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NRO
National Reconnaissance Office
OPERATIONS
MANUAL

HEXAGON CONCEPT OF OPERATIONS

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~~(S)~~ NATIONAL RECONNAISSANCE OFFICE
WASHINGTON, D.C.

THE NRO STAFF

MEMORANDUM FOR RECIPIENT

The HEXAGON Concept of Operations was prepared by the Satellite Operations Center (SOC) as a reference and planning document for those agencies involved in the preparation, planning, and conduct of HEXAGON missions. This document does not discuss the film processing, film indexing, or exploitation activities resulting from HEXAGON missions. However, it is felt that the information presented here will be useful to those agencies who do plan and conduct these activities.

This document describes organizational responsibilities and interfaces for each phase of HEXAGON operations. A discussion of HEXAGON software capabilities is provided to relate software functions to mission planning and execution.

This operational concept will be implemented by the HEXAGON Reports Control Manual. Reports control manuals are published as SOC directives and apply to all organizations participating in mission planning and execution, film processing and evaluation, and other related activities requiring mission performance data.

E. F. Sweeney
EDWIN F. SWEENEY
Colonel, USAF
Director
NRO Staff

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HEXAGON CONCEPT OF OPERATIONS

CHAPTER 1

ORGANIZATIONAL RESPONSIBILITIES

General. The HEXAGON Satellite Reconnaissance System was developed to obtain high-resolution photography of specified geographical areas for search and surveillance purposes as set forth by the United States Intelligence Board. The HEXAGON will be capable of obtaining stereo photography of large land areas comparable to the current search system, while at the same time obtaining a quality of photographic coverage comparable to early versions of the current high-resolution surveillance system.

In order to accomplish the HEXAGON system objectives, the Director of the National Reconnaissance Office (DNRO), with approval from the NRP Executive Committee, has assigned responsibilities to participating organizations with respect to program management, system development and procurement, software development, and mission management and control. Those organizations actively participating in conducting HEXAGON premission, on-orbit, and postmission operations are listed below.

Participating Organizations.

a. Committee on Imagery Requirements and Exploitation (COMIREX), United States Intelligence Board (USIB)
b. Eastman Kodak Company (EK)
c. Global Weather Central (GWC), Air Weather Service, USAF
d. Imagery Collection Requirements Subcommittee (ICRS), COMIREX
e. National Photographic Interpretation Center (NPIC)
f. Office of Special Projects (OSP), CIA
g. Satellite Operations Center (SOC), National Reconnaissance Office (NRO)
h. Satellite Test Center (STC), Air Force Satellite Control Facility (AFSCF)
i. Sensor Subsystem Project Office (SSPO), OSP
j. System Project Office (SPO), Directorate of Special Projects, Office of the Secretary of the Air Force (SAFSP)
k. U.S. Air Force Special Projects Production Facility (SPPF)
l. U.S. Army Topographic Command (TOPOCOM)

Responsibilities.

a. System Design and Development.

(1) SPD. The Director of Special Projects, SAFSP, is designated as the HEXAGON System Project Director (SPD). He directs and supervises the development and production of all subsystems except the sensor subsystem. This includes overall system engineering (including master system specifications) and system integration (including subsystem interface specifications) and overall system master planning, programming, and budgeting. The SPD is not expected to accomplish engineering analyses of the sensor subsystem except as required by his overall systems engineering and integration role or unless his assistance is solicited by the SSPO.

(2) SPO. The SPD has established the HEXAGON System Project Office (SPO) specifically to discharge assigned functions and responsibilities. In addition to the above SPD responsibilities, the SPO is responsible for the development and production of the spacecraft, the booster, the recovery vehicle (RV) subsystem, and the stellar-terrain (ST) camera subsystem.

(3) SSPO. The Director of Reconnaissance, CIA directs and supervises the development and production of the total sensor subsystem. He reports directly to the DNRO. The Director of Reconnaissance, CIA has established a HEXAGON Sensor Subsystem Project Office (SSPO) and designated a Chief thereof, responsive and responsible through him to the DNRO for total sensor subsystem development and production. The Director, SSPO is responsive and responsible to the SPD for overall system matters, to include adherence to master system specifications, subsystem interface specifications, and master project schedules established by the SPD. For technical and performance matters wholly internal to the sensor subsystem, the SSPO is responsible to the DNRO and not the SPD. By definition, the sensor subsystem includes the complete primary camera assemblies, close-in and fine camera environmental control, and close-in and camera-peculiar electronics or pneumatics, film supply spools, the film transport mechanism, film cut and wrap or film splice mechanisms, and film takeup spools in the recovery vehicles.

b. Software Development.

(1) SAFSP. SAFSP, under the direction of the SPD, is responsible for the design, development, and operation of all mission operational software to be operated at the STC, to include command generation and targeting software.

(2) SSPO. The SSPO will participate in the development of on-orbit command, control, and analysis software in support of the SPD and under his direction. Further, SSPO will participate in all software development to the full

extent necessary to assure optimum utilization of sensor capabilities and compatibility with all sensor interfaces, and will have full and complete access to all software development activities.

