



FIXED PRICE
RESEARCH & DEVELOPMENT CONTRACT
Specimen Contract Dated 1/7/00

Contract No. TBD

BETWEEN

CALIFORNIA INSTITUTE OF TECHNOLOGY
JET PROPULSION LABORATORY
(The "Institute" or "JPL")
4800 OAK GROVE DRIVE
PASADENA, CALIFORNIA 91109-8099

AND

TBD

THIS CONTRACT FOR

Terrestrial Planet Finder (TPF) Architecture Study

IS A

SUBCONTRACT UNDER JPL's NASA PRIME CONTRACT

TASK ORDER NO. **10284**

A DO - C9 Rating is assigned to this Contract under DMS Regulation 1

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SIGNATURE PAGE 15

The following documents are included by reference in this contract. Copies of these documents can be obtained at <http://acquisition.jpl.nasa.gov/e2000.htm>.

GENERAL PROVISIONS: Fixed-Price Research and Development Contract

JPL 1737, "Release of Information."

JPL 2385, "Notification to Prospective Contractors of JPL's Ethics Policies and Anti-Kickback Hotline."

JPL 2892, "Certifications of Nonsegregated Facilities, Clean Air and Water, Anti-Kickback Compliance, Americans with Disabilities Act Compliance, Certification and Disclosure Regarding Payments to Influence Certain Federal Transactions, Certification of Full Disclosure Regarding Debarred, Suspended, or Proposed for Debarment Status, and Certification of Toxic Chemical Release Reporting."

JPL 2895, "Asbestos Notification."

ADDITIONAL GENERAL PROVISIONS (AGPs)

Cost Accounting Standards and Administration of Cost Accounting Standards

New Technology

Or

Patent Rights - Retention By The Contractor (Short Form)

Safety And Health

Progress Payments

Or

Progress Payments - Small Business

Audit-Negotiation - Access to Computers

Security Requirements for Unclassified Automated Information Resources and Access to JPL's Controlled Facilities, Material, and JPL Web Space Domain

Special Test Equipment

Special Tooling

PREAMBLE

This Contract, entered into on
by and between the CALIFORNIA INSTITUTE OF TECHNOLOGY
(hereinafter called the "Institute" or "JPL"), a corporation organized and existing under the laws of the State
of California, and **'TBD'**
(hereinafter called the "Contractor"), a corporation organized and existing under
the laws of the State of **TBD** and constituting a subcontract under Prime Contract NAS7-1407 between
the Institute and the Government;

WITNESSETH THAT:

The Contractor agrees to furnish and deliver the supplies and perform the services set forth in this Contract
for the consideration stated herein.

Schedule

ARTICLE 1. STATEMENT OF WORK AND DELIVERY INSTRUCTIONS

On or Before

- 1.0 The Contractor shall develop mission architectures and explore variants of architectures for the Terrestrial Planet Finder (TPF) mission that meet the science requirements stated in Exhibit II, are consistent with the anticipated mission schedule shown in Exhibit III, and can be implemented in a cost effective manner. This study shall be performed in accordance with the requirements set forth below and in accordance with the Exhibits stated herein. In the performance of this effort, the Contractor shall:
- 1.1 Provide a broad preliminary architecture trade study (also referred to as Phase 1) to include the following: 10/2/2000
- 1.1.1 A diverse set of potentially viable architecture options for the TPF mission that meet the science requirements as outlined in Exhibit II, are consistent with the schedule as outlined in Exhibit III, and specifically including, but not limited to:
- 1.1.1.1 Architectures evolved from earlier studies and/or outlined in Exhibit I.
- 1.1.1.2 Architectures substantially different from those previously explored in earlier TPF studies.
- 1.1.1.3 Architectures not based on nulling interferometry. Architectures in this category are exempt from Exhibit II Section III Line 2.
- 1.1.2 For each architecture studied, the possible astrophysical research and studies not related to planet detection that could be performed shall be described.
- 1.2 Conduct a Preliminary Architecture Review (PAR) consisting of oral presentations that include a review of the full range of architectures explored by the Contractor under paragraph 1.1 at JPL or at a location mutually agreed upon between JPL and the Contractor. 10/2/2000
- 1.2.1 Provide viewgraphs and the recommended architecture(s) yielded from the effort defined in paragraph 1.1. 9/25/2000
- 1.3 Participate with JPL in an Architecture Down-Select process, following the PAR, to select two (2) or more architectures, as described below, for further study under the remainder of the contract. 10/2/2000

