

ATTACHMENT 4GROUND SYSTEM SEGMENTS FUNCTIONAL REQUIREMENTS

## 1.0 RECEIVING FACILITY SEGMENT FUNCTIONAL REQUIREMENTS

1.1 Introduction

The Receiving Facility (R/F) segment of the EOI System shall provide the complete ground terminal facilities for communication with all satellites of the system. Capability for acquisition of and communication with any satellite (R/S or I/S) of the EOI System shall be provided whenever the vehicle is in view of the R/F. Communications capability shall include angular tracking, ranging, commanding, receipt of telemetry data, and receipt of image data. All tracking, telemetry and command (TT&C) base band structures shall be SGLS compatible. Capability to perform insurance recording of all incoming image data for playback at the R/F or P/F shall be provided.

A secure ground communications path to the collocated O/F-P/F shall be provided as a part of the Receiving Facility segment. The R/F shall be located in an EMI compatible area. Location of the R/F can

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GROUP 1  
Excluded from automatic  
downgrading and  
declassification

up to

[Redacted]

for Configuration A, and should be collocated with O/F and P/F for Configuration B.

Capability for all TT&C functions shall be provided on [Redacted] and S bands. Primary TT&C operation shall be on the [Redacted] with the S band as a backup only. Image data shall be received only on the

[Redacted]

The image data must be protected to the extent that an unauthorized interceptor will be unable to determine the system image quality characteristics of the system. The requirement for data security should be established on the following basis:

- o Interceptor is three miles outside of the continental United States.
- o Threat Model consists of a 30 foot antenna (ship mounted) with a 3 db receiver noise figure, clear weather conditions at receiver assumed.
- o The signal containing image data received shall have a bit error rate of  $\geq 10^{-1}$ .

1.2 Site Location

The R/F complex shall be located within

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[redacted] on a site to be selected by the Program Office. Twenty to thirty acres (minimum) of land will be provided suitable for the erection of [redacted] and one S band steerable antennas and the location of an R/F building. All support required for the operation (excluding personnel) of the R/F complex will be provided in the local area. This support will include at least the security external to the R/F perimeter, fire protection, utilities, transportation, housing, etc.

1.3 Antenna

Sufficient antenna capability must be provided at the R/F to permit acquisition, tracking, and communications with relay satellites located in equatorial synchronous orbits and imaging satellites in low altitude orbits of up to 420 nautical miles over the R/F. North-South and South-North passes shall be accommodated for orbit inclinations from  $60^{\circ}$  to  $120^{\circ}$  with respect to the earth equatorial plane.

For the Configuration B system option, a single antenna capable of acquiring image data via the R/S

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segment shall be provided. This antenna will be used for all [ ] functions. A completely separate S band antenna shall also be provided with the capability for all TT&C operations [ ] of the EOI System in view of the R/F.

Radomes shall be provided on all steerable antennas.

1.4 Tracking

Capability shall be provided for telemetry readout of all movable antenna axis angles for digital transmission to the O/F. Antenna pointing angles shall be commandable from the O/F. Auto-track capability shall be provided on all steerable antennas with override capability from the O/F. Signals shall be provided to the O/F indicating the status of all tracking loops (angle and frequency/phase).

Range determination shall be performed in the standard SGLS manner using a pseudo random noise (PRN) digital signal. Detection of time delay on the returning signal and knowledge of the vehicle time delays shall result in unambiguous range determination

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[redacted] of the EOI System. Range determination to an R/S or I/S in view of the R/F shall take place directly. Ranging to a satellite out of view of the R/F shall take place via one or more satellites of the R/S segment. [redacted]

[redacted]

1.5 Telemetry

Telemetry data [redacted] shall be received and demodulated at the R/F for transmission to the O/F. Decryption and decommutation of PCM data is not required at the R/F. FM/FM analog telemetry shall be received and demodulated at the R/F for transmission to the O/F. Capability to handle telemetry from two R/S and one I/S simultaneously must be provided. One subcarrier is assigned to each of two R/S and [redacted]

[redacted]

1.6 Commanding

Commands shall be capable of being transmitted

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at all times  of the EOI System either directly or via one or more satellites of the R/S segment. Ternary commands shall be received from the O/F and transmitted using a three-tone system in accordance with SGLS practices for medium rate commanding. Command rates up to and including 1.0 Kbps shall be used.

#### 1.7 Frequency and Timing

The R/F shall provide precise frequency and time reference signals for control and operation of all other Receiving Facility subsystems. Correlation of the reference signals with National Bureau of Standards references to effect timing capability between the R/F and the other EOI System segments is required.

#### 1.8 Recording

The R/F must provide the capability to store and playback all received image data. The format of the playback data at the P/F segment interface should be the same as the  data.

