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Rec 10-3-77

U.S. ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION
NEVADA OPERATIONS OFFICE
POST OFFICE BOX 14100
LAS VEGAS, NEVADA 89114

CONTRACT NO. EG-77-S-08-1526

WITH

THE UNIVERSITY OF DENVER
(COLORADO SEMINARY)

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U.S. ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION
NEVADA OPERATIONS OFFICE
POST OFFICE BOX 14100
LAS VEGAS, NEVADA 89114

Contract No. EG-77-S-08-1526

THIS CONTRACT, effective the 1st day of September, 1977, is entered into between THE UNITED STATES OF AMERICA (hereinafter called the "Government"), acting through THE UNITED STATES ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION (hereinafter called the "ERDA"), and THE UNIVERSITY OF DENVER (COLORADO SEMINARY) (hereinafter called the "Contractor").

WITNESSETH THAT:

WHEREAS, the ERDA desires to have the Contractor perform certain research work, as hereinafter provided; and

WHEREAS, this negotiated Contract is authorized by Section 302(c)(5) of the Federal Property and Administrative Services Act of 1949, as amended, and Section 107(a) of the Energy Reorganization Act of 1974;

NOW, THEREFORE, the parties hereto agree as follows:

ARTICLE 1. THE RESEARCH TO BE PERFORMED

a. The Contractor shall, to the best of its ability, furnish personnel, facilities, equipment, materials, supplies, and services, except such as are furnished by the Government, necessary for the performance of the research provided for in Appendix A hereto, and shall perform the research and report thereon pursuant to the provisions of this Contract. It is understood that Appendix A, a guide to the performance of this Contract, may be deviated from by the Contractor subject to the specific requirements of this Contract.

b. This work shall be conducted under the co-direction of Dr. L. W. Ross and Ralph E. Williams, or such other member of the Contractor's staff as may be mutually satisfactory to the parties.

ARTICLE 2. THE PERIOD OF PERFORMANCE

The period of performance under this Contract shall commence on September 1, 1977, and expire on March 31, 1978. Performance may be extended for additional periods by the mutual written agreement of the parties.

ARTICLE 3. CONSIDERATION

a. In full consideration of the Contractor's performance hereunder, the ERDA shall furnish the equipment, supplies, materials, and services, if any, listed in Article A-2.b.(2) and pay the Contractor

the sum of $67,330, hereinafter called the "Support Ceiling," which sum shall be subject to adjustment as hereinafter provided.

b. Payments to the Contractor shall equal the "Cumulative Support Cost" of performance of this Contract, as the term "Cumulative Support Cost" is defined in the Article of this Contract entitled "Determination of Support Costs." PROVIDED, HOWEVER, and notwithstanding any other provision of this Contract, that the Government's monetary liability under this Contract shall not exceed the Support Ceiling specified in a. above. The ERDA shall not pay more than the Support Ceiling or an amount equal to the Cumulative Support Cost, whichever is less. The Contractor shall be obligated to perform under this Contract throughout the agreed upon period of performance, and to bear all costs which the ERDA has not agreed to pay; PROVIDED, HOWEVER, that the Contractor shall have the right to cease to perform the research provided for in this Contract, upon writen notice to the ERDA to that effect, at any time when or after the Cumulative Support Cost equals or exceeds the Support Ceiling.

c. The Support Ceiling specified in a. above may be increased unilaterally by the ERDA by written notice to the Contractor and may be increased or decreased by written agreement of the parties (whether or not by formal modification to this Contract). In the event the stated period of contract performance is extended, the Support Ceiling will be revised to reflect any increased ERDA support for the extended period or periods.

d. Upon termination or expiration of the total period of performance, the Contractor shall promptly refund to the ERDA (or make such disposition as the ERDA may in writing direct) any sums paid by the ERDA to the Contractor under this Contract, through direct payment or under letter of credit, in excess of the Cumulative Support Cost incurred in performance under the Contract.

ARTICLE 4. GOVERNMENT PROPERTY

The following items of property procured or fabricated by the Contractor are hereby listed as "Government Property."

NONE

ARTICLE 5. APPENDICES

Appendix A; Appendix B, "General Contract Provisions"; Appendix C, "Statement of Costs"; Appendix D, "Intellectual Property Articles"; and Appendix E, "Soviet-Bloc Controls," are hereby attached to and made a part of this Contract except that Appendix B is amended as follows:

Article B-23, "Reports and Renewal Proposals," is revised in its entirety to read as follows:

ARTICLE B-23. REPORTS AND RENEWAL PROPOSALS

The Contractor shall furnish six copies of the following reports and renewal proposals, if any, with two copies of each addressed to:

Dr. John W. Salisbury
Division of Geothermal Energy (M/S 31220)
U.S. Energy Research and Development Administration
20 Massachusetts Avenue
Washington, D.C. 20545

Mr. Robert W. Taft
Assistant Manager for Plans, Engineering & Budgets
U.S. Energy Research and Development Administration
Nevada Operations Office
Post Office Box 14100
Las Vegas, Nevada 89114

Dr. Howard Ross
Earth Sciences Laboratory
University of Utah Research Institute
Suite 1
Salt Lake City, Utah 84108

a. Monthly Progress Reports. These reports shall be submitted within 15 days after the end of each month and will briefly describe the activities during the past month, the financial status, the problems encountered, proposed solution to the problems, and the planned activities for the coming month.

b. Final Report. A final report shall be submitted as required by Article A-1, paragraph a.(7), and prepared in accordance with Sections II and III of "Requirements and Procedures for Reporting Geothermal Information" (ERDA-76/72). The draft final report shall be submitted in accordance with this Article for review and approval of the format and other comments. All comments will be compiled by the Contracting Officer who will notify the Contractor of approval or of recommended changes to be made in the report. Upon submittal of the approved report, the ERDA Technical Information Center (TIC) will duplicate and distribute this report as indicated in Section IV.C, D, and E of this Procedure and distribution will be in Category UC-66a, which shall be indicated on the report title page.

IN WITNESS WHEREOF, the parties hereto have executed this Contract in several counterparts on the respective dates indicated.

U.S. ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION

By: _____
Robert W. Taft, Assistant Manager
for Plans, Engineering & Budgets
Contracting Officer

Date: 9/19/77

THE UNIVERSITY OF DENVER
(COLORADO SEMINARY)

By: _____
Carl Gardner,
Title: Vice Chancellor - Treasurer

Date: 26 September 1977

I, Peggy M. Anderson, certify that I am the Assistant Secretary of the Contractor named under this Contract; that Carl Gardner, who signed this Contract on behalf of said Contractor, was then Vice Chancellor - Treasurer of said Contractor; that this Contract was duly signed for and on behalf of said Contractor by authority of its governing body and is within the scope of its legal powers.

