IG-97-016

AUDIT REPORT

CLEAR LAKE DEVELOPMENT FACILITY - NEUTRAL BUOYANCY LABORATORY REQUIREMENTS

MARCH 17, 1997

National Aeronautics and Space Administration

OFFICE OF INSPECTOR GENERAL

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National Aeronautics and
Space Administration

Headquarters
Washington, DC 20546-0001

Reply to Attn of: W

March 17, 1997

TO: Johnson Space Center
ATTN: AA/Center Director

FROM: W/Acting Assistant Inspector General for Auditing

SUBJECT: Final Report on Clear Lake Development Facility - Neutral Buoyancy Laboratory Requirements
Assignment Number A-JS-95-009
Report Number IG-97-016

The NASA Office of Inspector General completed an audit of the Clear Lake Development Facility lease/purchase contract. During the audit, we identified four conditions related to Johnson Space Center's and McDonnell Douglas Corporation's implementation of contract clauses and a fifth condition where the operations and maintenance letter contract was being used to fund an experiment's cost. A copy of the final report is enclosed.

We received your written response to our November 19, 1996 discussion draft report on January 13, 1997. Your comments are incorporated in the report and the complete written response is included as an Appendix to the report. Management concurred with the intent of all recommendations. Recommendations 1, 2, 3, 4, 5, and 6 are considered closed with the issuance of this final report. Recommendations 7, 8, and 9 will be closed after the requested additional supporting documentation is provided.

During the conduct of the audit we also issued two management letters and a rapid action report (RAR). The management letters addressed Schedule A concerns (Exhibit 1) and Schedule B concerns (Exhibit 2). The RAR reported on the inadequacy and inaccuracy of the hyperbaric chamber cost estimate on which JSC based its negotiating position (Exhibit 3). These three issues were resolved prior to the issuance of this final report.

Should you have questions, please contact Janice Goodnight at extension 34773, or Daniel J. Samoviski, Acting Director, Audit Division-A, or me at (202) 358-1232.

Robert J. Wesolowski

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Enclosure

cc:
HQs-JM/D. Green
JSC-OA/R. Brinkley
BJ/R. Etchberger
BQ/P. Ritterhouse

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ACRONYMS

AE	Architectural Engineering
ATB	Assembly and Test Building
CLDF	Clear Lake Development Facility
CO	Contracting Officer
COD	Center Operations Directorate
ISS	International Space Station
JSC	Johnson Space Center
LMF	Light Manufacturing Facility
MDC	McDonnell Douglas Corporation
NBL	Neutral Buoyancy Laboratory
NFPA	National Fire Protection Association
ORR	Operational Readiness Review
SSF	Space Station Freedom
UHCL	University of Houston - Clear Lake
UPS	Uninterruptible Power Source

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CLEAR LAKE DEVELOPMENT FACILITY - NEUTRAL BUOYANCY LABORATORY REQUIREMENTS

JOHNSON SPACE CENTER, TEXAS

EXECUTIVE SUMMARY

INTRODUCTION

On January 20, 1995, Johnson Space Center (JSC) entered into a $34 million contract with McDonnell Douglas Corporation (MDC) to lease and purchase the Clear Lake Development Facility (CLDF) which includes three large industrial buildings. MDC will construct a Neutral Buoyancy Laboratory (NBL) within the Assembly and Test Building and JSC will use the two other buildings as office and technical support facilities.

OBJECTIVES

The overall objective of the audit was to evaluate the CLDF lease/purchase contract. Specifically, we:

- evaluated the adequacy of the contract clauses;
- determined if the contractor has met contract requirements; and
- assessed the reasonableness of the operations and maintenance letter contract.

RESULTS OF AUDIT

Our assessment of the following areas disclosed the following four conditions related to the lack of implementing contractual requirements:

1. JSC did not arrange or participate in the joint **physical survey** and inspection report before the NBL's initial construction start.

2. MDC's contractually stipulated **completion date** is susceptible to slipping because the contract was negotiated with a day-for-day extension if International Space Station Flight 2A is delayed.

3 Information requested by Center Operations Directorate (COD) engineers for mechanical, structural, or electrical **engineering calculations** was delayed.

4. The hyperbaric chamber housed at the NBL will not be protected by a **fire retardant wall.**

In addition we determined that JSC management did not consider the **plasma experiment laboratory's** unusual power profile requirements before the decision was made to locate it at CLDF.

RECOMMENDATIONS

In order to correct these conditions, we recommend:

- The Director of Center Operations should determine if the cost to obtain a geotechnical opinion of the structural integrity of the building is warranted.

- If it is determined that the structural integrity of the building has been compromised, the Contracting Officer (CO) should assess JSC's financial exposure for the cracked foundation. Additionally, the CO should request a legal opinion on financial responsibility for any required repairs.

- The Director of the JSC Business Management Office should ensure that when the completion of a contractually required task is mission critical, liquidated damages are associated with a definite date.

- COD engineers should determine if the lighting meets contractual requirements.

- At the earliest time possible, COD engineers should test the illumination at the bottom of the pool to determine whether the illumination is adequate to "read standard print."

- If the lighting provision is determined to be inadequate, the CO should devise a plan to minimize any cost and schedule impact.

- The Director of Center Operations should determine if sufficient calculations for other engineering requirements have been made available to COD engineers.

- The CO should ensure MDC's compliance with National Fire Protection Association 99. If the CO accepts the safety risk of not enforcing the contractual requirement, then the CO should obtain compensation for the reduction in the scope of work.

- JSC management should determine where the experiment will be located, how power will be supplied for the project, and the amount of financial support to be given the plasma laboratory experiment. The astronaut-scientist should be consulted to ascertain if the decisions will affect the laboratory's hypothetical outcome.

INTRODUCTION

BACKGROUND

Johnson Space Center (JSC) had planned to build an on-site Neutral Buoyancy Laboratory (NBL). Estimates were received, the plans were redesigned, and a "barebones" NBL was planned for $32.2 million.

McDonnell Douglas Corporation (MDC) originally constructed Clear Lake Development Facility (CLDF) to support the Space Station Freedom (SSF) Program. In February 1994, following the Space Station redesign, MDC's SSF Work Package II contract became a subcontract to Boeing Aerospace, and the need for CLDF was limited. In October 1994, MDC submitted an unsolicited proposal to JSC for the lease and purchase of the property with the Assembly and Test Building (ATB) modified to house the NBL.

NASA considered the MDC proposal a better alternative. JSC could acquire the additional buildings and property as well as settle the MDC Work Package II termination claim. The NASA Administrator solicited enabling legislation from Congress for $35 million and in January 1995, JSC entered into a $34 million contract with MDC. JSC reserved the remaining $1 million for computer consoles. JSC subsequently cancelled the plans to build the on-site "barebones" facility.

On January 20, 1995, JSC entered into a $34 million contract with MDC to lease and purchase the CLDF, a 13-acre tract which includes three large industrial buildings. According to the terms of the contract, MDC will construct a NBL within the 101,000 square foot ATB. JSC will use the two other buildings, the 97,000 square foot Light Manufacturing Facility (LMF) and the 51,000 square foot Avionics Development Facility, as office and technical support facilities.

NASA needs an NBL to perform astronaut training because the current pools at JSC and Marshall Space Flight Center are not large enough to accommodate the assembly training of the International Space Station components. The NBL will be a water filled pool measuring 202 feet long by 102 feet wide with an overall depth of 40 feet.

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OBJECTIVES, SCOPE, AND METHODOLOGY

OBJECTIVES

The overall objective of the audit was to evaluate the CLDF lease/purchase contract. Specifically, we:

- evaluated the adequacy of the contract clauses;
- determined if the contractor has met contract requirements; and
- assessed the reasonableness of the operations and maintenance letter contract.

SCOPE AND METHODOLOGY

In February 1995, we initiated a survey of the CLDF contract under the Audit of Space Station Facilities Requirements, (A-JS-95-002). As a result of the survey, a decision was made to evaluate the CLDF lease/purchase contract under a separate assignment. Audit field work was conducted between May 1995 and November 1995 at JSC. The audit methodology included interviews, observation of meetings, examination of agency records, and analysis of contractor documentation.

MANAGEMENT CONTROLS REVIEWED

This report is an assessment of the contract administration process and, as such, the applicable management controls were reviewed. During our review, conditions came to our attention to indicate that the controls were inadequate and there was potential for JSC personnel or contractors to circumvent applicable laws and regulations. We immediately brought these conditions to management's attention in the form of two management letters dated October 10, 1995 (Exhibits 1 and 2).

- Management Letter, M-JS-96-001, NAS9-19350 Schedule B Concerns, October 10, 1995

- Management Letter, M-JS-96-002, NAS9-19350 Schedule A Concerns, October 10, 1995

AUDIT STANDARDS

The audit was performed in accordance with generally accepted government auditing standards.

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OBSERVATIONS AND RECOMMENDATIONS

RESULTS OF AUDIT

The audit has shown the following contract administration problems:

- JSC did not participate in the physical survey;
- NBL's completion date is questionable;
- MDC's engineering calculations were not timely provided;
- Hyperbaric chamber will not be protected by a fire wall; and
- Plasma experiment's location may not provide adequate power source.

JSC DID NOT PARTICIPATE IN THE PHYSICAL SURVEY

JSC did not arrange or participate in the joint physical survey and inspection report with the contractor before the NBL's initial construction start. The contract required a joint physical survey and inspection report. Since construction began, foundation cracks have developed in the concrete expansion joints of the adjacent CLDF LMF. Because the Contracting Officer (CO) did not aggressively pursue compliance with the contractual requirement, there is no definitive statement of the building's condition immediately prior to the start of construction. This lack of documentation may leave NASA vulnerable if responsibility disputes arise concerning the cracked foundation or other subsequent conditions.

