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SECOND QUARTERLY TECHNICAL PROGRESS REPORT,
incorporating MILESTONE SCHEDULE/STATUS

Fourth Quarter, 1992

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Pittsburgh Energy Technology Center
Pittsburgh, PA 15236-0940

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Contract No: DE-AC22-92MT92012

Title: Evaluation of Using Cyclocranes to Support
Drilling & Production of Oil & Gas in
Wetland Areas

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I Executive Summary

The planned program falls under wetlands area research related to drilling, production, and transportation of oil and gas resources. Specifically the planned program addresses an evaluation of using cyclocraft to transport drill rigs, mud, pipes and other materials and equipment in a cost effective and environmentally safe manner to support oil and gas drilling and production operations in wetland areas.

The cyclocraft is a proven hybrid aircraft that utilizes aerostatic and aerodynamic lift. This type of aircraft has considerable payload capacity, VTOL capability, high controllability, low operating cost, low downwash and high safety. The benefits of using a cyclocraft to transport drill rigs and materials over environmentally-sensitive surfaces would be significant. The cyclocraft has considerable cost and operational advantages over the helicopter.

The planned program has the following objectives:

- (a) Define transport requirements to support oil and gas operations in wetland areas.
- (b) Develop a cyclocraft preliminary design capable of meeting transport and environmental requirements.
- (c) Validate cyclocraft performance by conducting subscale free-flight tests.
- (d) Determine ground support requirements for the cyclocraft operations.
- (e) Determine environmental impacts of the operations.
- (f) Evaluate the costs, risks and benefits associated with the cyclocraft operations.
- (g) Prepare a prototype cyclocraft development plan.
- (h) Transfer technology developed to all relevant organizations.

During the reporting period, a report that contained the results of each of the five subtasks that comprise Task 1, Environmental Considerations, was prepared and submitted to DOE. The subtasks were an overview of oil and gas activities in wetlands; a review of present wetland access practices; identification of past environmental impacts experienced; definition of marsh habitat considerations and discussion of forested wetland considerations.

In Task 2, Transport Requirements, a report on the acquisition of

data on the transport requirements to support oil and gas drilling and production operations in Wetland Areas was prepared and submitted to DOE. The report contained data acquired from many industrial sources. It was learned that there is a desperate need to do work overs of the many existing oil and gas wells in the wetlands, that are presently working below full production levels. Interest was shown in utilizing cyclocraft to provide access to the existing wells.

Task 3, Parametric Analysis, was completed during the reporting period. The analysis showed that a cyclocraft, having a payload capacity of 45 tons, was the most economic and would be able to transport all of the required equipment and materials. The final report on the parametric analysis was to be submitted in January, 1993.

II Introduction

A major contributor to the U.S. Department of Energy's Enhanced Oil Recovery (EOR) Research Program would be the development of a means to extract oil and gas from wetland areas in a cost effective and environmentally safe manner. Past activities have resulted in significant adverse environmental effects and the President has affirmed no net loss of wetlands as a national goal.

Traditionally the helicopter, with its vertical take-off and landing (VTOL) capability, has been used for transport of drill rigs by air when surface transport is prohibitive. The helicopter is not a satisfactory solution however because of its poor operating economics, limited payload, limited adverse weather capability, poor reliability/maintenance, poor safety and high downwash.

The cyclocraft is a proven hybrid aircraft that utilizes aerostatic and aerodynamic lift. This type of aircraft has considerable payload capacity, VTOL capability, high controllability, low operating cost, low downwash and high safety. The benefits of using a cyclocraft to transport drill rigs and materials over environmentally-sensitive surfaces would be significant. The cyclocraft has considerable cost and operational advantages over the helicopter.

The planned program falls under wetlands area research related to drilling, production, and transportation of oil and gas resources. Specifically the planned program addresses an evaluation of using cyclocraft to transport drill rigs, mud, pipes and other materials and equipment in a cost effective and environmentally safe manner to support oil and gas drilling and production operations in wetland areas.