In witness whereof, I have hereunto affixed my hand and the seal of said Contractor.

Peggy M Anderson

(SEAL)

APPENDIX A

For the Contract period September 1, 1977, through March 31, 1978

ARTICLE A-1. RESEARCH TO BE PERFORMED BY CONTRACTOR

a. The Contractor shall perform certain reservoir engineering studies in Thermal Power Company's Utah State Well 14-2 substantially in accordance with its Proposal Number MC7740 entitled "Subsurface Investigation at Roosevelt KGRA" dated 27 May 1977 as amended by its letter dated 25 August 1977. The scope of work includes:

   (1) Opening well and flowing it for approximately 48 hours.

   (2) Obtain pressure and temperature logs during flow.

   (3) Obtain fluid samples during flow.

   (4) Provide ERDA with six (6) copies of data obtained in (2) above within one month of completion of flow test.

   (5) Provide a portion of all fluid samples obtained in (3) above to ERDA or its designated representative at the location (sample containers to be furnished by ERDA).

   (6) Perform analyses of energetic potential and geochemical limitations of the well from data in (1) through (3) above.

   (7) Provide a final report with all data reductions and interpretations within the term of the Contract.

b. The co-principal investigators except to devote a total of 5 man-months of time or effort to the work under this Contract.

ARTICLE A-2. WAYS AND MEANS OF PERFORMANCE

a. Items for which support will be provided as indicated in A-3:

(1)	Direct Salaries and Fringe Benefits		$22,390*
	Co-principal Investigators	$14,100	
	Research Geologist	5,700	
	Instrumentation Specialist	1,860	
	Clerical	730	
(2)	Indirect Cost		19,255
	86.0% Salaries		
(3)	Travel		2,540
	Domestic	2,540	
	Foreign	-0-	
(4)	Equipment		9,100
	Wellhead Hardware, Geothermal effluent sampling bomb & associated equipment	9,100	
(5)	Supplies and Expenses		14,045
	Telephone & Reproduction	400	
	Dismantling of flowline at 72-16 and reconstruction at 14-2	6,000	
	"Fishing" Insurance		
	Premium	790	
	Deductible (if required)	2,500	
	Sandia Expenses (as required)		
	Instrument Rental	360	
	Diesel Tractor Rental	995	
	Crane Rental	3,000	

*Eighty (80) professional man-hours of overtime are approved for the performance of work under this Contract.

b. Items, if any, significant to the performance of this Contract but excluded from computation of Support Cost and from consideration in proportioning costs:

(1) Items to be contributed by the Contractor:
Well liability insurance

(2) Items to be contributed by the Government:
Well logging truck by the U. S. Geological Service or wireline facilities from Sandia Laboratories

c. Time or effort of principal investigator(s) contributed by Contractor but excluded from computation of Support Cost and from consideration in proportioning costs:

None

ARTICLE A-3.

The total estimated cost of items under A-2.a. above for the contract period stated in this Appendix A is $67,330; the ERDA will pay 100 percent of the actual costs of these items incurred during the contract period stated in this Appendix A, subject to the provisions of the Article of this Contract entitled "Consideration" and the Article of Appendix B entitled "Determination of Support Costs." The estimated ERDA support cost for the contract period stated in this Appendix A is $67,330.

The estimated ERDA support cost is funded as follows:

a. Estimated unexpended balance from the prior period(s): $0.

b. New funds for the current period: $67,330

The new funds being added in A-3.b. constitute the basis for advance payments provided under the Article of Appendix B entitled "Payments."

II/E

COLORADO SEMINARY
UNIVERSITY OF DENVER
UNIVERSITY PARK • DENVER, COLORADO [illegible]

GRANTS AND CONTRACTS / 303 • 753-2121

23 May 1977
DRI Proposal MC7740

Energy Research and Development Administration
Nevada Operations Office
Post Office Box 14100
Las Vegas, Nevada 89114

Attention: Mr. James B. Cotter
Chairman
Source Evaluation Panel

Subject: RFP No. EY-R-08-0007
University of Denver Proposal No. MC7740

Gentlemen:

The following information is offered in support of subject proposal.

1. Although the subject solicitation anticipates issuing a fixed-price or cost-sharing contract, the University of Denver, as a non-profit educational institution, prefers contracting for R&D programs on a cost-reimbursement basis without fee. It is the policy of the University to not accept a cost-sharing contract. The General Provisions included in the solicitation are acceptable to the University if incorporated as General Provisions in a Cost Reimbursement R&D Contract with Non-Profit Institutions including Educational Institutions with special consideration of the following:

   a. Government Property (Cost Reimbursement, Non-Profit)

   b. Patent Rights (Retention by the Contractor)

   c. Termination for Convenience of the Government (Research and Development Contracts with Educational and Other Non-Profit Organizations)

   d. Negotiated Overhead Rates - Predetermined (Educational Institutions)

2. The Cognizant Government Audit Agency for the University of Denver is Defense Contract Audit Agency, Denver Branch, Mr. Ralph J. Mathews, Manager, New Custom House, Room 474, 19th and Stout Streets, Denver, Colorado 80202, Telephone: 303/837-3077.

3. Financial information and Certificate of Overhead Determination are available from the Department of the Air Force, Air Force Office of Scientific Research (AFSC), Building 410, Bolling Air Force Base, Washington, D. C. 20332.

4. The Indirect Cost rate of 51.4% of Direct Salaries and Wages and Fringe Benefits and the G&A rate of 16.3% of Modified Total Cost are presently being negotiated with the Department of the Air Force.

5. All materials, supplies, expense or equipment in this and all future proposals have been determined on past experience, per item vendor quotation and past established purchase pricing.

6. All air fare rates are based on round trip fares established by airline pricing. Per diem rates are based on a Government-approved rate.