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## 2.0 OPERATIONS FACILITY SEGMENT FUNCTIONAL REQUIREMENTS

### 2.1 Introduction

The Operations Facility (O/F) segment shall provide the central integrated control of all aspects of the EOI System operations including the necessary control of the collocated P/F operation during periods of imaging activity. The O/F must provide the capability to program the targets to be imaged, assemble and generate all commands for all system satellites, reduce and analyze all telemetry, generate all system satellite ephemerides, prepare all required correlation data pertaining to the images acquired and assess the overall EOI System performance.

### 2.2 Operations and Control

The O/F shall provide the capability to perform the following EOI System operations and control functions:

- o Implement a target acquisition plan to include target selection, preparation of a mission events sequence for all system segments, generation of commands  transfer of these commands to the R/F terminal, and verification that the commands were correctly

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received by the satellites.

- o System performance assessment and reporting through the monitoring and analysis of telemetry and tracking data, and the evaluation of target coverage and calibration imagery.
- o Orbit determination, ephemeris prediction and orbit maintenance control as required for all system satellites.
- o Support the launch, operational verification and on-orbit operations of the Imaging Satellites.
- o Provide control of on-orbit sensor calibration and optical alignment as required.
- o Support the launch, operational verification and on-orbit operations of the Relay Satellites.
- o Provide the necessary control of all system ground facility operations.

### 2.3 Support Functions

The O/F shall perform the following support functions:

- o Display appropriate engineering telemetry data in

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- o Display non-real-time data such as scheduling, system status, and computer output.
- o Provide for data storage and retrieval.
- o Provide housekeeping, equipment maintenance and logistics.

#### 2.4 Interface with User Groups

The user groups will provide guidance for overall system operation and target coverage requirements. The O/F shall provide the capability for responding to the following target request cycles:

- o Daily tasking of the complete EOI System in a manner which optimizes the quality and quantity of cloud-free images obtained.
- o Per revolution tasking of the EOI System based on the latest weather data and any results of imagery of the same day.
- o Priority tasking of a specific target prior to the target access.

The O/F shall provide the user groups with the following support and data to assist in the target

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acquisition.

- o A daily preliminary target acquisition plan for the next day's operation.
- o A daily list of attempted and successful target coverage.
- o An up-to-date status of coverage achieved vs coverage requirements on demand.
- o A method of interchanging target acquisition plans and options which enables rapid assimilation of the data by user representatives.

## 2.5 Interface with P/F

The O/F shall provide the Processing Facility (P/F) with scheduled image transmission times as soon as practical after a target coverage request has been processed. As image data is being received, the O/F shall provide the P/F with frame identification, target descriptors and location, date-time, I/S number, and other appropriate correlation data as required. These data shall be produced on a time scale compatible with P/F production schedules.

The O/F shall display selected image frame elements received from the P/F in  for quick-look analysis

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of gross system performance. Definition of the frame and location of the portion desired will be made prior to receipt of the data sequence in the P/F. The O/F shall also display P/F operational status information.

2.6 Interface with R/F

The O/F shall provide the following data to the communications terminal of the R/F:

- o Command bit streams for all system satellites.
- o Antenna pointing, acquisition, and best-look frequency predictions.
- o A schedule of R/F activities.

The O/F shall accept telemetry data bit streams from imaging and relay satellites, tracking data from two satellites (R/S or I/S) simultaneously, and R/F equipment operating parameters and status information.

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### 3.0 PROCESSING FACILITY SEGMENT FUNCTIONAL REQUIREMENTS

#### 3.1 Introduction

The Processing Facility (P/F) segment is defined to be that portion of the total EOI System that receives both image and non-image data from the I/S segment, performs the required data processing, reconstructs the image data into hard-copy images, and provides the required preliminary photointerpretation and reporting on significant intelligence content.

The P/F segment includes the physical plant and all the processing equipment, storage facilities, computer hardware and software, photointerpretation equipment, duplication equipment, and other equipment necessary to perform the P/F segment functions. Specifically excluded from the P/F 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.

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The primary products of the Processing Facility segment are time-critical and defined as the reconstructed images used in the preliminary photo-interpretation, initial duplication copies of these images, and the preliminary photointerpretation reports on significant intelligence content. All secondary products of the Processing Facility are non-time-critical and defined to include all other products.

### 3.1.1 Facility Design

The Processing Facility must be physically located in the  area, and collocated with the Operations Facility. The design must provide for a high reliability of continuous operation in the on-line mode as defined in Section 3.3 and ease of recovery in cases of equipment malfunctions. The capability is required to operate in the on-line mode at any time that the Imaging Satellite (I/S) is acquiring image data.

The physical design of the Processing Facility must provide sufficient space for the

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equipment and work areas required to perform the functions described in Section 3.1. The necessary security aspects of the operation such as handling of data, appropriate electromagnetic shielding of equipment, integrity of access to storage devices, compartmentation of functional groups within the facility, Tempest considerations, etc., must also be incorporated.

### 3.1.2 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 personnel support for the photointerpretation functions to be performed in the facility.

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 equipments, procedures and file integrity is required in addition

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to the routine physical security. Support for the maintenance of equipment within the facility will be supplied by an appropriate contractor.

