DOE/CS/40273--1

DE81 008923

TECHNICAL REPORT SEPTEMBER 1980

FOR

CONTRACT NO. DE-AC02-79CS40273

SUMMARY

1.1. Prestart-up Support Activities

Task 1.1.1. Instrument Checkout and Calibration

Nothing to Report

Task 1.1.2. Equipment Checkout and Calibration

Nothing to Report

1.2. Operating support activities

Task 1.2.1. Six-Months Operating Support Activities

Nothing to Report

1.3. Documentation and Reporting Activities

Task 1.3.1. Reporting of Plant Changes and Modifications

Removed reactor coil for modifications due to coke formation and structural failure due to fatigue.

Task 1.3.2. Reporting of Operating Performance

Nothing to Report

COMMENTS

As indicated in the previous monthly technical report the reactor coil failed again due to fatigue. Extended modifications are needed for the continuation of this project. The cost involved is going to cause an overrun estimated to amount to $310,977. The contracting officer has been officially notified in writing of the overrun in accordance to the terms of the contract.

The modifications and changes that are essential for the continuation of the operations and the testing of this new process are principally related to the performance of the reactor coil.

-Continued-

DISCLAIMER

(a) Coke formation which diminishes the heat exchange.

(b) Failure of the coil due to excessive stress caused by thermal expansion.

It is necessary to modify the present configuration of the coil. The six elements of the coil are presently connected in parallel and constitute an unity.

The change involves transforming the present coil in three units each containing two elements in parallel. By proper modifications one, two or three units can be operated in parallel and each one in turn can be connected to the decoking system without interruption of the operations.

A modified system for the support of the coils will eliminate the mechanical failure.

A series of testing in bench scale is also necessary to review the operating conditions and test some coating materials used in the industry for reduction of coking.

Downstream the reactor other modifications are necessary to handle situation when high viscosity material is collected in the heavy oil tank. The related modifications consist of installing an agitator and implementing a recirculation of the heavy material with pump and heat exchanger.

By the terms of the contract AC02-79CS40273 Novamont may proceed with the modification under the task 1.3.1. "Reporting of Plant Changes and Modifications" of the Statement of Work of contract, provided we do not exceed the present authorized funds. The above has been confirmed by Mr. Cranford of Washington and Mr. Vieschke of Chicago. The following work has been subcontracted to Procedyne to be implemented within the balance of the DOE funding of $345,338. Such balance is about $200,000. The Procedyne quotation FBS-80-01 is herein attached.

4.1. Coke Cleanout System and Related Support

4.1.1. Preparation of System for Revisions

4.1.2. Engineering and Purchasing Coil and Piping Revisions

4.1.3. Accomplish Coil and Piping Revisions in Plant

4.1.4. Checkout System and Ready for Start-up

4.2.2. Engineering for Purchasing Agitator, Heat Exchanger, Piping Jacket and Pump

-Continued-

4.3.1. Engineering and Purchasing Instrumentation Additions and Improvements

The cost of the total work quoted by Procedyne is $282,725.
USS Novamont G & A (10%) 28,272.
$310,997.

The portion of the work related to the repair and modification of the coil has been assigned to Procedyne for an anticipated expenditure of $161,677. plus USS Novamont G & A (10%) $16,167. for a total of $177,844.

The remaining work that will be done after approval by DOE of the additional funds requested for the described overrun includes the following:

4.1.5. Analytical Tracking of Feed and Product Streams

4.2.2. Purchasing of Agitator, Heat Exchanger, Piping Jacket and Pump

4.2.3. Accomplish Revision in Plant

4.2.4. Checkout System and Ready for Start-up

4.3.2. Accomplish Addition and Improvements of Instrumentation in Field and Checkout System for Start-up

4.4 Bench Scale Continuous Pilot Plant Support (at Procedyne Plant) consisting of testing various coil coatings in the Atactic Pyrolysis with the objective to reduce or eliminate the coking of the coil.

The results of this testing will be utilized in the USS Novamont plant for industrial application.