7. A copy of the University's financial statement is enclosed.

8. Our overhead period is from 01 July to 30 June.

9. It is requested that monthly vouchers/invoices be established as the method of payment.

10. The following individuals are authorized to conduct contractual negotiations for the Denver Research Institute.

Mr. Howard L. Mai, Director
Grants and Contracts
303/753-2121

Miss Deborah Bradford and
Mr. Lane McGrath
Assistant Directors
Grants and Contracts
303/753-2121

Yours very truly,

Howard L. Mai

Howard L. Mai, Director
Grants and Contracts

HLM/4:rjs
cc: L. W. Ross - DRI

PROPOSAL NUMBER: MC7740

PROPOSAL TO: U.S. Energy Research and Development Administration
Nevada Operations Office
P.O. Box 14100
Las Vegas, Nevada 89114

Attention: James B. Cotter
Chairman, Source Evaluation Panel

SUBMITTED BY: Laboratories for Applied Mechanics
Denver Research Institute
University of Denver
Denver, Colorado 80208

TITLE: Subsurface Investigation at Roosevelt KGRA

PERIOD: Six Months

PRINCIPAL INVESTIGATOR: Ralph E. Williams/Laurence W. Ross

DATE: 27 May 1977

ESTIMATED AMOUNT: $68,225

APPROVED BY:

Chester R. Hoggatt, Head
Laboratories for Applied Mechanics

PREPARED BY:

Ralph E. Williams, Associate Head
Laboratories for Applied Mechanics

Laurence W. Ross, Research Engineer

APPROVED FOR THE DIRECTOR BY:

Howard L. Mai, Director
Grants and Contracts

Jay D. Dick, Research Geologist

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INTRODUCTION

This proposal, MC7740, entitled "Subsurface Investigation at Roosevelt KGRA", is submitted in response to ERDA RFP No. EY-R-08-0007. The objective of the proposed program is to obtain new data with regard to pressure, temperature and brine chemistry at depth as a function of flowrate. A working agreement has been established with Thermal Power Co. of San Francisco, CA, to use their "Utah State" 14-2 well at Roosevelt. Thermal Power will participate in this program by giving access of the well to DRI as well as furnishing supervisory manpower. We expect all data generated to be shared with Thermal Power and ERDA.

DEFINITIVE PROPOSAL

It is proposed that Denver Research Institute, University of Denver, enter into a cost reimbursement type contract with Energy Research and Development Administration for a period of six months and in the estimated amount of $68,225. The correct corporate name to be used on all contracts is Colorado Seminary.

A. Proposer's Name

Laboratories for Applied Mechanics
Denver Research Institute
University of Denver
Denver, Colorado 80208

Principal Investigator: R. E. Williams/L. W. Ross

B. Technical Proposal

1. Investigation Site

Roosevelt, Utah KGRA

a. Legal description

Well "Utah State" 14-2
Roosevelt Steam Field, SW Utah
T27S, R9W, (South SLBM) Sec 2
from NW corner 2310'S, 350'E

b. Status of ownership

Thermal Power Company
601 California Street
San Francisco, CA 94108

c. Geologic description of geothermal parameters

The Roosevelt geothermal field is situated at the boundary between the Mineral Range and the Milford graben. Valley fill sediments in the graben are approximately 1,500 meters thick in the center of the valley. Bedrock is stepped up along several normal faults to the west flank of the Mineral Range, where the westernmost exposures consist of Precambrian gneissic rocks. These are intruded by Late Cenozoic granitic and related silicic rocks.

The westernmost exposures of Precambrian crystallines appear to be in a horst block which is bounded on the east by the Dome Fault. Rhyolitic flows, from seven or more eruptive centers, cap much of the granite on the eastern margins of the KGRA. Magma additions to the chamber, feeding these eruptive centers, are thought to be supplying the heat beneath the Roosevelt KGRA.

Recent faulting in the KGRA is indicated by fresh scarps in alluvium and the cutting and displacement of hot spring deposits. Faults appear to be major controlling structures in the subsurface hydrologic regime.

The thermal anomaly at the Roosevelt KGRA is underlain by intermediate and silicic crystalline rocks, at the surface or at shallow depths. The fracture system is the geothermal reservoir. The depth to the top of the reservoir is less than 900 meters over a significant portion of the anomaly. The fracture zones have extraordinarily high effective permeability locally, yielding up to 250,000 lbs/hr flashed steam from a reservoir in excess of 250°C, pressures near hydrostatic, and fluids with less than 8,000 mg/l total dissolved solids.

At depths of 1625 meters and temperatures above 240°C, terminating quartz crystals and drilling breaks indicate that open fractures are maintained in granodiorite. Open fractures are at significantly shallower depths and lower temperatures than the goethermal reservoir.[1]

d. Technical reasons for site selection

"Utah State" 14-2 was selected for two primary reasons: availability and well characteristics. In the Roosevelt KGRA there are, to date, only nine geothermal wells of which seven are owned and operated by the Phillips Petroleum Company. Phillips has expressed to DRI that they will not allow any well data from their Roosevelt Prospect to be included in an ERDA contract of this sort. This limits DRI's testing to the two wells owned and operated by the Thermal Power Company, "Utah State" 14-2 and 72-16. Well 72-16 exceeds the DRI desired specifications for well testing because of a mass flow in excess of one million lbs/hr. DRI and

1. Lenzer, R.C., G.W. Crosby, and C. W. Berge, 1976, Geothermal exploration of Roosevelt KGRA, Utah: Geothermal Resources Council Short Course No. 5, Snowbird, Utah.

Thermal Power engineers cannot assure that the DRI temperature/pressure probe would indeed stay downhole under such conditions. Thermal Power has granted DRI permission to conduct these proposed well tests in well 14-2. This well meets the DRI desired specifications of two-phase flow (flashing in the well bore), temperatures of 500°F (+) and mass flow of approximately 400,000 lb/hr.

2. Program data offered

a. Subsurface

Data acquired from these well tests will be in the form of direct temperature and pressure readings and chemical compositions. The value of these well tests is that a better model of the rate of energy delivery from the well can be derived because of continuous monitoring into the well bore. These tests will simultaneously record temperature and pressure, with depth, as a function of real time under flowing conditions. Sampling will be performed in separate runs.

The Roosevelt geothermal field is typical of a hydrothermal source that delivers the fluid as a mixture of steam and liquid, and such wells are said to be in a "flashing" mode. This type or resource is expected to the be the most common type of electric power-producing geothermal well in the U.S.

The presence of two fluid phases strongly affects the hydraulic characteristics of flashing wells. Two-phase flow is known to exhibit frictional losses that vary with the type of flow regime (bubble flow, slug flow, annular flow, etc.). Dissolved gases complicate the situation further because they will often form a vapor phase long before steam appears, i.e., at a higher pressure than the flash point.

