



SENTURION SCIENCES' RESPONSE TO
REQUEST FOR PROPOSAL NO. EY-R-08-0007
GEOHERMAL RESERVOIR ASSESSMENT CASE STUDY

SENTURION SCIENCES, INC.

TULSA, U.S.A.

SENTURION SCIENCES' RESPONSE TO

REQUEST FOR PROPOSAL NO. EY-R-08-0007

GEOHERMAL RESERVOIR ASSESSMENT CASE STUDY

A. Senturion Sciences, Inc.
Post Office Box 15447
Tulsa, Oklahoma 74112

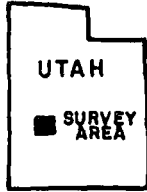
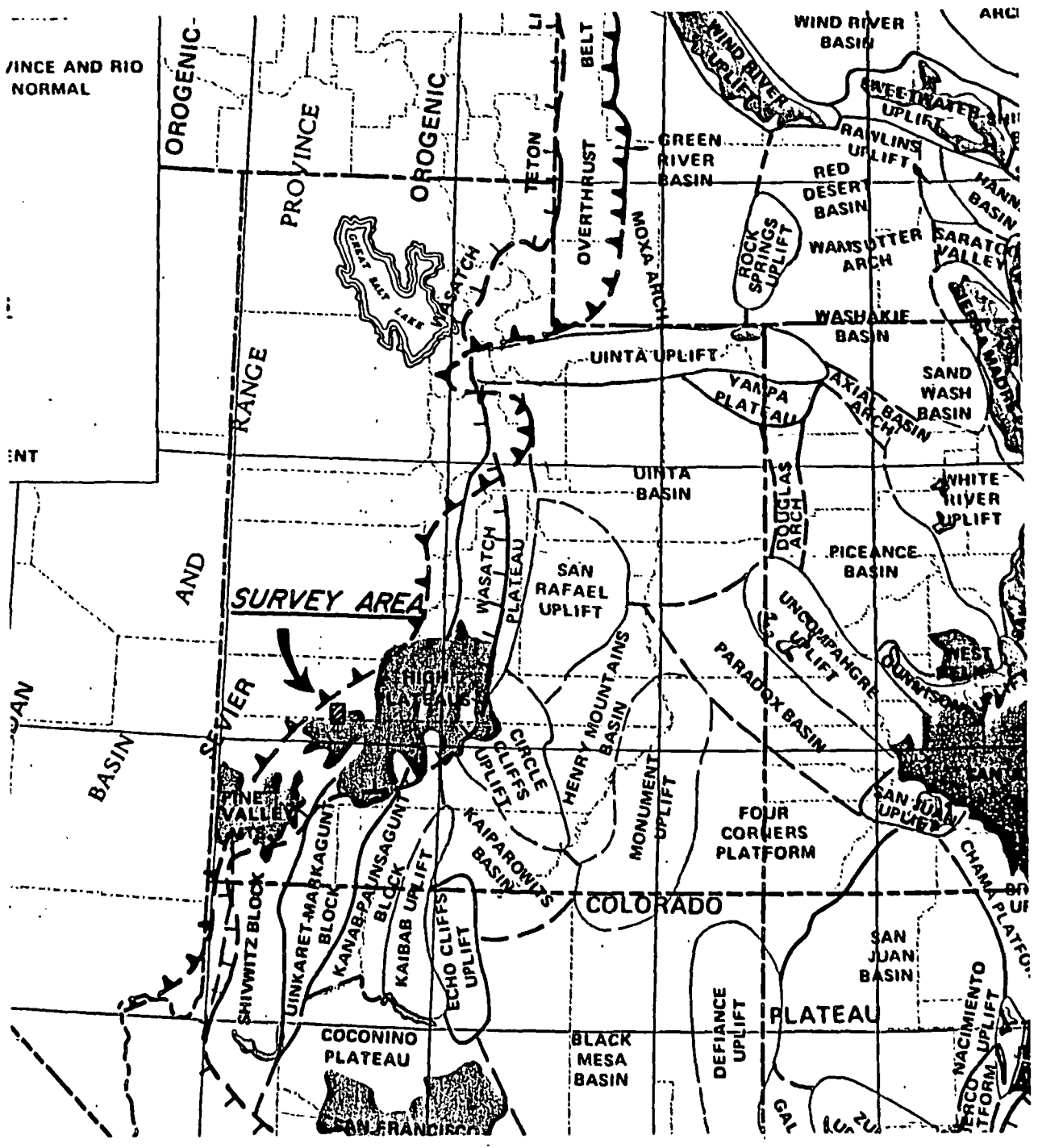
B. Technical Proposal