To ensure the integrity of the building prior to construction, the contract required a joint physical survey and inspection report. Paragraph H.3 states:

> *"A joint physical survey and inspection report of the facility will be made as of the effective date of this contract, reflecting the then present condition, and will be signed on behalf of the parties hereto."*

JSC did not arrange or participate in the joint physical survey and inspection with the contractor prior to the start of the NBL construction. MDC performed its own survey and provided the results to NASA. MDC offered drawings, survey benchmark, and a photograph album documenting the existing interior and exterior conditions. A letter from MDC stated "*...unless any requests for changes to the above items are received by March 24, 1995, we will consider these items to be in full compliance with Paragraph H.3.*"

The JSC CO did not respond to the MDC letter regarding contract requirements compliance. Additionally, Center Operations Directorate (COD) engineers had not been present during the MDC condition survey and had not done any evaluation prior to construction start themselves. Furthermore, the CO's files did not indicate if the condition report was completed as stipulated in the contract. Finally, neither the CO nor any COD representative signed on behalf of NASA as to the present condition of the building.

The CO did not aggressively pursue compliance with the contractual requirement of a joint physical survey. When asked about JSC's compliance with Paragraph H.3, the CO stated other priorities kept him from attending the survey or participating in the inspection. Since the condition report was not completed as specified in the contract, NASA does not have a baseline to assess whether the subsequent conditions are a result of NBL construction or natural occurrences.

During an August 1995 site visit, we observed the cracks at several LMF concrete expansion joints (Exhibit 5). We immediately brought this condition to the CO's attention who said he would look into the situation. Several weeks later, we asked the CO if actions had been taken to address the cause or potential problems that could result from a cracked foundation. He responded that based on his discussions with an MDC engineer, there was no cause for concern. On a third occasion in October 1995, we asked the CO for a status of the cracked foundation situation. He responded that MDC engineers had explained that the cracks would close at the termination of the dewatering process.[1]

We asked the CO if NASA engineers had assessed the cracks or evaluated MDC's claim that the cracks would close at the end of dewatering. He replied he had only discussed the issue with MDC engineers. We expressed our concern that:

(1) the solution that the crack would seal did not sound logical;

(2) JSC engineers had not been consulted; and

(3) the crack could be indicative of building integrity problems.

1. Dewatering is accomplished by drilling a deep well and pumping water away from the construction site. The risk associated with the dewatering process is that gaps or voids can develop in the supporting underground stratum .

The CO eventually asked JSC engineers to assess the cracked foundation at CLDF after we discussed our concerns with the JSC Assistant Chief Counsel for Procurement Matters who contacted the CO. Immediately after being notified, the COD engineer visited the site, inspected it, and documented the foundation cracks. Their assessment did not support MDC's assertion that the crack would close at the termination of the dewatering process.

The CO did not take aggressive action when informed of concrete foundation cracks in the LMF because of reliance upon JSC's management response to a December 9, 1994 management letter that our office issued on a previous audit assignment, Space Station Cost Estimating and Reporting, A-HA-94-007. The management letter expressed our office's concerns that a complete geotechnical survey was not being accomplished. The JSC Space Station Program Manager's response stated:

> *"MDC recognizes that changes may have to be made to accommodate unexpected soil conditions, and is satisfied that the MDC directed geotechnical survey alleviates any major concerns in this area. Nevertheless, the contract does not relieve MDC of responsibility for completing the NBL on schedule should soil conditions impact construction or design. Both NASA and MDC, in conjunction with their respective technical consultants, feel very strongly that the boundaries of the soil characteristics are well understood and acceptable for NBL construction. This conclusion was made based on the geotechnical study performed directly on and around the CLDF."*

The COs lack of participation in the physical survey and the lack of aggressive action on his part once the cracks were identified leaves the definitive statement of the building's condition as of the contract's effective date open to interpretation. Hidden conditions may become apparent after title passes with no basis for recourse against the contractor.

If the foundation cracks are indicative of structural integrity problems and the cracks do not adequately seal when dewatering is terminated, NASA may have to accept the building and incur the costly repair. The repairs could entail breaking out the damaged concrete slab and replacing with new concrete.

RECOMMENDATION 1

The Director of Center Operations should determine if the cost to obtain a geotechnical opinion of the structural integrity of the building is warranted.

Management's Response

We established a movement monitoring program to determine if the construction of the NBL walls caused ground movements to exceed allowable limits predicted during the design phase. The results of the survey data, gathered under the movement monitoring program, confirmed ground movement in and around the water tank remained within design limits. Based on this engineering data and no observed distress in the existing Assembly and Test Building (ATB) and the Light Manufacturing Facility (LMF) building structures or foundations, we concluded that the movement monitoring test supported the structural integrity of the building.

In addition, we have been able to prove through MDC photos that floor slab cracks existed in the LMF prior to the NBL's construction. We recommend no further action be taken on this issue.

Evaluation of Management's Response

Our conclusion that the floor cracked subsequent to the start of construction was based on individuals interviewed at the site. Because of the nature of this contract, the CO was our main point of contact. Our office must rely on the information provided by the points of contact. If the slab cracks existed in the LMF prior to the NBL's construction, the CO did not communicate that information to us. The CO said the crack would close when the dewatering process ceased. However, based on the information presented in JSC's response, we consider this recommendation closed.

RECOMMENDATION 2

If it is determined that the structural integrity of the building has been compromised, the CO should assess JSC's financial exposure for the cracked foundation. Additionally, the CO should request a legal opinion on financial responsibility for any required repairs.

Management's Response

This recommendation becomes non-applicable because of the position taken in response to Recommendation 1 that no further action be taken on the issue of floor cracks in the LMF.

Evaluation of Management's Response

Based on management's response to Recommendation 1, this recommendation is considered closed.

NBL'S COMPLETION DATE IS QUESTIONABLE

MDC's contractually stipulated completion date is susceptible to slipping because the contract was negotiated with a day-for-day extension if International Space Station (ISS) Flight 2A is delayed. A contract clause provides for such an extension to the completion date if ISS Flight 2A is delayed. The CO should not have allowed an extension of the completion date to be associated with a flight that appeared subject to slippage. If MDC is granted a day-for-day extension because Flight 2A is delayed, they would be able to make up time in their aggressive construction schedule, and be relieved of liquidated damages. In addition, JSC would lose valuable training time.

If MDC fails to complete the NBL on time, JSC will collect liquidated damages in accordance with contract clause Section F.3, Liquidated Damages--Construction:

> *"...if Contractor fails to meet the Completion Date or any extension thereof, the Contractor shall pay to the Government as liquidated damages, the sum of $11,000, for each day of delay ... up to ... $330,000..."*

However, MDC would attain an extension to the completion date if Flight 2A is delayed as referenced in contract Section F.2, Completion of Work, which states:

> *"...In the event the scheduled date of Space Station Flight 2A, scheduled for December 4, 1997... is delayed ... the Contractor shall automatically receive a day-for-day extension of the Completion Date for the NBL and the CLDF...."*

The contractually required completion date for the NBL is questionable. MDC will be granted a day-for-day slip in the completion of the NBL if the Space Station Program Office delays the launch of Flight 2A. At the time this contract was being negotiated, Flight 2A activities were experiencing significant delays. Furthermore, as reported in our Management Letter on Space Station Cost Estimating and Reporting, dated December 9, 1994, we expressed concerns with the aggressive construction schedule proposed by MDC. The Management Letter even quoted the NASA Director of Facilities Engineering Division's opinion that MDC's construction schedule was "extremely optimistic."

The CO should not have allowed the construction due date to be associated with a flight that appeared subject to slippage. The CO knew during NBL contract negotiations that Flight 2A activities were

experiencing significant delays. Good business practices dictate for a building to be available on a specific date, not based on a troubled flight. If, for some reason, the Space Station Program would have been cancelled in the interim, the contract is unclear about whether MDC would be excused from providing the building.

If Flight 2A is eventually delayed, MDC will be allowed to accommodate their aggressive construction schedule without incurring liquidated damages. In addition, JSC would not be able to utilize the NBL for mission critical space station training.

RECOMMENDATION 3

The Director of the JSC Business Management Office should ensure that when the completion of a contractually required task is mission critical, liquidated damages are associated with a definite date.

Management's Response

Liquidated damages are part of the contract, and tie in to the January 10, 1997, completion date.

Evaluation of Management's Response

We continue to believe that management of construction contracts would be strengthened by having a policy to establish a definite date for mission critical tasks associated with liquidated damages. Our office may monitor future contracts to ensure that liquidated damages are associated with a definite date.

MDC'S ELECTRICAL ENGINEERING CALCULATIONS WERE NOT TIMELY PROVIDED

COD engineers requested electrical engineering calculations to evaluate progress on the CLDF-NBL project; however, MDC delayed the calculations submission. The COD oversight was to be minimal because JSC did not want to interfere with the design-build concept accepted for this project. The delayed receipt of pool lighting calculations may result in an unacceptable NBL. Although MDC may be responsible for contractual deficiencies, any delay could adversely impact the acceptance and use schedule.

The Chief of the Facility Development Division drafted a position statement of conducting minimal oversight over the CLDF-NBL project. The position statement envisioned COD would review the contractor's submittal for compliance with the contracts requirements document. The reviews were to be done without impacting the design-build concept accepted for this project.

