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2 JUL 1970

MEMORANDUM FOR: Assistant Deputy Director for Intelligence

SUBJECT   :   EOI Processing Facility Functional
                      Requirements

1. When we last discussed the Electro-Optical Imaging
System and its interaction with the Intelligence Community, I
indicated that we were in the process of preparing an initial
functional requirements document for the Processing Facility
Segment of the system. We have now done this and I have attached
to this memorandum the initial version of the "Processing Facility
Segment Functional Requirements" document prepared by the
Office of Special Projects. This document has been used by OSP
to provide both imaging satellite and processing facility contractors
with guidance for the system design studies which are now drawing
to a close. In addition, this document has been passed to NPIC
informally for their review and comments. Later in this
memorandum I have listed those topics which seem to us to need
guidance from you and others in the user community. I propose
that we use this memo as a basis for discussion between us on
how we might provide the guidance.

2. There are many elements of the processing facility
whose configurations are dictated by the overall systems require-
ments. Design studies in these areas were initiated at a low
level approximately one year ago and, pursuant to a March 1970
ExCom decision, at an expanded level for the past three months.
Work in this area has progressed very satisfactorily and at this
point a number of alternative design concepts have been developed.

Group 1
Excluded from automatic
downgrading and
declassification
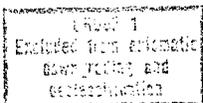
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3. However, several processing facility functions depend very much on the Intelligence Community interface with the EOI system. Areas of most specific current concern have to do with the level of interpretation activity to be carried on in the Processing Facility, hard copy dissemination questions, and requirements for archival storage of the image data as well as other types of data generated by the EOI system. OSP, taking into account its understanding of NPIC's interests, has developed a baseline concept. While this baseline concept probably has served its purpose adequately to date, I am concerned that as the system design matures a more detailed definition of these interface areas is required.

4. The OSP concept calls for an Initial Operational Capability (IOC) configuration of the Processing Facility designed to perform only those strictly essential functions necessary for the efficient utilization of the new capability represented by the EOI system. At a later date this IOC configuration could then be expanded into a final operational capability which would be influenced by early experience with the system and intended to take fuller advantage of the total capability represented by the system.

5. As you will see from the attached functional requirements document, the IOC configuration includes six basic functions. First, the digital bit stream from the imaging satellite is received and a series of calibration and geometric manipulation processing steps are performed. Second, the processed digital data is then operated on by modulation transfer function correction algorithms. Third, the resulting data is reconstructed into an image in the form of a silver halide film transparency for interpretation. Fourth, an area in the Processing Facility is provided for initial photointerpretation activities which result in the issuance of a Phase I teletype reports. Fifth, the image data in digital form is stored for archival purposes for later retrieval and processing as required. Finally, the Processing Facility will provide for the reproduction of multiple copies of the resulting imagery for dissemination to the Intelligence Community.

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6. I am sure that a number of questions will occur to you concerning how best to mechanize the output end of the Processing Facility. There are four specific questions which I feel need some preliminary answers within the next month or so and which are of a nature that requires guidance from you and COMIREX.

> 1) What is an appropriate level of photo-interpretation activity in the Processing Facility (if any)?

> 2) What are the hard copy distribution requirements, both in terms of quantity and timeliness?

> 3) What are the archival storage requirements for image data in digital form, and the likely demand for retrieval of this data from archival storage? (There are currently no plans for storing hard copy imagery in the P/F.)

> 4) What tasking procedures and mechanisms should be established to provide for the interface between the users (analysts) and the daily targeting of the system?

7. It is possible that ExCom will authorize us to proceed with formal system definition in August with a major milestone in December 1970, at which time we hope to definitize total system functional requirements. After you have had a chance to digest the information in the enclosure, I would like very much to discuss with you how we might develop the answers to the above questions.

8. Finally, it seems clear that we should not proceed with planning for this system in isolation from your long range plans for NPIC. Near-term planning for the initial operational capability of the Operations Facility and Processing Facility are beginning to take tangible form; however, the longer range planning for final operational capability in these areas should be influenced by your plans for NPIC and we would feel more comfortable in

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proceeding with our planning if we were simultaneously
participating in a planning group which was looking to NPIC's
future.

/S/

DONALD H. STEININGER
Assistant Deputy Director
for
Science and Technology

Attachment

Distribution:
   1 & 2 - Addressee w/att
       3 - Dr. Steininger w/att
       4 - R. Inlow w/att
       5 - J. Hicks w/att

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PROCESSING FACILITY SEGMENT FUNCTIONAL REQUIREMENTS

1.0 INTRODUCTION

1.1 PURPOSE

The purpose of this document is to provide the functional requirements for the Processing Facility segment of the EOI System for use in conducting system studies.