Therefore the assessment of a geothermal energy resource should include

measurements of temperature, pressure and chemical composition during flowing conditions. These data have not been measured in well 14-2 while flowing, and the data will consist entirely of new measurements.

b. Surface: Not Applicable.

c. Reservoir engineering studies

The data described in 2(a) will be used to analyze the energetic potential of this resource. The analysis is intended to serve as a model for evaluation of this type of resource, especially the Roosevelt field itself.

The energetic potential of a geothermal resource depends on its ability to supply energy at the surface. The energy loss in flowing from reservoir to surface can now be predicted by models of two-phase flow in geothermal wells, and several such models are in existence.

These models predict that energy loss is a minimum at some combination of well parameters, including production rate, well diameter, etc. Therefore each well in a given reservoir should be <u>designed</u> to exploit the resource in optimum fashion.

The pressure-temperature logs and the measured chemical compositions from well 14-2 will permit characterization of the energy deliverability from this resource. Using the measured values from the well tests, DRI will perform the following analysis:

1. Calculation of pressure loss due to friction and hydrostatic head in the single-phase mode near the producing zone at the bottom of the well.

2. Calculation of thermal loss in a single-phase mode.

3. Estimation of the point of onset of two-phase flow.

4. Application of wellbore model (computer program) to estimate pressure loss and associated thermal loss up the bore to the wellhead.

5. Recomputation as necessary to obtain confirmation of the model

selected.

6. Parametric studies to provide a predictive model for wells throughout the Roosevelt field.

3. Program description

a. Sursurface

(1) Well testing data to be offered under this proposal will be considered new data. To the best of our knowledge, this type of well testing has not been done previously, except by DRI under ERDA Contract No. EY-76-S-02-2729. We feel no one else has the capabilities to conduct such testing. To date, the only DRI testing of this type has been performed in the Imperial Valley, but future tests are planned for California and Nevada.

(2) Drilling and completion data for "Utah State" 14-2 are included in a separate proposal to be submitted by Thermal Power Company. All the information requested under this subsection is available from Thermal Power (attention Keith R. Davis), but it is not included in this proposal due to repetition and confidentiality.

(3) - (9) As per data and information in section (2), this information is available in the proposal submitted by Thermal Power for well 14-2. It is not included herein due to repetition and confidentiality.

b. Surface investigations: No Application

c. Reservoir Engineering Studies

(1) Measurements to be performed

The well ("Utah State" 14-2) will be opened and flowed for 48 hours. During this period, pressure and temperature logs of the well will be obtained with the DRI probe. This procedure will be conducted at least twice. An estimated three fluid samples will be taken from within the well, at a position where the overall compostion of the mixed fluid can

be sampled representatively.

The DRI probe depends on the use of a seven-conductor armored cable, approximately 7/16 inch in diameter. The probe is calibrated to 500°F, 2000 psia. In order to use the probe in the field, DRI is cooperating with the U.S. Geological Survey, Water Resources Division (Mr. Scott Keys, supervisor) who have expressed interest in investigating wells of this type in connection with ongoing U.S.G.S. geothermal research. This group, located at the Denver Federal Center, has a logging truck equipped with 16,000 feet of armored 7-conductor cable suitable for service to 500°F. If DRI is not able to fulfill their contract obligations by use of the USGS wireline capabilities (i.e., scheduling, liability, confidentiality, etc.), DRI reserves the option to conduct the said well testing for this contract with the wireline facilities of Sandia Laboratories. Sandia Labs has the seven-conductor armored cable, and winching capabilities that are needed for said well tests. These facilities combined with the instrumentation of DRI allow comparable well testing capabilities as with the USGS.

Sampling will be conducted during the flowing test, in order to obtain a sample that is representative of the overall composition of fluid that the well delivers. It is recognized that the fluid composition changes as the flowing life of the well lengthens, but a sample taken early in the life of the well will provide a "worst case" for dissolved gases.

There is agreement throughout the geothermal industry that sampling is difficult. Furthermore, sampling during flow presents special problems, since the sampling device must have a small diameter. DRI has surveyed the industry thoroughly, and has found only one sampling device that combines reliability, small diameter (but sufficient sample volume), and compatibility with DRI downhole equipment; this device is manufactured by the Crelad

Company of Long Beach, California, and is available for purchase only.

Three samples are anticipated. One sample will be taken without any chemical treatment of the fluid, but the second and third samples will be taken under conditions such that the sampled fluid is treated with acid and with base, respectively, in order to insure that certain dissolved materials remain fixed in solution. These materials include carbon dioxide and mineral carbonates, hydrogen sulfide, and ammonia. Because of the lack of facilities in the field, analysis will be performed by DRI in Denver. Samples will be withdrawn by flushing the sampler with inert gas into a pressure vessel. Sample size is anticipated as 1 liter.

It is anticipated that the sampling device will become the property of the U.S. government and will remain with the U.S.G.S. truck.

(2) Analyses to be performed

Energetic potential. The pressure and temperature logs will permit analysis of the energy that the well is capable of delivering.

These logs will be used to select the correct model for simulation of well bore hydraulics. There are several models available, including the model developed by Dr. G. E. Coury under subcontract to DRI in ERDA Contract No. EY-76-S-02-2729.*000. This model is available as a FORTRAN computer program that can be programmed for the Burroughs 6700 digital computer of the University of Denver.

With the model verified, well parameters such as diameter and flow rate will be varied in order to find the optimum production schedule for this particular resource. The results can then be extended to other wells in the Roosevelt field, subject to the limitation that the other wells are cased, as 14-2 is (14-2 is cased only to the top of the producing horizon).

Geochemical limitations. It is well known that many geothermal resources are "chemically limited". Constriction and plugging of well bores by carbonate and siliceous deposits, especially at the point of flashing, are well known phenomena.

One of the investigators has worked with both dissolved gases[2] and silica chemistry in brines in recent months, and DRI proposes to use its unique body of knowledge in these fields in the investigations related to the Roosevelt field.

First the measurements of the dissolved gases (see 3(c)1 above) will provide the basis for estimating when gas bubbles will appear in the flowing fluid and contribute to the "bubble flow" regime of two-phase flow. This analysis depends on the coupled equilibria between CO_2-carbonate-bicarbonate species (M_2S, NH_3, metals) on the carbonate equilibria and on silica. This will require a mathematical analysis based upon a computer routine. DRI performed a similar exercise in 1973[3].