(3) OSP. OSP is responsible for the development of software for the purpose of simulations and special studies, as relates to the HEXAGON system, and for the development of mission-planning data for the SOC. OSP software will be applicable to premission and postmission activities, as well as off-line monitoring and reporting of on-orbit operations, all in support of the SOC.

(4) SOC. The SOC will participate in SAFSP software development to the extent necessary to insure that the software is responsive to the search and surveillance requirements established by USIB. The SOC will participate in OSP software development to insure that the developed software provides the support needed by the SOC to function as a HEXAGON operations center.

c. Mission Planning and Preparation.

(1) ICRS/COMIREX. The ICRS will provide the SOC with mission guidance and current intelligence requirements not covered by the USIB standing requirements.

(2) SOC. The SOC is responsible for accomplishing the following premission activities:

(a) Select Launch Date. The date and time of launch are determined by the SOC in consultation with, and in consideration of recommendations from, the SPD, and announced to the intelligence community and all organizations participating in mission preparation and execution. The launch date and time are based on the status of the standing (USIB) requirements, current intelligence requirements, availability of payload, launch vehicle, launch pad, and climatology.

(b) Select Orbit. The SOC selects the orbit to be flown from a library of allowable orbits developed by the SPD. In the orbit selection process, the SOC shall consider current intelligence requirements and mission guidance provided by ICRS/COMIREX and mission simulations and orbital performance predictions provided by OSP.

(c) Establish Mission Objectives. Upon receipt of the current intelligence requirements from ICRS/COMIREX, the SOC provides OSP with special mission coverage requirements, control parameters, and mission objectives. OSP then furnishes the SOC with mission-planning documentation containing recommended area weighting data, current status of standing intelligence requirements, and a statistical prediction of mission performance against all intelligence and mapping needs. The SOC, in consultation with ICRS/COMIREX, then approves those area weights and control parameters to be transmitted to the STC for use with the targeting software. Final mission objectives and guidelines are provided by the SOC to the HEXAGON Operations Command Post at the STC.

(3) OSP. OSP is responsible for providing premission software support to the SOC as follows:

(a) Maintain Historical Data Base. Area history files will be maintained for mission planning and requirements status reporting. This data base will be used in conducting simulations and predicting mission performance. Standing requirements will be accounted for by 1:50,000 World Aeronautical Chart mosaics (WAC cells), which are areas approximately 12 by 18 nautical miles in size.

(b) Conduct Orbital Performance Predictions. OSP will predict the performance of each orbital candidate from a library of orbits toward satisfying the mission objectives. These data will assist the SOC in selecting that orbit which best satisfies the mission requirements.

(c) Perform Mission Simulations. OSP will conduct HEXAGON mission simulations to assist the SOC with special studies and mission planning, and to validate its own statistical predictions.

(d) Predict Mission Performance. OSP will generate a statistical prediction of mission performance against the collection requirements. An iterative process of parametric variation is performed against the collection requirements until the desired results are obtained. The prediction addresses expected film utilization, level of satisfaction to be achieved, and the impact on future missions with respect to categories of intelligence requirements.

(e) Recommend Weighting and Control Parameters. In conjunction with the statistical prediction, OSP also recommends to the SOC area weights and control parameters to be used in order to achieve the mission objectives.

(f) Format and Transmit Targeting Software Inputs. Following SOC approval of area weights and control parameters to be used for the mission, OSP will format and transmit these data to the STC for the SOC.

(g) Generate HPA Look-Ahead. Provide a list of high-priority targets and other areas of special interest, as determined by ICRS/COMIREX, to the SOC, along with the number of each orbital revolution on which these areas are accessed.

(4) SPO. The SPO is responsible for mission preparation as follows:

(a) Determine Vehicle Performance Characteristics. Vehicle parameters for all subsystems are collected and collated by the SPO leading to the determination of vehicle performance characteristics. These data are provided to the STC for input into the mission software data base.

(b) Establish Flight Objectives. Flight objectives are established and provided to the STC to provide guidance for mission-planning activities.

(c) Establish Operations Constraints. Vehicle and operations constraints are established and published by the SPO in consideration of all aspects of the vehicle and ground station systems. These constraints are provided to the STC and, where applicable, to the SOC for consideration in orbit selection.

(d) Vehicle Launch Preparation. The SPO monitors the assemblage and checkout of the total satellite system including booster, spacecraft, and payload subsystems pursuant to launch operations.

(e) Launch and Mission Operations Preparation. The SPO monitors the launch and mission operations preparations and rehearsal activities of all supporting agencies and provides guidance as required.

(5) SSPO. The SSPO is responsible to the SPD to participate in overall system assembly and prelaunch activities, to certify at appropriate times that the sensor subsystem is ready, and to act as the principal sensor assistant to the SPD. Specifically, the SSPO is responsible for the physical installation, integration, and checkout of the sensor subsystem in the spacecraft.

(6) STC. The STC, in support of the SPD, prepares for the on-orbit command and control of the vehicle and payload subsystems.