3.2 Interface Functional Requirements

3.2.1 Inputs

The Processing Facility must provide the capability to accept image data at an incoming rate of up to  in the on-line operating mode.

The Processing Facility must provide the capability to accept periodic calibration data for each of the detectors on-board  I/S.

The Processing Facility (P/F) must have the capability to accept data from the Operations Facility (O/F) with regard to planned operations.

The capability is required to accept frame identification data and other data relative to the conditions under which the image data was acquired from the O/F. This type of data includes that required for both the on-line and

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off-line operating modes. All off-line mode processing requests and operational guidance will be provided by the intelligence community through the P/F Director.

### 3.2.2 Outputs

The Processing Facility must provide the capability to generate transparencies of all reconstructed images, and preliminary interpretation reports on significant intelligence content.

The P/F must provide information to the O/F on readiness status of the P/F, quick-look priority target coverage assessment, and the quality of the reconstructed imagery.

### 3.3 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. In the on-line mode images are reconstructed in near real time, while in the off-line mode images are reconstructed after a time delay which may vary from minutes to days.

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### 3.3.1 On-Line Mode

The Processing Facility must provide the capability to operate in the on-line mode during all times that the I/S is actively acquiring image data. The objective of this mode of operation is to provide for the generation of a reconstructed image and a preliminary photointerpretation report within a minimum time delay from the I/S scene acquisition.

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

- Accept image data at a rate of up to
- Store all received image data in a manner that allows for subsequent retrieval.
- Perform the necessary data handling functions including reformatting, decoding, calibration and other digital data processing as defined in Section 3.4.
- Incorporate non-image data.

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- o Provide for the continuous monitoring of the Processing Facility performance.
- o Reconstruct images according to a specified format.
- o Produce and disseminate via GFE data link a preliminary photointerpretation report.
- o Produce a specified number of duplicate copies of the reconstructed image.

### 3.3.2 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 operations are by definition of lower precedence than on-line mode operations.

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

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

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- o Duplicate the functions of the on-line mode with the retrieved data as input.
- o Provide additional processing capability for improving the utility of a reconstructed image or a designated portion thereof.
- o Provide a mechanism for the real-time interaction between the photointerpreter and the image data processing equipment, i.e. display tubes, etc.
- 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.

### 3.4 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 device. These functional requirements apply equally well to

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either the on-line or off-line operating mode, hence no distinctions are made. The primary difference between the two operating modes is the time factor.

#### 3.4.1 Image Data Processing

Image data is defined to be that data acquired from the transducer-signal processor subsystem on-board an imaging satellite. This data will be grouped in terms of a frame of imagery and will consist of encoded detector samples.

##### a) Data Reformatting

The image data input to the Processing Facility consists of a digital bit stream of data from  arrays of detectors in the I/S. The arrays are simultaneously and continuously readout during the acquisition of a single frame, and successive data samples from the I/S do not correspond to contiguous ground samples. Since several subsequent Processing Facility functions require contiguous spatial samples, it is necessary to reformat the digital samples into the proper spatial relationship.

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b) Data Decoding

The image data is encoded in the I/S transducer-signal processor subsystem by a digitally coded modulation scheme. A decoding function must be provided by the Processing Facility if required for subsequent processing and reconstruction.

c) Calibration

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

d) Digital Data Processing

These functions consist of all other computerized processing techniques which are exercised against the image data prior to input to the image reconstruction device. The primary purpose of this digital processing is to allow the image data to be manipulated in such a way

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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 secondary purpose of this processing, particularly in the off-line mode, is to support other image exploitation requirements of the photointerpretation process.

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

- o 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

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relatively "noiseless" data and known filter characteristics, the image data can be processed such that the relative signal strength at each spatial frequency can be adjusted to compensate for this undesirable filtering up to the sampling frequency.

° 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. Examples of such techniques are: (1) The addition 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.

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### 3.4.2 Non-Image Data Processing

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 such as satellite attitude and attitude rates may also be available   e. g. within the image data stream, for use in the on-line and off-line mode processing.

### 3.5 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 evaluation by a photointerpreter. The primary objective of this function is to provide sufficient capability and flexibility of operation to ensure that the

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reconstructed imagery is capable of displaying the total information content inherent in the image data.

The capability must be provided to accept the processed image data stream from the data handling functional area, scale the image data (if necessary) to optimally match its characteristics to the appropriate characteristics of the reconstruction material, 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 reconstructed 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.

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### 3.6 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. It is expected that certain frames (or portions of frames) will be adjudged to contain no useful information by virtue of system malfunctions, cloud cover, 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 than that collateral material required by the photointerpreters for the preliminary interpretation during on-line mode operation.

### 3.7 Initial Photointerpretation Requirements

The Processing Facility will include an appropriately equipped work area to support initial photointerpretation

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of the incoming imagery. The interpretation area should be configured to support 10 photointerpreters with the necessary light tables, dark space, viewing aids, and storage space for limited quantities of hard copy imagery and supporting documentation.

The initial interpretation reports will be disseminated to designated recipients 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.

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