1. Investigation Area

- a. T. 30 S., R. 11 W., Beaver County, Utah (Figure 1)
- b. Data acquisition: April and May, 1973
Data interpretation: May and June, 1973
- c. The geology of the prospect is characterized by Quaternary alluvium and colluvium valley fill surrounded by ranges of Tertiary volcanic extrusive flows of basalt, andesite, dacite, and rhyolite. The geologic and topographic maps of the area indicate a collapsed caldera located in the Black Mountains, five miles south of the prospect. The small basin overlying the caldera is called Horse Valley. A high elevation separates Horse Valley from the main Escalante Valley to the west. These elevations rise a thousand feet above the valley floor, forming a small range of mountain peaks with a north-northeast trend, and covering an area of about 16 square miles. The surface is predominantly Late Tertiary rhyolite-dacite-quartz latite extrusive flows, suggesting the presence of a second caldera that has not reached the stage of collapse or explosion. A series of hot springs is located four miles north of the probable caldera and four miles west of the prospect. Temperatures of the springs range from 90° to 175° F. and flow 20 gallons per minute.
- d. Data for the seismicity study of the prospect were gathered by seismometer station networks laid out in the form of pentagonal, omnidirectional arrays with approximate four-mile diameters including five peripheral and one center seismic detector (Figure 2). The seismicity of the area proved to be very active. Geological conditions and the energetic seismicity of the prospect are criteria for a favorable geothermal project.

2. Program Data Offered

- b. The microearthquake survey is divided into Minersville and Minersville "A". The following is a list of the contents of the report:



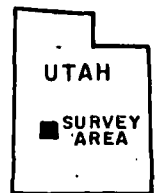
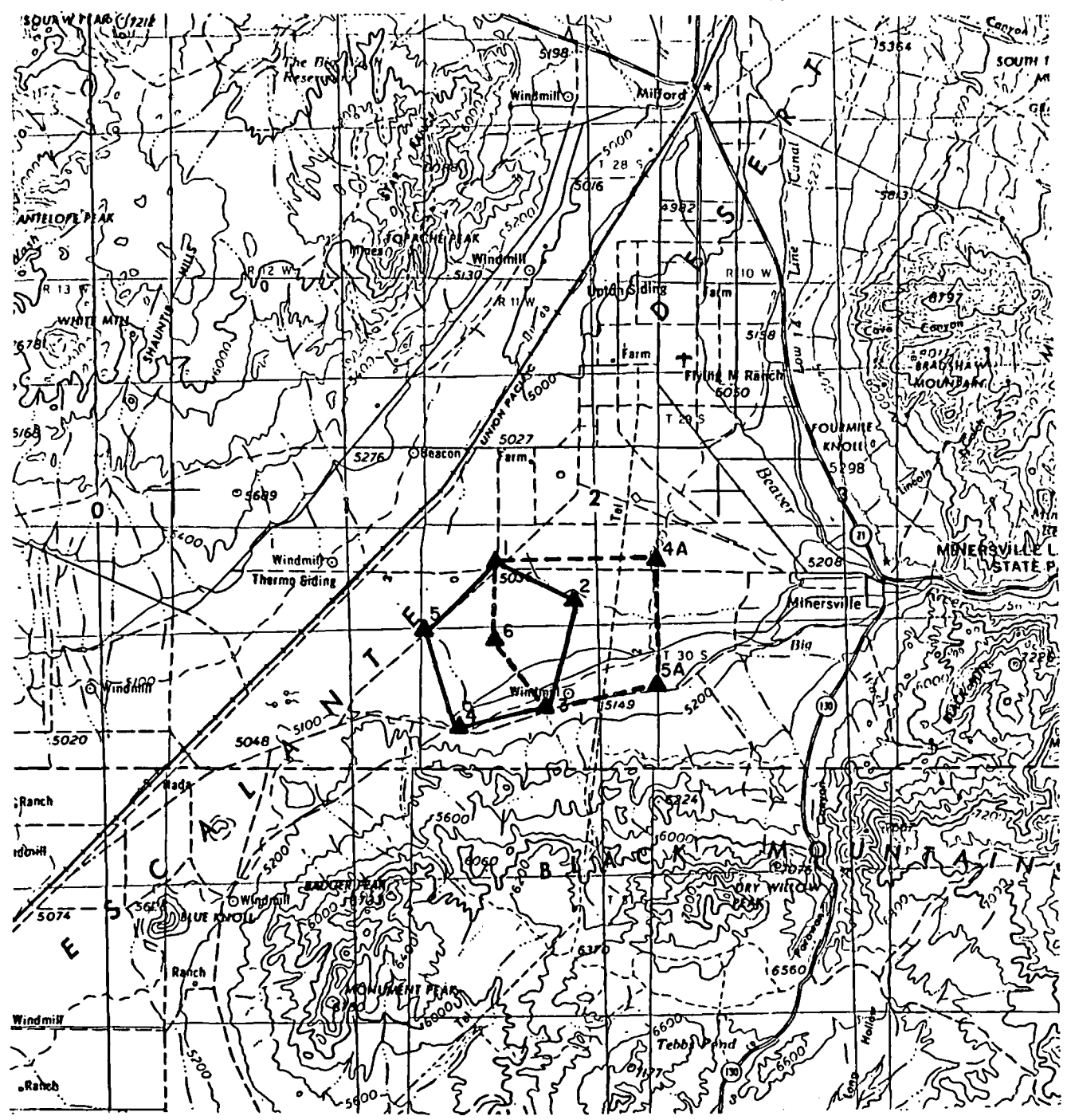
**TECTONIC SETTING OF
 MINERSVILLE, UTAH
 MICROEARTHQUAKE SURVEY**

**GEOHERMAL RESERVOIR
 ASSESSMENT CASE STUDY**

SCALE: 1:2,500,000
 FIGURE 1 SENTURION SCIENCES, INC.

R 12 W R 11 W R 10 W

T 28 S
T 29 S
T 30 S
T 31 S



SEISMOMETER STATIONS (▲)

MINERSVILLE, UTAH MICROEARTHQUAKE SURVEY

- MINERSVILLE ARRAY
- - - - MINERSVILLE A ARRAY

CONTOUR INTERVAL: 200 FT.
SCALE: 1:250,000

(RFP) NO. EY-R-08-0007

FIGURE 2 SENTURION SCIENCES, INC.

Minersville Seismic Summary
Minersville "A" Seismic Summary
Minersville and Minersville "A"; Seismicity vs. Calendar Day
Minersville; Seismicity vs. Time of Day
Minersville "A"; Seismicity vs. Time of Day
Minersville Prospect Seismometer Station Locations, and
Geologica and Geophysical Faults. Scale 1:62500
Epicenter Locations, and Geological and Geophysical Fault
Traces. Scale 1 inch = 1000 feet
Cross-sections A-a', B-B', C-C', and D-D'
Hypocenters Projected to Cross-section E-F
Hypocenters Projected to Cross-section G-H

3. Program Description

b. Surface Investigation

1. Completed investigation by Senturion Sciences, Inc., Tulsa, during April, May, and June, 1973.
2. This is a groundmotion/microearthquake investigation using a seismometer station network laid out in the form of a pentagon covering approximately 12 square miles. It consists of five peripheral and one central seismic detectors (Figure 2).

