UCRL--15476

DE82 019314

8204

May 1982

**Reactivation of the Shock-Tunnel Facility
at Fort Cronkhite
Final Report**

prepared for
**Lawrence Livermore National Laboratory
Livermore, California**

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

by

**Scientific Service, Inc.
517 East Bayshore
Redwood City, CA 94063
(415) 368-2931**

DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED

629

TABLE OF CONTENTS

	<u>Page</u>
List of Figures	iii
Introduction	1
Task I - Cleanup and Secure Facility	3
Task II - Reactivate the Shock Tunnel	12
Task III - Design Permanent Facility Improvements	26
Conclusions and Recommendations	27
<u>Appendix</u>	
A. Scope of Work Listing of Subtasks	
B. Shock Tunnel Brochure	
C. Firing Plan for 22 April 1982	
D. Firing Plan for 6 May 1982	
E. Safety Procedures	
F. Golden Gate Energy Center Electrical Power & Water Service Study and Report	

LIST OF FIGURES

<u>Number</u>		<u>Page</u>
1.	North casemate 16-inch gun pit	4
2.	South casemate view, prior to graffiti removal	4
3.	South casemate grillwork	6
4.	North gate	6
5.	Gate number 2	7
6.	Gate number 3	7
7.	South gate. Note portable generator	8
8.	Partially installed guard rail, central area	8
9.	Distribution panel and firing safety light control	10
10.	Shock tunnel facility at Fort Cronkhite	11
11.	Compression tube door	13
12.	Compression tube with chains in place	13
13.	Expansion chamber	14
14.	Restacked support hardware	14
15.	Instrumentation system	16
16.	Pressure gauge station	17
17.	Firing circuit locked box	17
18.	Firing circuit	18
19.	Plan view of shock tunnel facility	19
20.	Specifications for pressure transducers	19
21.	Shock-front incident overpressure as a function of the number of parallel strands of primacord detonated simultaneously in the compression chamber	22
22.	Sample data from four-strand open-tunnel test	23
23.	Open tunnel calibration test with four 60-foot strands of detonating cord, 6 May 1982, Station 10	25
24.	North casemate grillwork	28

Introduction

This final report describes the results of work undertaken to reactivate the Shock Tunnel Facility at Battery Townsley, Fort Cronkhite, Marin County, California. This work was accomplished by Scientific Service, Inc., under University of California Lawrence Livermore National Laboratory Purchase Order Number 6575901, dated February 26, 1982. The facility has been reactivated and can now be utilized for blast testing. The major emphasis will be testing of concepts pertaining to programs of interest to the Federal Emergency Management Agency (FEMA) and in particular to civil defense oriented research. However, a wide variety of testing requirements can be accommodated. For example, past programs at the facility have included: tests of debris from trees subjected to blast for Bell Telephone Laboratories; tests of the response of aluminum hull panels to blast loading and of the response of a model surface effects ship for the Naval Ship Research and Development center, and tests of the response of a radome prototype to blast loading conducted for ANCOM (the radome manufacturer).

The Shock Tunnel Facility is located in a former coastal defense 16-inch gun emplacement constructed by the U. S. Army beginning in 1938. It was converted in 1967 to serve as a facility for full-scale testing of the loading and response of structural elements and civil defense equipment. It remained in operation until November 1976 when Battery Townsley was turned over to the National Park Service. Guidance and support for the shock tunnel research were provided by the Office of Civil Defense, later the Defense Civil Preparedness Agency, and now the Federal Emergency Management Agency. Reference 1* contains a comprehensive summary report of the shock tunnel history and results through 1976.

Work under the present purchase order consisted of the following major tasks:

- Task I - Cleanup and Secure the Facility
- Task II - Reactivate the Shock Tunnel
- Task III - Design Permanent Facility Improvements

Appendix A contains a complete listing of the subtasks included in the various tasks.

*Ref. 1: Wilton, C., K. Kaplan, and B.L. Gabrielsen, "The Shock Tunnel: History and Results," SSI 7618-1, Final Report, prepared for Defense Civil Preparedness Agency, March 1978.

This final report will summarize the work accomplished under these tasks. As a result of this work: the facility has been cleaned up and security has been improved; the shock tunnel has been reactivated so that it can be utilized for a variety of experiments; and permanent facility improvements have been designed. The report includes conclusions and recommendations concerning the implementation of additional improvements. Appendix B is a copy of an information sheet that describes the Shock Tunnel Facility.

Task I - Cleanup and Secure the Facility

Conditions Found - During the more than five years that the shock tunnel was inactive, large quantities of dirt, rocks, water, leaves, branches, cans, bottles, and other debris accumulated in the facility. This resulted not only from natural causes but from human intervention. The facility was broken into repeatedly and was vandalized in many ways. Plumbing fixtures were smashed; lighting fixtures were broken; electrical cables were torn down; walls were covered with graffiti; gates and enclosures were damaged; pieces of equipment were moved around and damaged; and numerous sections of ducting, rocks, and other large and small items were thrown into the water-filled pit for the 16-inch gun emplacement in the north casemate. In addition, extensive rusting of the steel grillwork and gates and deterioration of their paint took place, accelerated by the harsh, salt air environment of the facility in its exposed, coastal location. Obviously, the conditions just enumerated needed to be corrected if the facility was to be reactivated. The various subtasks included in Task I were designed to secure their correction.

Cleanup - Facility cleanup was accomplished by removal of solid waste material to rented debris boxes, positioned successively at the various entrances to the facility as the work progressed. Larger pieces of debris were moved with a rented forklift truck and wheelbarrows. The forklift was also used to move large pieces of support equipment so that the areas where they had been stored could be cleaned. The entire facility was swept with brooms, augmented by brushes to get into tight corners. Standing water, present in many areas of the interior of the facility, was mopped up. The 15-foot deep north casemate pit (Figure 1) was pumped out, followed by lifting out of the large and small items that had been thrown into it by vandals. Ventilation ducting, pipe, lumber, and other usable material present at the facility were sorted out and stored. On the exterior of the battery, vegetation that had grown up around the various entrances was cut back, and accumulated dirt, branches and leaves obstructing the entrances were removed. The old steel gates lying on the ground by the north entrance were moved inside the facility and stored.

Graffiti Removal - During the years since the facility was last active, many of the walls and other surfaces on the interior and exterior of the facility had been defaced with graffiti (Figure 2). Those responsible had used a variety of media for their "art work", including spray paint in various colors, charcoal, chalk, mud, and ink.

Fig. 1. North casemate 16-inch gun pit.

Fig. 2. South casemate view, prior to graffiti removal.

They had applied these to painted and unpainted concrete, steel, plywood and timber surfaces. Removal was accomplished using a variety of techniques. These included scrubbing surfaces with a detergent solution, brushing, rubbing with a dry cloth, and using an organic solvent. When other methods failed, the graffiti were painted over in as unobtrusive a manner as possible, using a slurry of cement and water for unpainted concrete surfaces and white, gray, or brown paint for other surfaces.

Grillwork and Gates - There was abundant evidence that the facility had been broken into during its years of inactivity, including damaged gates and grillwork. As part of the reactivation program, it was essential to repair the past damage and improve the integrity of the gates and grillwork in order for there to be an acceptable degree of physical security for the facility. To improve the integrity of the grillwork and gates, a welder was employed to replace missing grillwork, repair the vandalism on the front gate next to the rollup door, and reinforce the structures of the gates and grillwork. For reinforcing, two hundred linear feet of one-half by two inch stock was procured and welded onto the structure at right angles to the existing bars, so as to make it more difficult for someone to create a gap large enough to crawl through (Figure 3). All of the gates were repainted (Figure 4 - 6), and in addition, large signs saying "Restricted Test Area, Keep Out" were painted on sheets of plywood and attached to the bars of two of the gates (Figure 7). These were supplemented with smaller "no trespassing" signs.

Safety Railings - In the north casemate the 15-foot deep pit where the 16-inch gun had been was not provided with any railing to keep people from falling into it. Similarly, in the center section of the battery, a large number of open pits exist, where diesel generators and other equipment for operating the guns once had been in place. Other smaller holes were found at other places in the facility. To eliminate these personnel hazards, safety railings consisting of four-foot lengths of pipe connected with chain were used to provide protection in the center section (Figure 8) and in the north casemate. Other existing holes were covered with metal plates or wooden covers as required.

Interior Electrical System - At the beginning of the reactivation period, none of the electrical lighting circuits was operable. Many of the individual light fixtures had been vandalized and the electrical cables connecting them had been cut and torn down in places. It was necessary to use Coleman lanterns for lighting during the

Fig. 3. South casemate grillwork.

Fig. 4. North gate.

Fig. 5. Gate number 2.

Fig. 6. Gate number 3.

Fig. 7. South gate. Note portable generator.

