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CHAPTER 2

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REQUEST FOR PROPOSAL

TRANSDUCER EVALUATION FACILITY

29 AUGUST 1969

ZAMAN

REQUEST FOR PROPOSAL

TRANSDUCER EVALUATION FACILITY

I. INTRODUCTION

A. BACKGROUND

This Request for Proposal (RFP) concerns the priority development and operation of a Transducer Evaluation Facility (TEF) whose function is to test electro-optical transducer arrays for ultimate use in the Electro-Optical Imaging System (EOIS).

The overall EOIS Program Plan calls for a highly compressed design and development of a complete system composed of Imaging Satellites (IS), Data Relay Satellites (DRS), a remote Receiving Facility (RF), and an Operations and Processing Facility (OPF) located in [redacted] The reconnaissance imagery data will be relayed in real time from the IS, through the DRS network, to the RF. The total delay from image acquisition by the IS to hard-copy output from the OPF will be [redacted] Initial operational capability of the complete system is scheduled for early 1974. The development of these system segments, in particular the IS, is proceeding in parallel with and is significantly dependent upon the timely operation of the subject TEF.

The schedule for the development and initial operational capability of the TEF will dictate the employment of priority handling of both administrative and technical problems. It is imperative that the contractor provide an organizational structure of both managerial and technical personnel who are willing and able to make an maximum effort to provide adequate solutions to problems as they arise, to cooperate fully and promptly with Government Contract Liaison Personnel, and to establish procedures sufficiently flexible to adapt to the urgent task at hand. The contractors' past performance in this regard, as well as their proposal content will be primary factors in selecting the winning contractor.

B. OBJECTIVES

The objective of the TEF is to perform imaging tests with transducer array subsystems of various designs and at various stages of subsystem completeness. The imaging test will be such as to provide a maximum of validity of the resulting data through realistic simulation of all the pertinent aspects of the imaging situation of an operational IS.

The experimental data generated by the TEF will subsequently be used to satisfy the following EOIS Program Objectives:

a. Verify the validity of a detailed parametric simulation of array-type imagery, which is already well underway. This simulation is designed to evaluate the effects of the inherent spatial sampling, noise, etc., on the utility of the resulting imagery.

b. Perform a comparative evaluation of the suitability of the various candidate transducer arrays.

c. Correlate the image test data with the detector-element parameter test data generated by the array manufacturers.

Growth objectives for the TEF may include such functions as:

a. Acceptance and qualification of operational arrays as part of the IS subsystem procurement operation.

b. Simulation of in-flight IS performance anomalies in order to facilitate prompt diagnosis and recommendation of remedial action.

C. GENERAL REQUIREMENTS

The testing will involve the simulation, with a maximum of realism, of the operating conditions and performance of the operational image data chain so as to maximize the validity of the resultant imagery. The detector elements will be interrogated in the same sequence and at the same rates anticipated for the operational arrays. However, because the test arrays will contain substantially fewer detector elements than the full-size operational versions, the average data rate output by the test arrays will be considerably less than that of an operational array.

The testing will be exclusively concerned with the imaging characteristics of the arrays.* Image testing will involve the projection of transparency images of both terrain and abstract-pattern targets onto the transducer array. The image will be driven across the array so as to accurately simulate the scanning motion of the operational IS with various types and magnitudes at scan-vector drive errors as well as with perfect scan-vector drive.

In addition, the testing may include a limited variation of parameters internal to the transducer subsystem, such as integration time, bias level, and baseplate temperature.

Because of the critical influence of TEF test results upon the EOIS in its formative phase, the time-urgency of the operational capability of the TEF will necessarily be a dominant factor in both the managerial and technological approaches and criteria to be employed in its development.

Operational capability of the TEF is divided into two distinct levels of complexity. Phase I capability involves the acceptance of [redacted] but will not contain any signal processing, bias light, or baseplate temperature control. These latter functions will be performed by TEF equipment. Signal recording at various points will be performed. Variations in element-to-element responsivity

*Detailed testing of individual detector elements, crosstalk, etc., will be performed by the respective array manufacturers.

will be compensated, the temporal-spatial sequence of element samples will be accomplished, and output signal processing will be performed in order to permit the final optical write-out of the resulting image. The contractor will provide this capability by 15 December 1969.

[redacted] As in Phase I, signal recording, responsivity correction, reformatting, output signal processing, and image write-out must be performed by TEF equipments. However, the substantially increased format size and data-rate duty cycle will probably require qualitatively different equipment designs from those employed in Phase I. The contractor will provide this capability by 1 June 1970. It is anticipated that the facility will be used for a period no shorter than one year following the beginning of Phase II capability.

II. FACILITY DESCRIPTION

The TEF subsystems required to satisfy its performance objective are shown schematically in Figure 1. The descriptions provided below and the arrangement shown in Figure 1 represent the Government's present view of the most satisfactory approach to the TEF requirement. In the event that the contractor considers alternate concepts to offer significant advantage in term of technical risk, cost, performance, etc., he should adequately document that position and present it to the Contract Technical Monitor immediately.