(a) Mission Profile. The STC constructs the mission profile of events designed to accomplish the objectives set forth by the SPD and the SOC.

(b) Software. The STC constructs the software data base, including the mission objectives and control parameters received from the SOC, and performs a checkout of the entire STC software system. In consonance with the SOC and under supervision of the SPD, the STC will establish certain software data base parameters to be used in the software targeting algorithms.

(c) Rehearsals. The STC, in conjunction with the tracking station network, conducts a flight rehearsal for the purpose of refining flight procedures, validating software system operation, and demonstrating flight support readiness.

(7) NPIC. The NPIC provides the STC with a listing of intelligence targets which are to be reported in the daily Mission Performance Report (MPR) during on-orbit operations.

d. On-Orbit Operations. The System Project Director has full and complete responsibility for HEXAGON operations from launch through recovery and will continuously operate a HEXAGON Operations Command Post at the STC during each mission. The HEXAGON Operations Command Post will consist of small staffs representing the SPO/SAFSP, SSPO/OSP, STC/AFSCF, Aerospace

Corporation, and each major subsystem contractor. The SOC has broad operational authority over the mission and will operate a HEXAGON Operations Center at the Pentagon.

(1) STC. The HEXAGON Operations Command Post will conduct the on-orbit operations of the HEXAGON system at the STC. The HEXAGON Operations Command Post, hereafter referred to as the STC, is responsible for the following on-orbit activities:

(a) The STC will operate the command generation and targeting software. Specific revolution-by-revolution camera operations will be determined considering weights, control parameters, and mission guidance provided by the SOC, cloud-cover information from GWC, and mission accomplishments to date. All vehicle expendables, to include film, will be managed and controlled at the STC.

(b) Requests for weather forecasts and assessments are provided to GWC. The weather forecast request informs GWC of the area of interest and requests cloud-cover information to assist in determining which areas to photograph on a specified orbital revolution. The weather assessment request informs GWC of areas photographed and requests an after-the-fact cloud-cover evaluation.

(c) The STC will direct the efforts of the recovery forces. Transportation of the recovered capsules to their destination is accomplished by the Military Airlift Command, USAF, under schedule arrangements coordinated by the SPD.

(2) SSPO. The Director, SSPO is the principal sensor assistant to the SPD. Accordingly, SSPO representatives will be located at the STC HEXAGON Operations Command Post and will be responsive to the SPD for assigned on-orbit activities.

(a) The SSPO will assist the SPD in on-orbit sensor planning, operations, and performance analysis activities.

(b) The SSPO will, in support of the SPD, conduct postrecovery film analyses in order to evaluate the sensor performance and make necessary changes to camera settings. A Payload Evaluation Report for the sensor subsystem will be made available following each recovery to those agencies requiring such information for mission assessment and on-orbit planning.

(3) SOC. The SOC will operate a HEXAGON Operations Center during missions and will deal principally and directly with the HEXAGON Operations Command Post.

(a) The SOC must be responsive to the intelligence community through ICRS/COMIREX during HEXAGON missions. As mission requirements are changed or as new intelligence needs develop during the course of the mission, the

SOC is responsible for translating these requirements into a format acceptable to the STC-operated targeting software. This is accomplished either by developing new weighting and control parameter assignments or providing new mission guidance to the STC. If changes are significant enough to affect the original mission objectives, the SOC will conduct on-orbit trade-off studies and evaluate the impact. These effects will be reported to ICRS/COMIREX and new mission objectives and parameters will be determined by the SOC, in consultation with ICRS/COMIREX, and furnished to the STC.

(b) The SOC receives a listing of clear WAC cells from OSP, as determined from a cloud-cover assessment of the photography obtained from each of the first three satellite recovery vehicles (SRV). These areas are reviewed following each recovery to determine those clear cells which satisfy the mission objectives. A final list of clear WAC cells for each SRV is sent to the STC for on-orbit updating of the mission objectives.

(4) OSP. OSP is charged with the following on-orbit operational support to the SOC:

(a) Perform mission simulations, as requested by the SOC. These simulations will be used to check updated performance predictions or to assist the SOC in trade-off studies whenever mission objectives are significantly changed, either by new intelligence requirements or system malfunctions, and when such support is specifically requested by the SOC.

(b) Recommend new weighting and control parameters and update mission performance predictions when requested by the SOC. Such replanning will not be a normal requirement. This planning is contemplated only in the event that the mission objectives are substantially changed.

(c) Generate an updated high-priority target acquisition list (HPA Look-Ahead), as required.

(d) Provide the SOC with a listing and computer plot of clear WAC cells as determined from those NPIC and TOPOCOM cloud-cover assessments of photography received from the first three SRV's.

(5) GWC. GWC is responsible for providing weather forecasts and assessments to the STC and the SOC. Weather forecast data are provided for each eighth of the full HEXAGON swath width for each orbital revolution and are expressed in percent probability that the area will be at least 90 percent cloud free. Weather assessments are also expressed in the same manner, but apply only to those eighths of the swath that were actually photographed. Special weather information is provided to the STC upon request. These special reports might be, for example, daily snow cover reports or a weather forecast for the recovery area.