Fig. 8. Partially installed guard rail, central area.

early stages. However, these would be unsuitable as a permanent solution. Therefore, work was accomplished to reactivate portions of the electrical system on an interim basis. A distribution panel and circuit breaker box was installed in the south casemate entryway (Figure 9). Provision was made to plug in the supply cable from the 5 kW portable generator used to provide power on an interim basis. Convenience outlets for power tools and extension cords were also provided. Sections of conduit were installed where needed to connect up the usable portions of the original system and unusable lighting fixtures were replaced where necessary. As a result of this work, electrical power is now available in the locations shown on Figure 10. Numbers in parentheses are the numbers of operable lighting fixtures in the specific locations. While this is recognized as being an interim system, it is sufficient to provide the lighting needed to carry out shock tunnel operations safely.

Fig. 9. Distribution panel and firing safety light control.

Task II - Reactivate the Shock Tunnel

Compression Tube - Prior to the beginning of the reactivation, the compression tube appeared to be intact, except that the small door that closes off one end of the tube had been torn off as part of the vandalization of the facility. There was also some concern that the rigid foam that supports the compression tube might not be adequate to support the tube. The chains used to hold the detonating cord were also missing, and the tube needed to be repainted. To check the adequacy of the foam, access to exposed areas of foam was obtained by crawling through the very small tunnel that leads to the former powder room located alongside the compression tube. Samples of foam were obtained and the foam was found to be in very nearly its original condition and adhering to the steel very well. The door to the compression chamber was rewelded where it had been broken off (Figure 11). Six new dogging bolts were procured and installed. The interior of the tube and the accessible end portion of the exterior were wire brushed and repainted. Horizontal and vertical chains were reinstalled across the tube at existing fittings near the closed end, near the middle, and near the open end of the tube, so as to provide supports for 60-foot lengths of detonating cord (Figure 12).

Expansion Chamber - Prior to the reactivation work, the expansion chamber was in need of painting, but otherwise undamaged. As part of the reactivation, it was cleaned up and completely repainted (Figure 13).

Support Hardware and Test Frames - Most of the support hardware and test frames from the previous period of utilization of the shock tunnel were intact, although a small portion was missing or had been damaged. In general, steel parts were rusted and badly in need of painting, and some of the frames were filled with mortar that had to be removed to allow for painting. To recondition them, power and hand wire brushing were used to remove rust and deteriorated paint, remaining mortar was broken out, and they were repainted and restacked (Figure 14).

Instrumentation and Control Cabling - As part of the reactivation of the shock tunnel, a new firing circuit and new instrumentation cabling had to be installed, since the circuits used during the previous period of operation had either been removed or were vandalized during the years of inactivation. Instrumentation cabling was run through existing cableways from the old control room, located

Fig. 11. Compression tube door.

Fig. 12. Compression tube with chains in place.

Fig. 13. Expansion chamber.

Fig. 14. Restacked support hardware.

adjacent to the south entrance corridor, to both sides of the expansion chamber. Sufficient cable length was provided to reach an instrumentation van parked in the entrance corridor.

For signal cables, 175-foot lengths of twisted pair shielded cable were run to 14 stations, 9 on the west side of the expansion chamber and 5 on the east side. These are designated as six pressure, four load cell, and four spare channels. Because of the uncertainty as to the nature of the future shock tunnel experimental programs, cabling for the fourteen channels for future expansion was obtained and is available but was not run to specific gauge locations. Figure 15 describes the six pressure gauge portion of the overall instrumentation system as it was configured for the tests conducted on May 6, 1982 (see also Figure 16).

The firing circuit was run from the old control room to a location adjacent to the end of the compression tube. New conduit was installed for the circuit, passing through the old shell rooms and powder rooms adjacent to the expansion chamber and compression tube. Locked boxes were installed at both ends of the circuit (see Figure 17). These are connected by three number 12 wires, with one pair "floating" and one wire for grounding both ends at the boxes. Figure 18 illustrates the firing system.

Basic Instrumentation System - During the previous operating period for the shock tunnel, instrumentation had involved : pressure gauges, installed in the walls of the expansion chamber and sometimes in the faces of non-failing test walls or in other locations; load cells, installed at the supports at the corners of the test walls; displacement gauges; accelerometers; roll, pitch, and yaw gauges; and high speed motion picture cameras, installed where they could photograph the experiments being performed. For the reactivation program, an open tunnel configuration was used for the series of test shots that were conducted. Pressure measurements were made using gauge locations 2, 5, 8, 9, 10, and 11 as shown in Figure 19.

The gauges used for these tests were of the piezoelectric transducer type with low impedance, PCB Piezotronics Model 102A02. The specifications for these pressure transducers are indicated in Figure 20. They were calibrated in place immediately prior to the tests utilizing a pulse type calibrator. Data recording utilized a CEC 3300, 14 channel, 20 kHz tape recorder and a Nicolet Series 2090

Fig. 15. Instrumentation system.

Fig. 16. Pressure gauge station.

Fig. 17. Firing circuit locked box.

EXPANSION CHAMBER

BUILDING WALL

CABLE RUN

BUILDING WALL

INSTRUMENTATION VAN

END OF COMPRESSION TUBE
"RED BOX"

3 No. 12 WIRES
1/2 CONDUIT

DETONATOR BOX
KEY LOCK

BATT
FIRE
BOX

NOTES:

- ① ALL INSTRUMENTATION
AC POWER FROM ON
BOARD 5 KW GENERATOR
ISOLATED FROM GROUND
- ② ALL SHIELDS COMMON AT VAN

FIRING CIRCUIT

NOTE: NOT TO SCALE

Fig. 18. Firing Circuit.

Fig. 19. Plan view of shock tunnel facility.

SPECIFICATIONS

Model 102A02 ICP PRESSURE TRANSDUCERS

		<u>102A02</u>
SENSITIVITY (NOM.)	mV/psi	50 $\pm$ 10
RESOLUTION Δ 1	Psi	.004
RESONANT FREQUENCY	kHz	250
RISE TIME	uSec	2.0
TIME CONSTANT	Sec	1.0
LOW FREQUENCY (-5%)	Hz	0.5
LINEARITY Δ 2	$\pm$ %	1.0
RANGE (5V OUT)	Psi	100
RANGE (10V OUT)	Psi	200
MAXIMUM PRESSURE	Psi	1000
OUTPUT IMPEDANCE	Ohms	100
OUTPUT BIAS	+V	9-12
VIBRATION/SHOCK	G	2000/20,000
ACCELERATION SENS.	Psi/G	.002
TEMP. RANGE	$^{\circ}$ F	-100 to +275
TEMP. SENSITIVITY	$^{\circ}$ F	.03
FLASH TEMPERATURE	$^{\circ}$ F	3000
CASE MATERIAL		17-4 PH S.S.
DIAPHRAGM MATERIAL		Invar
WEIGHT	gm	11
CONNECTOR		10-3C Microdot, Co-Axial
POWER SUPPLY VOLTAGE		+18 to +24
POWER SUPPLY CURRENT		2-20 mA thru current limiting diode (or other current limiting circuitry.) DO not exceed 20 mA input current.

Δ 1 200 uV pk-pk broadband electrical noise.

Δ 2 % F.S., Any calibrated range, zero based best fitting straight line.

Fig. 20. Specifications for pressure transducers.

Digital Oscilloscope. For this series of tests, this equipment was located in an instrumentation van positioned in the south entrance corridor. Data reduction proceeded from the CEC 3300 tape recorder to the Nicolet Digital Oscilloscope to floppy discs to computer terminal or xy plotter.

Initial Test Series - During the period from 1967 through 1976, several hundred tests had been conducted in the shock tunnel. Extensive calibrations had been made in 1967 of the relationships between the numbers of 60-foot strands of detonating cord used and the peak pressures produced in the open tunnel configuration. These calibrations were repeated in 1973. Figure 21 summarizes the results of these calibrations of the shock tunnel. The overall history of the previous testing programs is contained in Reference 1, from which Figure 21 was taken.

As a result of the inactivation of the facility and the partial dismantling of its equipment, it was necessary to reestablish the capability to conduct tests utilizing high explosives, to measure the environment produced, and to record data from these tests. Thus, tests were conducted on April 22 and on May 6, 1982 in order to check the operation of the tunnel and the instrumentation system. Appendices C and D are the firing plans used for these tests. Appendix E is the safety procedure that was promulgated for shock tunnel testing.

On April 22, three pressure gauges were utilized for a single high explosive test utilizing three 60-foot strands of Atlas 50 grain per foot detonating cord, fired with an electric blasting cap. On May 6, six pressure gauges were used, and three tests were conducted at approximately one hour intervals using two, three, and four strands of detonating cord respectively. Pressure vs time curves were recorded for all three gauges on the April 22 test and for all six gauges for the three and four strand tests on May 6. For the two strand test, no data could be recovered from the tape recorder following the test, although pressure vs time information for one of the gauges was observed at the time of the test using the Nicolet oscilloscope. The failure to record data for the two-strand test is considered to be a tape recorder malfunction. The other tests conducted this year were recorded without difficulty, and no problem is anticipated in recording future two-strand tests.