Tectonically-related microearthquakes are omnipresent in this active earth. Obviously, certain slabs and peripheral zones of plates are more active than other areas. The tectonically-related microseismicity are adjustments of fault blocks, slabs, and plates; and they evolve in a random scatter pattern. Seismicity that involves close clustering is characteristic of geothermal areas. Clusters occur in regions where the crust is weakened (rocks are hotter and weaker).

Senturion places considerable emphasis on locating events accurately because it is from the epicenter determinations that drilling targets are assigned and from which other derived quantities are dependent (i.e., fault plane solutions and magnitude determinations). Senturion's location capabilities provide accurate epicenters within less than 10% to distances of 200 km (125 miles) when using standard, six-station, 7-10 km diameter omnidirectional arrays. The processing techniques used by Senturion include time expansion and phase correlation capabilities which are necessary for phase identification and precise timing. For local events in which high precision is desired, we use more stations with array diameters dependent on the depth(s) of interest. All events are processed to maximize location accuracies by Senturion's Hypovector analysis. This entails use of apparent velocity vectors developed by Senturion to check phase arrival times and to measure phase and media velocities. Following this, hypocenters (event foci) are calculated.

4. Schedule: This investigation is completed and ready for immediate release.
5. Environmental Evaluation
 - a. The environment was barely touched. A small truck was driven to the array several times, and several shallow holes (less than two-feet deep) were dug for seismometer placement.
 - b. There was no environment impact.
 - c. There was no conflict with existing land use patterns and programs.

C. Costs

1. This groundmotion/microearthquake program in the Thermo-Minersville area required 45 days of survey. The results of both surveys are available at \$1200 per day for a total of \$54,000. The program reflects a coincidence in groundmotion anomalies and microearthquake occurrence. The program includes leap-frogging pentagonal arrays (plus a center seismometer) in various dimension recording modes. Microearthquake locations and hypocenters were recorded only when we had very good array patterns (approximately four-mile diameter arrays). Cost breakdown is as follows:

Two technicians at \$8 per hour for 45 days -----	\$ 5760.00
One geophysicist at \$12 per hour for 75 days (30 days of which were in the office) -----	7200.00
Amortization of field equipment (\$220 x 1.5 [\$70,000] x 3 years, or \$2700 per month -----	4050.00
Amortization of playback equipment -----	1600.00
Computer time -----	6500.00
Field vehicles at 50¢ per mile at 90 miles per day (including depreciation, operation, and maintenance) -----	2025.00
Drafting for six days at \$8 per hour -----	384.00
Secretarial for 10 days at \$6 per hour -----	480.00
Per diem for three men at \$48 days each -----	6480.00
	<u>\$34,479.00</u>
Service Company (G&A) -----	51,718.00
Fee (10%) -----	5100.00
	<u>\$56,818.00</u>

2. Proposed cost to the Government: \$54,000

D. Business and Management

1. Experience--Senturion personnel have over 30 man-years of experience in groundmotion and microearthquake surveying. Seventy-five groundmotion and 40 microearthquake surveys have been conducted for clients over the past six years. Surveys have been in Arizona, California, Colorado, Idaho, Oregon, Wyoming, Nevada, and Utah. Major Clients include Phillips Petroleum Company, Sun Energy and Development Company, Getty Oil Corporation, Amax Exploration, Inc., Union Oil Company of California, and Chevron Oil Company.
2. Principal Project Personal: Paul Caton (resume included).
3. Operational Plan Used:

Seismometers having a natural frequency of 2 Hz were buried in the soil at a depth of one to two feet. The signals were amplified and sent to an R.F. transmitter and transmitted to a central recording station. At the recording station, the signals were discriminated and recorded on an FM tape recorder providing 24-hour records. The tapes were sent back to Senturion in Tulsa, and the data were reproduced by multi-speed tape recorders. Records were edited and selected events were reproduced at a greatly expanded scale, allowing accurate timing. From the expanded records, arrival times were picked and entered in a computer along with station location information to compute epicenters and hypocenters.