The pool lighting requirements evolved from work accomplished on the earlier NBL designs. When writing the lighting specifications for the "on-site" laboratory, the amount of illumination needed could not be quantified in engineering terms; however, there was a specific need

for adequate lighting. The astronauts and trainers must adequately see in the pool to conduct experiments and train efficiently. In contractual terms, the NBL III "on-site" laboratory requirements document stated:

> *"A uniform lighting level shall be provided over the entire area of the pool. It is desired that a uniform lighting level be obtained without the use of underwater lights. Pool lighting shall be of such intensity that a test subject on the bottom of the pool can read standard print. Full spectrum light is desirable for video and safety requirements."*

COD engineers recognized a construction contractor would not be able to meet the requirements without specific foot candle criteria. JSC requested the clarifying information from the "on-site" NBL architectural engineering (AE) firm. The firm's September 1994 design analysis stated "...the overhead lights above the pool will ... provide a uniform lighting level of 25-foot candles at the bottom of the pool." COD engineers believed this would allow a construction contractor to meet the requirement of being able to read standard print at the bottom of the pool.

When the CLDF NBL contract was finalized, the lighting requirements did not specify foot candles. Paragraph 6.2.4 of the NBL Requirements Document stated *"...uniform lighting level shall be provided over the entire area of the water tank. Water tank lighting...shall be installed as per NBL III design."* As stated above, the NBL III design did not specify foot candles and Paragraph 6.2.4 did not reference the AE firm's design analysis in conjunction with the NBL III design.

Again, COD engineers tried to offset for the lack of specific requirements in the contract by developing a contract design criteria table. The table specified the lighting illumination for the pool at "50." COD engineers have interpreted the "50" as 50-foot candle light at the top of the pool. COD engineers believe that if the contractor can provide 50-foot candle light at the top of the pool, the AE firm's criteria of 25-foot candle light at the bottom of the pool would be obtained. This would allow a person to read standard print, the original requirement.

The change in contractual language was a result of numerous meetings. However, the specific reason for ambiguous language is unknown.

COD engineers had repeatedly asked for the contractor's electrical engineering calculations. These calculations would provide a basis to determine if the lighting provision would satisfy the contractual agreement. The Project Engineer began requesting calculations in March 1995; however, they were not provided by MDC until October 1995 after our office began a review in this area. At the time of this report, the engineers were evaluating for compliance with the contractual obligation.

The contractual obligation to provide 50-foot candle illumination at the top of the pool may not meet the user requirements. The contingency exists that lighting may not meet the user requirement to "read standard print" at the bottom of the pool. According to the NBL Project Engineer, a user has expressed concerns that illumination may not be sufficient. The three concerns are:

(1) the fixtures may not provide 50-foot candle illumination at the top of the pool;

(2) the 50-foot candle illumination at the top of the pool may not provide 25-foot candle illumination at the bottom of the pool; and

(3) the illumination provided may not be adequate to "read standard print" at the bottom of the pool.

If JSC does not evaluate the illumination until pool completion, they may face the unanticipated cost and schedule impact of providing supplemental lighting.

RECOMMENDATION 4

COD engineers should determine if the lighting meets contractual requirements.

Management's Response

Adequate lighting was a requirement in the contract. The lighting has been measured at the water tank deck level and found to exceed contractual requirements. At the bottom of the water tank, the lighting has been determined sufficient for training operations. Several NASA divers and suited astronauts have reported being able to read ordinary size print at the bottom of the water tank, a requirement in the NBL III, even though not specifically written into the Requirements Document for the NBL at the Sonny Carter Training Facility.

Evaluation of Management's Response

The actions taken to measure the pool lighting are responsive to the recommendation.

RECOMMENDATION 5	At the earliest time possible, COD engineers should test the illumination at the bottom of the pool to determine whether the illumination is adequate to "read standard print."
Management's Response	As stated in the response to Recommendation 4, several NASA divers and suited astronauts have reported the lighting is adequate to read ordinary size print at the bottom of the water tank.
Evaluation of Management's Response	The actions taken are responsive to the recommendation.
RECOMMENDATION 6	If the lighting provision is determined to be inadequate, the CO should devise a plan to minimize any cost and schedule impact.
Management's Response	This recommendation becomes non-applicable because of the response provided to Recommendation 4.
Evaluation of Management's Response	Since the lighting was determined to be adequate, no additional actions are required.
RECOMMENDATION 7	The Director of Center Operations should determine if sufficient calculations for other engineering requirements have been made available to COD engineers.
Management's Response	Center Operations Directorate engineers have been provided calculations to the extent normally prepared in a commercial project; however, they do not reside in a single location, particularly in the electrical and mechanical disciplines. Some calculations are located in the NBL Technical Library while others can be found within shop submittals in the Architectural-Engineering's (A&E) office. We plan to assemble all calculations in a single location and will work with the CO to direct MDC's collection of this data for NASA's use and archiving. With this planned action, this recommendation is considered closed.
Evaluation of Management's Response	The actions taken and planned are responsive to the recommendation. We request that the Center Operations Directorate provide our office with a schedule for the planned collection and archiving of the engineering data.
HYPERBARIC CHAMBER WILL NOT BE PROTECTED BY A FIRE WALL	The hyperbaric chamber housed at the NBL will not be protected by a fire retardant wall. The contract requires MDC to design and build the hyperbaric chamber system to meet the requirements of several National Fire Protection Association (NFPA) codes, one of which requires the hyperbaric chamber to be protected by a fire retardant wall. The CO will allow MDC to obtain a waiver for the fire wall

requirement. The waiver will be based, in part, on a definition for a health care facility from an outdated edition of the NFPA standard. A potential safety hazard exists should a fire occur in the building when a patient is being treated in the hyperbaric chamber, which could result in loss of life.

The contract requires MDC to design and build the hyperbaric chamber system to meet the requirements of several NFPA codes. According to contract Section C.2, Statement of Work, MDC "*...shall furnish all resources necessary and incidental to performance of the work set forth in Section J, Attachment J-2, NBL Requirements Document.*" Section 6.25 of the NBL Requirements Document deals with the Hyperbaric/Treatment Chamber System. Subsection 6.25.2, Applicable Design Criteria, states:

> *"As applicable, the hyperbaric chamber system shall be designed and built in accordance with the following codes and criteria: ...NFPA 99, Health Care Facilities..."*

The scope of NFPA 99, Chapter 19, Hyperbaric Facilities, applies to hyperbaric chambers and associated facilities that are used, or intended to be used, for medical applications, and covers the recognition of and protection against hazards such as fire. Section 2.1.1 of Chapter 19 states:

> "*...chambers and all ancillary service equipment shall be housed in fire-resistant construction of not less than 2-hour classification, which shall be ... separated from contiguous construction by 2-hour noncombustible ... wall construction.*"

The hyperbaric chamber housed at the NBL will not be protected by a fire retardant wall. During the June 1995 hyperbaric chamber pre-bid conference, potential bidders questioned the need for a full enclosure (fire wall) around the chamber and its auxiliary equipment. As a result, the JSC safety contractor was asked to perform an analysis on the fire wall requirement. Two days after the pre-bid conference, the safety contractor issued a memorandum stating the analysis determined NFPA 99 "*... requires that both the chamber and the auxiliary equipment be enclosed in a two-hour fire resistive construction.*" Despite the analysis, during the hyperbaric chamber bid openings in July 1995, the MDC Director of Construction questioned the need for a fire wall. The CO verbally agreed the chamber could be installed without the fire wall.

Consequently, MDC has pursued obtaining a waiver to build the wall, relying on an outdated standard. In September 1995, a representative from MDC's architectural firm met with the City of Houston Building Inspectors. They discussed and concluded a fire wall around the hyperbaric chamber was not necessary to comply with City of Houston building codes.

During the meeting with the City of Houston, MDC's architect stated that NFPA 99 is not applicable to the hyperbaric chamber because NFPA 99 applies only to health care facilities and the chamber did not satisfy the definition of a health care facility. However, the architect unknowingly used an outdated 1990 edition of the NFPA 99 standard to define a health care facility. In Chapter 2, Definitions, a health care facility is defined as:

> *"Buildings or portions of buildings that contain, but are not limited to, occupancies such as: hospitals; nursing homes; limited care; supervisory care; clinics; medical and dental offices; and ambulatory care; whether permanent or movable."*

The JSC safety contractor informed our office that in the current 1993 edition of NFPA 99, the chamber would meet the definition of a health care facility. In Chapter 2, Definitions, a health care facility is defined as:

> *"Buildings or portions of buildings in which medical, dental, psychiatric, nursing, obstetrical, or surgical care are provided. Health care facilities include, but are not limited to, hospitals, nursing homes, limited care facilities, clinic, medical and dental offices, and ambulatory care centers, whether permanent or movable."*

According to the JSC safety contractor, the 1993 definition applies to the CLDF because the definition is now broader.

A potential safety hazard exists should a fire occur in the area surrounding the chamber. If a patient is being treated in the hyperbaric chamber, loss of life could result to not only the patient, but also the medical personnel attending the patient. The two-hour fire wall could allow the attendants to safely decompress the chamber and escort the patient to safety. Otherwise, the attendants and the patient are exposed to unnecessary dangers.

RECOMMENDATION 8

The CO should ensure MDC's compliance with NFPA 99. If the CO accepts the safety risk of not enforcing the contractual requirement, then the CO should obtain compensation for the reduction in the scope of work.

Management's Response

The NBL Operational Readiness Inspection (ORI) Committee made the decision to obtain a waiver to NFPA 99's requirement for protecting the hyperbaric chamber with a fire retardant wall. The CO obtained consideration for the waiver of this requirement in the form of additional work needed by the Government which the contractor was not otherwise required to perform (specifically, providing and installing ancillary connections). Accordingly, we consider this recommendation closed.