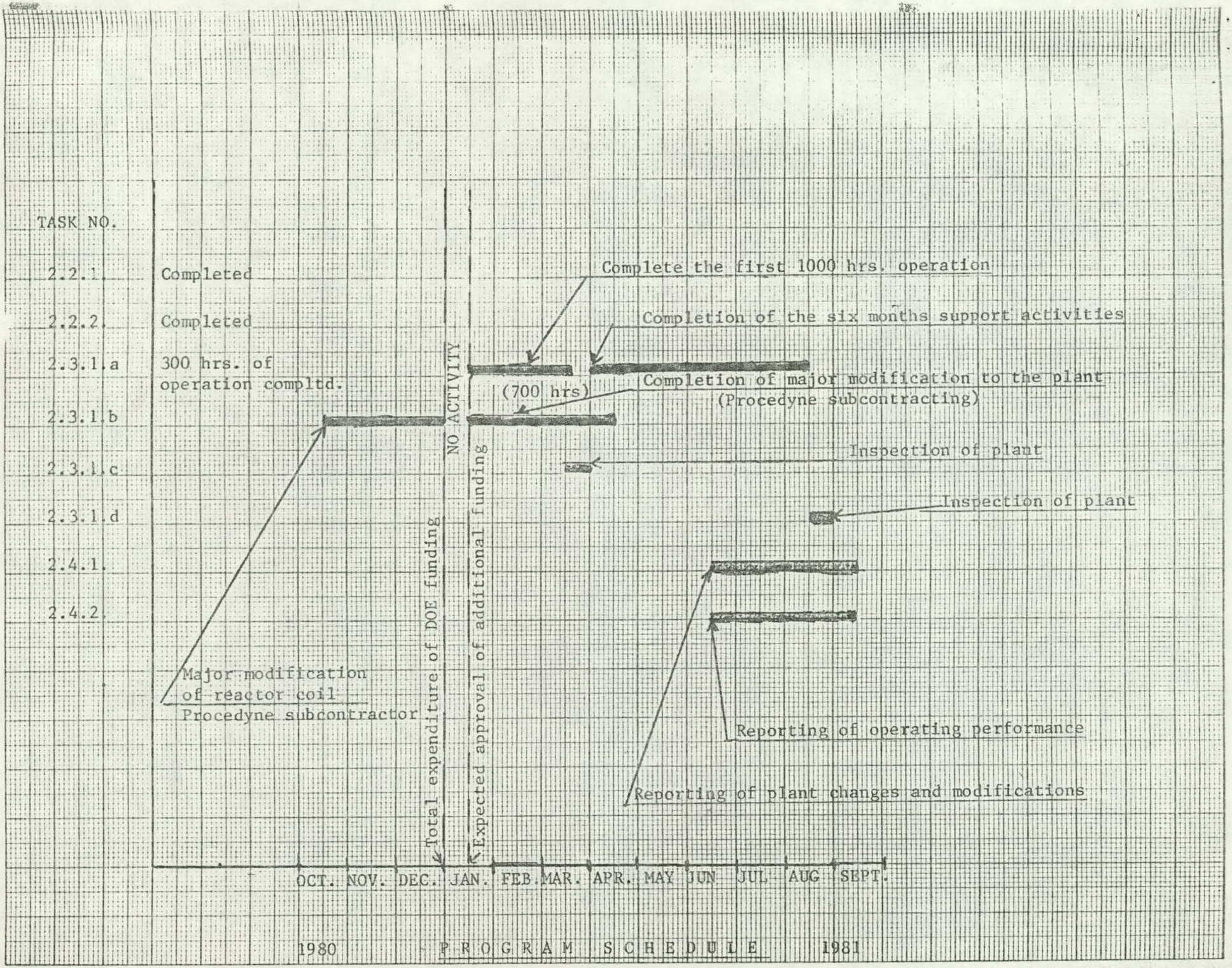
As soon as the first part of the program (coil repair and modification) is accomplished and the funds are available USS Novamont will start-up the atactic conversion unit and operate it in accordance with the plans under task 1.2. and 1.3. of the DOE contract.

Because of the time required to accomplish the changes and modifications the completion date, Period of Performance, which has already been extended to March 31, 1981 should be moved to September 30, 1981.

For a better illustration of the required time we are attaching herein a program schedule (bar graph) based on the assumption that the necessary funding from the Department of Energy will be approved and available by January 15, 1981.