The shapes of all of the pressure-time curves that were recorded differed from typical curves obtained during the previous shock tunnel operations. Figure 22

Fig. 21. Shock-Front Incident Overpressure as a Function of the Number of Parallel Strands of Primacord Detonated Simultaneously in the Compression Chamber.

Fig. 22. Sample data from four-strand open-tunnel test.

shows typical curves taken from Reference 1, while Figure 23 shows a curve from one of the tests conducted on May 6, 1982. The 1982 curves rose to a lower than anticipated level, based on previous calibrations, and then, after approximately 20 milliseconds, rose to pressure levels consistent with peak pressures obtained in the previous calibrations. The 1982 3-strand and 4-strand averaged peak pressure values have been added to Figure 21. Other than the observation that the delayed peaks are very suggestive of what could be expected from reflected shocks, they are not completely understood at this time. A more complete calibration, however, with variations of such factors as how the individual strands of detonating cord are arranged in the compression tube, would be expected to eliminate this problem area.

Explosives Handling Considerations - Explosives permits and new arrangements for obtaining, storing, and transporting of explosives had to be made before testing utilizing explosives could be undertaken. Therefore, early in the reactivation period, applicable laws and regulations were determined. Blasters' licenses were obtained from the State of California, Division of Occupational Safety and Health, by C. Wilton and R. Peterson. An explosives permit was issued by the Marin County Sheriff, permitting the receiving, transportation, and use of up to 100 pounds of explosives. A Federal explosives permit was also obtained from the Department of the Treasury, Bureau of Alcohol, Tobacco, and Firearms. Arrangements were made with the McNear Brick Works, San Rafael, California, for the procurement and storage of detonating cord and electric blasting caps.

Fig. 23 Open tunnel calibration test with four 60-foot strands of detonating cord, 6 May 1982
Station 10.

Task III - Design Permanent Facility Improvements

General - During the previous operating period for the shock tunnel, both electrical power and piped in water were available. However, the pole line carrying electrical power to Battery Townsley was cut down by the Park Service after the facility was shut down, and the water supply system was also dismantled. Therefore, as part of the shock tunnel facility reactivation, consideration was given to the design of electrical power and water supply systems. These would be installed in the future as permanent facility improvements. (For the present, a portable 5 kW generator is being utilized and small quantities of water have been brought to the site in tanks. There are no operable sinks or toilets in the facility.)

To accomplish this portion of the work, the services of Golden Gate Energy Center, which is located at Fort Cronkhite, were obtained. The two professional engineers assigned by GGEC to this task had already established working relationships with the cognizant technical personnel of the National Park Service and other pertinent organizations. Their report, which includes recommendations as to the design of electrical and water systems, as well as cost estimates, is attached as Appendix F.

Conclusions and Recommendations

Physical Security - The gate repairs and the strengthening of the grillwork and gates that have been accomplished, as well as the other cleanup and rehabilitation measures taken, which make the facility look as though it is in use rather than as though it has been abandoned, have improved the security of the installation considerably. However, in spite of the gate repairs and the strengthening of the grillwork and gates, it is still comparatively easy to break into the facility. One weak area is the upper portion of the north casemate barrier, which consists of chain link fencing (Figure 24). It is recommended that this fencing be replaced with steel bars, similar to those in the lower portion of the barrier. The possibility of installing intrusion alarms, or other security improvements, should also be investigated. In this regard, a perimeter fence around the entire installation might be advisable. This would have the added safety advantage of keeping people away from the outsides of the casemates while tests are being conducted.

Facility Preservation - The painting of the entrance gates, the south casemate grillwork, and the shock tunnel area, have made a major improvement in the appearance and preservation of the facility. However, the numerous solid steel doors, steel bar doors, and the exposed steel beams in the ceilings in both casemates, as well as other exposed steel components in Battery Townsley are badly rusted and unsightly. Although these conditions do not affect the capability to conduct testing, they do affect the overall preservation and appearance of the facility. While it is recognized that Battery Townsley is not a typical building, it is recommended that a phased program of repainting badly rusted and unsightly portions of the facility be undertaken in consultation with the National Park Service.

South Casemate Door Closer - The massive timber door used to close off the south casemate prior to tests was formerly equipped with a pneumatic door closer. However, this was vandalized during the period of inactivity and had to be scrapped. Moving the door is now accomplished by the use of improvised levers, which is not a satisfactory method. Also, the rollers for the door and some of the other steel components of the door require repair or replacement. It is recommended that a suitable system to open and close this door be designed and installed and that the door rollers and other components be repaired or renewed as necessary.

Fig. 24. North casemate grillwork.

Shock Tunnel Operation - The successful completion of a series of test shots during the reactivation period demonstrates that the capability to conduct tests has been regained. However, the reason for the difference in the shape of the pulses observed in 1982 from those typical of the earlier operation of the tunnel needs to be understood. Therefore, a comprehensive series of open tunnel calibration tests should be undertaken on a priority basis.

Permanent Facility Improvements - The design for electrical and water systems contained in Appendix F is appropriate for bringing power and water to the shock tunnel facility. It is recommended that suitable contracts be negotiated to construct these improvements and also to reactivate needed electrical circuits and water piping within the facility. If possible, at least one toilet and one sink should also be reinstalled and connected up to the sewage system used during the previous shock tunnel operating period.

Maintenance Agreement - In addition to the specific recommendations for facility improvements contained in the preceding paragraphs, there is a need for a continuing program of maintenance for the facility. To facilitate keeping the more than 25,000-square-foot facility and the approximately four acres surrounding it in good material condition, a level of effort maintenance agreement should be negotiated and funded on a continuing basis. This agreement would include routine cleaning, trash removal, graffiti removal, repainting, minor repairs to the lighting circuits, gates, and grillwork, and other items of a similar nature. Our preliminary estimate is that \$30,000 per year needs to be allocated for this purpose.

User Fees - The unique capabilities of the facility, as well as actual experience during the previous operation of the installation, indicate that it is very likely that other organizations will wish to conduct tests there. Wider utilization of this government asset should be encouraged, but some formula needs to be devised to allow sharing of the costs of maintaining the facility. We recommend that a user fee be established for outside agencies desiring to conduct tests. Our preliminary estimate is that \$200 per day would be an appropriate fee.

APPENDIX A
Scope of Work
Listing of Subtasks

APPENDIX A - SCOPE OF WORK

to

PURCHASE ORDER 6575901

between

UNIVERSITY OF CALIFORNIA LAWRENCE LIVERMORE NATIONAL LABORATORY

and

SCIENTIFIC SERVICE INC.

I. INTRODUCTION

As approved and directed by the University, Seller shall perform a study as specified in Part III - Technical Scope of Work.

As provided in Article XIV - CHANGES, University may direct, in writing, changes within this Scope of Work.

II. PURPOSE

The purpose of this study is to initiate a program for the reactivation of the Shock Tunnel Facility at Fort Cronkite, Marin County, California.

III. TECHNICAL SCOPE OF WORK

Seller shall furnish all necessary facilities, personnel, and materials, except as otherwise provided herein, to conduct a program consisting of the phased Tasks below which are required to initiate the reactivation of the Shock Tunnel Facility at Fort Cronkite.

Task I - Cleanup and Secure the Facility

- A. Cleanup, complete, of the Facility both inside and outside.
- B. Remove graffiti from walls.
- C. Replace portions of the grillwork at the south end as required and paint grillwork and gates.
- D. Repair or replace the gates at the center of the Facility.
- E. Repair vandalism on the front gate next to the rollup door.
- F. Cover all holes in the floor and install safety railings where necessary or required.

- G. Repair and replace where necessary the interior electrical system, including the installation of safety lighting.

Task II - Reactivate the Shock Tunnel

- A. Sandblast and paint the compression tube.
- B. Core and test the rigid foam that supports the compression tube to assure that it is still adequate to support the tube. (Repair and/or replacement of defective/missing foam is not included.)
- C. Sandblast and paint the expansion portion of the tunnel.
- D. Sandblast and paint all the support hardware and test frames.
- E. Install new instrumentation and control cabling in the shock tunnel and control room.
- F. Install and checkout the basic instrumentation system. This basic system shall include fourteen active channels: six pressure, four load cell, and four spare. Install sufficient cables for an additional fourteen channels for future expansion.
- G. Calibrate the instrumentation system and conduct a series of test shots to check the operation of the tunnel and instrumentation system.

Task III - Design Permanent Facility Improvements

- A. Meet with various representatives of the National Park Service to determine the various restrictions which may be imposed, such as determining specifications of aboveground or underground electrical service which may be required.
- B. Survey with PG&E, the Park Service and the U.S. Army and other cognizant government agencies (if necessary or desirable) to determine possible hookup points for water and power.
- C. Test existing springs on the hill as possible water sources.
- D. Design electrical and water systems and develop or obtain price and/or cost estimates from viable sources.