Evaluation of Management's Response

The actions taken appear to be responsive to the intent of the recommendation. We request the CO provide a copy of the waiver received, as well as the contract modification or other documentation that supports that consideration was received. Upon satisfactory review of these documents, the recommendation will be considered closed.

PLASMA EXPERIMENT LOCATION MAY NOT PROVIDE ADEQUATE POWER SOURCE

JSC management did not consider a plasma experiment laboratory's unusual power profile requirements before the decision was made to locate it at CLDF. This lack of planning resulted in the CO suspending laboratory financial support and may result in costly future delays. An astronaut-scientist is conducting a scientific experiment to develop an alternative propulsion mechanism. This device uses hydrogen gas and electrical pulses to change the gas to the fourth stage of matter, plasma. The scientific community considers the energy derived as innovative technology and "the wave of the future" for long distance space travel, as well as a potential navigational and guidance alternative for the ISS.

The plasma laboratory's location has not been settled. Although initially set up at Massachusetts Institute of Technology, the experiment was moved to Houston to expedite the astronaut-scientist's involvement in the project. The University of Houston - Clear Lake (UHCL) became a possible location. While UHCL was being considered, the laboratory components were stored at CLDF. When UHCL could not provide the necessary power requirements, the CLDF storage site evolved into the plasma laboratory.

The plasma laboratory experiment has unusual power profile requirements, both in terms of magnitude and duration. The experiment includes three large magnetic coils which utilize DC

current of a high capacity for a short duration. Six pulse rectifiers are used to convert AC power line current to DC and to control DC voltage. The experiment can cycle as often as every 15 minutes for 8 hours per day, and also requires miscellaneous support equipment that draws a more or less constant AC current from the power lines.

The plasma laboratory was established at CLDF without ascertaining whether the experiment's power requirements could be accommodated at that location. An uninterruptible power source (UPS) and batteries located at CLDF are being used by the laboratory until the NBL is operational. At that time, another power source will need to be in place or the experiment will have to be suspended.

At the time of the audit, JSC management has not made the logistical decisions necessary for the successful completion of the experiment. These decisions range from whether:

- the experiment will be moved;
- NASA will provide a UPS; and
- funding is available for the experiment.

The CO compiled a report of .the various options. Moving the experiment would result in extensive delays and power could still be a problem. The cost and installation of the UPS could be as high as $500,000. Although the astronaut-scientist is soliciting a sponsor, the Procurement Manager, Space Station Procurement Office, was tasked with evaluating the various options.

The decisions made concerning the plasma laboratory would increase the final dollar value of the operations and maintenance contract. Although the astronaut-scientist said the operating cost is minimal, the CO was concerned enough about the cost that he terminated project support for a month. The CO took this action to focus the need for a decision regarding the project's funding. Furthermore, once the NBL is operational, the experiment will have to stop operation because it will no longer have the necessary power.

RECOMMENDATION 9

JSC management should determine where the experiment will be located, how power will be supplied for the project, and the amount of financial support to be given the plasma laboratory experiment. The astronaut-scientist should be consulted to ascertain if the decisions will affect the experiment's hypothetical outcome.

Management's Response

Power for the Plasma Experiment is supplied by an independent source. Power fluctuations in that laboratory will not adversely impact other Sonny Carter Training Facility power sources. The

Safety, Reliability and Quality Assurance Office has already assessed the laboratory and found no major hazards which would preclude full operations. In addition, the JSC Operational Readiness Review (ORR) will investigate the laboratory more thoroughly within the next month and will recommend further technical evaluation, as necessary, to assure the safety and reliability of the facility. Both internal and external laboratory effects will be addressed. The astronaut-scientist will be consulted to ascertain if the decisions will affect the experiment's hypothetical outcome. With the oversight being provided this project, we consider this recommendation closed with the actions taken or planned.

Evaluation of Management's Response

The actions taken and planned appear responsive to the recommendation. We request a copy of the pending ORR. After a satisfactory review of this documentation, the recommendation will be considered closed.

MAJOR CONTRIBUTORS TO THIS AUDIT

JOHNSON SPACE CENTER	Janice L. Goodnight, Program Director, Human Exploration and Development of Space Connia Webb, Auditor-in-Charge Loretta Garza, Auditor June Glisan, Audit Program Assistant

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House Committee on Government Reform and Oversight
House Subcommittee on Space and Aeronautics
House Committee on Science

Space Administration

Office of Inspector General
Lyndon B. Johnson Space Center
Houston, Texas 77058-3696

EXHIBIT 1

Reply to Attn of: W

October 10, 1995

TO: Johnson Space Center
Attn: AA/Acting Center Director

FROM: W-JS/OIG Center Director

SUBJECT: Management Letter on Clear Lake Development Facility - Neutral Buoyancy Laboratory (NBL) Requirements
Assignment No. A-JS-95-009
NAS9-19350 - Schedule B
M-JS-96-001

The NASA Office of Inspector General is currently performing an audit to evaluate the effectiveness of the Clear Lake Development Facility (CLDF) lease/purchase contract. While performing our field work, we learned the Contracting Officer was about to definitize the operations and maintenance (O&M) Schedule B of the lease/purchase contract, NAS9-19350.

Although our field work will continue under this audit, we believe it is important to bring our concerns regarding the definitization of the O&M contract to your attention immediately. We identified two conditions through limited assessments performed during the audit. Therefore, the work on which our opinion is based was not performed in accordance with generally accepted government auditing standards.

McDonnell Douglas Realty Company (MDRC) submitted an unsolicited proposal to Johnson Space Center (JSC) in November 1994 to provide the O&M of the CLDF in conjunction with building the NBL. On October 4, 1995, our office met with the Contracting Officer to discuss the status of the definitization of the O&M portion of the contract. The Contracting Officer explained he made an offer to McDonnell Douglas on October 3, 1995, and showed us a draft copy of the modification for Schedule B of the lease/purchase contract.

During our review of the draft modification, we identified two conditions regarding the process the Contracting Officer is using to definitize the contract. During the review of the modification, we examined several contract line item numbers (CLINs). Several of the CLINs were written to include unit cost, skill mix, and rates, as well as other charges necessary to do the work. The additional cost would be the subcontractor's invoice plus a prearranged percent (i.e., 10 percent). Federal Acquisition Regulation 16.102(c) specifically states: "The cost-plus-a-percentage-of-cost system of contracting shall not be used..." Although we understand it was a draft copy of the modification we reviewed, it did represent the offer the Contracting Officer made to MDRC.

Secondly, the prenegotiation position was not reviewed by the Legal Office. Our office spoke with the JSC Assistant Chief Counsel for Procurement Matters on October 5, 1995, to verify our concerns on using cost-plus-a-percentage-of-cost in the CLINs. The JSC Assistant Chief Counsel for Procurement Matters shared our concerns. Furthermore, we learned the Contracting Officer's prenegotiation position was not reviewed by the JSC Legal Office in accordance with JSC Procurement Instruction (JPI) 94-7 prior to the Contracting Officer making an offer to MDRC . If the Contracting Officer had followed JPI 94-7, JSC's Legal Office could have eliminated the cost-plus-a-percentage-of-cost portion of the CLINs during its review.

We have discussed the information in this management letter with the JSC Contracting Officer and JSC's Legal Office. Based on our discussions, we believe the JSC Legal Office will take the necessary steps to correct the O&M modification; however, we are concerned other contracting officers may also be failing to request a legal review as required by JPI 94-7.

We request you keep us advised of the actions taken and ask that you respond within 15 days of this letter. If you would like to discuss this issue further, please call Janice Goodnight, Audit Manager, or me at extension 34773.

W. Preston Smith

cc:
HQs-JMC/P. Chait
W/C. Little
W/B. Richardson
W/OIG Field Offices
W/D. Orton
JSC-AL/J. Lottinville
BA/T. Hesse
BJ/R. Etchberger
BU/P. Ritterhouse
OA/R. Brinkley

National Aeronautics and
Space Administration

Lyndon B. Johnson Space Center
Houston, Texas
77058

NASA

OCT 26 1995

Reply to Attn of: BU-95-068

TO: W-JS/Director, Center Office of Inspector General

FROM: AA/Acting Director

SUBJECT: Response to Management Letter on Clear Lake Development Facility Neutral Buoyancy Laboratory (NBL) Requirements
Assignment No. A-JS-95-009
NAS 9-19350 - Schedule B

We have reviewed the subject letter in which you identified two concerns regarding the operation and maintenance, Schedule B, of the lease/purchase contract of the Clear Lake Development Facility. Specifically, those concerns addressed the lack of a Legal Office review of a prenegotiation memorandum (PNP), and an apparent cost-plus-a-percentage-of-cost system of contracting proposed in a draft contract modification. The PNP is still under development, and does not include a cost-plus-a-percentage-of-cost arrangement. At the time of the assessment performed by the Office of Inspector General, the NASA contracting officer was in the process of assessing the existing contractual arrangements that had been put in place by the McDonnell Douglas Realty Company with several commercial entities to perform operations and maintenance work, and was aware that there were, in some cases, appearances of cost-plus-a-percentage-of-cost arrangements. We concur with your letter statement that the concern regarding the type contracting has been resolved.

Our review of the second concern that other JSC contracting officers may be failing to request a legal review as required by JPI 94-7 determined that a revision to JPI 94-7 was released dated September 11, 1995. While the old version of JPI 94-7 would have required only Legal Office notification of the PNP review, the revised version does require a Legal Office review. Therefore, a reminder will be sent to all contracting officers of this new requirement, either through a Procurement Information Circular or by electronic mail.