- 1.3.1 Architectures shall be evaluated based on performance relative to the planetary detection science requirements, astrophysical science opportunities, technology requirements, life-cycle cost, risk, reliability/robustness, and heritage that they provide for future planet detection and characterization missions.
 - 1.3.2 The Contractor shall select one (1) architecture with JPL consent for further study.
 - 1.3.3 JPL will select one (1) architecture, from those presented, for further study by the contractor.
 - 1.3.4 Upon mutual agreement between JPL and the Contractor, additional architectures may be selected for further study.
- 1.4 Provide two or more comprehensive, optimized architecture studies (also referred to as Phase 2) for the TPF mission, including minor variants. The specific architectures to be studied in this phase of the effort shall be determined as a result of an Architecture Down-Selection (1.3) following the Preliminary Architecture Review. The studies must be of sufficient depth and detail to enable: 9/5/2001
- 1.4.1 Evaluation of the extent to which the architecture concept can meet the science requirements given in Exhibit II.
 - 1.4.2 Development of computer models as outlined in paragraph 1.6.
 - 1.4.3 Development of a life-cycle cost estimate as outlined in paragraph 1.7.
 - 1.4.4 Identification of technology needs and development of a technology roadmap as outlined in paragraph 1.8.
- 1.5 At a minimum, the following items must be studied for each down selected architecture and the results presented at the Final Review:
- 1.5.1 Overall observatory geometry and array configuration, as applicable, including requirements on tolerances and geometry.
 - 1.5.2 Complete end-to-end optical layout, specifically including noise reduction techniques (e.g. chopping), including requirements on tolerances and geometry.

- 1.5.3 Optical beam transport concepts including techniques to minimize unwanted straylight including glint, diffraction effects, and thermal emission,
 - 1.5.4 Effects of disturbances (mechanical, thermal, and other) on observatory performance and proposed disturbance mitigation techniques,
 - 1.5.5 Detector requirements (including cooling systems as applicable),
 - 1.5.6 Molecular and particulate contamination effects on optical and thermal surfaces and proposed mitigation techniques,
 - 1.5.7 Requirements on cryogenic components including mechanisms, actuators, optical elements, and opto-mechanical subsystems,
 - 1.5.8 Thermal design concepts,
 - 1.5.9 Approaches for integration-and-test and pre-launch performance verification,
 - 1.5.10 Orbit and sky coverage,
 - 1.5.11 Launch strategy,
 - 1.5.12 Deployment strategy as applicable,
 - 1.5.13 Operations scenario,
 - 1.5.14 Other observatory systems identified as relevant during the study,
- 1.6 Utilizing the software described in 1.14, provide the following in electronic format, complete with documentation: 8/31/2001
- 1.6.1 Optical, structural, thermal and control system computer models of the proposed architectures.
 - 1.6.2 Integrated end-to-end performance computer models demonstrating that the scientific goals, as defined in Exhibit II, will be met.
- 1.7 Provide a life-cycle cost estimate for the following: 1) technology development, 2) formulation, 3) implementation, 4) launch and deployment, and 5) mission operations phases. 8/31/2001