1.2 SCOPE

The functional requirements contained in this document are limited to those subsystems which are uniquely a part of the Processing Facility segment. Specifically excluded are functions of: (1) the Imaging Satellite segment, (2) the Relay Satellite segment, (3) the Receiving Facility segment and the (4) Operations Facility segment. Also specifically excluded are those exploitation-oriented functions beyond the preliminary inter-pretation and specified image improvement processing.

2.0 GENERAL FUNCTIONAL REQUIREMENTS

2.1 DEFINITIONS

The Processing Facility segment is defined to be that portion of the total EOI System that receives the raw image data, performs the required data processing, reconstructs surveillance-quality images, provides preliminary photointerpretation for

technical assessment of system performance and whatever quick
look reporting on significant intelligence content that may be
desirable. Included are the physical facility plus all processing
equipment, storage devices, computer hardware and software,
photointerpretation equipment, duplication equipment, etc.
necessary to perform the above. Specifically excluded are all
functions of tracking, command and control, and performance
analysis of both the Imaging Satellite(s) and the Relay Satellite(s),
detailed photointerpretation of the reconstructed images beyond
the preliminary interpretation, and other functions relating to
the operation of or data obtained from the EOI System.

The primary products of the Processing Facility segment
are time-critical and defined as the surveillance-quality images
used in the preliminary photointerpretation, initial duplication
copies of same, and any quick-look photointerpretation reports
on significant intelligence content. All secondary products of the
Processing Facility are non-time-critical and defined to include
all other products.

2.2 FACILITY DESIGN

The Processing Facility must be physically located in▯▯▯
▯▯▯▯▯▯▯▯▯▯and collocated with the
Operations Facility. It is to be designed such that there is a
high confidence of achieving an Initial Operational Capability
(IOC) in March 1974. The design must also provide for a high
reliability of continuous operation in the on-line mode as defined
in Section 4.0, and ease of recovery in cases of equipment mal-
functions. The capability is required to operate in the on-line
mode at any time that an Imaging Satellite (I/S) is acquiring image
data.

The physical design of the Processing Facility must
provide sufficient space for the equipment and work areas required
to perform the functions specified in Paragraph 2.1. The necessary
security aspects such as the internal handling of data, appropriate
electromagnetic·shielding of equipment, integrity of access to
storage devices, compartmentation of functional groups within
the facility, etc. must also be incorporated.

2.3 FACILITY OPERATION AND MANAGEMENT

The Processing Facility will be managed by a Processing Facility Director. The Processing Facility Director will be responsible for the operation of the Processing Facility and for providing adequate support for the photointerpretation functions to be performed in the Facility. Policy guidance pertaining to the operation of the Processing Facility will be supplied by the governing intelligence authority, with day-to-day processing requests provided by the appropriate exploitation committee.

All physical facility maintenance and housekeeping chores will be performed by GSA. A security staff is required on a 24-hour basis. Periodic inspections of the various equipment, procedures and file integrity is required in addition to the routine physical security. Support for the maintenance of equipment within the facility will be supplied by an appropriate contractor.

2.4 EVOLUTIONARY IMPROVEMENT

The dominant considerations in the design and operation of the Processing Facility are the high confidence for continuous operation with an Initial Operational Capability in March 1974. It is essential, however, that the design allow for easy expansion to accommodate evolutionary improvements in system capabilities.

3.0 INTERFACE FUNCTIONAL REQUIREMENTS

3.1 INPUTS

The Processing Facility must provide the capability to accept the raw image data at an incoming rate of up to [ ] for use in the on-line operating mode. This data includes DPCM encoded sample data in addition to periodic PCM encoded samples of the absolute readings of detectors on-board the I/S.

The Processing Facility must provide the capability to accept periodic calibration data for each of the detectors on-board [ ]

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The capability is required to accept frame identification
data relative to the conditions under which the image data was
acquired. This type of data includes that required for both the
on-line and off-line modes of operation.

All off-line mode processing requests and operational
guidance will be provided by an organization of the intelligence
community.

3.2 OUTPUTS

The Processing Facility must provide the capability to
generate transparencies of all reconstructed images, a limited
number of hard copy photographs, and preliminary interpretation
reports highlighting significant intelligence content. In addition
priority target interpretability assessments and technical
assessment of system performance are required for use in I/S
tasking.