(6) EK and SPPF. EK and SPPF are responsible for accepting delivery of the SRV filmload and processing the two working prints to be used initially by the NPIC Readout Team and the SPO/SSPO Postrecovery Analysis Team. These prints are then shipped to NPIC and TOPOCOM for final film readout.

(7) NPIC.

(a) NPIC will provide a preliminary film readout team to support the SOC in on-orbit evaluation of mission performance, effectiveness, and accomplishments. The readout team will be at the film processing site and will quickly assess the photography from each of the first three SRV's on a first-priority basis. The readout information provided to the SOC will be used in updating the mission objectives for the remainder of the mission.

1. The team will assess the cloud-cover conditions and usable quality of each 15-degree scan segment of each frame of photography from one of the panoramic camera systems. This information is then furnished to the SOC and OSP.

2. The team will determine cloud-cover conditions and interpretability of SOC-specified high-priority targets and areas of special interest from the photography of both pan cameras.

(b) The NPIC team will supervise breakdown and packaging of material derived from each SRV.

(8) TOPOCOM. The U.S. Army TOPOCOM will perform a final operational film readout of each SRV to provide cloud-cover information to OSP. This information will be processed by OSP for use by the SOC in accounting for actual mission accomplishments and, when possible, for updating mission objectives for the remainder of the current mission.

e. Activities Concurrent with On-Orbit Operations. There are a number of mission-related activities which are "off line" in nature in that they do not interact directly with satellite command and control. These activities are, for the most part, monitoring and planning functions.

(1) STC. The STC provides the following information concerning vehicle performance:

(a) The STC will keep the SOC informed of on-orbit activities and events, to include vehicle and payload health, selected camera operations data, expendables' status, planned and executed orbit adjustments, and recoveries, as well as malfunctions which might affect the intelligence collection mission.

(b) The Mission Performance Report (MPR) will be provided on a daily basis to the SOC, OSP, NPIC, EK, SPPF, and TOPOCOM, as well as those organizations not directly involved in mission execution, but requiring performance data, such as the Defense Intelligence Agency (DIA) and the U.S. Air Force Aeronautical Chart and Information Center (ACIC). A more complete discussion of the contents of the MPR can be found in Chapter 2 under 'TUNITY.

(c) STC will compile a daily listing of WAC cells photographed and their GWC weather assessment. These data will be provided to the SOC and OSP.

(d) A predicted ephemeris will be provided to OSP and GWC.

(e) Predicted ground tracks based on the predicted ephemeris will be provided to the SOC, as required.

(2) SOC. The SOC will monitor the mission and continually evaluate the mission accomplishments and payload performance with respect to the mission objectives, area weights, and control parameters set forth prior to launch.

(3) OSP. OSP will provide the following support:

(a) Prior to launch OSP provided a list of high-priority targets and other areas of special interest to the SOC with the number of each orbital revolution on which these areas were to be accessed. This target look-ahead will be updated as required throughout the mission.

(b) Following each day of HEXAGON operations, OSP will provide to the SOC a daily summary of camera operations, intelligence categories and target clusters photographed, probable and actual accomplishments to date, and requirements satisfaction levels. This report is based on the MPR and WAC Cell/Weather Assessment listing received from the STC.

(4) NPIC. NPIC will maintain a backup capability to the Mission Performance Report (MPR). In the event the MPR cannot be made available, NPIC will develop ephemeris and frame data based on telemetry tapes provided from the STC and actual film formats. This information will then be made available to all MPR recipients.

f. Postflight Activities. The on-orbit operations end and postflight activities begin, for purposes of this document, upon delivery of the last SRV to its destination.

(1) EK and SPPF. EK and the SPPF will accomplish film handling, processing, and distribution, to include developing and printing processes, titling, breakdown, inspection, packaging, and shipment to the customer.

(2) NPIC. NPIC will provide a team to the processing site to supervise breakdown and packaging of material derived from the mission.

(3) TOPOCOM. The U.S. Army TOPOCOM will perform a final operational film readout of the entire mission (excluding readout performed during the mission)

in order to provide cloud-cover information to OSP. After the cloud-cover data are correlated to the ephemeris and processed by OSP, this information will be returned to TOPOCOM in two forms--a computer plot of clear WAC cells and a magnetic tape of cloud boundaries defined by geodetic coordinates. These data are used as the basis for preparing map overlays of areas photographed clear this mission and to depict graphically the status of the USIB search requirements. These overlays are provided to the SOC to facilitate future mission planning.

(4) OSP. OSP performs the following postmission tasks in support of the SOC:

(a) Account for actual mission accomplishments in terms of clear WAC cells and target coverage, based on the TOPOCOM assessment of the photography, and store these data in the historical data base.

(b) Provide TOPOCOM with mission accomplishment tapes and computer plots to assist in their graphical support to the SOC.