In the current program, which has a projected completion date of 30 November, 1993, it is planned that a careful evaluation of the applicability of the cyclocraft, in the support of oil and gas drilling and production operations in wetland areas, will be made. The program was initiated in June, 1992 and no progress, other than program preparation, was accomplished in the Second Quarter of 1992. In the Third Quarter of 1992, the following three tasks were addressed:

Task 1. Environmental Considerations

Task 2. Transport Requirements

Task 3. Parametric Analysis

Under Task 1, Environmental Considerations, the activities comprised a) compiling a historical overview of oil and gas activities and impacts in wetland areas; b) compiling information

on present wetland access practices and c) cataloging past and present environmental impacts of oil and gas operations in wetland areas. Specific activities for Task 2, Transport Requirements, comprised defining requirements for transporting drill rigs over wetland areas, including options for drill rig breakdown; defining requirements for transport of materials, including mud, to support drilling operations in wetland areas; defining requirements for transport of materials, including pipes, to support production operations in wetland areas; defining cyclocraft operational requirements based upon the results obtained and developing criteria for evaluating cyclocraft operations in wetland areas. The scope of the work accomplished under Task 3, Parametric Analysis, was to modify the existing computer-based cyclocraft design model to be representative of the subject application.

During the Fourth Quarter of 1992, the intent was to:

- (a) Complete Tasks 1 and 2,
- (b) Continue Task 3,
- (c) Initiate Task 4.

III Project Description

The scope of the planned evaluation program will include a determination of the environmental impact of operating cyclocraft in wetland areas. In addition, validation of the aircraft's operational capabilities will be obtained, through subscale flight tests. A planned long-term development program is included, to address sponsorship of the production of heavy-lift cyclocraft. A technology transfer program is planned, to ensure that the results obtained from implementation of the program, will be communicated to all government agencies, educational institutes and business entities, that might benefit from the program.

The proposed program has the following objectives:

- (a) Define transport requirements to support oil and gas operations in wetland areas.
- (b) Develop a cyclocraft preliminary design capable of meeting transport and environmental requirements.
- (c) Validate cyclocraft performance by conducting subscale free-flight tests.
- (d) Determine ground support requirements for the cyclocraft operations.
- (e) Determine environmental impacts of the operations.
- (f) Evaluate the costs, risks and benefits associated with the cyclocraft operations.
- (g) Prepare a prototype cyclocraft development plan.
- (h) Transfer technology developed to all relevant organizations.

Mission Research Corporation is utilizing its cyclocraft technology base of theoretical and empirical data, to accomplish the planned program of evaluation of the cyclocraft in the support of drilling and production of oil and gas in wetland areas. Because of the significant potential applications of a heavy-lift cyclocraft, opportunities will be explored for cost-sharing for the prototype aircraft development.

It is planned that accomplishment of the program will be completed by 30 November, 1993. Table 1 shows the completion dates for each program task and deliverable.

IV Project Status

1. Task 1, Environmental Considerations

On October 31, 1992, a final report on the work accomplished under Task 1, Environmental Considerations was submitted to the Department of Energy. The work, which was performed by Louisiana Geological Survey, addressed five subtasks as follows:

- 1.1 Overview of Oil and Gas Activities
- 1.2 Present Wetland Access Practices
- 1.3 Past Environmental Impacts
- 1.4 Marsh Habitat Considerations
- 1.5 Forested Wetland Considerations

The summary of the LGS Report is as follows:

"The oil and gas industry has operated productively in the coastal zone since 1921. Oil and gas fields have been developed in all coastal habitats in Louisiana, including barrier islands, open water and bays, salt, brackish, intermediate and fresh marshes, swamps and bottomland hardwood forests. Historically 75% of all leased acreage has fallen within the coastal zone. The coastal zone now carries 50% of the leasing in the state and more than one-half production. This area has contributed \$12 billion of more than \$28 billion in state revenues generated from oil and gas activities. This accounts for more than 40% of the state's mineral revenues which have been generated in one-sixth of its area.