The capital investment by USS Novamont for the atactic to fuel conversion plant has been $1,700,000. (in round figures). The interest lost because of one year delay would constitute an ample contribution (cosharing) by USS Novamont for the additional requested funding of this project.

Angelo Amato
AA:mp
Attachments


TASK NO.
2.2.1
Completed
2.2.2
Completed
2.3.1.a
300 hrs. of operation compltd.
2.3.1.b
2.3.1.c
2.3.1.d
2.4.1
2.4.2
Complete the first 1000 hrs. operation
Completion of the six months support activities
(700 hrs)
Completion of major modification to the plant (Procedyne subcontracting)
Inspection of plant
Inspection of plant
NO ACTIVITY
Total expenditure of DOE funding
Expected approval of additional funding
Major modification of reactor coil Procedyne subcontractor
Reporting of operating performance
Reporting of plant changes and modifications
OCT. NOV. DEC. JAN. FEB. MAR. APR. MAY JUN JUL AUG SEPT.
1980
PROGRAM SCHEDULE
1981

QUOTATION NO. FBS-80-01 REVISION A.

ENGINEERING MODIFICATIONS
TO EXISTING WASTE ATACTIC
POLYPROPYLENE TO FUEL CONVERSION
PLANT, NOVAMONT CORP.,
LAPORTE, TEXAS..

Submitted to:

NOVAMONT CORP.
LaPorte, Texas

by:

PROCEDYNE CORP.
221 Somerset Street
New Brunswick, N.J. 08903

ENGR. CONTRACT MANAGER: Robert B. Roaper

Telephone: 201-249-8347

Date: October 1, 1980

Approved by: Robert Staffin
Dr. Robert Staffin
Vice President

Date: 10/15/80

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ABSTRACT

Procedyne Corp. demonstrated a process for the conversion of waste atactic polypropylene to fuel oil on Contract No. EC-77-C-01-5077 dated 9/12/77. The demonstration program was successful and resulted in construction of the first commercial scale Waste Atactic to Fuel Conversion plant at the Novamont Corp. polypropylene producing plant in Texas. The design capacity of the plant is 17,000,000 lbs. per year of waste atactic polypropylene converted to 2,300,000 gallons per year of fuel oil.

The original funding basis for Contract No. EC-77-C-01-5077 was $165,121 by the Department of Energy and $151,666 by Procedyne Corp. In April 1979, to provide increased technical support of program, this contract funding was increased by $36,620 and on June 23, 1980, the contract period was extended to September 30, 1980 on a no funding increase basis and the Contract No. became DE-AC01-77CS40329.

The commercial plant has been in startup operation since early 1980. The conversion process has been successfully operated, however, there are four areas which are giving difficulties and preventing stable long-term operation.

This quotation is for the necessary modifications for the plant to meet design basis operation. The price of this work is $282,729.

Delivery of all items will be before March 30, 1981.

It is anticipated that the proposed modification will eliminate current operating difficulties.

The success of the commercial operation on the Novamont Corp. plant, LaPorte, Texas is fundamentally important to the success of the total waste atactic to fuel conversion program and to the waste plastic to fuel conversion program.

1.0 BACKGROUND INFORMATION

Procedyne Corp. demonstrated a process for the conversion of waste atactic polypropylene to fuel oil on Contract No. EC-77-C-01-5077 dated 9/12/77. The primary objective of this contract was to demonstrate the feasibility of pyrolyzing the waste atactic polypropylene to commercial grade fuel.

This objective was accomplished and Novamont Corp., LaPorte, Texas approved construction of the first commercial scale Waste Atactic to Fuel Conversion plant at its new polypropylene producing plant in Texas. The design capacity of the plant is 17,000,000 lbs. per year of waste atactic converted to approximately 2,300,000 gallons per year of fuel oil.

The funding basis for Contract No. EC-77-01-5077 was $165,121 by the Department of Energy and $151,666 by Procedyne Corp. To provide additional technical support of the waste conversion process thereby increasing the chances of commercial success of the program, on 4/79 this contract funding was increased by $36,620 by D.O.E. On 6/23/80, the contract period was extended to September 30, 1980 on a no funding increase basis and the contract no. became DE-AC01-77CS40329.