IV. REPORTS

Seller shall provide verbal reports weekly to the University's Technical Representative, describing the work performed, problems encountered or anticipated, significant findings and results, and work planned for the succeeding period.

A monthly informal progress report, in five copies, shall be submitted to the Technical Representative with one copy sent concurrently to the designated Contract Administrator. This report shall describe work performed during the period reported, and work planned for the successive period. Any significant findings, test results, or other significant data relating to this Order shall be included.

A Final Report containing a comprehensive summary covering work results and conclusions shall be submitted in fifteen (15) copies at the end of the contract period. If requested by the Technical Representative, a draft final report shall be submitted for approval prior to final typing. The Final Reports shall be addressed to the designated Contract Administrator, University of California, Lawrence Livermore National Laboratory, P. O. Box 5012, Livermore, CA 94550.

The Seller shall not distribute reports of work under this Order to any individual or organization other than those indicated above or an authorized representative of the Department of Energy or Federal Emergency Management Agency without prior written approval of the Contract Administrator.

It is understood that there will be other information exchanged between the parties from time to time. These data may be exchanged directly between the parties concerned. Formal reporting and distribution is not required in these instances.

V. COORDINATION AND ADMINISTRATION

The University's Technical Representatives under this Order are Messrs. Thomas A. Reitter, or Mr. Barry R. Bowman, or their designee, who shall represent the University in matters relating to the technical performance of the Scope of Work described in this Appendix A. During the established term of this Order, the Technical Representatives will interpret the technical requirements of the Scope of Work. All other matters relating to the performance of this Order are reserved to the Contract Administrator. Provided, however, any technical direction which will affect the cost or time for performance of this work shall require prior formal amendment of this Order or prior written direction from the Contract Administrator, as provided in ARTICLE XIV - CHANGES. Technical direction resulting in work outside the general Scope of Work requires prior formal amendment to this Order.

The University's Contract Administrator is Mr. H. L. Halunen, or his designee. All matters relating to the interpretation and administration of this Order shall be conducted through the Contract Administrator; and any notice for approval from the University to the Seller will be issued by the Contract Administrator.

APPENDIX B
Shock Tunnel Brochure

APPENDIX C

Firing Plan for
22 April 1982

Memo to: Fort Cronkhite Shock Tunnel Personnel

Subject: Firing Plan for 22 April 1982

**References: (a) Battery Townsley Shock Tunnel Safety Procedures,
20 April 1982**

**(b) Preparations for First Shock Tunnel Test Using
Explosives (Revised 20 April 1982)**

Scope

This firing plan promulgates the responsibilities and procedures for the first test firing in 1982 in the Shock Tunnel at Battery Townsley, Fort Cronkhite, Golden Gate National Recreation Area, California. This firing is scheduled to take place on 22 April 1982 at 2:00 p.m. An Industrial Protection experiment will be conducted. However, the primary purpose of the test firing is to reestablish the capability to do tests in the shock tunnel.

In addition to this memo, reference (a) promulgates safety procedures which must be followed by all personnel participating in the firing. Reference (b) is a listing of specific responsibilities for actions required to get the facility and equipment ready for the first firing. Both references supplement the information found in this firing plan.

Responsibilities

Personnel responsibilities are as described in the safety procedures, reference (a). Specific assignments for the 22 April 1982 firing are as follows:

Project Engineer:	R. Peterson
Test Engineer:	R. Peterson
Explosives Handler:	J. Boyes
Instrumentation Engineer:	L. Hall
Safety Guards:	G. Shephard D. Wilton D. Boyes

Schedule

Preparations for the first firing will be accomplished in accordance with the listing in reference (b). Specifically scheduled events will be as follows:

A. **Pre-firing Conference:** Wednesday 21 April at 3 PM

B. **Pick up explosives:** Thursday 22 April at 10 AM
(Arrival time at Mc Near
Brick Works in San Rafael)

C. **Dry Run Walk Through:** Thursday 22 April at 1 PM

Ensure Condition Green in effect at start of dry run

Set Condition Yellow.

Check out test instrumentation

Position industrial protection experiment in test area

Close casemate sliding door

Station Guards to protect public

Set Condition Red

Simulate removal of explosives from temporary storage and installing Primacord and blasting caps in compression chamber. Actually remove one blasting cap.

Close and dog compression chamber hatch

Account for all personnel at site

Connect leads of one blasting cap to firing circuit

Conduct count down and firing of one blasting cap; simulate data recording

Reopen hatch, inspect compression chamber, simulate inspecting to see that all of the explosives have fired

Energize blower and air out the compression chamber (or use natural ventilation if blower not available)

Reset Condition Yellow

Reopen casemate sliding door

Simulate data collection in test area

Reset Condition Green

D. Actual Firing: Thursday 22 April at 2 PM

Set Condition Yellow

Check out test instrumentation

Install industrial protection experiment

Close casemate sliding door

Station guards to protect public

Remove explosives from temporary storage and install primacord and blasting caps in compression chamber

Close and dog compression chamber hatch

Account for all personnel at site

Unlock firing circuit terminal box. Connect blasting cap firing leads to firing circuit.

Conduct count down, firing and data recording

Reshort firing circuit

Reopen hatch, inspect compression chamber, ensure that all of the explosives have fired

Air out the compression chamber

Reset Condition Yellow

Reopen casemate sliding door

Collect data in the test area

Reset Condition Green

APPENDIX D

Firing Plan for
6 May 1982

Memo to: Fort Cronkhite Shock Tunnel Personnel

Subject: Firing Plan for Thursday 6 May 1982

Reference: (a) SSI Policy and Procedure Manual, Number 8.1
20 April 1982, Safety Procedures for Battery
Townesley Shock Tunnel

General

This firing plan lists the personnel responsibilities, schedule, and detailed procedures to be followed for the firings scheduled for 6 May 1982. Shock Tunnel Personnel who will participate in this firing should be familiar with this firing plan and with the Safety Procedures contained in reference (a).

Responsibilities

Responsibilities of the personnel listed below are as described in reference (a). Specific assignments for the 6 May 1982 firings are as follows:

Project Engineer:	R. Peterson
Test Engineer:	R. Peterson
Explosives Handler:	J. Boyes
Instrumentation Engineer:	L. Hall
Safety Guards:	G. Shephard D. Wilton D. Boyes

Schedule

Planned firings for 6 May 1982 will be a blasting cap to check the firing circuit, followed by successive firings of 2, 3, and 4 strands of primacord. The anticipated schedule is as follows:

Blasting cap	11:00 A.M.
2 strand firing	11:30 A.M.
3 strand firing	1:00 P.M.
4 strand firing	2:00 P.M.

Firing Sequence

The sequence of events for the blasting cap firing and for each of the primacord firings will be as follows:

Set Condition Yellow

Check out test instrumentation

Position experiments in test area (except for 11:00 A.M. firing)

Close casemate sliding door

Position guards to protect public

Set Condition Red

Remove cap and primacord strands as required from temporary storage and install them in the compression chamber

Close and dog compression chamber hatch

Connect leads of blasting cap to firing circuit

Conduct count down and firing including data recording

Reopen hatch, inspect and air out compression chamber

Reset Condition Yellow

Reopen casemate sliding door

Collect data in test area

Repeat firing sequence (or set Condition Green after final firing)

APPENDIX E
Safety Procedures

Effective: 20 April 1982

Page 1 of 5 pages

1. Scope

These procedures describe the organization, general requirements, and methods of operation that will be employed for tests involving the use of explosives at the Shock Tunnel at Battery Townsley, Fort Cronkhite, Golden Gate National Recreation Area, Marin County, California.

These procedures are applicable to all Scientific Service, Inc. employees, consultants, and subcontractors while they are participating in testing at Battery Townsley.

Visitors to the facility when test activities are taking place will be under the positive control of responsible SSI personnel who will ensure that they comply with these procedures.

2. Organization

On test days, when explosives are to be used, the following organization will be used. It should be noted that, depending on the complexity of the test, the duties for two or more areas may be assigned to one person, i.e., the project engineer may also act as test engineer.

- (a) Project Engineer - Has overall responsibility for the design, safety, and conduct of the testing and assigns the other responsibilities for each test or test series as appropriate. No test will be performed without qualified personnel in each position and no test will be conducted without being under the supervision of a licensed blaster. (Currently licenses are held by Pete Peterson and Chuck Wilton.)
- (b) Test Engineer - Has responsibility over the installation of the test objects, lighting, explosive handling, personnel control, firing, and post-test survey and control.
- (c) Explosives Handler - Under designation and control of the test engineer, has responsibility for receiving, storage, installation, and arming of the explosive charges.
- (d) Instrumentation Engineer - Has responsibility over the instrumentation, including cameras, timing, and pre- and post-test photo documentation.