We appreciate your participation in the Clear Lake Development Facility effort underway, and will keep you apprised of decisions being made. If you have any questions, please contact David J. Westfall, Internal Management Control Officer, at 483-4600.

George W. S. Abbey

George W. S. Abbey

cc:
AC/S. H. Garman
AL/J. K. Lottinville
BA/T. A. Hesse
BA/R. S. Thompson
BJ/R. E. Hall
BJ/R. Etchberger
JA/J. A. Hickmon
LA/W. L. Draper
OA/R. H. Brinkley
HQ/JMC/P. Chait

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Space Administration

Office of Inspector General
Lyndon B. Johnson Space Center
Houston, Texas 77058-3696

EXHIBIT 2

Reply to Attn of: W

October 10, 1995

TO: Johnson Space Center
Attn: AA/Acting Center Director

FROM: W-JS/OIG Center Director

SUBJECT: Management Letter on Clear Lake Development Facility - Neutral Buoyancy Laboratory (NBL) Requirements
Assignment No. A-JS-95-009
NAS9-19350 - Schedule A
M-JS-96-002

The NASA Office of Inspector General (OIG) is currently performing an audit to evaluate the effectiveness of the Clear Lake Development Facility (CLDF) lease/purchase contract. During this evaluation, our office issued a rapid action report on September 7, 1995, Report No. JS-95-001, addressing the procurement of a hyperbaric chamber. Since the issuance of that report, we continued our field work, and learned that McDonnell Douglas Realty Company has issued a letter contract to Johnson Engineering Corporation for the hyperbaric chamber procurement.

Our field work will continue under this audit; however, we believe it is important to give immediate notice of our concern regarding the funding of the additional costs for the hyperbaric chamber procurement. We identified the condition through a limited assessment performed during the audit. Therefore, the work on which our opinion is based was not performed in accordance with generally accepted government auditing standards.

On October 4, 1995, our office met with the Contracting Officer. The subject of the interview was certain aspects of the lease/purchase CLDF-NBL contract, NAS9-19350 Schedule A. The total firm fixed contract price is $34,000,000 which includes a specific clause dealing with the hyperbaric chamber procurement that states:

> *"The Contractor's obligation to deliver a hyperbaric chamber system in accordance with the NBL Requirements Document is limited to $400,000, in expenditures. Should the Contractor determine that the hyperbaric chamber system costs are estimated to exceed the $400,000 limit, the Contractor shall promptly notify the Contracting Officer. The Contracting Officer shall then take appropriate action."*

After a technical review of various chambers, the Contracting Officer gave verbal approval to proceed with a procurement in excess of $400,000. McDonnell Douglas Realty Company issued Johnson Engineering Corporation a letter contract to "proceed with the work required to meet the established milestone dates." A contractual commitment was established for $446,962 or $46,962 more than the contractual limit between NASA and McDonnell Douglas Realty Company. Although the Contracting Officer is aware of this exposure, additional funds have not been committed nor has the contract been modified to reflect this change.

We have discussed the information in this management letter with the JSC Contracting Officer, the JSC's Legal Office, and the OIG's Legal Office. The Contracting Officer has reservations about our concerns. The JSC Assistant Chief Counsel for Procurement Matters and the OIG Deputy Attorney Advisor suggest that this contract administration practice has the potential to result in an anti-deficiency law violation. As a result of our discussions, the Assistant Chief Counsel for Procurement Matters contacted the Contracting Officer. To date, however, this issue has not been resolved.

We request you keep us advised of the actions taken and ask that you respond within 15 days of this letter. If you would like to discuss it further, please call Janice Goodnight, Audit Manager, or me at extension 34773.

W. Preston Smith

cc:
HQs-JMC/P. Chait
W/C. Little
W/B. Richardson
W/OIG Field Offices
JSC-AL/J. Lottinville
BA/T. Hesse
BJ/R. Etchberger
BU/P. Ritterhouse
OR/R. Brinkley

National Aeronautics and
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Lyndon B. Johnson Space Center
2101 NASA Road 1
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NOV 0 3 1995

Reply to Attn of: BU-95-069

TO: W-JS/Director, Center Office of Inspector General

FROM: AA/Acting Director

SUBJECT: Response to Management Letter on Clear Lake Development Facility Neutral Buoyancy Laboratory (NBL) Requirements Assignment No. A-JS-95-009, Schedule A

Your comments relative to the Neutral Buoyancy Laboratory and the hyperbaric chamber are very much appreciated.

The lease/purchase contract for the Clear Lake Development Facility, Neutral Buoyancy Laboratory, contains a specific clause dealing with a hyperbaric chamber system and limiting the expenditures for that chamber to $400,000. The clause requires the contractor to notify the contracting officer should the contractor determine that the costs are estimated to exceed the $400,000 specified by the clause. We have received such notification from the contractor, and per the clause, the contracting officer is attempting to understand the issue and the steps the contractor intends to take to remain within the $34,000,000 firm fixed price of the contract.

The present contractor estimate exceeds the $400,000 specified in the clause by $46,962. The contractual commitment for the chamber is between McDonnell Douglas Realty Company and Johnson Engineering Corporation.

We will keep you informed of the status of this activity.

George W. S. Abbey

George W. S. Abbey

cc:
AC/S. H. Garman
AL/J. K. Lottinville
BA/T. A. Hesse
BA/R. S. Thompson
BJ/R. E. Hall
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JA/J. A. Hickmon
LA/W. L. Draper
OA/R. H. Brinkley
HQ/JMC/P. Chait

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EXHIBIT 3

JS-95-001

AUDIT REPORT

RAPID ACTION

AUDIT OF CLEAR LAKE DEVELOPMENT FACILITY NEUTRAL BUOYANCY LABORATORY REQUIREMENTS HYPERBARIC CHAMBER PROCUREMENT

JOHNSON SPACE CENTER

September 7, 1995

National Aeronautics and Space Administration

OFFICE OF INSPECTOR GENERAL

National Aeronautics and
Space Administration

Office of Inspector General
Lyndon B. Johnson Space Center
Houston, Texas 77058-3696

Reply to Attn of: W

September 7, 1995

TO: Johnson Space Center
Attn: AB/Acting Director

FROM: W-JS/OIG Center Director

SUBJECT: Final Rapid Action Report on Clear Lake Development Facility
Neutral Buoyancy Laboratory Requirements-
Hyperbaric Chamber Procurement
Assignment No. A-JS-95-010
Report No. JS-95-001

The NASA Office of Inspector General is conducting an audit of the Clear Lake Development Facility (CLDF) lease/purchase contract (A-JS-95-009). The overall objective is to evaluate the effectiveness of the contract. Specifically, we will: (1) evaluate the adequacy of the contract clauses; (2) determine if the contractor is meeting contract requirements; and (3) assess the reasonableness of the operations and maintenance letter contract. During the audit, we identified a condition related to Johnson Space Center's (JSC) and McDonnell Douglas Corporation's (MDC) implementation of a contract clause added to the statement of work for the procurement of a hyperbaric chamber for CLDF. Due to the significance and time sensitivity of this issue, we issued this rapid action report containing a recommendation for your immediate attention.

The audit showed the hyperbaric chamber cost estimate on which JSC based their negotiating position was inadequate and inaccurate. Additionally, the contract specifications were vague and subject to bidders' interpretation. Bids received based on the specifications could result in costly change orders. The specifications and cost estimate were relied upon without a definitive study of the user's needs in relation to cost. While the contract limits MDC's liability to $400,000, an estimate received from an independent source indicates the cost could be as high as $1.5 million. Management action to address this condition will ensure that JSC obtains an acceptable hyperbaric chamber efficiently.

We issued a draft of this audit report to the Center on August 1, 1995, and a written response was received on August 16, 1995. That response is summarized in the recommendation section of this report and is included in its entirety as an Appendix. Because the proposed actions are not complete, please include our office in the concurrence cycle for closing recommendation 1 in accordance with NMI 9910.1B.

The NASA Office of Inspector General staff members associated with this audit express their appreciation to the JSC procurement officials and contractor personnel for their courtesy, assistance, and cooperation.

W. Preston Smith

Enclosure

cc:
HQs-W/C. Little
D. Orton
JSC-BJ/ R. Etchberger
BU/D. Westfall
OA/R. Brinkley
SD25/Dr. C. La Pinta

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INTRODUCTION

BACKGROUND

On January 20, 1995, Johnson Space Center (JSC) entered into a $34 million contract with McDonnell Douglas Corporation (MDC) to lease/purchase the Clear Lake Development Facility (CLDF). The facility was originally constructed by MDC in support of the Space Station Freedom (SSF) Program. However, when the SSF Work Package II contract with MDC was novated to Boeing Aerospace in February 1994, there was limited need for the CLDF. In October 1994, MDC submitted an unsolicited proposal to JSC for the lease/purchase of the three large industrial buildings and the surrounding 13-acre property located near Ellington Field in Houston, Texas.

The proposal outlined the potential utilization of the CLDF. Within the 101,000 square foot Assembly and Test Building, MDC would construct a Neutral Buoyancy Laboratory (NBL). JSC would use the two other buildings, the 97,000 square foot Light Manufacturing Facility and the 51,000 square foot Avionics Development Facility, as office and technical support facilities.

JSC originally planned to build a "Barebones" NBL for $32.2 million. However, the MDC proposal for a lease/purchase of an NBL and the additional buildings for $35 million, the $34 million contract with MDC and $1 million for consoles to be provided by JSC, was considered a better alternative. As a result, JSC cancelled the "Barebones" facility.

