I. INTRODUCTION

This proposal addresses the effort requested by the customer of SSC in support of the recovery of RV #3 from the ocean bottom off Hawaii. It documents the effort, on the part of SSC, which has been performed to date and provides a description of remaining effort to support the task of recovering the lost RV and the information it contains.

The recovery sequence for RV #3, after successfully completing its on orbit mission requirements wherein the take-up was loaded to its nominal capacity of 52,000 feet of exposed film from primarily high priority operational sequences, commenced on JULY 10, 1971. After proceeding successfully through most of the recovery sequence and entering the atmosphere within the expected impact area, a failure in the primary parachute system prevented normal aerial recovery and allowed the RV to fall, unsupported, into the ocean at a velocity estimated to be 307 (450 ft/sec) miles per hour.

Preliminary reports, rumored to be from the recovery task force, indicated that a visual sighting of the RV on the surface of the ocean for a short period after impact have been found to be erroneous. The confusion seems to have been the result of a spurious signal, generated by one of the recovery aircraft in the area, which was similar to the normal output of the beacon on the RV. There were, however, reports that a spot in the expected impact area exhibited evidence, such as bubbles and a discoloration of the water which could have been caused by the high velocity impact of the RV with the water.

It is estimated that the impact point of the RV with the water can be determined to an accuracy of about 10 square miles. The film manufacturer, Eastman Kodak, has indicated that there is a high probability that if the spools can be recovered without significant exposure to light, and if maintained "wet", that a good percentage of the imagery can be recovered.

The problem then, is how to locate and retrieve the spools from the bottom of the ocean at a depth of 14,400 feet.

II. BACKGROUND

A. Preliminary Planning

A preliminary planning meeting was called at Headquarters on 27 July 1971 (Ref. BYE 109733-71). At this meeting a review of the information retrieval potential confirmed the value of attempting a recovery from the ocean bottom. Consultation with the Navy revealed that the deep submergence vehicle Trieste II could be used to penetrate the ocean depths if the payload could be located. They (the Navy) indicated that a search vehicle, operating out of the Scripps Oceanographic Institute, commanded by Dr. F.N. Spiess is experienced in and capable of locating such objects on the ocean floor. The technique employed in locating an object on the ocean bottom is to search the target area with a ship towing a sensor "fish" suspended on a 30,000 foot cable. The primary sensor in the "fish" is a high resolution scanning sonar system having a cross track range of 1000 feet reported to be capable of locating objects smaller than 5 feet cubed at the operating depth.

Once located, and confirmed by television pictures, a camera is lowered and pictures are taken of the payload. If confirmed to be the RV, a transducer will be lowered to the site to mark the target location. The Trieste will then be located over the transducer and subsequently lowered to the bottom for the recovery operation.

The meeting identified several areas of investigation required to implement the recovery. SSC was requested to:

1. In cooperation with MWC assess the probable damage to the RV and take-up to aid in identifying the configuration of the unit on the bottom.

2. Define the probable configuration of the unit and devise a means to attach the recovery cable from the winch on the Trieste.

3. Investigate the illumination levels at approximately 120 feet depth to determine the vulnerability of the film to exposure at that level.

4. Investigate the availability of a suitable shipping container for the return of the payload to the despooling facility while maintaining it

immersed in water and protected from light exposure.

5. Coordinate with Eastman Kodak and provide technical liaison concerning disassembly of the damaged take-up and adapting a despooling apparatus.

The meeting also established a "recovery team" consisting of representatives from the various organizations involved as well as established communication channels for information flow between parties.

B. First Working Session

Immediately following the meeting at Headquarters a working session was held at MWC to discuss the probable configuration of the payload after impact with the water. Although there is no positive means, other than by recovery of the payload or by duplicating the impact situation, of determining the final (after impact) configuration concensus of opinion of those most familar with the hardware is that the unit will be in one piece.

A means for attaching the payload to the lifting cable on the Trieste was discussed. Several approaches presented were:

1. The use of a net, which could be laid on the ocean floor with long cables which are attached to the recovery hook on the Trieste's wench was considered.

2. The use of "Vise-grip" type pliers or clamps, attached to the lifting cables which could be fastened to the parachute bridle straps was discussed.

3. A plunger, inserted into the empty drogue morter-canister was considered.

4. A "Hay hook" type of device which has arms large enough to encircle the entire payload was suggested.

The meeting adjourned with the recommendation that either the net or the "Hay hook" approach be considered further. Discussion of these approaches with the Operations Team was recommended so as to assess the compatibility of the hardware available and the experience of the crew.

c. <u>Second Working Session</u>

A working meeting was held ~~to discuss~~, with Navy personnel at the Pentagon, for the purpose of discussing the proposed recovery technique and to define the hardware interfaces involved.