(c) Provide the SOC with a statistical mission summary of standing and current intelligence requirements which were satisfied on the mission and a status report on standing requirements satisfaction levels.

(d) Assist the SOC with software support and simulations for postmission analyses.

(5) SOC. The SOC will evaluate the mission accomplishments in light of the mission objectives and weighting and control parameters provided to the STC prior to launch and during the mission. The SOC will report the mission results to ICRS/COMIREX.

(6) SPD. The SPD, with the support of the SPO, STC, and SSPO, will perform postflight analyses of all aspects of spacecraft and total system performance, on-orbit operations, targeting and command generation software support functions, and launch, tracking, and recovery operations. A Command Post Mission Report will be written following these analyses.

(7) SSPO. The SSPO will perform postflight analyses of sensor subsystem performance, to include a film quality evaluation. The SSPO will provide a Payload Evaluation Report for the entire mission to the SPD for inclusion in his Command Post Mission Report.

CHAPTER 2

SOFTWARE CAPABILITIES

General. This chapter provides a general description of the major software programs used in HEXAGON planning and execution, their capabilities, and some of their products, in order to better understand the part they play in the overall conduct of a mission. Table 2-1 summarizes the specific intelligence planning and targeting software available.

Orbital Search. The Orbital Performance Prediction Program is operated by OSP to assist the SOC in the orbit selection process. The SOC will submit several orbital candidates to OSP based on a library of allowable orbits provided by the SPD. These orbits are defined in terms of initial or injection conditions, which consist of active mission life, inclination, orbital period, launch date and time, altitude and latitude of perigee, drag factor, planned times and revolution numbers for orbit adjustments with the new expected orbit conditions, and special comments and limitations. In consideration of the orbit, climatology, and obliquity requirements, the Orbital Performance Prediction Program provides specific data for SOC consideration. Such data might include, for each orbit under consideration, the probability of acquiring cloud-free photography for specified areas or the number of opportunities to photograph particular target clusters and special interest areas during the mission.

Statistical Prediction/Simulation.

a. CRYSPER. The Sensor Subsystem Performance Prediction Program (CRYSPER) is used to assist in the selection of optimum weighting and control parameters for the mission. As a part of the mission planning support, OSP will provide to the SOC a mission simulation which will provide predicted ground resolved distances (GRD) for selected targets. In the GRD prediction the CRYSPER program will consider the fundamental operating characteristics of the sensor subsystem to be flown, the type of film selected for the mission, the selected orbit and time of launch, haze characteristics, and the contrast and reflectances of the individual targets.

b. HAMPER. The HEXAGON Analytic Mission Planning Estimation Routine (HAMPER) is used to statistically predict mission performance, with respect to satisfying intelligence collection requirements, and to generate recommended weighting and control parameters on a WAC cell basis for use in the targeting software. HAMPER will perform the following functions:

(1) Predict performance level against complex surveillance, area search, and special areas of interest unique to the mission being planned.

(2) Estimate amount of film required to satisfy the mission objectives.

(3) Generate curves depicting levels of performance versus the amounts of film required to attain these performance levels for each target cluster, target cluster grouping, search category, or specially designated area.

(4) Report current status of intelligence collection requirements and predict expected status by completion of the mission.

(5) Generate recommended WAC cell parameters. Specifically, these parameters are the weight and acceptable probabilistic level of successful photographic coverage for each cell. The program will have the capability to generate, upon request, suggested camera scan angle limits to improve on photographic resolution at the expense of area coverage, should this option be desirable.

c. HSIM. The HEXAGON Simulation Program (HSIM) will be capable of rapid simulation of HEXAGON camera operations by taking into consideration the orbit to be flown, standing and mission unique collection requirements, hardware constraints, film management, actual cloud-cover conditions from historical data on file, targeting software camera operation selection logic, and weighting and control parameters provided from HAMPER and the SOC. HSIM will generate these simulations for use by the SOC in performing studies, mission planning, orbit selection, and on-orbit replanning.

Operations.

a. 'TUNITY. The TRW Unified Information Transfer Software System ('TUNITY) will perform on-orbit mission targeting, command and control, and mission reporting. It is a software package made up of many computer programs and routines.

(1) General System Functional Requirements.

(a) Mission Targeting functions accomplished by 'TUNITY are as follows:

1. Store and maintain descriptive information pertaining to areas of interest to the intelligence community.

2. Accept dynamic changes to mission-specific areas requiring intelligence collection.

3. Allow area weighting and control parameters to be easily modified at any time prior to or during the mission.

4. Identify all areas of interest within view of the camera system for specified time periods.

5. Select the actual areas to be photographed, subject to the maximization of intelligence value per unit of film expended.

6. Provide to the operator sufficient intermediate information to allow effective manual control over the above tasks.

(b) 'TUNITY Command and Control functions will:

1. Generate commands required to allow the sensor and vehicle to accomplish the selected photographic operations.

2. Translate the above commands into a conflict-free command message and identify any conflicts should they exist.

3. Construct a command message for transmission to the remote tracking stations.

4. Maintain a ground-based up-to-date image of the commands stored in the vehicle command memory.

5. Provide sufficient intermediate information to allow effective manual control over the above tasks.

(c) 'TUNITY Reporting and Assessment functions can:

1. Provide information such that assessments of the relative accomplishment of the mission objectives can be made, based on photographic accomplishments to date.