NEED FOR NBL

NASA needs the NBL to perform astronaut training because the current pools at JSC and Marshall Space Flight Center (MSFC) are not large enough to accommodate the assembly of the International Space Station components. The NBL will be a water filled pool measuring 202 feet long by 102 feet wide with an overall depth of 40 feet. The pool environment best simulates the weightless environment of space.

NEED FOR HYPERBARIC CHAMBER AT CLDF

A safety issue was raised during the evaluation of MDC's CLDF proposal. In case of a water related incident, divers must have access to a hyperbaric chamber within a five-minute window. The hyperbaric chamber is a vessel designed to withstand high internal pressures. Should an incident occur, the injured diver is placed inside the chamber and a prescribed treatment, hyperbaric medicine, is administered.

Hyperbaric medicine is simply intermittent, short-term, high-dose oxygen administration. Hyperbaric oxygenation is achieved by having the patient breathe 100 percent oxygen while pressurized in a compressed air chamber. The technician who administers the oxygen is concerned with the medical and physiological problems as well as the therapeutic applications of pressure greater than sea level.

The necessity for treatment in a hyperbaric chamber is illustrated through an understanding of the breathing gas process used while diving. Nitrogen is taken up by the body during the dive. The amount depends on the depth of the dive and the duration of exposure. If the quantity of nitrogen dissolved in the tissues exceeds a critical amount, a condition can result called "bends." Bends is an imprecise term denoting *any* form of decompression sickness. Symptoms can range in severity from a mild feeling of euphoria to serious dizziness and vertigo. Without treatment, the milder cases can correct themselves over time. The more seriously affected patients could suffer seizures, convulsions, and death. A pressure-reduction procedure (decompression) is designed to allow the body time to eliminate the excess nitrogen. The procedure is administered in a hyperbaric chamber.

A hyperbaric chamber is effectively used in treating a variety of disorders. Since reactions vary from a mild ear block to neurocirculatory collapse, the safety of the patient should be a prime consideration. Because reactions in the chamber do not follow a set pattern, the patient must constantly be attended by a member of a trained, hyperbaric medicine team.

JSC has a 25-year old pressurized chamber capable of providing treatment for four patients. The JSC chamber, however, is too far from CLDF to provide services within the prescribed time constraints. The chamber cannot be moved to CLDF because it is needed to support other JSC test facilities that can induce decompression illnesses, i.e., the vacuum chambers.

MDC'S AGREEMENT

After it was determined the JSC chamber could not support the CLDF, MDC agreed, as part of the contract, to procure a chamber to be located at the CLDF. Specifications were written and a clause was added as Section C.II.A. of the contract. The clause stipulates MDC's obligation to deliver a hyperbaric chamber is limited to $400,000. If the cost exceeds the limit, the Contracting Officer is required to "take appropriate action."

OBJECTIVES, SCOPE, AND METHODOLOGY

OBJECTIVES

The overall objective in the initial phase of the audit is to evaluate the CLDF lease/purchase contract. Specifically, we will:

- evaluate adequacy of contract clauses;
- determine if the contractor is meeting contract requirements; and
- assess the reasonableness of the operations and maintenance letter contract.

SCOPE AND METHODOLOGY

For the purpose of this interim report, we limited the scope of the audit to JSC's and MDC's implementation of a contract clause added to the Statement of Work under Section C.II.A. The clause states:

> *"The Contractor's obligation to deliver a hyperbaric chamber system in accordance with the NBL Requirements Document is limited to $400,000, in expenditures. Should the Contractor determine that the hyperbaric chamber system costs are estimated to exceed the $400,000 limit, the Contractor shall promptly notify the Contracting Officer. The Contracting Officer shall then take appropriate action."*

Audit field work began May 15, 1995, at JSC. The audit methodology included interviews, observations at the bid conference, examination of agency records, and analysis of bids.

MANAGEMENT CONTROLS REVIEWED

This report is an interim assessment of the procurement process for the hyperbaric chamber and, as such, the applicable management controls are being monitored. During our review, nothing came to our attention to indicate that the controls were inadequate or that JSC personnel or contractors had not complied with applicable laws and regulations. However, for the purposes of this report, we express no opinion on the system of management controls taken as a whole. Additional assessments of management controls will be reported on in subsequent reports.

AUDIT STANDARDS

The audit is being performed in accordance with generally accepted government auditing standards.

OBSERVATIONS AND RECOMMENDATIONS

INTERIM RESULTS OF AUDIT

To date, the audit has shown the hyperbaric chamber cost estimate on which NASA based their negotiating position was inadequate and inaccurate. Additionally, the contract specifications were vague and subject to bidders' interpretation. According to a Navy hyperbaric chamber expert, a chamber procured from the bids received may not be adequate to the user's needs without costly change orders. These conditions occurred because the procurement officials relied upon the medical user community to provide specifications and cost estimate without conducting a study of their needs in relation to cost. While the contract limits MDC's liability to $400,000, the Navy expert estimates a chamber built in accordance to the specifications would be approximately $1.5 million.

Due to the significance and time sensitivity of this issue, we are providing this rapid action report containing recommendations for your immediate consideration.

DEPARTMENT OF THE NAVY ROUTINELY BUILDS HYPERBARIC CHAMBERS

Our office contacted the Ocean Construction Division of the Department of the Navy to provide a cursory review of the hyperbaric chamber specifications written in the contract. Because a JSC medical officer confirmed that Navy certified hyperbaric chambers were of premium quality, our office felt the Navy would provide an objective evaluation. The division's mission is to accomplish "all functions associated with developing and providing NAVFAC's (Navy Facilities) capability to support Navy requirements for planning, engineering, design, construction . . . of . . . hyperbaric facilities . . . ." In other words, the division supervises all Department of Defense hyperbaric chamber procurements. When MSFC procured a new chamber in 1990, they contacted the Navy division to provide assistance.

The Navy Hyperbaric and Diving Facilities Product and Program Line Manager reviewed the contract specifications and stated they were vague and open to a bidder's interpretation. The Manager stated specifications should not be incorporated by reference. It allows the contractor to interpret a requirement liberally, while NASA might have a very stringent requirement. For example, the contract specifications state the chamber should be painted. The Manager strongly suggested this requirement be rewritten. He stated the bidders would provide a chamber with painted hinges. The Navy requires their hinges to be made of unpainted, stainless steel. If the hinges are painted, the maintenance costs will be very high.

POOR SPECIFICATIONS

The specifications for the hyperbaric chamber were not well defined. Issues were raised concerning the treatment gas supply, the entrance door size and shape, and patient monitoring systems. Three months after contract award, JSC responded to an MDC request to change requirements to reduce overall expected chamber costs. Then, on June 19, 1995, MDC held a conference to allow prospective bidders an opportunity to clarify the bidding requirements. During the conference, one of the medical users made a presentation. Various bidders questioned the need for some hardware specified in the presentation. In particular, comments concerning the expense associated with providing viewports and audio entertainment systems were made by several prospective bidders. The presenter commented that these items had been added for user comfort and convenience, but readily conceded to the elimination of the stereo system and the viewing ports.

COST EXCEEDS ESTIMATE

Following the contract award, it became apparent that the contractually obligated $400,000 could not adequately cover the cost of the specified hyperbaric chamber. Prior to negotiations, the medical users provided a rough estimate without conducting a definitive study to determine the cost of the proposed hyperbaric chamber. NASA management and MDC agreed that the estimated cost was inadequate after the NBL contract was negotiated.

BIDS REQUESTED AND RECEIVED

After the presentation and subsequent confusion of what NASA wanted, the bidders were asked to submit two bids:

1. The cost of a hyperbaric chamber as presented in the contract specification's document; and

2. A bid in the range of $300,000 that satisfies the number of patients and attendants described in the requirements and also meets all applicable codes, i.e., safety, fire, etc.

Only two bids were received for the chamber as specified in the requirement's document. The base bid from both companies was over $400,000. One of the bidders commented in its bid proposal that "this project is a real *'free-for-all'* as far as the specifications are concerned." MDC's general contractor will perform a cost and technical analysis to determine what additional work and associated costs are necessary for each bid. A conservative estimate by the Contracting Officer for the additional work, i.e., piping, configuration, and the fire wall, is an additional $100,000. Since the resulting bids exceed the $400,000, NASA must decide whether to obtain additional funding or procure a less sophisticated chamber.

NASA Does Not Have a Hyperbaric Chamber Expert

The Facilities Operations Branch Acting Group Leader for the Weightless Environment Test Facility (WETF) stated since NASA did not have a hyperbaric chamber expert, the user community was tasked with writing the specifications and providing cost estimates. Detailed specifications were not written into the contract because the user assumed they could be incorporated by reference. As a result, the users provided an unsophisticated cost estimate to be used as the cost basis in the contract based on their limited knowledge of hyperbaric chamber procurement.

To justify the lack of adequate specifications, the WETF Acting Group Leader provided a comparison. He said because the medical user group knew their general requirements, the thought was a driver could use an automobile without knowing how to build a high performance vehicle.

Vague Specifications Could Lead to Costly Change Orders

The chambers procured from the bids received may not provide a chamber that is adequate to the users' needs without costly change orders. Although the contractor would be in compliance with the overriding requirement, the delivered product could be a lesser quality chamber subject to high maintenance cost. Or conversely, NASA would be vulnerable to cost growth through excessive change order issuances.

The Navy's rough estimate for a comparable chamber built to Navy specifications was $1.5 million.

Recommendation 1

The Contracting Officer should arrange a meeting with JSC management, legal, and the medical user community to reach an agreement as to the best chamber obtainable with available funding.