Participants at the meeting were:

[redacted] (Navy)
(Navy)
(HQS)
L.B. Molaskey (SSC)

[redacted] presented slides of the Trieste II showing the overall configuration. He did not, however, have detailed information and/or drawings which are required to interface the proposed hardware.

A review of the proposed recovery technique indicated that the scheme appeared to be compatible with the capability of the Trieste and in some ways was preferable to the techniques being investigated by the Navy. A significant point brought out by [redacted] was that the use of a net or other sling type of device would undoubtedly stir up the sediment on the ocean floor to the extent that the operator's visibility would be reduced essentially to zero for periods of up to an hour. A technique which did not disturb the bottom until after the payload was secured, such as the hook technique proposed, therefore, would be far less time consuming.

[redacted] indicated that the Navy is considering the use of a purse net which could be dragged along the bottom. If the payload is not imbedded too deeply into the mud the net would cause the unit to tumble into its pocket and when lifted would completely surround the unit. It could be transferred to the support ship in the same manner as originally proposed. This technique, however, has a potential light exposure problem at the 120 foot transfer depth if the unit has any large holes and is held at that depth for any length of time.

[redacted] indicated that he would request the interface information required as it was now understood. He suggested that we review the drawings and get together with his office personnel again. He also suggested that we continue with the hook concept layouts and design but prior to committing the hardware to fabrication that we contact and visit with the crew and inspect the vehicle (at San Diego). He indicated that such arrangements could easily be made from his office. (Ref. BIF 007-1266-71 - ME52 Trip Report - Recovery of RV #3)

d. Recovery Hook Design

During this period of interface and requirements definition SSC has undertaken a design effort to convert the hook concept into manufacturable hardware. The design process has, in turn, revealed additional operational requirements. Four primary considerations for successful implementation are:

1. Simplicity of Operation - The design should be capable of performing with a minimum of control required of the operator. A purely mechanical device is preferable (no built-in electrical, hydraulic or other power source should be considered). The device will be activated by the manipulator on the Trieste II.

2. Reliability - The device must be as fool-proof as possible. It must be capable of multiple operation (open and close) while at the operating depth.

3. Flexibility of Operation - Because of the uncertainty of the payload status after water impact and its position on the ocean floor, the hook must be capable of accommodating whatever the combination of configurations and penetration into the mud may be.

4. Cost and Schedule - The fabrication cost and time required to build, assemble and test the apparatus must be minimized. Solidification of design requirements and firm interface constraints must be achieved as soon as possible to provide adequate fabrication and test time. The goal, of course, is to have a fully operational device on station on October 1, 1971.

III. RECOVERY PLAN

As a result of the first two meetings and subsequent effort and discussions with Headquarters the following recovery plan is proposed:

1. The Navy, with cooperation from the Air Force, determine the impact area as accurately as possible. Investigation of all available sources such as, from tracking data, telemetry, recovery ship position logs, recovery air craft flight recorders, etc. should be undertaken. The above data should be cross-checked against an analysis of the trajectory for compatibility. (It is assumed that this process is underway).

2. Using the above impact point as a reference and with the estimated water descent rates provided by SSC and MWC (see ME-45 dated 2 August 1971) and the Navy provided sea current information a prediction of the payload location on the bottom should be calculated.

3. The search vessel, after making whatever modifications to its instrumentation may be required, should be dispatched to search the area starting from the predicted resting point. The total area to be searched will depend largely upon the accuracy of the predicted water impact point. The drift of the payload in the water during descent is negligible as compared to the above accuracy. ($D = VT = .5\left(\frac{17.2}{60}\right) = .14$ nautical miles = 865 feet).

4. Once the payload has been located, photographs and/or televison imagery should be acquired so as to assess its condition and configuration. SSC proposes to support this on site assessment to verify the identification of the payload and to determine the compatibility of the retrieval plan and equipment with the remainder of the operation.

5. Assuming that the payload is essentially intact as predicted, the Trieste II will descend to the spot homing in on the marker transducer.

6. Using the manipulator on the Trieste II the payload will be extracted from the soft surface of the bottom. (It is predicted that the payload will be imbeded up to 80% in the soft silt of the ocean bottom).

7. The Trieste II will then be positioned so as to locate the "Hay hook" over the payload and the hook lowered and actuated to encircle the payload. A trial lifting test should then be performed within view of the crew to determine the adequacy of the hook grip on the payload. The gripping procedure can be repeated by opening the hook, droping the payload a short distance (6 - 8 feet) and repeating the gripping process. When it has been established that the payload is secure the curtain will be released protecting the unit and its contents from further exposure 'as the Trieste is raised to the surface.