2. Retain information for later targeting and command and control functions discussed earlier.

3. Provide sufficient intermediate information to allow effective manual control over the above tasks.

4. Evaluate mission performance.

5. Report on mission performance. A more detailed discussion of this report is found in the following paragraph.

(2) The Mission Performance Report (MPR). The MPR will be received and used by more organizations than any other software output. It is therefore discussed in detail in this document, as it is the basis for vehicle performance monitoring and evaluation, exploitation planning, and film distribution; and aids in the imagery interpretation process.

(a) General. The MRP will be provided from the STC daily on a revolution-by-revolution processing basis. It utilizes, as a starting point for its execution, the following:

1. Best-fit ephemeris to define the vehicle position as a function of time.

2. History of executed commands.

3. Frame reference times for frames of film exposed by the cameras.

(b) Data Content. Each MPR will contain general information on the vehicle, orbit, and camera systems and specific data for each orbital revolution (rev), camera operation, photographic frame, and photographic frame's target content.

1. General Information. Each MPR will be dated and will state the mission number, vehicle number, ephemeris identification, and the rev span for which the report is applicable. Time correlation and initial orbital parameters will be displayed along with physical earth constants. The report will also contain the times of orbit adjustments and reentry vehicle firings, with their attitudes and rates of thrust.

2. Camera Information. Camera identification numbers and lens serial numbers, along with the film types, filter type, and focal length used with each camera, are provided in each report. A display of the main cameras' 32 slit calibrations is provided for correlation of slit width in inches with the slit settings listed in the photographic frame data part of the report.

3. Orbital Revolution Data. Each rev is defined by its rev number, numbered sequentially from the start of the mission, its date, and a 20-point ephemeris.

4. Photographic operations are defined as "camera on to camera off." They are numbered sequentially throughout the mission. Photographic operations are listed in the MPR by operation number, rev number, date, reference system times for the first and last frames of the operation, and the geodetic latitude and longitude of the four corners of the area photographed by the operation. The scan angle or scan mode and scan center placement in degrees from nadir are also provided for the main camera. The exposure overlap mode of the stellar-index camera will be reported for each operation.

5. Each frame of photography is numbered sequentially beginning with each photographic operation. A frame of panoramic photography will vary in length according to the scan mode selected for the operation; however, each frame within an operation will be the same length. Each frame of photography will be listed in the MPR with the following frame data:

a. Rev number

b. Operation number to which frame belongs

c. Frame number

d. Optical bar designator for frame (forward or aft pan cameras only).

e. Frame reference times (system and vehicle)

f. Geodetic latitudes and longitudes of the frame reference point, vehicle nadir, and frame corner points (pan cameras only).

g. Solar elevation and azimuth

h. Vehicle flightpath angle

i. Slit number used (correlate with main camera slit width display in earlier section of report).

j. Vehicle altitude at frame reference time

k. Velocity and azimuth of ground track

l. Vehicle inertial velocity and azimuth

m. Commanded FMC rate (stellar/terrain cameras only).

n. Commanded and computed velocity-altitude ratio, film speed, and optical bar rotation rate (pan cameras only).

o. Right ascension and declination of each stellar axis (stellar/terrain cameras only).

6. The targets totally or partially photographed by a particular frame will be listed according to frame. The degree to which the target was framed, its ID number, geodetic latitude and longitude of the target center, frame coordinates of the target center, and target elevation will be provided in the MPR. This applies only to main camera photography.

b. Vehicle and Telemetry Software. Computer programs are available to the SPD to assist him in the preparation and conduct of HEXAGON missions. These programs will be applied to HEXAGON vehicle and telemetry functions. Specifically, they will support vehicle testing, aerospace vehicle pad testing, ascent guidance, and telemetry analysis.

c. General Support Software. SAFSP and STC computer programs, which support various satellite systems, will also support HEXAGON. These general computer programs will provide the following capabilities:

(1) Orbit determination and ephemeris generation

(2) Orbit maintenance and orbit adjust determination

(3) Command and tracking station acquisition data and scheduling.

(4) Telemetry processing and display

(5) Vehicle-clock-to-GMT calibration

(6) Data handling, display, and command message transmission to remote tracking stations.