Management's Response

Concur. A meeting was held on August 4, 1995, with representation from Business Management, Center Operations, Space and Life Science, Safety, Reliability and Quality Assurance, JSC Legal Office, and the McDonnell Douglas Corporation (MDC). Please note that the procurement is being handled by MDC, and not by NASA. McDonnell Douglas completed its evaluation of the bids on August 9, 1995. The offer from one of the bidders was selected as being the most technically sound and with the best potential for negotiating a contract within the funding available for the requirement. JSC technical and business personnel will continue to closely monitor the contractor's progress to ensure that the chamber procured meets the Government's requirement in the most efficient and cost effective manner available.

EVALUATION OF MANAGEMENT'S RESPONSES

Actions taken or planned by NASA management are responsive to the recommendation. However, a firm price has not been established because a definite decision has not been made as to the type of chamber that will be obtained. We will continue to monitor any decisions made regarding the chamber.

National Aeronautics and
Space Administration
Lyndon B. Johnson Space Center
2101 NASA Road 1
Houston, Texas 77058-3696

AUG 16 1995

Reply to Attn of: BU-95-050

TO: W-JS/OIG Center Director

FROM: AB/Acting Director

SUBJECT: Rapid Action Report on Clear Lake Development Facility, Neutral Buoyancy Laboratory (NBL) Requirements - Hyperbaric Chamber Procurement Assignment No. A-JS-95-010

This rapid action report contained one recommendation which stated:

> "The Contracting Officer should arrange a meeting with JSC management, legal, and the medical user community to reach an agreement as to the best chamber obtainable with available funding."

We have reviewed the report and concur in the recommendation. A meeting was held on August 4, 1995, with representation from Business Management, Center Operations, Space and Life Science, Safety, Reliability and Quality Assurance, JSC Legal Office, and the McDonnell Douglas Corporation (MDC). The JSC technical and business personnel team evaluated the bid results from July 19, 1995. Please note that the procurement is being handled by MDC, and not by NASA. The result of the bid evaluation was also discussed at a meeting on August 9, 1995, with MDC representatives.

Additionally, JSC personnel traveled to Washington, D.C., on August 3, 1995, and met with the Navy Hyperbaric Facilities Program Manager for the purpose of obtaining an independent assessment of the JSC requirements and of the bids received. It is important to note that the operational needs of the parties are fundamentally different, with the Navy using its chambers on a daily operational basis while the JSC chamber is intended primarily for use during the emergency treatment of arterial gas embolisms and related disorders.

All comments contained in the subject rapid action report have been carefully considered. As a result, the chamber requirements have been validated as meeting the minimum acceptable needs for the delivery of a commercial Hyperbaric/Treatment Chamber.

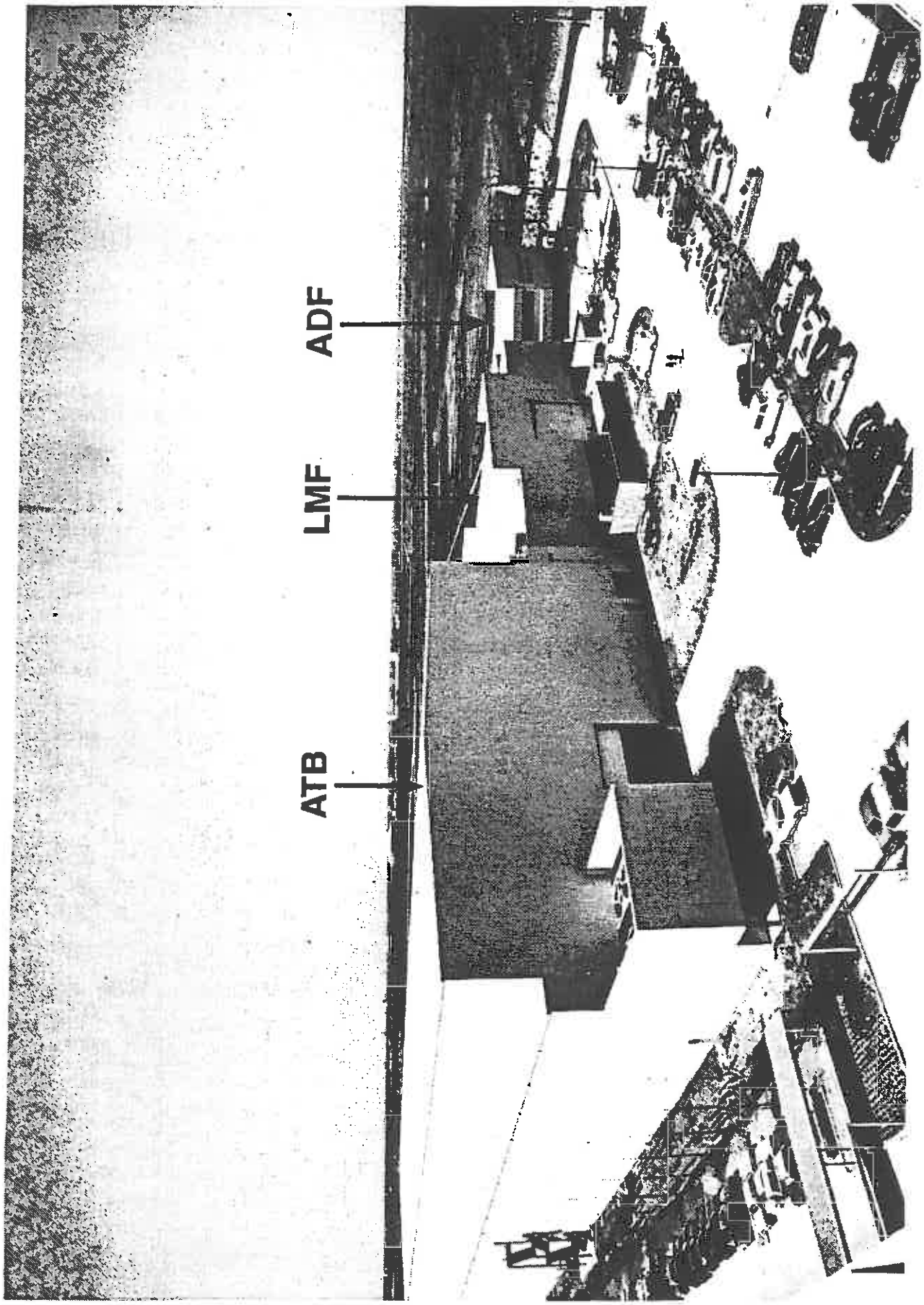
McDonnell Douglas Aerospace completed its evaluation of the bids on August 9, 1995. The offer from Johnson Engineering was selected as being the most technically sound and with the best potential for negotiating a contract within the funding available for the requirement. JSC technical and business personnel will continue to closely monitor the contractor's progress to ensure that the chamber procured meets the Government's requirements in the most efficient and cost effective manner available.

Based on the actions taken in response to the subject recommendation, it is requested that this recommendation be closed by our response. If you have any questions, please contact David J. Westfall at 713-483-4600.

George W. S. Abbey

George W. S. Abbey

cc:
BA/T. A. Hesse
BJ/R. E. Hall
BJ/R. Etchberger
OA/R. H. Brinkley
SA/D. E. Robbins
SD25/C. La Pinta
SP/C. D. Perner
SP5/H. Roberts
SP5/W. Langdoc



Clear Lake Development Facility
(CLDF)

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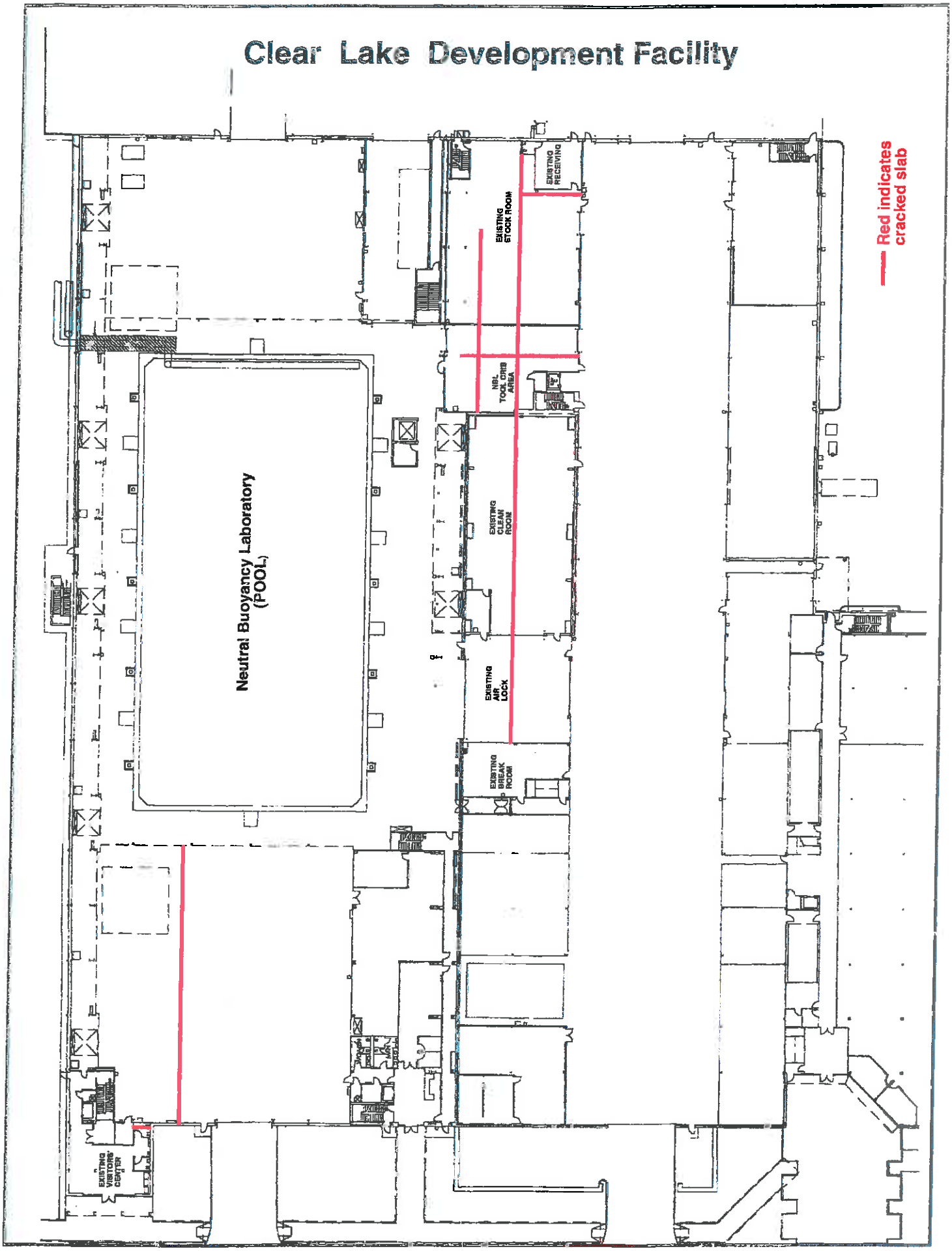
Clear Lake Development Facility