While playing out the cable on the winch the Trieste II will be raised approximately 120 feet off the bottom. The payload will then be lifted by the cable and will ascend with the Trieste II suspended about 120 feet below the winch.

8. When the Trieste II reaches the surface a support ship will come alongside and divers will descend 120 feet to the suspended payload. operation for this phase is required - hence the the payload. The divers will first secure the bottom of the tubular curtain to completely enclose the payload into a bag having appropriate drain tubes to allow the sea water to escape when lifted above the surface.

The divers will transfer the payload from the cable of the Trieste II to a net suspended from the wench of the support ship. The unit can then be lifted out of the water and onto the deck of the support ship.

9. In order to minimize the size and weight of the recovery shipping container, it will be necessary to remove the lifting hook from the payload. This can either be accomplished on deck or in a enclosure within the ship. A one ton crane, with appropriate ropes or slings will be required to open the hook and remove the curtain.

10. The payload can then be lifted and placed into the waiting shipping container which is partially filled with sea water. The container will then be completey filled with sea water and a fungicide added to prevent bacterial growth during the trip to the despooling facility. This action is required to preclude the need for maintaining the unit temperature below 40°F for the entire trip. Assuming the shipping container to be 64 inch diameter by

61 inches high (a typical container which has been located by SSC) the estimated shipping weight loaded is 8,100 pounds. If the hook and curtain, etc. were not removed prior to loading into the container the volume of the container, and hence the weight of water required to fill it would be doubled.

11. The container is then sealed and transported via ship to Hawaii where it is loaded onto an awaiting Air Force aircraft for its flight to Rochester, New York.

12. At the facility the sealed container will be moved to the despooling area and the sea water drained and saved for use in the operation. The container can then be opened and the payload lifted clear. Suitable cranes and handling equipmemt, of course, will be required.

13. It is expected that the pressure canister will have to be cut away from the payload. Manual shears are planned. It is expected that since the shaft is broken, the mounting clamp need not be removed. The electronics in the shaft will be cut away and the RV equipment shelves pried apart with a special hydraulic spreader designed for the purpose by [illegible]. The will be separated from the structure of the RV and set up for removal of the TU structure from the stacks. This hardware also will be cut off using high strength shears. A hole, approximately 1 inch in diameter, will be drilled through the remaining electronics in the shaft. An axle will be inserted and the manually rotated for The sea water will be used to wet down the stack periodically.

14. The remainder of the recovery and processing operation will be accomplished manually by removing the in 2000 to 3000 foot lengths, maintaining the unit saturated with sea water and delivering the material, wet, for

IV. STATEMENT OF WORK

Perkin-Elmer proposes to support the recovery plan outlined in Section III of this proposal by providing the manpower, material, and facilities to:

1. Attend and provide technical liaison to planning and operational discussion meetings required to define the details of the recovery hardware herein proposed.

2. Provide technical support for the determination of the probable configuration of the payload as it rests on the bottom of the ocean.

3. Design, fabricate and test a lifting hook for use in the under-water recovery operation. Interfacing and operational details required to assure the compatibility of the hardware design with the Trieste II will be provided by HQS. The hook will be capable of:

   A. Multiple operation (open and close) at the operating depth estimated to be 14,400 feet.

   B. Lifting and containing the payload and its major internal components.

   C. Protecting the contents from significant exposure to sunlight as it is raised to the surface of the water and installed into the sealed shipping container.

4. Investigate the availability of a suitable shipping container for transporting the payload, immersed in sea water, to the despooling facility. The cost of such a shipping container is not included in this proposal.

5. Provide on-site technical support during the recovery operation. This effort will include evaluation, from photographs taken of the hardware on the ocean bottom, of the compatibility of the recovery method proposed. Identification of the payload and assessment of damage thereto prior to attempting actual recovery is assumed necessary for a successful operation.

6. Coordinate with the operation's force and provide instructions as to the operation of the hook, and the scheme to transfer the payload from the Trieste II lifting cable to the net of the support ship.

7. Provide technical liaison and information to EK in support of the disassembly of the take-up structure and installation of an appropriate despooling axle.

8. Provide a summary report of the overall operation with emphasis on the affectivity of the technique employed, the hardware used, and the survivability of the photographic data recovered.