- 1.8 Provide requirements for proposed architecture-related technology development consisting of: 8/31/2001
- 1.8.1 A listing of technology needs.
 - 1.8.2 A roadmap for technology development.
 - 1.8.3 Metrics for assessing technology maturity and readiness.
 - 1.8.4 Identification of technologies requiring flight validation.
 - 1.8.5 Specification of the requirements that the architecture places on a formation-flight space demonstration for those architectures that are based on formation-flying.
- 1.9 Attend a one-day technical Kick-Off meeting held at JPL. The discussions shall include the following: 1) study objectives, 2) clarifications and 3) a summary of the baseline TPF study efforts completed by JPL to date. 4/10/2000
- 1.10 Participate in bi-weekly teleconferences with JPL.
- 1.11 Conduct an informal Mid-Term Progress Review, at the Contractor's facility or at a location as mutually agreed upon between JPL and the Contractor, to include:
- 1.11.1 Viewgraphs and studies of the recommended architecture(s) yielded from the effort defined in paragraphs 1.1 through 1.8. 3/30/2001
 - 1.11.2 Oral presentations of the work performed to date and a plan for conducting the remaining work on the Contract. 4/9/2001
 - 1.11.3 Responses to JPL recommendations and concerns resulting from the review within thirty (30) working days from date received.
- 1.12 Conduct a Final Review, at the Contractor's facility or at a location mutually agreed upon between JPL and the Contractor, consisting of oral presentations that include: 9/5/2001
- 1.12.1 Review of all work performed throughout the Contract.
 - 1.12.2 Responses to any JPL recommendations and concerns resulting from the review within thirty (30) working days from date received.

- 1.13 Provide reports as described below:
- 1.13.1 Twenty (20) copies including one electronic copy (Microsoft Office 97 format) of the viewgraphs to be used for the Preliminary Architecture Review described in paragraph 1.2 above, including statement of the architectures deemed most viable by the contractor. 9/25/2000
 - 1.13.2 Twenty (20) copies including one electronic copy (Microsoft Office 97 format) of the viewgraphs to be used for the Mid-Term Progress Review described in paragraph 1.11 above, including responses to any JPL recommendations or concerns received during the review. 3/30/2001
 - 1.13.3 Twenty (20) copies including one electronic copy (Microsoft Office 97 format) of the technology needs list and Technology Development Roadmap documenting the effort described in paragraph 1.8 above. 8/31/2001
 - 1.13.4 Twenty (20) copies including one electronic copy (Microsoft Office 97 format) of the Final Report detailing the results of the studies outlined in paragraphs 1.1 through 1.8 above. The report shall consist of viewgraphs to be used in the final review with text annotations on facing page. 8/31/2001
- 1.14 Use software as described below:
- 1.14.1 Industry standard analysis software such as 1) NASTRAN, 2) SINDA/TRASYS, 3) CODEV, and 4) IMOS is required for the structural, thermal and optical analyses except as allowed in 1.14.2.
 - 1.14.2 Other software packages are acceptable following approval by JPL and providing that their mathematical models can be translated and verified by JPL for use with the standard software mentioned above.
- 2.0 The following Exhibits are hereby incorporated into and made a part of this Contract:
- 2.1 Exhibit I, “Terrestrial Planet Finder”, JPL publication 99-3, May 1999. Available at http://tpf.jpl.nasa.gov/library/tpf_book/index.html.
 - 2.2 Exhibit II “Science Requirements” Dated January 7, 2000.
 - 2.3 Exhibit III “Origins Program Schedule” dated October 28, 1999. Available at <http://acquisition.jpl.nasa.gov/rfp/tpf/schedule.pdf>.

3.0 Summary of Deliverable Dates:

<u>Deliverable</u>	<u>On or Before</u>
3.1 Kick-Off meeting (1.9)	04/10/2000
3.2 Preliminary Architecture Review (PAR) (1.2)	10/02/2000
3.3 Mid-Term Progress Review (1.11)	04/09/2001
3.4 Final Review (1.12)	09/05/2001
3.5 Technology needs and Development Roadmap Report (1.8)	08/31/2001

4.0 JPL will:

- 4.1 Conduct a Kick-Off meeting in which current concepts will be described for Contractor discussion and comment.
- 4.2 Conduct informal bi-weekly teleconferences with the Contractor.
- 4.3 Attend the PAR as noted in paragraph 1.2 above and select one (1) architecture for further study as part of the Down Select described in paragraph 1.3 above following the review.
- 4.4 Attend the Mid-Term Progress and Final Reviews as noted in paragraph 1.11 and 1.12 above.