National Aeronautics and
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Lyndon B. Johnson Space Center
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APPENDIX

Reply to Attn of: BQ-96-069

JAN 13 1997

TO: W-JS/Program Director, Human Exploration and Development of Space

FROM: AA/Director

SUBJECT: Management Response to Discussion Draft on Clear Lake Development Facility - Neutral Buoyancy Laboratory (NBL) Requirements
Assignment No. A-JS-95-009

As discussed with your office, we waive the opportunity to hold an exit conference and are responding to the draft report findings and recommendations. Since the field work was completed in November 1995, many of the issues raised in the report are no longer pertinent. The NBL is now complete, and JSC took acceptance of the Clear Lake Development Facility on December 6, 1996.

We have taken this opportunity to individually address the audit findings and recommendations, and to present actions taken or rationale for decisions made as shown in the enclosure. With your acceptance of these actions, the recommendations and the audit will be considered closed on issuance of the final report. If you have any questions regarding this response, please contact Pat Ritterhouse at 483-4220.

George W. S. Abbey

Enclosure

cc:
JA/J. A. Hickmon
OA/R. H. Brinkley
HQ/JM/M. Peterson

BQ/PRitterhouse:lsd:12/18/96:34220

Management Response to Discussion Draft on Clear Lake Development Facility
Neutral Buoyancy Laboratory Requirements
Assignment No. A-JS-95-009

Audit Findings

"JSC did not arrange or participate in the joint physical survey and inspection report with the contractor before the NBL's initial construction start. The contract required a joint physical survey and inspection report. Since construction began, foundation cracks have developed in the concrete expansion joints of the adjacent CLDF LMF. Because the Contracting Officer (CO) did not aggressively pursue compliance with the contractual requirement there is no definite statement of the building's condition immediately prior to the start of construction. This lack of documentation may leave NASA vulnerable if responsibility disputes arise concerning the cracked foundation or other subsequent conditions."

Recommendation 1

"The Director of Center Operations should determine if the cost to obtain a geotechnical opinion of the structural integrity of the building is warranted."

JSC Comment

We established a movement monitoring program to determine if the construction of the NBL walls caused ground movements to exceed allowable limits predicted during the design phase. The results of the survey data, gathered under the movement monitoring program, confirmed ground movement in and around the water tank remained within design limits. Based on this engineering data and no observed distress in the existing Assembly and Test Building (ATB) and the Light Manufacturing Facility (LMF) building structures or foundations, we concluded that the movement monitoring test supported the structural integrity of the building.

In addition, we have been able to prove through MDC photos that floor slab cracks existed in the LMF prior to the NBL's construction. We recommend no further action be taken on this issue.

Recommendation 2

"If it is determined that the structural integrity of the building has been compromised, the CO should assess JSC's financial exposure for the cracked foundation. Additionally, the CO should request a legal opinion on financial responsibility for any required repairs."

Enclosure

JSC Comment

This recommendation becomes non-applicable because of the position taken in response to Recommendation 1 that no further action be taken on the issue of floor cracks in the LMF.

Auditors' Findings

"MDC's contractually stipulated completion date is susceptible to slipping because the contract was negotiated with a day-for-day extension if International Space Station (ISS) Flight 2A is delayed. ...If MDC is granted a day-for-day extension because Flight 2A is delayed, they would be able to make up time in their aggressive construction schedule, relieved of liquidated damages, and JSC would lose valuable training time."

Recommendation 3

"The Director of the JSC Business Management Office should ensure that when the completion of a contractually required task is mission critical, liquidated damages are associated with a definite date."

JSC Comments

Liquidated damages are part of the contract, and tie in to the January 10, 1997, completion date.

Auditor's Findings

"The pool lighting requirements evolved from work accomplished on the earlier NBL designs. When writing the lighting specifications for the 'on-site' laboratory, the amount of illumination needed could not be quantified in engineering terms, however, there was a specific need for adequate lighting. The astronauts and trainers must adequately see in the pool to conduct experiments and train efficiently."

Recommendation 4

"COD engineers should determine if the lighting meets contractual requirements."

JSC Comments

Adequate lighting was a requirement in the contract. The lighting has been measured at the water tank deck level and found to exceed contractual requirements. At the bottom of the water tank, the lighting has been determined sufficient for training operations. Several NASA divers and suited astronauts have reported being able to read ordinary size print at the bottom of the water tank, a requirement in the NBL III, even though not specifically written into the Requirements Document for the NBL at the Sonny Carter Training Facility.

Recommendation 5

"At the earliest time possible, COD engineers should test the illumination at the bottom of the pool to determine whether the illumination is adequate to 'read standard print.' "

JSC Comments

As stated in the response to Recommendation 4, several NASA divers and suited astronauts have reported the lighting is adequate to read ordinary size print at the bottom of the water tank.

Recommendation 6

"If the lighting provision is determined to be inadequate, the CO should devise a plan to minimize any cost and schedule impact.

JSC Comments

This recommendation becomes non-applicable because of the response provided to Recommendation 4.

Recommendation 7

"The Director of Center Operations should determine if sufficient calculations for other engineering requirements have been made available to COD engineers."

JSC Comments

Center Operations Directorate engineers have been provided calculations to the extent normally prepared in a commercial project; however, they do not reside in a single location, particularly in the electrical and mechanical disciplines. Some calculations are located in the NBL Technical Library while others can be found within shop submittals in the Architectural-Engineering's (A&E) office. We plan to assemble all calculations in a single location and will work with the CO to direct MDC's collection of this data for NASA's use and archiving. With this planned action, this recommendation is considered closed.

Auditor's Findings

"The hyperbaric chamber housed at the NBL will not be protected by a fire retardant wall. The contract requires MDC to design and build the hyperbaric chamber system to meet the requirements of several National Fire Protection Association (NFPA) codes, one of which requires the hyperbaric chamber to be protected by a fire retardant wall. The CO will allow MDC to obtain a waiver for the fire wall. The waiver will be based, in part, on a definition for a health care facility from an outdated edition of the NFPA standard. A potential safety hazard exists should a fire occur in the building when a patient is being treated in the hyperbaric chamber, which could result in loss of life."

Recommendation 8

"The CO should ensure MDC's compliance with NFPA 99. If the CO accepts the safety risk of not enforcing the contractual requirement, then the CO should obtain compensation for the reduction in the scope of work."

JSC Comments

The NBL Operational Readiness Inspection (ORI) Committee made the decision to obtain a waiver to NFPA 99's requirement for protecting the hyperbaric chamber with a fire retardant wall. The CO obtained consideration for the waiver of this requirement in the form of additional work needed by the Government which the contractor was not otherwise required to perform (specifically, providing and installing ancillary connections). Accordingly, we consider this recommendation closed.

Auditor's Findings

"The plasma laboratory was established at CLDF without ascertaining whether the experiment's power requirements could be accommodated at that location. An uninterruptible power source (UPS) and batteries located at CLDF are being used by the laboratory until the NBL is operational. At that time, another power source will be needed to be in place or the experiment will have to be suspended.

...The decisions made concerning the plasma laboratory would increase the final dollar value of the operations and maintenance contract."

Recommendation 9

"JSC management should determine where the experiment will be located, how power will be supplied for the project, and the amount of financial support to be given the plasma laboratory experiment. The astronaut-scientist should be consulted to ascertain if the decisions will affect the experiment's hypothetical outcome."

JSC Comments

Power for the Plasma Experiment is supplied by an independent source. Power fluctuations in that laboratory will not adversely impact other Sonny Carter Training Facility power sources. The Safety, Reliability and Quality Assurance Office has already assessed the laboratory and found no major hazards which would preclude full operations. In addition, the JSC Operational Readiness Review (ORR) will investigate the laboratory more thoroughly within the next month and will recommend further technical evaluation, as necessary, to assure the safety and reliability of the facility. Both internal and external laboratory effects will be addressed. The astronaut-scientist will be consulted to ascertain if the decisions will affect the experiment's hypothetical outcome. With the oversight being provided this project, we consider this recommendation closed with the actions taken or planned.