Effective: 20 April 1982

Page 2 of 5 pages

3. General Requirements

- (a) Firing Circuit - As part of the rehabilitation of the facility a firing cable will be installed from the designated instrumentation room to the outside of the dome end of the compression chamber. This will consist of three wires, #12 or larger - two black and one white, and will be enclosed in a protective steel conduit its entire length. Steel lock boxes will be installed at each end of this line.
- (1) At the dome end, the white wire will be fastened to the dome of the compression chamber and the black wires to a dual banana plug type receptacle. A shorting plug for this receptacle will be fabricated and installed.
  - (2) At the instrumentation room end, the white wire will be tied to a dedicated firing line ground stake and the black wires to a similar dual banana plug with shorting plug.
  - (3) The firing system will be a completely separate grounded system, and will have no tie to the instrumentation system for timing or any other reason.
- (b) Safety Lights & Flags - To assist in the control of workers and visitors to the facility on test days a three level control system will be used. Early in the program while only temporary power is available, flags will be used. These will be replaced and/or supplemented with lights when permanent power is available at the facility.
- (1) The three levels of control, which will be under the jurisdiction of the test engineer, will be green, yellow and red.
  - (2) When green is in effect, all personnel have unlimited access to the facility. Under this condition no hazardous conditions exist in the shock tunnel area and, if any explosives are present, they are stored in the temporary magazines in the center of the facility.
  - (3) When the yellow is in effect, only project personnel have access to the shock tunnel area and any visitors to the facility must be escorted by the test engineer or his designate. Under the yellow condition, test objects and test hardware can be moved about in the tunnel area, cameras loaded, pretest photographs taken, and other activities not involving arming or firing of the charge can be undertaken without endangering outside visitors.
  - (4) Under the red condition, guards must be posted at the casemate entrance, and all visitors must remain either outside the facility or

Effective: 20 April 1982

Page 3 of 5 pages

in the instrumentation room, except that under special circumstances and with the permission of the instrumentation engineer a visitor may be allowed to remain in the instrumentation van.

- (5) The red condition will remain in effect while the charge is armed, fired and until the test engineer determines that it is safe to enter the casemate portion of the tunnel facility.
- (6) The yellow condition will then be reinstituted and will remain in effect until all post-test pictures have been taken and other data from the test have been obtained.
- (7) Only when the green condition returns are visitors allowed to move freely around the facility.
- (8) Under actual operating conditions it is anticipated that the yellow condition will remain in effect throughout the remainder of the test day after firing is completed.

4. Explosive Handling Procedures

For general explosive handling procedures, refer to applicable Federal and State regulations. A compilation of these regulations will be maintained by the project engineer. These should be read by all those handling explosives. It is also required that the Dupont Blaster's Handbook sections on primacord, and detonators, and Appendix B, Do's and Dont's, be read.

No one, aside from the licensed blasters noted above, may handle or transport explosives without reading the above material and being certified by one of the licensed blasters.

(a) Magazine Keys

- (1) There will be no overnight storage of explosives at the facility. We have contracted with the McNear Brick Works in San Rafael to furnish us with overnight storage facilities.
- (2) All sets of keys to these magazines will be under the control of the office manager, Larue, who will keep them locked in the safe along with any papers and log books that identify where the magazine is located.
- (3) When needed, the project manager or the test engineer will sign for the keys and become responsible.

Effective: 20 April 1982

Page 4 of 5 pages

- (4) The keys will be returned at the end of each test day or if necessary at the end of a series of test days.

(b) Obtaining Explosives

- (1) Either the project engineer or the test engineer or their trained designee will be sent to the brick yard for the explosives that will be required for that given day.
- (2) Along with the keys will be a log book. As explosives are removed from the magazine they are to be recorded in the log so that an accurate inventory of the magazine is maintained. As new explosives are placed in the magazine by McNear they must also be recorded.
- (3) Only the amount of explosives required for that day's shooting, as determined by the project engineer, will be taken to the test site.
- (4) Primacord - will normally be required in 65-ft lengths. Roll out the lengths of primacord from their container one at time, cutting the primacord with a razor blade on a smooth surface. Each length should be coiled, taped with masking tape and placed in the explosives box before the next one is rolled out.
- (5) Detonators - Normally, two detonators will be used for each shot. A spare detonator may also be required for a test shot to check the firing circuit. These are to be transported in the detonator box.
- (6) Required supplies, including razor blade, masking tape, and explosives boxes will be brought to the brick works when explosives are to be transported.

(c) On-site Handling of Explosives

- (1) Upon arrival at the site the explosive handler will receive the explosives and store them in the secure area provided in the center of the facility.
- (2) When ready to test, the sliding door to the tunnel area is closed, the facility is placed in red and this is announced to all workers and visitors to the facility by the test engineer. The guards to protect the outside public are also put in place at this time.
- (3) Once the test engineer has determined that all visitors and guards are in place he then directs the explosive handler to place primacord in the tunnel.

Effective: 20 April 1982

Page 5 of 5 pages

- (4) The explosive handler removes the number of strands required for the specific test from the storage area and installs them one by one in the compression chamber.
  - (5) When this is complete he informs the test engineer, who again checks that all visitors and guards are in place and then informs the explosive handler to install the detonators.
  - (6) The two detonators are then removed from the storage area and installed on the end of the primacord strands, using tape and with the detonators pointing toward the desired direction of the detonation. Throughout this process, the detonators are to remain shorted. These shorted ends are to be fed out through the provided hole in the dome end.
  - (7) After the door in the dome end is closed and secure, the detonators are tied to the banana jacks and the dome end shorting bar removed.
  - (8) The explosive handler then makes sure the north end of the facility is locked or guarded, locks up the center of the facility or sees that it is guarded and returns to the south end and reports in to the test engineer.
  - (9) After a readiness check and a check with the guards that it is clear, he authorizes the arming of the charge.
  - (10) After a fourth readiness check including all guards and the instrumentation engineer, the countdown starts and the charge is fired either by the test engineer or his designee.
  - (11) Immediately after firing, the test engineer -- or if a designee, the designee -- returns the firing circuit to the shorted condition.
  - (12) After the firing circuit is shorted (i.e., returned to the safe condition -- prepared for the next test), the explosive handler returns to the dome end of the compression chamber, opens the door and checks for misfires. He leaves the door open for ventilation and reports to the test engineer who returns the area to yellow and releases the guards.
  - (13) The door to the shock tunnel area remains closed until any smoke has been removed from the tunnel.
- (d) Disposal of Explosives - At the end of the day, all explosives not used during the day will be disposed of by detonation or, if large quantities are involved, returned to the magazine. For detonation the same firing procedures noted above will be used.

APPENDIX F
Golden Gate Energy Center
Electrical Power & Water Service
Study and Report

GOLDEN GATE NATIONAL
RECREATION AREA
BUILDING 1055
FORT CRONKHITE
SAUSALITO
CALIFORNIA 94965
415 561-7692

Study and Report

PRIMARY ELECTRICAL POWER AND WATER SERVICE

for

BATTERY TOWNSLEY

Revised May 19, 1982

Scientific Service, Inc. intends to conduct scientific activities in Battery Townsley, located at Fort Cronkhite in Rodeo Valley, Marin Headlands, GGNRA. To support these activities, it will be necessary to provide both water and primary electrical service to the Battery. (Secondary electrical service from the transformer is not a part of this report.) This report outlines the available options for providing these utilities.

EXISTING CONDITIONS

The history of Battery Townsley dates back to its construction in 1938. This original construction included water, electrical, sewer and communications/fire alarm services. In addition, underground secondary electrical service originated at Battery Townsley and served the "PSR" operations bunker, south of the Battery and the fire control bunker to the north. All of the utilities services are part of the main Forts Barry/Cronkhite systems.

A broad valley separates Battery Townsley and Fort Cronkhite. This valley contains numerous seasonal springs and carries a large amount of runoff. The utilities have periodically washed out or been inundated, making necessary their repair and relocation. A thorough research of the plan files at the Presidio reveals a number of different locations and none seem to indicate all of the present known locations.

The last recorded locations of the primary electrical and water utilities are shown on the attached maps.

ELECTRICAL

The electrical power to Fort Townsley has apparently always been an aerial line from the northwest corner of the Fort Cronkhite barracks. Manholes with both electrical and communications cabling (one filled with rubble) are in evidence at both Battery Townsley and the PSR bunker. The only record of these manholes found was on a set of 1941 electrical distribution system drawings which show aerial primary service up the valley and short runs of underground cable from the nearest pole to the manholes at the Battery and bunker. A secondary line is also indicated between the Battery and Bunker. A transformer manhole vault exists outside of Battery Townsley. No record was found as to when the secondary connection was de-energized.

The entire electrical pole line serving the Battery and beyond was cut down in 1973. The poles were left where they fell and the remaining butts can be easily found. The last pole line location, therefore, is definitely known and can be verified.