4.0 OPERATING MODES FUNCTIONAL REQUIREMENTS

The Processing Facility must provide the capability to
operate in two basic modes, the on-line mode and the off-line
mode. The on-line mode is defined to include all functions
necessary to produce the time-critical primary products, while
the off-line mode is defined to include all other functions
necessary to produce the non-time-critical secondary products.

4.1 ON-LINE MODE

The Processing Facility must provide the capability to
operate in the on-line mode during all times that an I/S is
actively acquiring image data. The objective of this mode of
operation is to provide a surveillance-quality transparency to
a photointerpreter within a minimum of time delay from the
actual scene imaging, and a brief report on the significant
intelligence content of the scene as desired.

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The Processing Facility shall provide the capability to perform the following functions when operating in the on-line mode:

o Accept image data at a rate of up to [   ]

o Store all received image data in a manner that allows for subsequent retrieval.

o Perform the necessary data handling functions including reformatting, decoding, calibration and other digital data processing as defined in Section 5.0.

o Incorporate non-image data.

o Provide for the continuous monitoring of the Processing Facility performance.

o Reconstruct surveillance-quality images according to a specified format.

o Produce and disseminate via GFE data link a preliminary photointerpretation report as desired.

o Produce a specified number of duplicate copies of the reconstructed image.

4.2 OFF-LINE MODE

The Processing Facility must be capable of operating in the off-line mode only in such a manner as not to impair the capability to perform the on-line function. All off-line mode operation is by definition of lower precedence than on-line mode operation.

The Processing Facility shall provide the capability to perform the following functions in the off-line operating mode:

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o Retrieve stored image and non-image data for any frame or designated portion thereof on the basis of specified inputs.

o Duplicate the functions of the on-line mode with the retrieved data as input.

o Utilize additional digital processing algorithms for improving the utility of a frame of image data or a designated portion thereof.

o Provide a mechanism for the real-time interaction between the photointerpreter and the image data processing equipment.

o Provide digital data in the form of magnetic tape recordings for off-site image reconstruction.

o Maintain data storage files.

o Provide housekeeping and equipment maintenance.

5.0 DATA HANDLING FUNCTIONAL REQUIREMENTS

The data handling functional requirements are defined to be those required in transforming a detector sample from its encoded digital form into a form suitable for input to the image reconstruction process. These functional requirements apply equally well to either the on-line or off-line operating mode, and hence no distinctions are made. The primary difference between the two operating modes is the time factor.

5.1 IMAGE DATA

Image data is defined to be that data acquired from the transducer-signal processor subsystem on-board an I/S. This data will be grouped in terms of a frame of imagery, and will consist of DPCM encoded detector samples plus periodic PCM

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encoded absolute readings from multiple arrays, each containing several thousand detectors.

5.1.1 DATA REFORMATTING

The image data input to the Processing Facility consists of a digital bit stream of data from multiple arrays of detectors in the I/S. The arrays are simultaneously and continuously readout during the acquisition of a single frame, and successive serial stream data points from each array do not correspond to contiguous ground sample points. Since several subsequent Processing Facility functions require contiguous samples (ground or focal plane), it is necessary to reformat the digital samples into the proper space-time relationship.

5.1.2 DATA DECODING

The image data is encoded in the I/S transducer-signal processor subsystem and is compressed in order to conserve link bandwidth and to take advantage of the essential redundancy inherent in the sampling of brightness distributions that are transfer function limited. The encoding process consists of differential pulse code modulation (DPCM) and is exercised on successive samples of the same photosensitive element. The corresponding decoding process must be carried out at the Processing Facility as the successive samples are available. Absolute sampled outputs for each detector, encoded in PCM, will be periodically supplied in addition to the DPCM data. This redundant PCM value prevents the extended propagation of d-c offset errors to which pure DPCM is vulnerable. These PCM samples must be segregated from the DPCM data for appropriate combination to obtain the values for all detector samples.

5.1.3 CALIBRATION

The individual data samples from each detector must be adjusted to correct for variations in offset, gain, and linearity from detector to detector. Data for this function are periodically obtained from the I/S and must be available for use in performing this calibration function.

5.1.4 DIGITAL DATA PROCESSING

These functions consist of all those computerized processing techniques which are exercised against the calibrated image data prior to input to the image reconstruction process. The purpose of this digital processing is to manipulate the data in such a way as to reduce system-induced limitations on the ability of the Processing Facility to reproduce an original ground brightness distribution that is limited only by the sampling process. The extent to which this digital data processing may be utilized will be determined by the output image quality required and the appropriate processing time constraints.