4. Business and Technical Contacts
 - a. T. C. Wesson; Energy Research and Development Administration; Post Office Box 1398; Bartlesville, Oklahoma 74003; Phone: 918-336-2400 (ERDA-Senturion article in Appendix)
 - b. William J. Zwart; Amerada Hess Corporation; Post Office Box 2040; Tulsa, Oklahoma 74105; Phone: 918-584-5554
 - c. Stephen B. Evans; Rainbow Resources, Inc.; 10 Lakeside Lane; Denver, Colorado 80212; Phone: 303-458-5663.
 - d. Robert C. Roesch; Energy Reserves Group, Inc.; Suite 3200, First of Denver Plaza; Denver, Colorado 80202; Phone: 303-572-3323
 - e. Ronald C. Barr; Earth Power Corporation; Post Office Box 1566; Tulsa, Oklahoma 74101; Phone: 918-587-9704
 - f. Richard F. Dondanville; Union Oil Company of California; Post Office Box 7600' Los Angeles, California 90051; Phone: 213-486-6600
 - g. Robert C. Edmiston; Chevron Oil Company; Post Office Box 7643; San Francisco, California 94120; Phone: 415-894-0673
 - h. Gary W. Crosby; Phillips Petroleum Company; Post Office Box 752; Del Mar, California 94120; Phone: 715-755-0131

- i. Milton McKenzie; Viking Petroleum, Inc.; 2805 East Skelly Drive, Suite 806; Tulsa, Oklahoma 74105; Phone: 918-749-2296.
5. Senturion accepts the "General Contract Provisions"
6. The "Program Technical Scope" set forth in RFP No. EY-R-08-0007 has been reviewed, and all data which will be furnished pursuant to a contract may be published.
7. Senturion Sciences is a closed corporation and does not prepare a certified financial statement. Senturion's financial capability to carry out this program is evidenced by being in business for six years and the list of satisfied clients included under Section 4 of this proposal.
8. GSA Form 19B, "Representation and Certifications," is enclosed. There is no proprietary information in this proposal.

PROFESSIONAL RECORD

Name: PAUL CATON Title: Mathematical Geophysicist

Years Actively Engaged in Profession: 1960 - Present

Academic Training:

University of Alaska
University of Tulsa

B.S. Geology, 1960
PhD Geophysics, 1973

Employment Record:

August 1971 to present

Senturion Sciences, Inc.

1968 - 1971

University of Tulsa

1960 - 1968

Amerada Hess

Professional Experience:

Senturion Sciences, Inc.

Performing mathematical simulation and computer modeling of physical phenomena. Responsible for microearthquake analysis and earth structure derivation via surface and body wave analysis.

University of Tulsa

Instructor, University of Tulsa Department of Physics and Science. Duties included teaching basic physics and empirical analysis. Research included evaluation of data concerning fault movements and crustal studies in and about rift systems.

Amerada Hess

Chief Observer. Responsible for evaluating seismic field data as well as performing parameter computations for continuous seismic profiling.

Society Affiliations:

American Geophysical Union
Seismological Society of America
Society of American Geophysicists

Publications (In Press):

Plane Wave Apparent Velocity Vectors: an aid for accurate event location using portable seismometer arrays.

Publications (Continued):

Accuracy of Poisson's ratio determinations from small array data.

PhD Dissertation: The Surtsey pond problem; determination of mean sea level.

REPRESENTATIONS
AND CERTIFICATIONS
(Construction Contract)
(For use with SF 19 and 21)

REFERENCE (Enter same No. (s) as on SF 19/21)
APPROP. NO. EY-R-08-0007
PROJECT NO.
CONTRACT NO.

NAME AND ADDRESS OF BIDDER (No., Street, City, State, and ZIP Code)

Senturion Sciences, Inc.
1539 North 105th East Avenue, Post Office Box 15447
Tulsa, Oklahoma 74112

DATE OF BID

May 27, 1977

DATE OF INVITATION

March 25, 1977

In negotiated procurements, "bid" and "bidder" shall be construed to mean "offer" and "offeror."