The cut-off ends of the secondary electrical cables between Battery Townsley and the PSR bunker were located within the structures by jumpering and making an electrical connection at the opposite end. These cables are lead shielded and armoured with copper conductor, and are a type used in the past by the military for direct burial. Both cables were tested and the results are shown on the following figure:

Biddle Megger Serial #2093478

Field checked with 10 & 20 ohm resistors following test

MEGGER CABLE TEST

MAY 15, 1982

The conclusion drawn from the test data is that the integrity of the cable insulation has disappeared over the years of disuse. Based on the rule of thumb of meg-ohm/1000 volts or one millamp leakage current, the minimum insulation that would be considered is 600,000 ohms. The tests show that the cables are far short of that.

WATER

Originally, the Fort Cronkhite and Fort Barry water was obtained from surrounding springs. These water sources were very seasonal and did not produce adequate quantities during dry periods. The building of the Baker-Barry tunnel in 1918 permitted a pipeline connection to the Marin Municipal Water District and all other water sources were abandoned.

The water system has undergone numerous relocations and changes. However, most of the system can still be traced through exposures, valve markers, and trench depressions. Water was supplied from the Fort Barry/Cronkhite system from a 3-inch tap at the northwest corner of the Fort Cronkhite barracks and also from a 3-inch connection to the Fort Cronkhite reservoir. These lines join about midway up the valley and continue to a pumping station located at the road intersection just north of Townsley. Here, the water was boosted to a 50,000 gallon reservoir and pump station about 600 feet further north. Townsley was served with water pressure from this reservoir through 6-inch and 4-inch water mains.

The Townsley pump stations were demolished in 1973 and apparently the pipelines were cut off below the ground surface. The pump station below Townsley was left in place but the motors were removed. The remainder of the system appears to be intact. However, some valves are inoperable and the line may be broken in places.

The upper reservoir appears to be in good condition and the pipeline intact, except at the demolished pump station. It was not possible to activate and prove the system. However, the general consensus of NPS maintenance personnel and the writer is that the system can be made operable with minimum effort.

The elevation of Battery Townsley is about 340 while the static water pressure on the system at Fort Cronkhite is 380 feet. When water service is restored at Battery Townsley, about 17 psi of pressure should be available. This could yield about 30 gallons per minute at Townsley at zero pressure. This is sufficient for limited domestic use but not for fire protection nor equipment requiring water pressure.

The water reservoir north of Townsley is located at elevation 440 feet. If activated, this should yield a static pressure of 43 psi and provide at least 300 gallons per minute at 20 psi residual pressure at Battery Townsley.

SEWER

A 6-inch sewer line served Battery Townsley and the PSR bunker. This sewer discharged into the Fort Cronkhite collection system on Bunker Road at the barracks. The sewer is probably usable provided the plug at its entrance to the Cronkhite system is removed. However, the sewer line most likely will contribute considerable infiltration and surface water inflow into the Cronkhite system during wet weather. The National Park Service currently has restrictions on new connections to the Cronkhite sewer system.

WORK REQUIRED TO RESTORE PRIMARY ELECTRICAL AND WATER SERVICE

Both primary electrical and water utility services were in use in 1972 and portions of these systems are in existence today. It is therefore recommended that all usable components of the existing systems necessary to establish service to Battery Townsley be restored and the remaining portions be re-constructed in their original positions. The work proposed herein is essentially a rehabilitation of the existing systems and will be very similar in appearance.

ELECTRICAL

The electrical requirements at Battery Townsley are low and do not warrant the installation of a 12,000 volt 3-phase primary power transmission line as would be normally recommended. A 4,160 volt single phase transmission line will be adequate for present needs.

The aerial transmission line should be restored by placing new poles directly over the old locations and running in new conductors. The run from the last pole to the new transformer will be underground.

The new transformer will be a pad mount located near the Battery entrance. As a reminder, the secondary electrical work will require a meter.

In the event that necessary permission to restore the original aerial transmission line is not forthcoming, an estimate for underground is also included herein. Routing should follow that of the aerial line.

WATER

The work required for restoration will include replacement of broken or malfunctioning valves, repair of broken or leaking piping, reconnecting cut pump station piping, repair of hydrants, vandalism protection and installation of a water meter and box. The completed system must be flushed and disinfected.

Should more pressure be required, it is suggested that the existing 50,000 gallon reservoir be re-activated and a small booster pump be installed at the old Townsley location to boost water into the reservoir.

CONSTRUCTION COST

The estimate of construction cost to provide primary electrical power and water service to Battery Townsley is summarized as follows:

Primary Electrical Power

Aerial transmission	\$26,000
or	
Underground transmission	\$35,000
Low pressure water service	\$15,000
Additional for higher pressure water	\$16,000

PERMITS

The contents of this report have been discussed with representatives of GGNRA. At the time of this writing, preliminary verbal approval for the restoration of the existing aerial electrical service and water system has been indicated from concerned departments except for the environmental advisory group. This group meets periodically and will discuss this work in early June.

Inasmuch as restoration of the aerial line is historically correct and the construction of the alternate underground line will be more environmentally damaging, it is the general consensus that the restoration will receive environmental approval.

George Fullerton, PE
Civil Engineer

Bill Carney, PE
Electrical Engineer

A horizontal scale bar with alternating black and white segments. It is marked with the numbers 400, 0, 400, 800, and 1200. Below the bar, the text "SCALE IN FEET" is printed.

PUMP STATION ■ RESERVOIR
50,000 GAL

PUMP STATION ■

COLLECTING RESERVOIR
B. PUMP HOUSE

RESERVOIR
400,000 GAL

TOWNSLEY
RESERVE

MASTER PLAN
BASIC INFORMATION MAPS

GENERAL WATER MAP

WATER SYSTEM - ESTIMATE

	MATL	LABOR
WATER METER & BOX	500	1 MD
REPAIRS 3@ 50'	540	4
NEW GATE VALVES & BOXES	1440	2
HYDRANTS	120	1
FLUSH	-	2
DISINFECT & FLUSH	50	1
FIND THE SYSTEM	-	3

MATERIALS	\$2650	13 MD
CREW 13@ \$675	8,775	
BACKHOE 6@ \$230	1380	
	<u>\$12,805</u>	
CONTINGENCY @ 15%	1920	
TOTAL	<u>\$14,725</u>	

RESERVOIR

CLEAN OUT & REPAIR RESERVOIR	1000	6
PIPING	300	2
PUMP STATION	3500	5
MATERIALS	4,800	
LABOR 13@ 675	8,775	
BACKHOE 2@ 230	460	
	<u>14,035</u>	
CONTINGENCY	2,105	
TOTAL	<u>\$16,140</u>	

QUANTITY TAKE-OFF				<u>Prelim</u> ESTIMATE	
LOCATION & FY PROGRAM <u>HEADLANDS - TOWNSLEY</u>				JOB NO.	
DIRECTIVE JOB NO.		COMPUTED BY		PREPARED BY	
LINE ITEM NO.		CHECKED BY		CHECKED BY	
DESCRIPTION <u>4.16KV Underground</u>		DATE		DATE	
ITEM NO.	DESCRIPTION	ESTIMATED QUANTITY	UNIT	UNIT COST	TOTAL COST
1	45' Class 3 Pole	1	EA	695	695
2	Guy	1	EA	50	50
3	Transformer - Pad Mount	1	EA	3150	3150
4	Cable 5KV DB (Copper)	4400	LF	3	13200
	(a) Trenching	2200	LF	<u>50</u>	1100
	(b) Sandbed	2200	LF	<u>25</u>	550
	(c) Backfill	2200	LF	<u>25</u>	550
*5	Cable 5KV DB (Copper)	400	LF	3	1200
	(a) Trenching	200	LF	14	4800
	(b) Sandbed	200	LF	4	800
	(c) Backfill	200	LF	2	400
6	Manhole Modification	106	LS	—	300
7	Handholes	3	EA	675	2025
8	TAXES				1132
	Subtotal				29952
	15% Contingency				4189
	Estimate				34141
	* All HAND Labor Up hill				

DRAWINGS AND SPECIFICATIONS
FOR
RESTORING WATER AND PRIMARY ELECTRICAL
SERVICE TO BATTERY TOWNSLEY
AT
FORT CRONKHITE
GOLDEN GATE NATIONAL RECREATION AREA

FOR
SCIENTIFIC SERVICE INC.
517 EAST BAYSHORE ROAD
REDWOOD CITY, CA 94063

MAY 1982

Prepared By
GOLDEN GATE ENERGY CENTER
GOLDEN GATE NATIONAL RECREATION AREA
BUILDING 1055-FORT CRONKHITE
SAUSALITO, CA 94965

GENERAL REQUIREMENTS

1. Protection of Property:

The work on this project is upon land controlled by the National Park Service whose mission includes the preservation of the existing environment. The Contractor shall at all times protect existing vegetation and wildlife and shall disturb only those areas as is absolutely necessary for the conduct of his work and the successful completion of this project.

All areas disturbed by construction shall be restored to the original condition; by grading to a smooth surface, disposing of removed and damaged brush and slash and other debris; and shall be left in a neat and workmanlike condition. The National Park Service disposal areas in Rodeo Valley will be made available to the Contractor for this purpose.