Although Louisiana has benefitted economically from the oil and gas industry, there have been some long term detrimental environmental effects. Oil and gas activities in the coastal zone have contributed to land loss in Louisiana. Louisiana loses about 40 square miles of wetlands annually and it is estimated that 40-80% of this is related to dredging. Although natural processes of wetland loss are at work in the coastal zone, canals, pipelines, navigation channels, road dumps, and other activities which serve the industry, also contribute to direct and indirect causes of wetland loss. Since wetland loss is a serious problem, the state and industry are now aware that impacts to coastal habitats must be avoided or minimized when human activities occur there."

The results of Task 1 are providing a basis for the ongoing cyclocraft parametric analysis and preliminary design, being performed under Tasks 3 and 4 respectively.

Task 2, Transport Requirements

Work under Task 2, Transport Requirements, was also completed in October. A report on the acquisition of data on the transport requirements to support oil and gas drilling and production operations in Wetland Areas was also submitted to DOE in early

November. The report contains data acquired from a large number of sources. The data acquired shows compatibility between the payloads to be carried and cyclocraft capabilities.

An additional report on the transport requirements to support work over of existing wells in wetland areas, will be prepared and submitted later.

The Task 2 report is broken down into eleven major sections, as follows:

1. Introduction
2. Oil and Gas Drilling in S. Louisiana
3. Considerations for Cyclocraft Operation
4. Drill Site Preparation
5. Inbound Transportation Requirements
6. Liquid Supply Requirements
7. Non-Liquid Supply Requirements
8. Outbound Requirements
9. Production Transportation Requirements
10. Summary Transportation Requirements
11. Conclusions.

The conclusions reached in the report are quoted below:

"This study indicates a clear picture of the requirements for the cyclocraft to support drilling operations in wetland areas. It is considered that a 120,000 pound payload cyclocraft, combined with the Poly Pipe system, will complete a turnkey airlift contract in fewer than 100 round-trip flights. The 120,000 pound cyclocraft will likely have a retail price of \$5,000 per flight hour and earn a total turnkey contract income in the range of \$500,000. Considering that the total cost of drilling and producing a new well is in the range of \$2 to \$4 Million, a \$500,000 cyclocraft cost is very realistic.

Helicopter-portable drilling rigs do not have sufficient depth capacity to be considered as part of this research. Helicopter operation costs have not been included in this report.

It is planned that the future trade-off studies be started on the basis of the lightest 90,000 pound lift, versus larger lifts such

as 120,000 to 200,000 pounds. Secondly, the trade-off of flying 15 miles from a land base, versus flying 3 miles from an inland barge base, with the added barge costs, will be addressed. Thirdly, the trade-off of airlifting all liquid products, versus the cost of setting up temporary Poly Pipe pipelines and barges to transport most of the liquids, needs to be studied.

Future research of this nature may focus on other wetland areas within the U.S. market. These areas include the Florida Everglades; Alaska's A.N.W.R., or Arctic National Wildlife Refuge; Wyoming Indian Reservation lands; and the Appalachian Mountain forests.

The beneficial spin-offs of developing the cyclocraft could be realized in several other applications in Southern Louisiana. These new aerial roles may be found in support of oilwell workover contracts; oilwell plug & abandon jobs; new slim-hole drilling methods; offshore marine drilling operations; civil engineering projects carried out by the Corps of Engineers, and the Louisiana Coastal Restoration Program; or in support of contracts issued by the new National Wetlands Research Center.