The bidder makes the following representations and certifications as a part of the bid identified above. (Check appropriate boxes.)

1. SMALL BUSINESS

He is, is not, a small business concern. (For this purpose, a small business concern is a business concern, including its affiliates, which (a) is independently owned and operated, (b) is not dominant in the field of operation in which it is bidding on Government contracts, and (c) had average annual receipts for the preceding 3 fiscal years not exceeding \$7,500,000. For additional information see governing regulations of the Small Business Administration.)

2. CONTINGENT FEE

(a) He has, has not, employed or retained any company or person (other than a full-time bona fide employee working solely for the bidder) to solicit or secure this contract, and (b) he has, has not, paid or agreed to pay any company or person (other than a full-time bona fide employee working solely for the bidder) any fee, commission, percentage or brokerage fee, contingent upon or resulting from the award of this contract; and agrees to furnish information relating to (a) and (b) above as requested by the Contracting Officer. (For interpretation of the representation, including the term "bona fide employee," see Code of Federal Regulations, Title 41, Subpart 1-1.5.)

3. TYPE OF ORGANIZATION

He operates as an individual, partnership, joint venture, corporation, incorporated in State of Delaware.

4. INDEPENDENT PRICE DETERMINATION

(a) By submission of this bid, each bidder certifies, and in the case of a joint bid each party thereto certifies as to his own organization, that in connection with this procurement:

(1) The prices in this bid have been arrived at independently, without consultation, communication, or agreement, for the purpose of restricting competition, as to any matter relating to such prices with any other bidder or with any competitor;

(2) Unless otherwise required by law, the prices which have been quoted in this bid have not been knowingly disclosed by the bidder and will not knowingly be disclosed by the bidder prior to opening, in the case of a bid, or prior to award, in the case of a proposal, directly or indirectly to any other bidder or to any competitor; and

(3) No attempt has been made or will be made by the bidder to induce any other person or firm to submit or not to submit a bid for the purpose of restricting competition.

(b) Each person signing this bid certifies that:

(1) He is the person in the bidder's organization responsible within that organization for the decision as to the prices being bid herein and that he has not participated, and will not participate, in any action contrary to (a)(1) through (a)(3) above; or

(2) (i) He is not the person in the bidder's organization responsible within that organization for the decision as to the prices being bid herein but that he has been authorized in writing to act as agent for the persons responsible for such decision in certifying that such persons have not participated, and will not participate, in any action contrary to (a)(1) through (a)(3) above, and as their agent does hereby so certify; and (ii) he has not participated, and will not participate, in any action contrary to (a)(1) through (a)(3) above.

(c) This certification is not applicable to a foreign bidder submitting a bid for a contract which requires performance or delivery outside the United States, its possessions, and Puerto Rico.

(d) A bid will not be considered for award where (a)(1), (a)(3), or (b) above, has been deleted or modified. Where (a)(2) above, has been deleted or modified, the bid will not be considered for award unless the bidder furnishes with the bid a signed statement which sets forth in detail the circumstances of the disclosure and the head of the agency, or his designee, determines that such disclosure was not made for the purpose of restricting competition.

THE FOLLOWING NEED BE CHECKED ONLY IF BID EXCEEDS \$10,000 IN AMOUNT.

5. EQUAL OPPORTUNITY

He has, has not, participated in a previous contract or subcontract subject to the Equal Opportunity Clause herein, the clause originally contained in Section 301 of Executive Order No. 10925, or the clause contained in Section 201 of Executive Order No. 11114; he has, has not, filed all required compliance reports; and representations indicating submission of required compliance reports, signed by proposed subcontractors, will be obtained prior to subcontract awards. (The above representation need not be submitted in connection with contracts or subcontracts which are exempt from the clause.)