2. Documents:

All other contract documents for this project are complementary and applicable to these specifications.

3. Scope of Work:

Under this heading shall be included all labor and material required for the complete installation, as shown or covered by the specifications. In general, this includes the furnishing of all labor, equipment, materials and tools for the restoration of a primary power line and water supply system to Battery Townsley, complete and ready for use.

4. Visit to Site:

The Contractor shall visit the site, take his own measurements, and verify the exact conditions for himself. It shall be the Contractor's responsibility to obtain for himself all information necessary for an intelligent proposal. No allowance will be subsequently made for any error or omission on the part of the Contractor in this connection.

5. Site Conditions:

The Contractor shall exercise extreme care during construction to avoid damage to existing utilities. He shall be held responsible for any damage arising from his operations and shall repair to the satisfaction of the National Park Service any such damage.

6. Supervision and Workmanship:

The Contractor shall personally, or through an authorized and competent representative, constantly supervise the work and shall so far as possible keep the same foreman on the work from commencement to completion. The workmanship of the entire job must in every way be first class, and only experienced and competent workmen will be allowed on the job. Incompetent workmen shall be dismissed.

7. Shop Drawings:

The shop drawings shall be submitted for, but not limited to:

- (1) Transformer
- (2) Fused cutouts
- (3) Lightning Arrestors
- (4) Breakers
- (5) Motor Starter
- (6) Post Insulators
- (7) Pump and Control Systems
- (8) Water Meter
- (9) Valves

8. Guarantee:

The Contractor shall guarantee all materials and workmanship for a period of one year from date of acceptance by the owner. Any defects due to faulty materials, method of installation or workmanship within the period shall be repaired or replaced by the Contractor promptly upon notice by the owner at the expense of the Contractor.

RESTORE EXISTING WATER SYSTEM

1. Scope of Work:

The existing water supply system serving Battery Townsley shall be restored between the connection to the Fort Cronkhite barracks loop, the connection to the Fort Cronkhite reservoir line near the bottom of reservoir hill, and the Townsley reservoir located approximately 800 feet above Battery Townsley. The objective of this work is to provide Battery Townsley with a safe potable water system.

The water system is shown on Drawing W-1.

The work to be accomplished shall consist of the following items:

- (1) Replacement of gate valves (and boxes on buried valves)

3-inch	3 each
4-inch	2 each
6-inch	3 each
  - (2) Installation of 2-inch water meter in pump house.
  - (3) Installation of new water pump and motor, automatic controls, piping, valves, electrical work and enclosure, complete.
  - (4) Replacement of 6 2-inch post hydrant valves.
  - (5) Plugging of 5 existing pipeline taps.
  - (6) Replacement of 3 reservoir hatch covers.
  - (7) Cleaning the 50,000 gallon water storage reservoir.
  - (8) System flushing.
  - (9) System sterilization.
  - (10) System testing.
2. It shall be the Contractor's responsibility to field verify all existing conditions, including materials, sizes and condition before ordering new materials and/or equipment.

3. Water system work shall be conducted in such a manner that the existing Fort Cronkhite water distribution system shall at all times remain in service and contain clear safe potable water. The Contractor is reminded that the Townsley reservoir is located at a higher elevation than the Cronkhite system and therefore water will back flow if permitted to do so. National Park maintenance personnel shall be notified 48 hours in advance whenever connections are to be made between the systems.

4. The pump shall be a close-coupled turbine type for cold potable water service. The pump shall be bronze fitted construction with hydraulically balanced bronze impeller, 416 stainless steel shaft, mechanical seal, and replaceable channel rings. The pump shall have an approximate capacity of 17 gpm at 80 feet TDH and 19 gpm at 60 feet TDH, all at 3/4 Brake Horsepower or less.

The motor shall be 240 volt, 60 cycle, single phase, totally enclosed 3/4 horsepower for operation at 100°F maximum temperature outdoors in a marine environment.

The pump and installation shall conform to the standards of the Hydraulic Institute and shall be an Aurora 130 Series Model J05 with 2" suction and 1-1/2" discharge.

5. Water Meter shall be Neptune Trident 8 or Hersey MHD Models with straight reading registers measuring in gallons.
6. Gate Valves shall be 150# minimum water working pressure iron body, bronze mounted, double disc, parallel seat, AWWA C-500 with non-rising stems opening left. Valves within enclosures shall have hand wheels. Buried valves shall have 2-inch operating nut.
7. Valve boxes shall be Christy 8-1/4" I.D. with "water" clearly cast into the concrete lid.
8. Repair clamps, couplings, saddles and other pipe fittings and adapters shall be Smith-Blair/Rockwell or approved equal.
9. Check valves shall be iron body, bronze mounted swing check for 125 psi minimum water working pressure.
10. Buried Piping: Buried piping shall be:
  - A. Copper tubing, type K, annealed, conforming to ASTM B88 with flared brass or solder-type bronze or wrought-copper conforming to ANSI B16.26 or B16.22.

B. Above Ground Piping: Piping above ground shall be one or more of the following:

- (1) Zinc-coated, standard weight, screw-joint, steel pipe conforming to ASTM A120 with zinc coated malleable fittings conforming to WW-P-521.
- (2) Copper tubing, type L, conforming to ASTM B88, with brazed or solder-joint copper, brass or bronze fittings conforming to ANSI B16.18 or B16.22.
- (3) Same as for buried piping.

11. Reservoir cleaning: All debris, dirt and other foreign matter shall be thoroughly cleaned from the reservoir. The reservoir shall then be completely and thoroughly scrubbed with stiff bristle brushes and then thoroughly rinsed to waste.
12. Flushing: The completed reservoir and pipe lines shall be thoroughly flushed by flowing water to waste through the existing piping to remove all remaining dirt, colored water and other debris and contamination.
13. Testing: After the piping work and before backfilling of any joints specified herein is completed, the entire pipeline between the Townsley reservoir, the Cronkhite reservoir connection, and the Cronkhite water distribution system shall be pressure tested for leakage. The pressure test shall be made by the Contractor in the presence of a representative of the National Park Service utilizing Contractor furnished and installed equipment. The water system shall be subjected to a hydrostatic pressure of 200 psi at the lower end which shall be maintained for a period of 6 hours, during which time no apparent leakage shall be visible from the new pipeline restoration work. If leakage is observed, the Contractor shall repair the leaks and reconduct the test in full.

Following the successful 6-hour test, the Contractor shall measure the total leakage from the Townsley system during a one-hour period and shall report the amount of leakage to the Owner.

14. Sterilization: The water pipe, fittings, and storage tank shall be sterilized upon completion of the work and prior to placing the system into service. Sterilization may take place during testing. However, should the system require additional work after testing, it shall again be sterilized at the Contractor's expense. The system

shall be filled with owner furnished potable water to which the Contractor shall add sufficient chlorine to provide a concentration of 50 ppm in the full system. (The Contractor may spray sterilizer in the reservoir in accordance with AWWA D102-64, Section 5.3.3. at his option.) The chlorine solution shall be retained in the tank and piping for a period of 24 hours. After sterilization, the system shall be drained and thoroughly flushed to waste.

15. Backfill: All backfill shall be compacted to at least 85% of maximum dry density in accordance with ASTM D-1557. Following backfill, the entire area disturbed by construction shall be graded to a neat, smooth and well draining surface.
16. The pump shall be controlled automatically from the water pressure in the suction and discharge pipelines. The pump shall be started when the discharge pipeline pressure falls to a predetermined point and shall stop when the pressure in the suction line falls to below a predetermined point or the discharge pressure rises to a predetermined point.

The suction line pressure gauge shall be fitted with a red indicator light which shall come on whenever the low pressure shuts down the pump and remains on until manually shut off.

Separate pressure sensors shall be utilized for each function, shall be adjustable to maintain accurate pressure control and shall be fitted with time delays to prevent false operation due to surge, hammer, etc. The approximate pressure ranges will be 35-55 psi discharge and 0-2 psi suction line.

The complete unit shall be housed in a NEMA 3R enclosure, welded, phosphatized, primed and finished; except that the suction line pressure switch may be located in a separate enclosure. Included with the automatic control system shall be a hand-off-automatic switch and motor starter NEMA size 1.

The complete automatic control system shall be Autocon Industries, Inc. Tanktrol Class 1100, designed to operate the 3/4 HP, single phase, 240v, 60 cycle pump motor specified or approved equal.

17. Pump enclosure shall be fabricated from 12 ga corrugated metal culvert pipe and 3/16-inch thick steel plate. It shall be constructed tamper proof utilizing welding and carriage type bolts. The entire enclosure shall be hot dip galvanized after fabrication. Hinges, hasp and connections shall be stainless steel. Bolts will be 1/4-inch minimum diameter.

18. The reservoir new hatch covers shall be fabricated from 3/16-inch steel plate, 1" x 3/16" strap hinges full hatch width and 1" x 1" x 1/8" reinforcing angles. Covers shall be true and shall fit snugly on the existing frame, hinge supports and lock hasp, to prevent entrance of rodents, birds or rain runoff.