The commercial plant installation at Novamont Corp., was completed early in 1980 and has been in startup operation since.

Novamont has a cost sharing contract with D.O.E. (Contract No. DE-AC-02-79CS40273) which provides for operating the plant, maintaining the plant and documenting experience and performance. It calls for a complete plant inspection of the plant equipment after 1000 hours of operating experience and 4000 hours of operating experience to provide information on the plant equipment performance.

The plant is currently approximately one third of the way through the first 1000 hour operating period. There are some technical difficulties which are hampering the plant operation that need correction. These technical difficulties can be eliminated with additional engineering support and some equipment modifications.

It is the objective of this quotation to provide the engineering support of, and equipment changes to, this initial commercial operation to eliminate the technical problems which have developed during commercial plant operations.

Detailed information and support for this quotation are presented in the following sections.

2.0 OPERATING STATUS - COMMERCIAL PLANT

The commercial plant operating performance confirmed that the basic process as demonstrated under Contract No. EC-77-C-01-5077 dated 9/12/77 is sound. However, technical problems have been encountered in the following areas which have hampered continuous operations.

2.1 Coke formation in the reactor coil which diminishes the heat transfer coefficient over a period of time. In addition, there have been two coil failures at a support point attributed to excessive stress caused by thermal expansion.

2.2 If the plant encounters any upset conditions which cause some high viscosity material in the heavy oil tank system, difficulties are encountered in handling this material in the heavy oil system with respect to reprocessing or removal.

2.3 Circulating pump performance on the heavy oil system has not been satisfactory with respect to shaft seals and with respect to pressure relief.

2.4 Some process instrumentation needs minor modifications.

The details of these technical difficulties, the current processing approach to handling them, and the proposed permanent solutions under this contract extension request are presented in the following sections.

3.0 PROPOSED TECHNICAL PROGRAM

3.1 Coke Formation in Coil and Coil Failure

3.1.1 Coke Formation

The waste atactic feed material from the Novamont Polypropylene Production Plant to the fuel conversion plant generates some coke during the pyrolysis reaction which coats the inside of the reactor coil and slowly reduces the heat transfer coefficient from the fluidized bed furnace to the waste polymer inside the reactor coil. This coke formation was not encountered in the demonstration operation under Contract No. EC-77-C-01-5077.

The Novamont waste atactic feed material has been pyrolyzed in the benchscale fuel conversion facility at Procedyne laboratory and the rate of coke build-up as a function of weight rate of waste atactic converted to fuel oil has been determined. Comparisons with Hercules waste atactic and Amoco waste atactic have confirmed that Novamont material shows a higher rate of coke formation. This is believed due to a difference in the basic polypropylene catalyst system used by Novamont.

The commercial conversion plant at Novamont has been equipped for in place coil cleaning. The procedure being followed is to operate the conversion plant

until the coke formation decreases heat transfer rate which in turn decreases operating rate until the operating rate reaches 50 percent of design. The feed is then discontinued, the reactor coil valved off and air is passed through the coil with the fluidized bed furnace operating. This procedure is continued until the coke is burned out of the coil. The air in the coil is then purged out with nitrogen and the feed is re-started.

Benchscale work in the Procedyne laboratory indicates that reducing reactor residence time on the Novamont atactic would significantly reduce the rate of coke formation.

It is proposed to modify the reactor coil during the current operating shutdown to divide it into three parallel coils with valving external to the reactor. Each coil section would be equipped with separate air burnout cleaning capability. This would permit reducing residence time in the reactor by keeping one or more sections of the coil out of service during operation and it would also permit successive on line cleaning of the coil sections.

It is then planned to routinely operate with one or two sections in service, and one section in cleaning service and keep advancing the cycle on a time basis to be determined.

In addition, benchscale work in the Procedyne laboratory indicates that coke formation during pyrolysis is related to the composition and physical condition of the reactor vessel; in this case, the inside wall of the reaction coil. This conclusion is confirmed in the technical literature in related processes.

The rate of coke formation with Novamont atactic polypropylene pyrolysis has been reduced by a factor of two in the Procedyne benchscale continuous pilot plant by various coatings applied to the reaction coil inside wall.