The capability must be provided to perform the following forms of digital data processing:

a) Modulation Transfer Function Compensation

Each subsystem of the EOI System through which the image data passes can generally be characterized by a modulation transfer function, given that the subsystem is sufficiently linear. These characteristics are such that the various subsystems can be considered as a series of low-pass filters having well-defined roll-off characteristics and cut-off frequencies. Consequently, under the condition of relatively "noiseless" data and known filter characteristics, the image data matrix can be processed such that the signal

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strength at each spatial frequency can be adjusted to
compensate for this undesirable filtering out to the
sampling frequency. The selection of the relative
response at each spatial frequency determines the degree
of compensation required.

b) Other Filtering and Processing Operations

These functions consist of the implementation
of other digital processing techniques to aid in the
extraction of useful intelligence information from the
digital image data matrix. Examples of such techniques
are: (1) the additional of the signal derivative, (2) the
extraction of details from shadows, (3) additional non-
linear filtering to reduce any residual effects of the data
compression techniques, (4) the use of telemetry data for
image improvement, and (5) the replacement of samples
corresponding to non-operable detectors with an appropriate
weighted average of neighboring detectors.

5.2 NON-IMAGE DATA

There are non-image data pertinent to the Processing
Facility functions for producing useful hard-copy pictures. Each
picture produced must contain a frame identification number. It
may also be required to contain additional information such as
target descriptors, the date, I/S identification, orbital revolution
number, or other similar data. All data of this nature will be
available on a prepass basis. Certain telemetry data may also be
required both for use in the on-line and off-line mode processing.

6.0 IMAGE RECONSTRUCTION FUNCTIONAL REQUIREMENTS

The image reconstruction function consists of all those
processes and equipments necessary to transform the processed
digital image data into a form suitable for viewing and detailed
evaluation by a trained photointerpreter. The primary objective
of this function is to provide sufficient capability and flexibility

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of operation to ensure that the reconstructed imagery contains
the total information content inherent in the raw image data
stream.

The capability must be provided to accept the formatted,
calibrated, and processed image data stream (PCM encoded)
from the data handling functional area, scale the image data if
necessary to optimally match its characteristics to the appropriate
characteristics of the reconstruction or write-out media, convert
the digital data to a properly synchronized analog waveform, and
utilize the resultant signal to modulate the intensity and position
of a controlled light (or electron) beam to produce a latent image
on reconstruction material. The latent image must be processed
to produce a hard-copy, photographic recording of the target
image.

Critical factors that must be included in this function are
reconstruction spot intensity distribution control, spot positional
and modulation accuracy, speed of operation, reconstruction
material characteristics, and format. It is desired that the
recorded image be configured so as to be compatible with existing
interpretation duplication and film handling equipment.

7.0 DATA STORAGE FUNCTIONAL REQUIREMENTS

The Processing Facility must provide for at least
temporary storage of all image data collected by the Imaging
Satellites, in addition to all detector calibration, additional frame
information and any telemetry data used in the processing. This
data must be stored in a form such that it can be rapidly retrieved,
processed and reconstructed. Subsequent retention for long-term
storage is contingent on several factors to be determined by the
intelligence community and based on detailed photointerpretation.
It is expected that certain frames (or portions of frames) will be
adjudged to contain no useful information by virtue of system
malfunctions, cloudcover, haze, etc., and would not be retained
for long term storage.

There is no current requirement for storage of
reconstructed hard-copy pictures in the Processing Facility other

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than those required by the photointerpreters for the preliminary
interpretation during on-line mode operation.

8.0 INITIAL PHOTOINTERPRETATION REQUIREMENTS

The Processing Facility will include an appropriately
equipped work area to support initial (Phase I) photointerpretation
of the incoming imagery. The interpretation area should be
configured to support 10 PI's with the necessary light tables,
dark space, viewing aids, and storage space for limited quantities
of hard copy imagery and supporting documentation.

The Phase I interpretation reports will be disseminated to
appropriate community elements in teletype form. The Processing
Facility will provide the necessary facilities for the preparation
of these reports, and the floor space for GFE telecommunications
equipment.

To support initial interpretation, the PI's will require
current collateral target information. This information will be
retrieved from central data files external to the Processing
Facility and transmitted to the Processing Facility on GFE data
lines. The Processing Facility will include space for the data
line terminal and handling the collateral information in a timely
manner.