[redacted]

equivalent ground scene brightness from 100 to 5,000 foot lamberts for the situation of 100% transparency-image transmittance. Instrumentation shall be provided with the capability to continuously monitor and record the intensity level with an absolute accuracy within 5% of the true value. The spectral distribution shall be known [redacted]

B. TRANSPARENCY SCENES AND PATTERNS. Scenes shall be high-resolution aerial near-nadir views of man-made facilities to include a range of types of objects of general reconnaissance interest. All pertinent conditions of observation and the characteristics of the taking camera system(s) shall be fully documented. The scenes must represent a realistic range of sun-elevation angles and atmospheric clarity conditions. To the maximum extent possible, the transmittance of all points in the scene shall be accurately proportional to the brightness of the corresponding scene; this condition provides the requisite realism in the brightnesses and contrasts in the image projected onto the detector array. The image quality of the transparency must be such that the modulation transfer function of the aerial image projected onto the transducer array accurately reproduce that of the planned IS optics; i.e., a nearly diffraction- [redacted] While the scene transparencies will be provided by the contractor, the Government may elect to provide additional selected transparencies compatible with the above requirements.

The abstract geometrical pattern transparencies will include patterns of varying contrast and orientation, such as tri-bar targets, sinusoidal patterns, brightness step tablets, and full-length bars. The projected spacing of quasi-periodic patterns such as tri-bars and sinusoids shall adequately bracket the dimensions of the individual detector element photosensitive area.

C. TRANSPARENCY MOTION-VECTOR DRIVE - shall provide accurately controlled and continuously monitorable transparency drive speed such that the aerial image at the transducer plane is [redacted]

D. PROJECTION OPTICS - shall provide a projected image with negligible distortion and in conformance with the brightness uniformity, image-scale, and image quality conditions specified in Paragraphs A and B above. Adequate protection against spurious light and internal reflections shall be provided.

E. TRANSDUCER BIAS ILLUMINATOR* - shall provide uniform and invariant brightness onto all detector elements at levels specified by the transducer manufacturer.

F. TRANSDUCER ADDRESSING CIRCUITRY - shall provide switch of individual detector elements according to sequence and rates specified by transducer manufacturer. Nominal average rate is 18,200 samples per millisecond

G. TRANSDUCER ARRAY - to be provided by transducer manufacturers. Detailed characteristics are given in Appendix 1.

*Required only for initial capability; ultimately to be provided as part of the complete transducer array subsystem.

H. SIGNAL PREAMPLIFIER - shall provide optimum amplification of transient analog waveform produced by transducer array, according to transducer manufacturers' specifications.

I. TRANSDUCER SIGNAL PROCESSOR* - shall provide analog-to-digital conversation and optimum data compression processing, such as delta modulation or PCM encoding. To the extent this function is performed by the TEF contractor, the processing subsequent to A-to-D conversion will actually be done following the recording process of subsystem K below. Encoding levels may be varied parametrically in order to permit an assessment of their influence on the resulting imagery. The number of bits required for adequate fidelity of A-to-D conversion will depend on the individual array, but is expected to be in the vicinity of 9-15 bits per sample.

J. DATA SAMPLE REDISTRIBUTOR, BUFFER - shall convert the data rate produced by the transducer array subsystem to the minimum uniform date rate by spreading the peak rate data samples in time to fill the time voids associated with the substantial segment of the [redacted]

K. DIGITAL DATA RECORDER - shall record the redistributed date rate emerging from subsystem J above on magnetic tape. Format and readout rates shall be compatible with subsystem L below.

L. IMAGE-RECONSTRUCTOR (G. P. COMPUTER) - shall accept processed digital image signal and perform the required time-space reformatting of samples, equalization of detector-to-detector responsivity variations, and digital data-decompression (e.g. delta demodulation). Subsystem shall also perform initial-capability data compression function as described under subsystem I above.

M. TRANSDUCER RESPONSE CALIBRATION DATA FILE - shall contain sufficient response values corresponding to specified input exposure values for each individual detector element to permit responsivity equalization as described under subsystem L above. File to be generated by programmed exposure of array to specified brightness levels.

*See preceeding page

N. DIGITAL DATA RECORDER - shall record on magnetic tape the reconstructed digital-image signal from subsystem L above at compatible date rates, and subsequently read out the signal to subsystem O below, aslso at compatible rate. The feasibility of using a single recorder subsystem to satisfy the requirements of subsystem K above as well N, herein, should be considered.

O. DIGITAL-TO-ANALOG CONVERTER - shall accept the reconstructed digital image from subsystem N above and convert it into an analog-image signal appropriate to feed subsystem P below.

P. IMAGE WRITE-OUT DEVICE - shall convert the analog-image signal from subsystem O above into a two dimensional image on a hard-copy recording medium. The conversion shall impose the minimum feasible degradation of the spatial and brightness data inherent in the analog-image signal. Any associated operations such as photographic processing and process control and calibration shall be included within this subsystem. The total allowable duration for readout of the digital-image data record at subsystem N through to the finished hard-copy output transparency, ready for handling and evaluation is one hour.

The physical plant to house the TEF should be a single closed area within the contractors existing plant or a specially leased facility. All TEF-related operations will take place within closed-area facility, with the possible exception of general-purpose computer processing. All subsystems of the TEF will be housed within the facility and will be dedicated to sole use within the TEF for TEF purposes for the duration of the contract. Exceptions to the above constraints will require prior written consent of the contracting officer. Computer operations may be allowed in another area provided special security procedures are followed. All data generated within the TEF and all equipment fabricated and/or procured for the TEF will be Government property.

Because of the compressed development and operational testing schedule and the critical nature of the test results, it is imperative