It is proposed to evaluate some additional coatings with benchscale continuous pilot plant experiments and ultimately reduce the rate of coke formation with respect to this process.

This progress is regarded as most significant with respect to the progress of the total program.

The coke formation problem and program has increased the need for product sample analysis with respect to quantity of samples as well as number and type of analyses. It is proposed to work with Arizona State University to meet the required analysis effort. They have the equipment and experience to meet the analysis needs of the proposed program.

3.1.2 Coil Failure

During plant operations there have been two coil failures in the form of a leak at a coil support point. The coil has been tested metallurgically and the support stresses have been analyzed. It was concluded that the failure was due to overstress induced by thermal expansion of the coil.

The porposed redesign of the coil in Section 3.1.1 above

eliminates the particular support geometry involved in overstress. However, it is proposed to carefully analyze the new configuration with respect to stress loading at various temperatures to be sure that the new configuration does not induce excessive stress at any joint.

3.2 Heavy Oil Intermediate Storage System

The heavy oil intermediate storage tank and circulating pumps were designed to handle the heated oil product at the anticipated viscosity of approximately 2000 cp and the anticipated temperature of 500°F.

During periodic upsets of the plant, the product viscosity on the heavy oil side sometimes increases to the point where it is difficult to pump out of the tank. In addition, if the plant is down for a period of time, the heavy oil tank temperature drops which further increases the viscosity.

The more viscous product is sometimes blended off with low viscosity light oil product or it is recycled back to the feed tank to be blended with feed atactic and pyrolyzed once again.

It is proposed to modify the Heavy Oil Intermediate Storage Tank System as follows:

1. Equip the tank with a 2 HP agitator mounted on and through the existing manhole.

2. Install a steam heated heat exchanger in the heavy oil recycle line back to the Heavy Oil Intermediate Storage Tank.

3. Steam jacket the heavy oil recycle and transfer line sections.

4. Replace one heavy oil recycle and transfer pump with a jacketed pump with improved shaft seal to handle higher viscosity product when necessary.

3.3 Improved Control Instrumentation

It is proposed to make the following additions and improvements in control instrumentation:

1. O_2, CO_2, CO analyzer installed on the coil cleanout air discharge line to monitor cleaning progress.

2. Install fuel gas flow instrumentation to measure rate of fuel gas generation directly and close material balance.

3. Cascade control loop from product temperature to plenum air flow.

4.0 PROGRAM TASKS

4.1 Coke Cleanout System and Related Support

Task 4.1.1	Preparation of system for revision
Task 4.1.2	Engineering and Purchasing coil and piping revision, including complete stress analysis.
Task 4.1.3	Accomplish coil and piping revisions in plant.
Task 4.1.4	Checkout system and ready for start-up.
Task 4.1.5	Analytical tracking of feed and product streams.

4.2 Heavy Oil Intermediate Storage System Revision

Task 4.2.1	Preparation of system for revision.
Task 4.2.2	Engineering and Purchasing addition of agitator, heat exchanger, piping jacket and pump.
Task 4.2.3	Accomplish revisions in plant.
Task 4.2.4	Checkout system and ready for startup.

4.3 Instrumentation Additions and Improvements

Task 4.3.1	Engineering and Purchasing instrumentation additions and improvements.
Task 4.3.2	Accomplish additions and improvements in field.
Task 4.3.3	Checkout system and ready for startup.

4.4 Benchscale Continuous Pilot Plant Support

Task 4.4.1 Operate the Procedyne benchscale continuous pyrolysis pilot plant on Novamont atactic polypropylene with various coil coatings on the pyrolysis reaction coil including the following:

a. Five runs using a sulfide coating.
b. Five runs using an alonising coating.
c. Five runs using a glass coating.

Task 4.4.2 Perform required analysis on feed and product streams to evaluate potential coatings with respect to durability, influence on product composition.

Task 4.4.3 Engineer and specify the resulting internal finish and coating system so that it will be available to be installed in the Novamont commercial plant during the scheduled 4000 hour maintenance and inspection shutdown.