The second analysis is the estimation of the point at which carbonate scale may form. This usually occurs at the flash point, where the liquid pH drops suddenly as the vapor phase becomes enriched in CO_2, but the potential for carbonate scaling may appear much sooner. This can be estimated by methods which have been published; the procedure is very accurate with respect to calcium carbonate, but magnesium, iron and other potentially scaling cations are attended with some uncertainty. The best procedure may be to consider total hardness.

As an example, the points at which the well casing telescopes are

2. L. W. Ross, "Solubility of Gases in Fluids under Geothermal Conditions." Paper for the 1977 annual meeting of the GRC, San Diego, May 11, 1977.
3. H. P. Larsen, J.K.P. Shou and L. W. Ross, "Chemical Treatment of Metal-Bearing Mine Drainage." J. Water Pollution Control Fed. 45, 1682-95 (1973).

points where the pressure may change significantly during flow, and thus they may present the opportunity for scale buildup. There is concern around the geothermal industry that there may be a scaling hazard associated with telescoping. Consequently, the telescoping of a well may be a significant aspect of its design, not only for hydraulic and drilling/completion reasons but also for scaling reasons.

4. Schedule of investigations and ERDA publication

a. Schedule of well testing procedures

(1) lead time: 4 - 6 weeks

This includes such things as:

liability, confidentiality, and insurance agreements
scheduling exact well testing dates
scheduling well services equipment and rentals
final preparation and calibration of DRI probe

(2) well test: 10 days - 2 weeks

This includes:

travel time to Roosevelt KGRA
USGS and DRI testing (USGS or Sandia Labs)
return travel time

(3) reduction and interpretation of data - 2 - 3 weeks

analysis, computation, etc.
(engineering and time required)

b. Justification of six month program

Although the actual time frame appears to be three months, past experience has shown us that a "safety factor" is necessary. We request an extra three months to allow for slippage in flow tests, coordination with U.S.G.S., etc.

c. Earliest publication dates

All data derived directly from these well tests are available immediately to ERDA for publication. Permission for immediate release has

been affirmed by Thermal Power Company.

Data which is derived from well testing will be used by DRI in computer applications and other aspects as mentioned in this proposal. This data will be submitted to ERDA for publication immediately upon data reduction, interpretation, and formulation into final report form.

5. Environmental evaluation

a. Environment affected

There are anticipated minimal environmental effects as the result of this testing. Those areas which may undergo environmental impact are discussed below.

(1) well site and pad: minimal to no effect

The only impact to existing conditions would be the result of vehicle movement and the effects of flow line construction. No modifications need be made to the drill pad.

(2) roads to well site: minimal or no effect

Increased traffic for a brief period may be the only impact.

(3) dismantling and reconstruction of flow line: minimal impact

To perform these tests the flow line from the wellhead of "Utah State" 72-16 to the sump must be dismantled and moved to the well site of 14-2 where it will be reconstructed from the wellhead to the sump. The impact of this work will be minimal since most construction will take place on existing well sites and drill pads.

(4) reworking and modification of sump: minimal impact

Before flow can be directed into the sump some further modification must be conducted. This will probably entail limited caterpillar work. The maximum impact could be destruction of one or two junipers or small pines.

(5) liquid flow into sump: nominal environmental effect

Due to the size of the sump only 48 hours of flow can be allowed. This will fill the sump to its maximum. With the sump modifications described in (4) there would be no fluid leaks or emissions out of the sump or pond itself.

(6) steam venting to the atmosphere: minimal impact

From previous flow testing of 14-2 there has been no recognizable environmental impact to the area. The chemistry of the vapor emitted during flow testing at other Thermal Power and Phillips wells in the Roosevelt KGRA lends support to the potential of minimal environmental impact from these tests.

(7) noise: minimal impact

Loud noise is incurred as the result of flow into the sump and steam venting. Depending upon the distance from the sump to the wellhead, the effect to testing personnel can be determined. Noise incurred to unrelated personnel will be nonexistent as the nearest community (Milford) is 15 miles away.

b. Long term environmental impact

None is anticipated. The only feasible long term impact is the killing of a few trees (unlikely) due to caterpillar work, or if the sump/pond were to leak. No long term atmospheric impact is foreseen.

c. Potential land use impacts

None. These tests will be conducted using existing facilities.

C. COSTS

1. Detailed breakdown of the estimated or actual total costs

a. Salaries and Wages

	Man-Months	Average Rate/Month*	Cost
Engineer - A (Ross)	4	$2,870	$11,480
Engineer - A (Williams)	1	2,870	2,870
Geologist - C (Dick)	2.25	1,785	4,015
Instrumentation Specialist (Brown)	1	1,775	1,775
Clerical	.75	825	620
			$20,760
5% direct salary increase as of July 1, 1977			1,040
Total direct salaries			21,800

*Average rate includes 15.6% fringe benefits and 16% vacation and sick leave reserve.

b. Indirect Costs

Based on 51.4% of direct salaries	11,205

c. Travel

San Francisco 3 trips	R/T*	315	945
Albuquerque*** 2 trips	R/T*	220	440
Washington, D.C. 1 trip	R/T*	400	400
Roosevelt KGRA Field Testing	R/T**		755
Total travel			2,540

*This includes air and surface travel plus 2 days per diem.
**Includes air and surface travel plus 3½ days per diem for 2 men.
***If Sandia option is required.

d. Equipment

Wellhead hardware

10", 600 psi ANSI adaptor flange	100	
Geothermal effluent sampling bomb plus 6" riser string lubricator	10,000	
Total equipment expense		10,100

e. Supplies and Expense

(1) Supplies

Telephone (LD + WATS)	100
Graphics, materials, xerox	300

(2) Expenses

Dismantling of flowline at 72-16 and reconstruction at well 14-2	6,000	
Fishing cost insurance to $25,000		
Premium	765	
Deductible*	2,500	
Well liability[4]		
Sandia expenses**		
Instrument rental	360	
Diesel tractor R/T (Denver - Albuquerque - Roosevelt)***	995	
Crane rental		
5 days x 8 hrs/day x $50/hr	2,000	
Total supplies and expenses		13,020

*To be refunded if not needed.
**If Sandia option is required.
***This includes rental, driver, fuel, etc.

2. Proposed cost to government

a.	Salaries and Wages	21,800
b.	Indirect Costs	11,205
c.	Travel	2,540
d.	Equipment	10,100
e.	Supplies and Expenses	13,020
f.	General and Administrative Based on 16.3% of a, b, c, d, and e	9,560
	TOTAL ESTIMATED BUDGET	$68,225

4. Thermal Power will not incur liability for damages to their wellhead, bore, casing or well site in general. DRI expects ERDA to be considered ultimately liable for any damages to the well except in the case of negligence by DRI or Thermal Power. The geologists and engineers of both DRI and Thermal Power feel there is very minimal likelihood of any well damages as the result of these tests.

