: These combustion tests have been performed by GE at no cost to the Fireside Corrosion Task 1 Program.)

Designs of the modified combustion hardware have been prepared and are now ready for fabrication. This will be available well in advance of the initiation of the Initial Low-BTU Gas Tests at ERDA/MERC (scheduled to begin in January).

Sketches of the overall GE-furnished test apparatus have been sent to Morgantown to assist them in their piping installation.

Design of an optical window to provide visual observation of the simulator nozzles is now under consideration. The challenge here is to cool the window adequately without altering the cooling capacity/capabilities of the nozzle segment to be viewed.

Subtask 5-Prepare Specimens

(a) Initial Coal-Derived Liquid Fuel Testing

As indicated in Monthly Technical Progress Report No. 4, all test specimens for the Initial Coal-Derived Liquid Fuel Tests were available in mid-October.

(b) Initial Low-BTU Gas Testing

Test specimen preparations are nearing completion. Cooling air for the "nozzle simulation" pins will be taken directly from the preheater outlet. This means that the air pressure drop through the cooling holes of the pins will be the same as that through the main combustion liner. For satisfactory cooling, the pressure drop must be about 4% of the combustor pressure level (2atm). Ways to modify the existing MS 5000 liner to achieve this pressure drop have been established and verified (see Subtask 4).

(c) Screening Tests

Preparation of small burner test specimens are proceding per plan. Some of the specimens to be coated or clad have been received from vendors; all are expected to be ready in four (4) weeks, i.e., in time to start the screening tests in accordance with the original schedule.

Subtask 6 - Program Management

ERDA has formally approved GE's cost proposal covering the shipping of the 6000 gallons of COED fuel oil verbally committed by ERDA, plus costs associated with developing a "synthetic COED" fuel to be used for the balance of Initial Testing (40,000 gallons) as well as for Confirmation Testing (40,000 gallons); however, this formal approval indicated that the contract was not increased by the added cost associated with this increased work. Following subsequent discussions of this matter with ERDA personnel, General Electric this month requested a formal contract change that will change the Statement of Work (Appendix A), and will increase the estimated cost, the fixed fee, and the total contract amount to reflect the change in the Statement of Work. (The latter was prepared

at ERDA's request.)

In the interim, GE is proceeding with Initial Testing plans while awaiting resolution of this matter. This action is being taken to preclude the accrual of additional schedule slips.

The ERDA Program Manager has been advised that failure to reflect the increased costs associated with the development of the "synthetic COED fuel oil" in the contract would necessitate the deletion of two to three of the eight test runs in the Confirmation Testing Program.

Applicability of ERDA Administrative Orders No. 3 and No. 4 pertaining to the distribution of monthly, quarterly, annual and final reports, also formed the basis for continued discussions and correspondance. Following in-depth discussions of this matter with ERDA, GE this month formally proposed four (4) alternative approaches, with the advantages and disadvantages of each being delineated. ERDA has been requested to select that alternative most acceptable to it, and then direct GE to proceed accordingly.

In the interim, GE has received ERDA's comments on the draft of Quarterly Technical Progress Report No. 1, and has reflected these in this draft. Copies of this report will be reproduced and disseminated upon receipt of ERDA's directive.

GE personnel visited ERDA in Washington on November 5 to discuss programmatic matters. Discussions were held with ERDA procurement personnel (Mr. J. Peel and Mr. S. Lake) and with the ERDA Program Manager (Mr. L.M. Raring). Topics discussed included: (1) means for expediting ERDA approval for GE requests; (2) resolution of the situation involving ERDA Administrative Orders No. 3 and No. 4; (3) means for enhancing communications; and (4) program delays (primarily how the "building block" nature of the program is impacted by delays in acquisition of COED fuel oil); and (5) approval of GE's cost proposal covering the cost of COED fuel oil delivery and the development of "synthetic COED fuel oil." The meeting was informative, cordial and constructive, and subsequently led to actions cited both in this section and under "Open Items" (Section III herein).

As indicated in Open Item C (Section III herein), delays in acquisition of Government-furnished COED fuel, the limited amount of same being furnished, and the need to develop "synthetic COED fuel oil" have all impacted the original program schedule. Program efforts are being closely monitored, and a revised schedule will be developed (to replace the original schedule presented in Figure 1), when the full

impact of these delays can be explicitly and qualitatively evaluated. This situation is being and will continue to be given close scrutiny by GE.

A GE-ERDA interface meeting was held at ERDA/MERC on November 6 to discuss the forthcoming Initial Low-BTU Gas Testing to be performed in Morgantown. This meeting primarily involved GE-CR&D and ERDA/MERC (since this work is being performed under their separate contract); nevertheless, both the ERDA Program Manager (Mr. L.M. Raring) and GE-GTPD representatives were in attendance. Information needed via action items assigned to GE-GTPD were rapidly resolved (see Subtask 3) via correspondance to the ERDA Program Manager for his transmittal of same to ERDA/MERC.

GE has formally requested contractually required ERDA approval to name Mr. D.P. Smith as "Key Individual" in the contract, in place of Dr. P.H. Kydd who is leaving the Company.

Meetings with project contributors in all subtask areas continue to be held. These are directed at identification of critical areas and insuring attainment of milestones.

Subtask 7 - Conduct Tests

(a) Initial Coal-Derived Liquid Fuel Tests

As indicated in Monthly Technical Status Report No. 3, in mid-October, all test preparations were completed per schedule and are awaiting the delivery of the COED fuel so that testing can be initiated. Just prior to the arrival of the COED fuel, it is planned to subject these test arrangements to a brief shakedown test (not to exceed thirty (30) hours) on distillate (#2) fuel oil in early December. This will serve to uncover any minor problems that might possibly be present in the test arrangements.

(b) Initial Low-BTU Gas Testing

Interface Arrangements for these tests were worked out at the GE-ERDA meeting at Morgantown on November 6. These tests are scheduled to begin in late January.

(c) Screening Tests

While the Screening Tests were originally scheduled to start in January, their scheduled initiation was predicated upon the completion of most of the Initial Liquid Coal-Derived Fuel Testing at that time. The latter test results will form the basis for

establishing the test conditions for the Screening Tests, to be performed in small burner rigs. While all preparations for these tests will have been completed by the end of December, an assessment of the current initial test situation indicates that these test conditions cannot be established until the results of the first four Initial Coal-Derived Liquid Fuel Testing runs (Table 1) have been evaluated. Hence, it is quite obvious that the initiation of the Screening Tests must be deferred for several months (very probably to the end of the first quarter of calendar year 1976).

Subtask 10 - Confirmation Tests

Planning for engineering activities to be performed starting in January to develop Confirmation Test hardware, has been initiated. This work will encompass the development of:

(1) Film-Cooled Nozzle Cascade: This is expected to feature both leading edge and trailing edge cooling holes

(2) Film-Cooled Bucket Cascade: This is currently envisioned to encompass two chopped MS-7001 buckets; it is also expected to feature both leading edge and trailing edge cooling holes

(3) Dual Fuel Combustion System: This system is envisioned to be a scaled-down version of a commercial dual fuel combustor design (capable of burning both Low-BTU gas and "synthetic COED Fuel Oil").

A standard GE-GTPD Engineering Schedule covering the design of the test hardware is being prepared to encompass this design work.

Design integration meetings covering the development of this test hardware have been initiated.