5.0 MANPOWER, MATERIAL, EQUIPMENT, AND OTHER REQUIREMENTS

5.1 Manpower Requirements

5.1.1 Coke Cleanout System and Related Support

	MAN HOURS				
Manpower Classification/Task No.	4.1.1	4.1.2	4.1.3	4.1.4	4.1.5
Project Engineer	40	108	8	8	-
Process Engineer	-	140	-	-	520
Mechanical Engineer	-	20	8	-	-
Draftsman	-	228	16	-	-
Field Crafts *	40	-	573	-	-
Startup Technician	40	-	-	80	-
Startup Engineer	-	-	-	280	-
Direct Purchasing	-	28	-	-	-
TOTALS	120	524	605	368	520

*It is proposed to subcontract field man hours to Brown & Root, Houston, Texas. They are the engineering firm that erected and installed the existing plant and are the maintenance contractors of Novamont Corp.

5.1.2 Heavy Oil Intermediate Storage System Revision

	MAN HOURS			
Manpower Classification/Task No.	4.2.1	4.2.2	4.2.3	4.2.4
Project Engineer	-	108	-	-
Process Engineer	20	40	-	-
Mechanical Engineer	-	20	-	16
Draftsman	-	250	-	60
Field Crafts*	16	-	104	16
Startup Technician	40	-	8	24
Startup Engineering	20	-	-	124
Direct Purchasing	-	56	-	-
TOTALS	96	474	112	240

*It is proposed to subcontract field man hours to Brown & Root, Houston, Texas. They are the engineering firm that erected and installed the existing plant and are the maintenance contractors of Novamont Corp.

5.1.3 Instrument Additions and Improvements

	MAN HOURS		
Manpower Classification/Task No.	4.3.1	4.3.2	4.3.3
Project Engineer	8	-	8
Process Engineer	40	-	8
Draftsman	80	-	-
Field Crafts	-	32	-
Startup Technician	-	8	8
Startup Engineering	-	8	108
TOTALS	128	48	132

5.1.4 Benchscale Continuous Pilot Plant Support

	MAN HOURS		
Manpower Classification/Task No.	4.4.1	4.4.2	4.4.3
Process Engineer	200	120	20
Mechanical Engineer	-	-	40
Laboratory Technician	150	-	-
TOTALS	350	120	60

5.2 Materials and Equipment Requirements

Task 4.1 Coke Cleanout System	
Piping Materials*	$ 21,758.
Valves	$ 12,830.
Instrumentation	$ 4,125.
Sub Total	$ 38,715.
Task 4.2 Heavy Oil Intermediate Storage System Revision	
Agitator	$ 4,617.
Heat Exchanger	$ 5,100.
Piping Materials	$ 954.
Pump	$ 3,000.
Sub Total	$ 13,671.
Task 4.3 Instrument Additions & Improvements	
Analyzer	$ 4,000.
Instrumentation	$ 1,050.
Sub Total	$ 5,050.

* Includes insulation of new piping and repair of existing insulation.

Task 4.4 Benchscale Continous Pilot Plant Support

Multipoint recording capability	$ 2,000
Replacement coated reaction coils (3 required)	$ 5,000
Sub Total	$ 7,000

5.3 Other Requirements

Task 4.1.5 Analyses of atactic feed streams and product streams for trace components in Novamont Commercial Plant Operation.

Task 4.4.2 Analyses of atactic feed streams and product streams for trace components in Procedyne Benchscale Continuous Pilot Plant.

It is proposed to subcontract this activity to Arizona State University - Professor Keuster. They have facilities and experience to do the required trace analyses.

Task 4.1.2 Consultant on reaction coil support to insure there are no excessive stresses induced by thermal expansion.

Task 4.1.4 Inspection and code review of reactor coil.

5.4 Travel

Two (one day) trips to Arizona State University - discussion and coordination of trace analysis activities.

Six (five day) trips to Novamont Commercial plant facility.

6.0 BUDGET REQUEST

6.1 Manpower Cost - Direct Labor

Task 4.1

	hrs x $/hr.	=
Project Engineer	164 x 18.69	$ 3,065.
Process Engineer	660 x 14.32	9,451.
Mechanical Engineer	28 x 18.69	523.
Draftsman	244 x 9.72	2,372.
Startup technician	120 x 9.50	1,140.
Startup Engineering	280 x 13.14	3,679.
Direct Purchasing	28 x 18.17	509.
SUB-TOTAL DIRECT LABOR		$20,739.