D. Business and Management

1. Activities similar to the proposed activity

In September 1976 DRI led a team of investigators at the East Mesa geothermal field in the Imperial Valley California. The purpose of this investigation was to obtain field experience with the DRI temperature/pressure probe and to collect data from a flowing well in order to verify the wellbore simulation model developed by a subcontractor on a similar project.

Present among the team were members of DRI, the USGS team with the logging truck, and the subcontractor. The measurement series extended for one week, and included two days of flowing geothermal well tests. The probe functioned satisfactorily, and only minor wiring revisions were found to be necessary.

In conjunction with the previous well testing of DRI, we have been in close contact with the geothermal industry to perform similar well tests. DRI personnel are very active and well informed with the institutional and legal issues involved with well testing in private industrial wells.

Some members of the DRI staff are familiar with the Roosevelt Steam Field (see resumes). They have done geothermal exploration field work in the area and are aware of the land and leasing, well sites, and terrain of the Roosevelt KGRA.

2. Principal project personnel

The principal project personnel include the following members of the Denver Research Institute:

Jay D. Dick (Geologist)
Laurence W. Ross (Chemical Engineer)
Ralph E. Williams (Chemical Engineer/Geochemist)
Laurence L. Brown (Instrumentation Specialist)

The proposed research will be conducted within the Laboratories for Applied Mechanics of the Denver Research Institute and, as such, will fall under the general administrative supervision of Mr. Chester Hoggatt, Division Head. Technically, the program falls under the general supervision of Mr. Ralph E. Williams, Associate Head. Dr. L. W. Ross and Mr. Ralph E. Williams will serve as co-principal investigators on the proposed project.

DRI personnel are working in close conjunction with the following personnel of Thermal Power Company in the proposed investigation:

Keith R. Davis (Geologist)
Jake M. Rudisill (Reservoir Engineer)

Resumes of the DRI personnel are attached to this section of the proposal.

JAY D. DICK
Research Geologist, Laboratories for Applied Mechanics
Denver Research Institute, University of Denver

B.S. (Geology) Wheaton College 1973
M.S. (Geology) Northeast Louisiana University 1976

Mr. Dick's total effort at the Institute has been devoted to geothermal research. His main committment has been as "Project Coordinator of Field Operations" for the well testing procedures of Denver Research Institute's program of two-phase flow in geothermal energy sources. While working on this project Dick has been very involved with industrial dealings and procedures in geothermal well testing. He also has close ties and connections in the geothermal industry as a whole. Besides his work in coordination of field testing, Mr. Dick is actively involved in research into the drilling, reservoir fracturing, and utilization of hot dry rock geothermal energy sources.

Prior to joining the Institute in 1976, Dick served as an exploration geologist for Phillips Petroleum Company - Geothermal Operations in San Diego, California. While working for Phillips he became familiar with the Roosevelt Steam Field in southwest Utah. Mr. Dick has done exploration field work in the Roosevelt KGRA and is acquainted with the well sites and terrain of the area.

Dick's graduate studies were done in the field of geothermal temperature modeling. His work consisted of applying chemical and mineralogical geothermometers to a geothermal system in central Colorado. During Mr. Dick's graduate studies he was a temporary employee (consultant) of Occidental Petroleum - Geothermal Operations, as an exploration geologist.

Mr. Dick is an active member of the Geothermal Resources Council where he serves on the Exploration and Evaluation Subcommittee. He is also a member of Sigma Gamma Epsilon and has received research grants in geothermal energy from the Anschutz Corporation, Petro Lewis, Occidental Petroleum, and the Society of Sigma Xi.

LAURENCE W. ROSS
Research Engineer, Laboratories for Applied Mechanics
Denver Research Institute, University of Denver

B.S. (Chemical Engineering) Georgia Tech 1954
M.S. (Chemical Engineering) Georgia Tech 1956
Ph.D. (Chemical Engineering) Georgia Tech 1966

Dr. Ross has spent the past two years as Principal Investigator on ERDA Contract No. EY-76-S-02-2729.*000 entitled "Two-Phase Flow in Geothermal Energy Sources". He has initiated many of the industry contacts which now make DRI's involvement with the geothermal industry so well developed, and he has visited most of the industry personally. Dr. Ross serves the DRI geothermal effort as principal scientist for those portions of research contracts that involve advanced thermodynamics, heat transfer, and chemical kinetics. He was also Principal Investigator in 1976-1977 of a project entitled "A Study of Silica Scaling in High Recovery Reverse Osmosis Systems".

Prior to joining DRI on a full-time basis in 1975, Dr. Ross was Associate Professor of Chemical Engineering at the University of Denver and part-time research engineer at DRI. Earlier he was a member of the faculty of the Catholic University of America in Washington, D.C., a research engineer at the Georgia Institute of Technology, and a process engineer with the Union Carbide Corporation. He has more than 40 professional publications in fields of science and engineering, including two papers in the field of geothermal energy in 1977.

Dr. Ross is a member of the Geothermal Resources Council, and is very active in GRC affairs, most recently in the organization of the 1977 annual GRC meeting in San Diego, the first of its kind.

RALPH E. WILLIAMS
Associate Head, Laboratories for Applied Mechanics
Research Geochemist, Denver Research Institute

B.A. (Geology), University of Colorado, 1959
B.S. (Chemistry), University of Denver, 1965
M.S. (Chemical Engineering), University of Denver, 1970

Since joining the Institute in 1962, Mr. Williams' major efforts have been directed toward energy and environmental research. He is currently program manager for two geothermal programs: 1) To prepare a Design Manual for the extraction of two-phase fluids from wells, and 2) To prepare a "Users' Guide" for the exploitation of Hot Dry Rock.