Edge lap shall be 1-inch. Hatch covers shall be similar to the existing. The covers shall be hot dip galvanized following fabrication.

19. Post hydrant valves shall be iron body, bronze mounted angle valves for 150 psi water working pressure, threaded to fit the existing posts, with 2-1/2" hose connection, cap and chain and tamper proof hand wheel hub. Two handwheels shall be provided.

RESTORE EXISTING ELECTRICAL SYSTEM

1. Scope of Work:

The existing electrical distribution system serving Battery Townsley shall be restored between the connection to the Fort Cronkhite barracks system and the Battery. This system is shown on Drawing E-1.

The work to be accomplished shall consist of the following items:

- Connection to Existing System
- Replacement of Poles and Equipment
- Primary Conductor
- Secondary Conductor
- Transformer
- Pump Connection and Controls
- Necessary and Usual Incidentals

2. The new poles shall be placed adjacent to the butts of the existing poles. (The existing pole line has been cut down). The existing guy anchors may be utilized in the new work.
3. It shall be the Contractor's responsibility to field verify all existing conditions before ordering new materials and/or equipment.
4. Electrical system work shall be conducted in such a manner that the existing Fort Cronkhite electrical distribution system shall at all times remain in service. National Park Service maintenance personnel shall be notified 48 hours in advance whenever connections are to be made between the systems.
5. The Contractor shall provide, procure and pay for all permits, licenses, fees, etc., required to carry on and complete his work. All work and materials shall be in full accordance with the latest rules and regulations of the National Electrical Code; the National Board of Fire Underwriter's; Local and State ordinances; the Electrical Safety Orders issued by the Division of Industrial Safety of the State of California; and with any prevailing rules and regulations pertaining to adequate protection and/or guarding of any moving parts or otherwise hazardous locations. Nothing in these specifications is to be construed to permit work not conforming to these regulations.

Whenever the drawings or specifications require materials, workmanship, arrangement or construction of a higher standard or larger size that is required by the above rules and regulations. The drawings and specifications shall take precedence.

Should there be any direct conflict between the above mentioned regulations and the drawings or specifications, the regulations shall govern. No extra charge will be paid for furnishing items required by the regulations, but not specified or shown on the drawings. Rulings and interpretations of the enforcing agencies shall be considered a part of the regulations.

6. All electrical materials shall be new and listed with the Underwriter's Laboratories, Inc., shall meet their requirements and shall bear their label wherever standards have been established and label service is regularly furnished by that agency.

Catalog numbers and manufacturer's names and data are given in the drawings and specifications to establish the standards of equality, utility, function, safety, appearance, dimensions, and accessories, required. It shall be the responsibility of the Contractor to furnish to the Engineer complete supporting data and samples, if required, to prove equality to the standards specified.

Within twenty days after award of the Contract, a complete list of materials proposed for installation shall be submitted to the owner. This list shall include manufacturer's names, shop drawings, catalog cuts, brochures, etc., and shall be submitted in quadruplicate. If the list includes items proposed as substitutes, it shall be accompanied by supporting data that clearly compares the substitute with the specified item in detail as to quality, utility, function, safety, appearance, dimensions and accessories. Should any tables, graphs, curves, charts, etc., be based on a standard set of basic conditions and requirements as established by recognized engineering societies, manufacturer's associations, etc.

If items or material used is specified on the drawing or specification by catalog numbers, a submittal is not required. A letter stating that those items will be installed will suffice.

7. Grounding shall be in accordance with the State of California General Order 95.
8. Conductors shall be sag in accordance with the State of California General Order 95.

PLUG SUCTION TAP
TO TOWNSLEY LINE
AT DISMANTLED PUMP
STATION

REACTIVATE RESERV.
SEE DRAWING W-3

PLUG EXISTING
VALVED TAP TO
WATER LINE

INSTALL NEW PUMP
STATION & REPLACE
2 GATE VALVES
SEE DRAWING W-2

REPLACE VALVES
ON G POST
HYDRANTS

REPLACE 3"
GATE VALVE

ABANDONED

RESERVOIR
W-3

RESTORATION OF EXISTING WATER SYSTEM

SCALE 1" = 400'

DRAWING W-1

SITE PLAN

SCALE: 1" = 5'-0"

PROVIDE REDWOOD
BLOCKING FOR
CURVE & CORRUGATIONS

NOTE
CABINET MOUNTS, CUTOUTS,
BOLT HOLES & WELDING ON
ENCLOSURE SHALL BE COMPLETE
BEFORE GALVANIZING. BOLTS
SHALL BE STAINLESS STEEL.

WIRING TO CABINET SHALL BE
IN FLEXIBLE CONDUIT.

PUMP STATION

SCALE 1"=1'-0"

DRAWING XI-2

REPLACE 2-4"
& 2-6" FLANGED
GATE VALVES

UP TO OVERFLOW

TO BATTERY
TOWNSLEY 28

6" FILL LINE
(ABOVE)

4" DRAIN LINE

VALVE
CHAM
BELC

REPLACE 3
HATCH COVE

VALVE CHAMBER

NOTE

RESERVOIR TO BE THOROUGHLY
CLEANED, RINSED, STERILIZED
& FLUSHED

HEADROOM 8'-0"
FLOOR TO GROUND 10'-0"

RESERVOIR PLAN

TOWNSLEY RESERVOIR

NOT TO SCALE

DRAWING W-3

PLAN

ELEVATION

<u>NEW METER</u>	
SCALE 1" = 1'-0"	
DRAWING	W-4

TRANSFORMER

BATTERY TOWNSLEY

INSTALL 1 NEW
GUY ANCHOR

UNSTABLE SOIL
INSTALL SWAMP
SHOES 3 POLES

NOTE

SET NEW POLES
ADJACENT TO BUTTS
OF OLD POWER LINE

2-#4 CU HD STR
4.16 KV CONDUCTORS

FIRST REPLACEMENT
POLE - USE EXISTING
GUY ANCHORS (TYPICAL)

FORT CRONKHITE

CONNECT TO EXISTING
POLE ON CRONKHITE
SYSTEM BEGIN NEW
ELECTRICAL WORK

RESTORATION OF
EXISTING ELECTRICAL SYSTEM

SCALE 1" = 400'
DRAWING E-1

- ⑩1 CHANCE #881
- ⑩2 COPPERWELD

FIGURE 6
ANCHOR DE

See Detail
4
4" to 15"
Only

DETAIL "A"

DETAIL "B"

FIGURE 7
GUY DETAIL

- (103) GUY HOOK - 5000 #
- (104) MACHINE BOLT, 5/8" DIA.
LENGTH AS REQ'D.
- (105) CURVED WASHER 3" X 3"
- (106) GUY WIRE, 7 STR., 3/8" DIA.,
ALUMOWELD
- (107) STRAIN INSULATOR, ASA CL. 54-1

88135
LD 5/8" DIA - 7'

E 6
DETAIL

POLE DETAILS

DWG. E-2

SWAMP SHOE DETAIL

MATERIALS	
ITEM	DESCRIPTION
1	Pole, Wood. CLASS 3, 45'
2	Cutouts and Fuses, as req'd.
3	
4	
5	Insulator, Post Type, Tie Top. LAPP # 9425X70
6	Insulator, Post Type, Clamp Top. LAPP # 4225LN70
7	Insulator, Suspension Type. OHIO BRASS # 32439
8	
9	Stud, Post Insulator. 3/4" x 1 3/4"
10	
11	▲
12	Bracket, Post Insulator, 9"
13	
14	Bracket, Pole Top, For Post Insulator.
15	
16	Clamp, Angle, for Suspension Insulator.
17	
18	
19	Extension Link Assembly, 14"
20	
21	Armor Rod.
22	
23	Side Tie, (formed Insulator Tie)
24	Clevis Eye, DB Cat. No. 83928 or equiv.
25	
26	
27	
28	Bolt, Machine. 5/8" x length as req'd.
29	
30	
31	Washer, Lip, Tapped, for 5/8" Bolt
32	Washer, Square, 2 1/2", for 5/8" Bolt
33	
34	Washer, Round, 1 3/4" O.D., for 5/8" Bolt
35	
36	Washer, Lock, Galv., for 5/8" Bolt
37	Washer, Spring, Double Coil, for 5/8" Bolt, Galv., Electrical Material Co. Type M-W or equiv.
38	
39	
40	
41	High Voltage Sign

DETAILS AND MATERIAL LIST

- PIN INSULATOR
WET FLASHOVER 50KV
DRY FLASHOVER 30KV

WEATHER HEAD .

PUMP { 1" C. 3" (

CIRCUIT { THW (TH

W.P. SWITCH
60A 2P S/N, 25
FUSED 40A
PROVIDE PAD L
MASTER KEYED

TO PUMP —

TRANSFORMER & SECONDARY DETAIL

PUMP-ONE LINE

MISCELLANEOUS DETAILS