(7) Ascent/reentry determination

(8) Computer operation and utility programs

(9) Remote tracking station software

Operational Support. Area coverage history and accounting programs are operated and maintained by OSP in support of the SOC. These programs are used to generate statistical data which are used in all phases of HEXAGON operations. These programs are, for the most part, oriented to 12-by-18-nautical-mile WAC cells.

a. ACCOMP Program. The ACCOMP Program maintains the status of the mission objectives and intelligence requirements satisfaction during and after the mission. The 'TUNITY output of WAC cells photographed and the corresponding assessed weather information is used by the ACCOMP Program to establish probabilistic levels of satisfaction for each intelligence requirement category. The ACCOMP Program is updated as actual film readout is obtained and processed by the Area Coverage Program. This information is provided to the SOC in a daily mission status report.

b. Area Coverage Program. The Area Coverage Program is one which accepts a cloud-cover assessment of each frame of exposed film and transforms this cloud information, defined in terms of frame coordinates, to ground coordinates by merging with the MPR. Then the ground coordinate cloud definition is superimposed upon the appropriate WAC cells internally by the software to determine the number of twenty-fourths or 3-by-3-mile WAC cell sectors which are cloud covered and cloud free. Those WAC cells having 22 or more cloud-free sectors or subcells are considered cloud free. This information updates the previous listing of WAC cells and their probabilistic cloud-freeness derived from weather assessments.

c. Area History Program. The Area History Program will draw from the ACCOMP Program files and store WAC cell historical data. The Area History file will contain the mission number and date of each photographic attempt and each photographic success on a WAC cell basis. This program will generate data to support HSIM, HAMPER, and 'TUNITY.

TABLE 2-1

Organizational Responsibilities for HEXAGON Mission Planning and Targeting Software

MISSION PLANNING AND TARGETING SOFTWARE

	Developed By	Funded By	Managed By	Operated By	Supporting
Orbit Performance Prediction Program	Lockheed	NRO	OSP	OSP	SOC
CRYSPER	Perkin-Elmer Eastman-Kodak	NRO	OSP	OSP	SOC
HAMPER	TRW	NRO	OSP	OSP	SOC
HSIM	OSP/TRW	CIA/NRO	OSP	OSP	SOC
'TUNITY	TRW	NRO	SAFSP	STC	STC
ACCOMP Program	Lockheed	NRO	OSP	OSP	SOC
Area Coverage Program	Lockheed	NRO	OSP	OSP	SOC
Area History Program	Lockheed	NRO	OSP	OSP	SOC

CHAPTER 3

OPERATIONAL AND ORGANIZATIONAL INTERFACES

General. Chapter 1 discussed the organizational responsibilities for the development, preparation, planning, execution, and analysis of HEXAGON missions. Chapter 2 identified HEXAGON software programs and their functions. This chapter will highlight the information presented in Chapters 1 and 2 by presenting a chronological flow of data from one organization to another for the premission, on-orbit, and postmission operational phases of a typical HEXAGON mission. It must be recognized that this chapter presents only the communication of data from one organization to another. It does not address internal organizational functions and data flows which occur in connection with the preparation and execution of a mission.

Premission Information Flow. The activities depicted graphically in Figure 3-1 begin following an announcement of the launch date by the SOC. The SPO/SSPO informs the STC of vehicle parameters, payload constraints, and flight objectives. Operational status reports are provided back to the SPO/SSPO from the STC as mission preparations progress.

ICRS will provide current intelligence requirements and mission guidance to the SOC to the extent necessary to enable the SOC to select an orbit. Normally, the standard sun-synchronous HEXAGON orbit will be flown, but other orbits may be considered in light of ICRS mission-specific requirements. Orbit candidates are provided to the SOC from the SPO whenever a nonstandard orbit is being considered. The SOC will call upon OSP for an orbit performance prediction prior to selecting a nonstandard orbit. The SPO/SSPO, STC, and OSP are notified by the SOC of the orbit selected.

OSP provides the SOC with a statistical report showing the launch-date status of the USIB standing requirements. Concurrently, ICRS finalizes its mission guidance and mission-specific requirements for current intelligence collection to the SOC. After evaluating the total mission requirement and current status of standing requirements, the SOC will supply OSP with the mission objectives and control parameter assignments. These control parameter assignments might include such specific WAC-cell-oriented parameters as maximum acceptable resolution, maximum or minimum obliquity of scan, desired frequency of coverage, minimum acceptable solar elevation, acceptable probabilistic level of satisfactory coverage, and direction of photography, e.g., photograph east side of target only.