Mr. Williams has also directed programs in the following:

- Oil Well Stimulation - Proprietary
- Oil Shale Fire/Explosion - TOSCO/Bureau of Mines
- Spontaneous Coal Combustion - D'Appolonia Consulting Engineers, Inc.
- Denver Air Pollution - EPA
- Balloon-borne Stack Emission Sampler - EPA
- Nuclear Rocket Engine - NASA
- Denver Technological Innovation Center - DUO/NSF
- Hydrometeor Photography - DNA
- Human Factors - Bureau of Mines/Navy
- Ambient Air Monitoring - Eastman Kodak
- Fabric Filter Symposium - American Air Filter
- Metal Particle Combustion - ONR/Eglin AFB/W-P AFB

Mr. Williams is a member of Sigma Gamma Epsilon, Sigma Xi, The Combustion Institute, and the Colorado Mining Association. He is a consultant to the National Science Foundation, Ordnance Engineering, Inc., and to Fay Associates. He is on the Colorado Governor's Task Force on Energy, and the National Transportation Research Board. He holds a Secret security clearance.

LARRY L. BROWN

Instrumentation Specialist, Laboratories for Applied Mechanics
Denver Research Institute, University of Denver

Mr. Brown is supervisor of the Electronic and Photo Instrumentation Laboratories for the Laboratories for Applied Mechanics and is involved in the design and fabrication of electronic circuits and systems for use in high energy deformation, cloud physics, information transfer and high velocity impact research. Calibration and repair of electronic circuits and systems is routinely accomplished during the course of the research activity. He has been an instructor in basic electronics and photo instrumentation for projects laboratories in the Mechanical Engineering Department at the University of Denver. He has designed and built instrumentation for pressure and temperature logging in real-time of geothermal wells.

Mr. Brown has been involved in the design and fabrication of electronic circuits and systems used by cardiovascular and pulmonary medical engineering laboratories, including input-output instrumentation and control interfacing for Digital Equipment Corporation, PDP-8 and NOVA computers. He has also been actively involved in the solar energy field, having designed and manufactured two models of electronic controllers for solar energy systems.

Mr. Brown is experienced in all types of photographic instrumentation from still to ultra high speed cinephotography and has conducted ballistic research using Schliern techniques. He is also experienced in darkroom procedures for black and white and color processing and printing.

Aviation has been an important part of Mr Brown's career as he has a commercial license, single and multi-engine with instrument rating and has flown experimental devices for cloud seeding operations for the University of Denver. Mr. Brown has 18 years' experience in the above capacities. He holds a Secret security clearance.

3. Operational plan

a. Field investigation

This will be the first phase of the proposed study. As in previous field work with the U.S.G.S., one week is anticipated at the well site. The well can only be flowed for 48 hours because of sump capacity, and the remaining three days will be used for nonflowing tests including a shut-in temperature log, caliper, televiewer, and possibly other U.S.G.S. logs. The shut-in logs are not believed necessary to the present investigation, but they are useful for familiarization, and the shut-in temperature log may be useful for comparison with the flowing temperature logs to provide an estimate of the heat transfer coefficient from the flowing fluid to surrounding earth.

An electronics specialist from DRI will be present at the field test to provide expertise in the measurements and (if necessary) on-site adjustments to the measuring equipment.

If field testing cannot be scheduled with the USGS due to reasons beyond the control of DRI, an alternative wireline rig may be available via Sandia Laboratories in Albuquerque, New Mexido. If Sandia's equipment and operations are used, the three days of static well testing will not be required.

b. Data reduction

The pressure and temperature logs will be analyzed for purposes of obtaining the P-T profile in the well. Data are recorded as resistance, and the resulting strip chart readouts must be converted to pressure and temperature afterward. Another part of the data reduction process is a search for anomalies such as rapid pressure changes.

c. Wellbore flow modeling

With the P-T profiles available, they can be supplied to the computer as data for modeling the two-phase flow situation in the wellbore. The computation is rapid, and can be completed quickly. A few permutations on well parameters for hypothetical wells may be performed to provide illustrations of how the field may be exploited.

d. Design analysis

The data from modeling (see c. above) will be analyzed to provide a recommended plan for design of wells in the Roosevelt field. This design plan will apply to individual wells, without reference to interactions between wells.

Geothermal staff at ERDA have pointed out the dangers of labeling a "good" well on the basis of any given parameter without assessing the entire thermodynamic cycle in which the well is employed. For example, inspection of a T-S diagram for steam quickly reveals that a 10°C drop in the rejection temperature is more valuable than an additional 10°C in the fluid at the wellhead. Because of these types of thermodynamic considerations, the processing pathways and the rejection conditions will be included in the analysis.

It is possible that the energy-extracting cycle will be chemically limited, but the successful experience of the Niland facility seems to indicate that even very high salinity and CO_2 content do not necessarily limit the process. This will be considered in the analysis.

The final report of the project will discuss the factors involved in optimum exploitation of the resource, with emphasis on graphs and charts. The step-by-step procedure of analysis will be illustrated by examples.

4. Primary technical contacts

Laurence W. Ross (Chemical Engineer)
Denver Research Institute
University of Denver
Denver, CO 80208
303-753-3383 or 303-753-2891

Jay D. Dick (Geologist)
Denver Research Institute
University of Denver
Denver, CO 80208
303-753-2891

Keith R. Davis (Geologist)
Thermal Power Company
601 California Street
San Francisco, CA 94108
415-981-5700 Ext. 164

Jake M. Rudisill (Reservoir Engineer)
Thermal Power Company
601 California Street
San Fancisco, CA 94108
415-981-5700 Ext. 162

Business Contacts

H.C. Mai
Director, Grants and Contracts
University of Denver
Denver, CO 80208
303-753-2121

5. The acceptability of the "General Contract Provisions" is discussed in the enclosed letter from Grants and Contracts, Denver Research Institute.

6. The "Program Technical Scope" set forth in ERDA RFP No. EY-R-08-0007, "Geothermal Reservoir Assessment Case Study", has been reviewed, and all data which will be furnished pursuant to a contract may be published.

7. The University's Financial Statement is enclosed with this proposal.

8. GSA Form 19B "Representations and Certifications" is enclosed.

CONTRACT PRICING PROPOSAL

(RESEARCH AND DEVELOPMENT)

Office of Management and Budget Approval No. 29-R0184

This form is for use when *(i)* submission of cost or pricing data (see FPR 1-3.807-3) is required and *(ii)* substitution for the Optional Form 59 is authorized by the contracting officer.