NOTE.—Bids must set forth full, accurate, and complete information as required by this invitation for bids (including attachments). The penalty for making false statements in bids is prescribed in 18 U.S.C. 1001.

6. PARENT COMPANY AND EMPLOYER IDENTIFICATION NUMBER

Each bidder shall furnish the following information by filling in the appropriate blocks:

(a) Is the bidder owned or controlled by a parent company as described below? Yes No. (For the purpose of this bid, a parent company is defined as one which either owns or controls the activities and basic business policies of the bidder. To own another company means the parent company must own at least a majority (more than 50 percent) of the voting rights in that company. To control another company, such ownership is not required; if another company is able to formulate, determine, or veto basic business policy decisions of the bidder, such other company is considered the parent company of the bidder. This control may be exercised through the use of dominant minority voting rights, use of proxy voting, contractual arrangements, or otherwise.)

(b) If the answer to (a) above is "Yes," bidder shall insert in the space below the name and main office address of the parent company.

NAME OF PARENT COMPANY	MAIN OFFICE ADDRESS (No., Street, City, State, and ZIP Code)
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(c) Bidder shall insert in the applicable space below, if he has no parent company, his own Employer's Identification Number (E.I. No.) (Federal Social Security Number used on Employer's Quarterly Federal Tax Return, U.S. Treasury Department Form 941), or, if he has a parent company, the E.I. No. of his parent company.

EMPLOYER IDENTIFICATION NUMBER OF	<input checked="" type="checkbox"/> PARENT COMPANY Senturion Sciences, Inc.	<input type="checkbox"/> BIDDER E.I. #73-0800505
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7. CERTIFICATION OF NONSEGREGATED FACILITIES

(Applicable to (1) contracts, (2) subcontracts, and (3) agreements with applicants who are themselves performing federally assisted construction contracts, exceeding \$10,000, which are not exempt from the provisions of the Equal Opportunity clause.)

By the submission of this bid, the bidder, offeror, applicant, or subcontractor certifies that he does not maintain or provide for his employees any segregated facilities at any of his establishments, and that he does not permit his employees to perform their services at any location, under his control, where segregated facilities are maintained. He certifies further that he will not maintain or provide for his employees any segregated facilities at any of his establishments, and that he will not permit his employees to perform their services at any location, under his control, where segregated facilities are maintained. The bidder, offeror, applicant, or subcontractor agrees that a breach of this certification is a violation of the Equal Opportunity clause in this contract. As used in this certification, the term "segregated facilities" means any waiting rooms, work areas, rest rooms and wash rooms, restaurants and other eating areas, time clocks, locker rooms and other storage or dressing areas, parking lots, drinking fountains, recreation or entertainment areas, transportation, and housing facilities provided for employees which are segregated by explicit directive or are in fact segregated on the basis of race, color, religion, or national origin, because of habit, local custom, or otherwise. He further agrees that (except where he has obtained identical certifications from proposed subcontractors for specific time periods) he will obtain identical certifications from proposed subcontractors prior to the award of subcontracts exceeding \$10,000 which are not exempt from the provisions of the Equal Opportunity clause; that he will retain such certifications in his files; and that he will forward the following notice to such proposed subcontractors (except where the proposed subcontractors have submitted identical certifications for specific time periods):

NOTICE TO PROSPECTIVE SUBCONTRACTORS OF REQUIREMENT FOR CERTIFICATIONS OF NONSEGREGATED FACILITIES

A Certification of Nonsegregated Facilities must be submitted prior to the award of a subcontract exceeding \$10,000 which is not exempt from the provisions of the Equal Opportunity clause. The certification may be submitted either for each subcontract or for all subcontracts during a period (i.e., quarterly, semiannually, or annually).

NOTE: The penalty for making false statements in offers is prescribed in 18 U.S.C. 1001.

8. The bidder, its officers or agents, have, have not, refused to furnish to any Government agency or any establishment in the legislative or judicial branch of the Government information or records reasonably pertinent to any Government contract in connection with which the bidder has performed work or furnished materials or supplies or undertaken to do so.