5.0 Delivery Instructions

- 5.1 Except as otherwise provided in this Contract, the point of inspection, acceptance and delivery of all supplies deliverable under this Contract shall be the Jet Propulsion Laboratory, 4800 Oak Grove Drive, Pasadena, California 91109. All such supplies shall be packaged, packed, boxed, or crated in such a manner to ensure safe delivery and shall be shipped prepaid and at the Contractor's expense to the point of delivery.

ARTICLE 2. PRICE AND PAYMENT

1.0 Total Fixed Price: **\$1,800,000.00**

2.0 MINIMUM LEVEL OF EFFORT

The Contractor agrees to supply, at a minimum, "**TBD**" hours of Engineering effort in the performance of the tasks defined in Article 1. STATEMENT OF WORK and to maintain adequate records to show the hours expended. If after receipt of the deliverables defined in Article 1. DELIVERY OR PERFORMANCE SCHEDULE it is JPL's judgment that the Contractor may have supplied less than "**TBD**" hours the Contractor shall be required to disclose the actual Engineering hours applied to the tasks defined in Article 1. If after JPL's examination of the Contractor's records the number of Engineering hours is less than "**TBD**" hours the contractor shall either be required to expend additional Engineering hours up to "**TBD**" hours in order to supply JPL with acceptable study deliverables or reduce the total fixed price of the contract. The Contractor shall not be entitled to an equitable adjustment should the expended Engineering hours exceed the minimum.

3.0 Invoices. Invoices shall be submitted, in triplicate, to JPL Accounts Payable, 4800 Oak Grove Drive, Pasadena, California 91109

ARTICLE 3. LIMITATION OF JPL's OBLIGATION

- 1.0 The Firm Fixed Price of this Contract is the amount set forth in paragraph 2.0 of ARTICLE 2, PRICE AND PAYMENT, subject to the limitations set forth in this Article.
- 2.0 Subject to paragraph 6.0 below, the amount set forth in Period No. 1 of the following Incremental Liability Schedule reflects the maximum limitation of the Institute's liability for all purposes, including incurred costs, termination costs (including amounts payable with respect to subcontracts and settlement costs) and allowance for profit or fee:

INCREMENTAL LIABILITY SCHEDULE

<u>Period No.</u>	<u>Cumulative Maximum Liability</u>	<u>Terminal Date</u>
FY 2000	~27%	TBD
FY 2001	~73%	TBD

- 3.0 It is anticipated that JPL shall, prior to the terminal date, if any, of the Period specified in the first line of paragraph 2.0 above, issue a Unilateral Modification to revise the maximum limitation to the amount set forth in the next successive period. The determination as to whether to issue such a modification shall be at JPL's sole discretion. In the event that JPL does not issue such a modification prior to the terminal date, this Contract shall, unless the Contractor requests a terminal date extension in writing prior to the terminal date, be deemed terminated for convenience and the Contractor shall proceed as if the Contractor has received a Notice of Termination pursuant to the GP Article entitled "Termination for Convenience." JPL shall, upon receipt of a written request from the Contractor for Terminal Date extension, immediately issue a unilateral modification extending the Terminal Date in accordance with Contractor's request. If the Contractor or JPL have reason to believe that any other change in the Incremental Liability Schedule would be in the best interest of the contract effort, the Contractor or JPL may notify the other party in writing to that effect, together with the requested change. If the Contractor and JPL agree with the requested change, the Incremental Liability Schedule will be revised by Supplemental Agreement to the Contract.
- 4.0 In the event that JPL issues such a UM to increase the liability after the terminal date, the Contract shall no longer be deemed terminated, and such UM shall have the same effect as if it had been issued prior to the terminal date; provided however, that if JPL's failure to issue the UM by the terminal date caused an increase of the cost of, or the time required for, performing this Contract, because the Contractor proceeded as if a Notice of Termination had been issued, an equitable adjustment shall be made in (i) the Contract Price, the time of performance, or both; and (ii) other affected terms of the Contract. The Contractor must assert its right to such equitable adjustment within 30 days of receipt of the UM. However, if JPL decides that the facts justify it, JPL may receive and act upon a proposal submitted before final payment of the Contract. Subject to paragraph 6.0 below, in the event that this Contract is terminated pursuant to this Article, or otherwise terminated by JPL pursuant to the GP Article entitled "Termination for Convenience," the cumulative liability amount set forth in the Incremental Liability Schedule for the Period referenced in the first sentence of paragraph 2.0 of this Article, reflects JPL's maximum liability notwithstanding anything to the contrary in the GP Article entitled "Termination for Convenience," or the value of supplies and services delivered to and retained by JPL.