Subcontracted Field Crafts 613 hrs x $19.70 hr = $12,076

Task 4.2

Project Engineer	108 x 18.69	$ 2,019.
Process Engineer	60 x 14.32	859.
Mechanical Engineer	36 x 18.69	673.
Draftsman	310 x 9.72	3,013.
Startup Technician	72 x 9.50	684.
Startup Engineering	144 x 13.14	1,892.
Direct Purchasing	56 x 18.17	1,018.
SUB-TOTAL DIRECT LABOR		$10,158.

Subcontracted Field Crafts 136 hrs x $19.70/hr = $2,679.

Task 4.3

	hrs x $	=
Project Engineer	16 x 18.69	$ 299
Process Engineer	48 x 14.32	687
Draftsman	80 x 9.72	778
Startup Technician	16 x 9.50	152
Startup Engineering	116 x 13.14	1,524

SUB-TOTAL DIRECT LABOR $3,440.

Subcontracted Field Crafts 32 hrs x $19.70/hr = $ 630.

Task 4.4

Process Engineer	340 x 14.32	4,869
Mechanical Engineer	40 x 18.69	748
Laboratory Technician	150 x 9.50	1,425

SUB-TOTAL DIRECT LABOR $7,042.

6.2 Manpower Cost Summary

6.2.1 Direct Labor

Direct Labor Task 4.1	$ 20,739
Direct Labor Task 4.2	10,158
Direct Labor Task 4.3	3,440
Direct Labor Task 4.4	7,042
TOTAL DIRECT LABOR	$ 41,379

6.2.2 Subcontracted Field Crafts

Task 4.1	$ 12,076
Task 4.2	2,679
Task 4.3	630
	$ 15,385

6.3 Materials and Equipment Cost Summary

Materials and Equipment Task 4.1	$ 38,715
Materials and Equipment Task 4.2	$ 13,671
Materials and Equipment Task 4.3	$ 5,050
Materials and Equipment Task 4.4	$ 7,000
TOTAL MATERIALS	$ 64,436

6.4 Travel Costs

Trips: New Brunswick to Houston - Six Trips (5 days each)
New Brunsiwck to Arizona State University - two (one day) trips

Transportation costs	$ 5,740
Per diem	$ 1,900
TRAVEL TOTAL	$ 7,640

6.5 Other Costs

Analysis of Feed Stream and Components
Subcontract to Arizona State University

$20,000.

Consulting

Task 4.1.2	3,000
Task 4.1.4	2,000
TOTAL OTHER COSTS	$25,000

6.6 Cost Summary

1.	Direct Labor	= $ 41,379
2.	Burden (135% of Direct Labor)	55,862
3.	Subcontract Field Craft Labor	15,385
4.	Materials & Equipment	64,436
5.	Travel	7,640
6.	Other Cost	25,000
	TOTAL COST	= 209,702
7.	General & Admin. (26% of Cost Item 1 through 6)	54,523
	TOTAL COST	264,225
8.	FEE (7%)	18,496
9.	Total Cost & Fixed Fee	$282,729

7.0 JUSTIFICATION FOR BUDGET REQUEST

The Waste Atactic Polypropylene to Fuel Conversion Plant at Novamont Corp., LaPorte, Texas is the first commercial plant under this program.

We have interest by other Polypropylene producers in the installation of similar plants.

D.O.E. has approved cost sharing Contract No. DE-FC01-80CS40336 to accelerate the commercialization of this process.

The plant at Novamont Corp. is the major factor in the continued commercialization of this process and the possible extension of this commercialization to other waste plastic materials.

The commercial operation has performed well in most aspects of the process and it is anticipated that the proposed modifications will eliminate most or all of the operating difficulties.

The technical and economic success of this major commercial pyrolysis to fuel process will be a major step forward in establishing thermal pyrolysis as a viable mechanism of waste to energy recovery processes.

8.0 PROPOSED SCHEDULE

The proposed program schedule is shown schematically on the following page. It is planned to coordinate with the operating schedule of the Commercial Atactic to Fuel Oil Conversion Plant at the Novamont site, LaPorte, Texas.

It is anticipated that the work proposed in this request for funding increase will be completed by March 30, 1981.