9. The schedule for the above effort shall be from July 27, 1971 to November 30, 1971. Milestones are as follows:

A. Initiate planning 27 July '71.

B. Hook design complete 27 August '71.

C. Complete fabrication of hook 23 September '71.

D. Complete hook test 27 September.

E. Commence on-site operational support 1 October '71.

F. Complete recovery operation 15 October '71.

G. Complete technical liaison at despooling facility 29 October '71.

H. Complete final report 30 November '71.

V. TASK DESCRIPTIONS

1.0 OPTO-MECHANICAL ENGINEERING

1.1 INTRODUCTION

The Opto-Mechanical Engineering Department will direct, coordinate, and manage all of the activity herein proposed. It will also perform the necessary customer, co-contractor, and other agency interface tasks. It will provide the "on-site" personnel required for the recovery operation. Within its operation it is also responsible for engineering, layout, and release of all the hardware involved.

1.2 OPTO-MECHANICAL ENGINEERING TASKS

1.2.1 Provide technical liaison to planning meetings as required.

1.2.2 Engineer, design, and release for fabrication the "hay hook".

1.2.3 Provide technical support for the fabrication and inspection of the hardware.

1.2.4 Prepare test plan and supervise testing of the hardware.

1.2.5 Coordinate shipment of the hareware to the operational site.

1.2.7 Provide on-site technical support for the recovery operation.

1.2.7 Provide technical support at despooling facility.

1.2.8 Write final report.

1.2.9 Investigate availability of appropriate shipping container.

2.0 SYSTEMS ENGINEERING

2.1 INTRODUCTION

The Systems Engineering Department will provide analytical support for the design of the hook hardware and recovery operations.

2.2 SYSTEM ENGINEERING TASKS

2.2.1 Calculate descent rate of payload after impact with the water.

2.2.2 Perform force flow analysis to determine loading of hook components. Several hook concepts will be analyzed.

2.2.3 Perform detailed stress and weight analyses of selected hook design.

2.2.4 Document the above analyses for incorporation into the final report.

2.2.5 Support test planning and witness testing of the hook.

3.0 MANUFACTURING

3.1 INTRODUCTION

The Manufacturing Department provides the necessary manpower, materials and facilities to fabricate and assemble the hardware.

3.2 MANUFACTURING TASKS

3.2.1 Fabricate and/or purchase all detail parts and hardware as described in the released "hook" drawing set.

3.2.2 Assemble the hook hardware.

3.2.3 Provide appropriate shipping crate.

3.2.4 Arrange for shipment to the operational site.

4.0 QUALITY ASSURANCE

4.1 INTRODUCTION

One hundred percent inspection of parts is not proposed for this one of a kind hardware fabrication task. Therefore, the hardware will be inspected at the assembly level only. Quality Assurance will, however, participate in the hardware testing.

4.2 QUALITY ASSURANCE TASKS

4.2.1 Inspect hardware for compliance with the intent of the design layout drawing (NOTE: The design layout drawing will be used as the final assembly drawing. Detail parts and components will be described by appropriate auxiliary views and/or separate drawings as required to facilitate fabrication and assembly, ~~as required.~~)

4.2.2 Review and approve test plan.

4.2.3 Witness hook testing.

5.0 TEST DEPARTMENT

5.1 INTRODUCTION

The Test Department will provide the manpower and equipment required to perfrom a simulated, in air, loading test of the hook.

5.2 TEST DEPARTMENT TASKS

5.2.1 Prepare written procedures for test to be performed. It is anticpated that the tests to be performed will consist of a simple demonstration of the load carrying capability of the hook. The test procedures, therefore, will be simply a list of steps and/or operations to be performed using an appropriate load and crane.

6.0 TECHNICAL DOCUMENTATION

6.1 INTRODUCTION

The Technical Documentation Department is responsible for publishing the proposaland fin report. They provide typing, editing, and illustrating support to the engineers who actually write the report.

6.2 TECHNICAL DOCUMENTATION TASKS

6.2.1 Edit, Type, and illustrate as required, the proposal and the final report.

6.2.2 Print and distribute the proposal and final report in accordance with security regulations.

6.2.3 Incorporate interim reports of the project activity into the monthly DMR.

VI. COST INFORMATION

VII. ATTACHMENTS

The attached illustrations show various hook concepts investigated during the design process. The recommended configuration shown in Figure 1 provides the best combination of simplicity of operation, minimum size and weight, fabrication cost and load carrying capability. It incorporates the desirable feature of increased gripping force with increased load. This is achieved through the use of a simple "ice tong" mechanism employing a pivit for the arms which is located so as to cause the lifting cable tension tend to close the hook. A latch arrangement is used to hold the hook in the open position and a spring force, released by the latch to close the arms.