PAGE NO. | NO. OF PAGES

NAME OF OFFEROR	SUPPLIES AND/OR SERVICES TO BE FURNISHED
UNIVERSITY OF DENVER (COLORADO SEMINARY)	
HOME OFFICE ADDRESS University Park Denver, Colorado 80208	
DIVISION(S) AND LOCATION(S) WHERE WORK IS TO BE PERFORMED Denver Research Institute	TOTAL AMOUNT OF PROPOSAL $ 68,225
GOV'T SOLICITATION NO. EY-R-08-0007	

DETAIL DESCRIPTION OF COST ELEMENTS

1. DIRECT MATERIAL *(Itemize on Exhibit A)*			EST COST *($)*	TOTAL EST COST[1]	REFERENCE[2]
a. PURCHASED PARTS			13,020		
b. SUBCONTRACTED ITEMS					
c. OTHER—*(1)* RAW MATERIAL					
(2) YOUR STANDARD COMMERCIAL ITEMS					
(3) INTERDIVISIONAL TRANSFERS *(At other than cost)*					
TOTAL DIRECT MATERIAL				13,020	Ex. A
2. MATERIAL OVERHEAD[1] *(Rate %X$ base=)*					
3. DIRECT LABOR *(Specify)* months	ESTIMATED ~~HOURS~~	RATE/ ~~HOUR~~	EST COST *($)*		
Engineer A	4.00	2,870	11,480		
Engineer A	1.00	2,870	2,870		
Geologist C	2.25	1,785	4,015		
Instrumentation Specialist	1.00	1,775	1,775		
Secretarial/Clerical	0.75	825	620		
5% Direct Salary Increase as of 1 Jul 77			1,040		
TOTAL DIRECT LABOR				21,800	------
4. LABOR OVERHEAD *(Specify Department or Cost Center)*[1]	O.H. RATE	X BASE=	EST COST *($)*		
@ 51.4% of Direct Labor	51.4%	21,800	11,205		
TOTAL LABOR OVERHEAD				11,205	------
5. SPECIAL TESTING *(Including field work at Government installations)*			EST COST *($)*		
TOTAL SPECIAL TESTING					
6. SPECIAL EQUIPMENT *(If direct charge) (Itemize on Exhibit A)*				10,100	Ex. A
7. TRAVEL *(If direct charge) (Give details on attached Schedule)*			EST COST *($)*		
a. TRANSPORTATION					
b. PER DIEM OR SUBSISTENCE					
TOTAL TRAVEL				2,540	Ex. A
8. CONSULTANTS *(Identify—purpose—rate)*			EST COST *($)*		
TOTAL CONSULTANTS					
9. OTHER DIRECT COSTS *(Itemize on Exhibit A)*					
10. *TOTAL DIRECT COST AND OVERHEAD*					
11. GENERAL AND ADMINISTRATIVE EXPENSE *(Rate* 16.3% *of cost element Nos.* 1,3,4,6 & 7				9,560	------
12. ROYALTIES[1]					
13. *TOTAL ESTIMATED COST*				68,225	
14. FEE OR PROFIT					
15. *TOTAL ESTIMATED COST AND FEE OR PROFIT*					

OPTIONAL FORM 60
October 1971
General Services Administration
FPR 1-16.806
5060-101

This proposal is submitted for use in connection with and in response to *(Describe RFP, etc.)*
RFP No. EY-R-08-0007, "Geothermal Resevoir Assessment Case Study
University of Denver Proposal No. MC7740

and reflects our best estimates as of this date, in accordance with the Instructions to Offerors and the Footnotes which follow.

TYPED NAME AND TITLE	SIGNATURE
Howard L. Mai, Director Grants and Contracts	Howard L. Mai

NAME OF FIRM	DATE OF SUBMISSION
UNIVERSITY OF DENVER (COLORADO SEMINARY)	23 May 1977

EXHIBIT A—SUPPORTING SCHEDULE *(Specify. If more space is needed, use reverse)*

COST EL NO.	ITEM DESCRIPTION *(See footnote 5)*		EST COST *(S)*
1a.	Telephone (LD & Watts)	$ 100	
	Graphics, materials, xerox	300	
	Fishing cost insurance to $25,000 premium	765	
	deductible	2,500	
	Sandia expenses		
	Instrument rental	360	
	Diesel tractor RT (Denver-Albuquerque-Roosevelt)	995	
	Crane rental 5 days x 8 hrs./day x $50/hr.	2,000	
	Dismantling of flowline at 72-16 & reconstruction at well 14-2	6,000	$13,020
6.	Wellhead hardware		
	10", 600 psi ANSI adaptor flange	$ 100	
	Geothermal effluent sampling bomb plus 6" riser string lubricator	10,000	$10,100
7.	Denver/San Francisco, 3 trips $315/RT	$ 945	
	Denver/Albuquerque, 2 trips $220/RT	440	
	Denver/Washington, D. C., 1 trip $400/RT	400	
	Denver/Roosevelt KGRA Field Testing, 1 trip $755/RT	755	$ 2,540

I. HAS ANY EXECUTIVE AGENCY OF THE UNITED STATES GOVERNMENT PERFORMED ANY REVIEW OF YOUR ACCOUNTS OR RECORDS IN CONNECTION WITH ANY OTHER GOVERNMENT PRIME CONTRACT OR SUBCONTRACT WITHIN THE PAST TWELVE MONTHS?

☒ YES ☐ NO *(If yes, identify below.)* Defense Contract Audit Agency

NAME AND ADDRESS OF REVIEWING OFFICE AND INDIVIDUAL	TELEPHONE NUMBER/EXTENSION
New Custom House, Room 474, 19th and Stout Streets, Denver, Colorado 80202	303/837-3077

II. WILL YOU REQUIRE THE USE OF ANY GOVERNMENT PROPERTY IN THE PERFORMANCE OF THIS PROPOSED CONTRACT?

☐ YES ☒ NO *(If yes, identify on reverse or separate page)*

III. DO YOU REQUIRE GOVERNMENT CONTRACT FINANCING TO PERFORM THIS PROPOSED CONTRACT?

☒ YES ☐ NO *(If yes, identify.)*: ☐ ADVANCE PAYMENTS ☐ PROGRESS PAYMENTS OR ☐ GUARANTEED LOANS Monthly Invoices

IV. DO YOU NOW HOLD ANY CONTRACT *(Or, do you have any independently financed (IR&D) projects)* FOR THE SAME OR SIMILAR WORK CALLED FOR BY THIS PROPOSED CONTRACT?

☐ YES ☒ NO *(If yes, identify.)*:

V. DOES THIS COST SUMMARY CONFORM WITH THE COST PRINCIPLES SET FORTH IN AGENCY REGULATIONS?

☒ YES ☐ NO *(If no, explain on reverse or separate page)*

See Reverse for Instructions and Footnotes OPTIONAL FORM 60 (10-71)