- 5.0 The Contractor has used the Incremental Liability Schedule to plan its progress payments, partial payments, obligations and termination liability. It is a management prerogative of the Contractor to determine if any part of these elements are to be under funded or at risk (relative to the Incremental Liability Schedule) for any period of time. This is a firm fixed price type Contract. The Contractor assumes all risk for any variance between planned and actual costs, including planned and actual termination liability. The Contractor is strictly liable for all cost variances, including cost variances attributable to indirect rate changes and shall in no event be excused from the obligation to complete performance in accordance with the price, delivery schedule, and technical requirements of this Contract.
- 6.0 If the Contract is modified, the provisions of this Article shall not limit the Contractor's obligation pursuant to GP Article entitled "Changes," to diligently pursue the performance of the Contract as modified. In the event that a unilateral modification contains a liability limit for work performed under such modification, the Contractor's obligation to pursue performance of such modification and the Institute's liability for such modification, shall, until the UM(s) is bilaterally settled, be limited by the amount of the liability limit included in the UM. Until such a UM is settled, the liability limit on the UM does not increase the baseline liability in paragraph 2.0. In the event that this Contract is deemed terminated pursuant to paragraph 3.0 of this Article or the GP Article entitled "Termination for Convenience," prior to the settlement of an outstanding UM(s), the Institute's maximum liability for all purposes, including incurred costs, termination costs (including amounts payable with respect to subcontracts and settlement costs and consideration for delivered supplies and services) and allowance for profit or fee, shall be no more than the sum of the cumulative liability amount set forth in the Incremental Liability Schedule for the Period referenced in the first sentence of paragraph 2.0 of this Article, plus the liability limit(s) set forth in the UM(s).
- 7.0 In the event that this Contract contains a provision providing for progress payments, such provision shall be subject to the limitations set forth in this Article and the "contract amount" referred to in any such provision for progress payments is the Firm Fixed Price of this Contract set forth in paragraph 1.0 of ARTICLE 3, PRICE AND PAYMENT.
- 8.0 The provisions of this Article shall in no way limit the Institute's rights under the GP Article entitled Default.

ARTICLE 4. SPECIAL PROVISIONS

1.0 Key Personnel/Facilities

1.1 The personnel and/or facilities, if any, specified below in paragraph 1.2 are considered essential to the work being performed hereunder. Prior to removing, replacing, or diverting any of the specified individuals or facilities, the Contractor shall notify JPL reasonably in advance and shall submit justification (including proposed substitutions) in sufficient detail to permit evaluation of the impact on this Contract. No diversion shall be made by the Contractor without the written consent of JPL; provided, that JPL may ratify in writing the change, and such ratification shall constitute the consent of JPL required by this Article. Paragraph 1.2 below may, with the consent of the Contracting parties, be amended from time to time during the course of the Contract to either add or delete personnel and/or facilities, as appropriate.

1.2 The following Contractor personnel shall be considered Key Personnel under this Contract:

<u>Name</u>	<u>Title</u>	<u>% of Time Available to this Contract</u>
TBD	TBD	TBD

ARTICLE 5. ALTERATIONS TO THIS CONTRACT

1.0 Audit and Examination of Records - Negotiation.

In the Article entitled "Audit and Examination of Records - Negotiation," delete paragraphs (b), (c), (d)(1), and (e) and substitute:

- (b) Examination of Costs. If this is a cost-reimbursement, incentive, time-and-materials, labor-hour, or price-redeterminable Contract, or any combination of these, the Contractor shall maintain and the Contracting Officer, or an authorized representative of the Contracting Officer who is an employee of the Government, shall have the right to examine and audit all records and other evidence sufficient to reflect properly all costs claimed to have been incurred or anticipated to be incurred directly or indirectly in performance of this Contract. This right of examination shall include inspection at all reasonable times of the Contractor's plants, or parts of them, engaged in performing the Contract.
- (c) Cost or Pricing Data. If the Contractor has been required to submit cost or pricing data in connection with pricing action relating to this Contract, the Contracting Officer, or an authorized representative of the Contracting Officer who are employees of the Government, in order to evaluate the accuracy, completeness, and currency of the cost or pricing data, shall have the right to examine and audit all of the Contractor's records, including computations and projections, related to:
 - (1) The proposal for the Contract, subcontract, or modification;
 - (2) The discussions conducted on the proposal(s), including those related to negotiating;
 - (3) Pricing of the Contract, subcontract, or modification; or
 - (4) Performance of the Contract, subcontract, or modification.
- (d) Comptroller General
 - (1) The Comptroller General of the United States, or an authorized representative who is an employee of the Government, shall have access to and the right to examine any of the Contractor's directly pertinent records involving transactions related to this Contract or a subcontract hereunder.
- (e) Reports. If the Contractor is required to furnish cost, funding, or performance reports, the Contracting Officer, or an authorized representative of the Contracting Officer who is an employee of the Government, shall have the right to examine and audit the supporting records and materials, for the purpose of evaluating (i) the effectiveness of the Contractor's policies and procedures to produce data compatible with the objectives of these reports and (ii) the data reported.

IN WITNESS WHEREOF, the parties hereto have executed this Contract as of the day and year first above written.

CALIFORNIA INSTITUTE OF TECHNOLOGY

By _____

By _____
(Typed Name)

(Title)

Instructions to Contractor: Do not insert date on Preamble page.

**Exhibit II Science Requirements
Dated January 7, 1999**

I. General Mission Assumptions	Requirement	Goal	
1. Sky coverage	60%	90%	
2. Mission duration (years)	5	10	
3. Nominal planet is defined as solid body with Earth radius at 1 AU, T=270 K.			
4. The planet detection and characterization program will be allocated ~50% of the design mission lifetime with the remainder of the lifetime allocated for general imaging and spectroscopy.			
5. Spacecraft use non-nuclear power sources.			
II. Planet Detection/Characterization	Requirement	Goal	
1. Number of stars (F5-K5) surveyed for planets (R=3, SNR=5)	150	500	
2. Number of scans for CO ₂ /H ₂ O (R=20, SNR=10)	30	100	
3. Number of scans for Ozone/strongCH ₄ (R=20, SNR=25)	5	25	
4. Spectral Band (μm)	7 - 17	3 - 23	Zodiacal light limited
5. Spectral Resolution	20	100	Additional goal R=100 at 7.6 μm
6. Maximum distance of ozone detection (pc)	10	20	
7. Minimum distance of planet detection (pc)	3	2	
8. Exo-zodiacal dust will be the same as in our own solar system for requirement, up to 10 times the solar system level.			
9. Follow-up (high spectral resolution) surveys are uniformly distributed throughout the volume of the initial survey.			
10. Point source sensitivity: 5 σ, 2 hr at 12 μm, R=3. (μJy)	0.3	0.1	
III. High Resolution Imaging	Requirement	Goal	
1. Imaged objects for 5 yr mission	800	1600	(1 object/day)
2. Resolution at 3 μm (milliarcsecond)	0.75	0.75	
3. Band (μm)	3 to 17	2 to 40	(zodi limited at λ<=20μm)
4. Spectral resolution	3 to 300	3 to 1000	
5. Special purpose spectral resolution (FTS mode) in specified lines		10 ⁵ at 3-20 μm	
6. Capable of using a guide source within radius (arcsecond)	On-axis	120	(guide source equivalent to K band at 2 μm, 14 th mag)
8. Effective minimum baseline for synthetic imaging (m)	100	<50	Applies only to interferometric architectures
9. Dynamic range in Reconstructed Image	50:1	100:1	

Note to proposers:

The use of the science requirements Exhibit represented above as a baseline in no way represents a commitment that the final mission will be built to the same scientific program. The contractor may propose corrections and additions to the baseline mission. See Exhibit I for more detailed descriptions of the scientific goals of TPF.