One official with the Corps of Engineers suggested that the cyclocraft be employed to construct new artificial barrier islands and refurbish existing islands. The State of Louisiana might be motivated to support this activity, because it will help maintain more land within their 3 mile jurisdictional limit. The problem today is that Louisiana is losing coastline to subsidence and erosion. As the coastline moves further North, more and more oil & gas fields become the property of the U.S. government under the M.M.S., Minerals Management Service, and the State of Louisiana loses millions of dollars of minerals revenue. Further benefits of island building are added protection for the natural environment, and hurricane & storm tide protection. If the oil companies were to pay for island building as part of their normal site building costs, then they might have an opportunity to barter that cost against their environmental liability in other parts of the State.

To help hold down costs, future improvement in cyclocraft dispatch efficiency will result in loaded flights in both directions, thus reducing the overall airlift requirement.

To reduce costs further, savings will be realized in moving rigs directly from a completed well site over to a new well site within the same oil field. This direct move will eliminate a whole series of inbound flights that would have otherwise been necessary for the next job.

Additional cyclocraft cost reductions would occur as drill contractors build lightweight containers, baskets and skids. Contractors will be motivated by the desire to turn air-lift expense into bottom line profits.

In future years, drilling engineers may find ways to build more efficient drilling rigs as a result of cyclocraft heavy-lift capability. For example, perhaps drillers could employ extra-long 90 foot joints of drill pipe in place of the current 3 joints of 30 foot lengths. This will reduce the number of tool joints in the drill string. Fewer tool joints means less risk of twisting off in the hole and the associated risk of environmental damage. Fewer tool joints may also reduce the drilling cost-per-foot by reducing drill string internal pressure losses and by reducing drill crew labor costs."

Task 3, Parametric Analysis

This task was initiated in July and the parametric analysis was completed in December. Modifications were made to the algorithms in the computer-based Parametric Design Model, to reflect the type of operations to be performed by cyclocraft in support of oil and gas drilling and production operations in wetland areas.

Application of the design model was broken down into two phases. In Phase I, runs with the modified computer model were made, for the following nine parametric combinations:

Payload (lb)	90,000	120,000	150,000
Endurance (hours)	4	8	12

From the results of the Phase I study, two conclusions were drawn:

1. There is no economic benefit in utilizing a cyclocraft that has a payload carrying capability greater than the minimum value of 90,000 lb.

2. The most economic cyclocraft would have a relatively low endurance, i.e. less than 8 hours.

Based upon the results of the Phase I study, it was decided to limit the Phase II work to the minimum acceptable payload of 90,000 lb. Because Phase I results indicated that the optimum cyclocraft would not be encumbered with a large fuel weight, the additional values of endurance selected for study, to determine the optimum fuel weight at a payload of 90,000 lb, were 2 hours, 3 hours, 5 hours and 6 hours.

Some of the design parameters of the cyclocraft studied in Phase II are tabulated below:

Design Parameter	Endurance						
	2 hours	3 hours	4 hours	5 hours	6 hours	8 hours	12 hours
Aerostat Volume, cub ft	3,479,500	3,544,750	3,612,790	3,683,860	3,758,110	3,917,050	4,284,590
Aerostat Length, ft	376.0	378.3	380.8	383.2	385.8	391.2	403.0
Installed Power, SHP	5,065	5,174	5,286	5,404	5,526	5,790	6,399
Empty Weight, lb	149,540	152,200	154,975	157,875	160,900	167,380	182,357
Fuel Weight, lb	3,900	5,970	8,140	10,400	12,760	17,830	29,560
Payload, lb	90,000	90,000	90,000	90,000	90,000	90,000	90,000
Gross Weight, lb	244,240	248,970	253,915	259,075	264,470	276,010	302,715
Aerostatic Lift, lb	197,290	200,990	204,840	208,870	213,080	222,100	242,940
Max Aerodynamic Lift, lb	48,750	49,790	50,870	52,000	53,180	55,715	61,580

From the results of the Phase II work, the cyclocraft that has an endurance of 5 hours was shown to be most economic in the defined support mission. This parametric design was selected as baseline for future work. The utilization and productivity of the baseline cyclocraft design is summarized below:

Endurance	5 Hours
Number of Work Days per Annum	180
Average Refuels per Work Day	1.25
Average Operating Hours per Work Day	9.583
Unproductive Operations per Work Day	2 Hours
Annual Utilization	1,725 Hours
Productive Utilization	1,365 Hours
Number of Pilots per Cyclocraft	3.5
Average Time per Delivery Round Trip	1.25 Hours
Number of Delivery Round Trips per Annum	1,092
Maximum Payload with Full Fuel	45 Tons
Average Payload	40.5 Tons
Equipment and Materials Delivered per Annum	44,226 Tons

A summary of the operating cost of the baseline design follows:

Depreciation	\$1,319.64	
Insurance	362.87	
Licenses and Taxes	109.31	
Operating Base	18.69	
Total Ownership Costs		\$1,810.51
Salaries - Pilots	\$92.75	
Mechanics	78.36	
Others	53.62	
Helium and Purification	42.10	
Total Annual Operating Costs		266.83
Fuel	\$599.09	
Oil	8.99	
Engine Maintenance	283.71	
Other Maintenance	197.34	
Total Hourly Operating Costs		1,089.13
Total Cost per Operating Hour		\$3,166.47
Total Cost per Ton Delivered		\$123.51

On December 31, 1992, a report containing the results of Task 3 was in preparation and it was planned to submit the report to DOE in January, 1993.

4. Cyclocraft Preliminary Design

This task was initiated in October. Some progress was made, but most of the work on this task will be based on the results of Task 3. No significant results were available at the end of the reporting period.

V Milestone/Schedule Status

The planned and actual completion dates for each of the program milestones are presented in Table 1. The table shows that through the Fourth Quarter of 1992, five milestones were accomplished, i.e. Management, Schedule and Cost Plans, Environmental Considerations, Transport Requirements and Revised Management, Schedule and Cost Plans.

TABLE 1. MILESTONE SCHEDULE/STATUS

Element Code	Description	Planned Completion Date	Actual Completion Date	Comments
1	Environmental Considerations	9-30-92	10-15-92	
2	Transport Requirements	9-30-92	10-31-92	
3	Parametric Analysis	12-31-92		
4	Cyclocraft Preliminary Design	4-30-93		
5.A	Subscale Test Plan	5-31-93		
5.B	Subscale Tests	7-31-93		
5.C	Test Data	8-31-93		
6	Ground Support Requirements	7-31-93		
7	Environmental Impacts	7-31-93		
8	Prototype Development Plan	9-30-93		
9	Operating Costs	10-31-93		
10	Technology Transfer Seminar	11-30-93		
11.A	Management, Sched & Cost Plans	6-30-92	6-30-92	
11.B	Revised Mgt, Sched & Cost Plans	12-31-92	12-31-92	
11.C	First Program Review	3-31-93		
11.D	Annual Technical Progress Report	7-31-93		
11.E	Second Program Review	7-31-93		
11.F	Revised Mgt, Sched & Cost Plans	9-30-93		
11.G	Third Program Review	11-30-93		
11.H	Final Report	11-30-93		

VI Planned Activities

The following activities are planned for the First Quarter, 1993:

1. Complete Task 3, Parametric Analysis and submit report.
2. Continue work on Task 4, Preliminary Design.

VII Summary

A report that contained the results of each of the five subtasks that comprise Task 1, Environmental Considerations, was prepared and submitted to DOE. The subtasks were an overview of oil and gas activities in wetlands; a review of present wetland access practices; identification of past environmental impacts experienced; definition of marsh habitat considerations and discussion of forested wetland considerations.

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IX Report Distribution List

Three copies of this document are submitted to the following address, in accordance with the terms of the contract:

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A handwritten signature in cursive script, reading "Wilfred J. Eggington", is written over a horizontal line.

Wilfred J. Eggington

Principal Investigator

DATE

FILMED

7/13/94

END