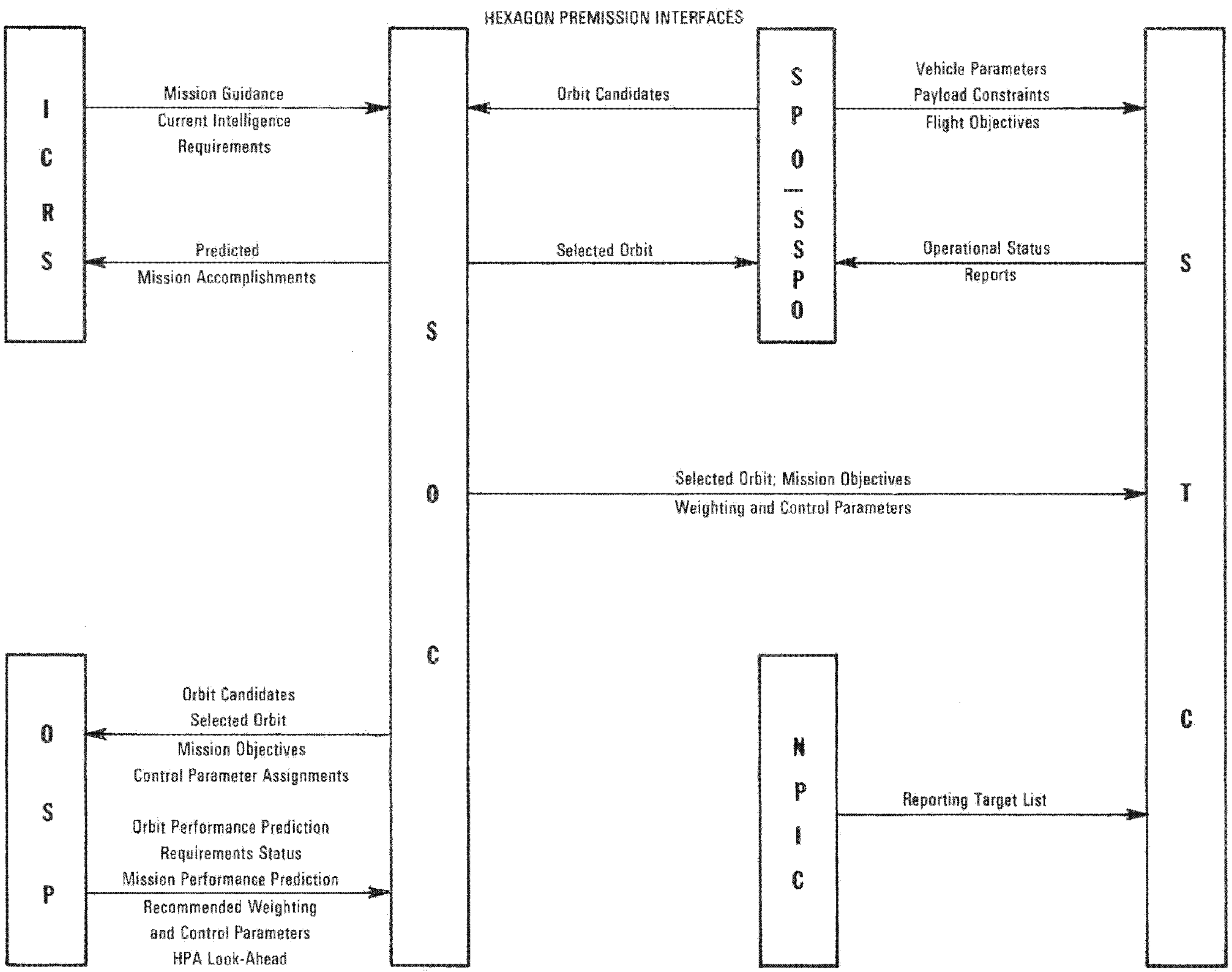

Figure 3-1. HEXAGON Premission Interfaces

OSP runs HAMPER and, when required, HSIM programs. The outputs are formatted into a statistical performance prediction, which estimates what can be accomplished by this mission towards satisfying the mission objectives. This prediction and the accompanying weighting and control parameters generated from HAMPER are studied by the SOC in consultation with ICRS until a proper balance of film expenditures and expected intelligence collection accomplishments is achieved. The parameters which will best accomplish the mission objectives will be approved by the SOC and released for transmission to the HEXAGON Operations Command Post at the STC for use with the 'TUNITY targeting software. The SOC then provides ICRS with the final prediction of expected mission accomplishments. OSP provides the SOC with a high-priority target access prediction, called the HPA Look-Ahead. NPIC will format and transmit the reporting target list to the STC for use by 'TUNITY in generating target information in the MPR.

On-Orbit Information Flow. The HEXAGON Operations Command Post will operate continuously at the STC throughout the mission to accomplish the rev-by-rev payload and vehicle command and control functions. Decisions for activating the cameras over designated areas will be determined at the STC by the 'TUNITY camera operation selection process. 'TUNITY processes timely forecasts of cloud-cover conditions over accessible areas of interest, along with the weighting and control parameters previously provided by the SOC, to arrive at such decisions.

Before camera operations can be considered for selection, the STC must first request a weather forecast from GWC for the specific areas to be accessed. The GWC weather prediction is received by the 'TUNITY selection algorithm just prior to the command generation process (see Figure 3-2). 'TUNITY selects the most efficient scan mode, scan center, and camera on and off points to obtain the highest intelligence score per unit of film. The camera operation selections are formatted and transmitted to the appropriate remote tracking stations (RTS) where the selected operations are commanded to the satellite. The SOC receives a message from the STC which lists the camera operations selected and commanded.

The RTS will furnish tracking and telemetry data to the STC as it becomes available. Part of the data are used to provide the SOC with a vehicle and payload status report. Tracking and telemetry data are also used by 'TUNITY to generate the MPR. The STC disseminates the MPR to appropriate organizations, as shown in Figure 3-2.

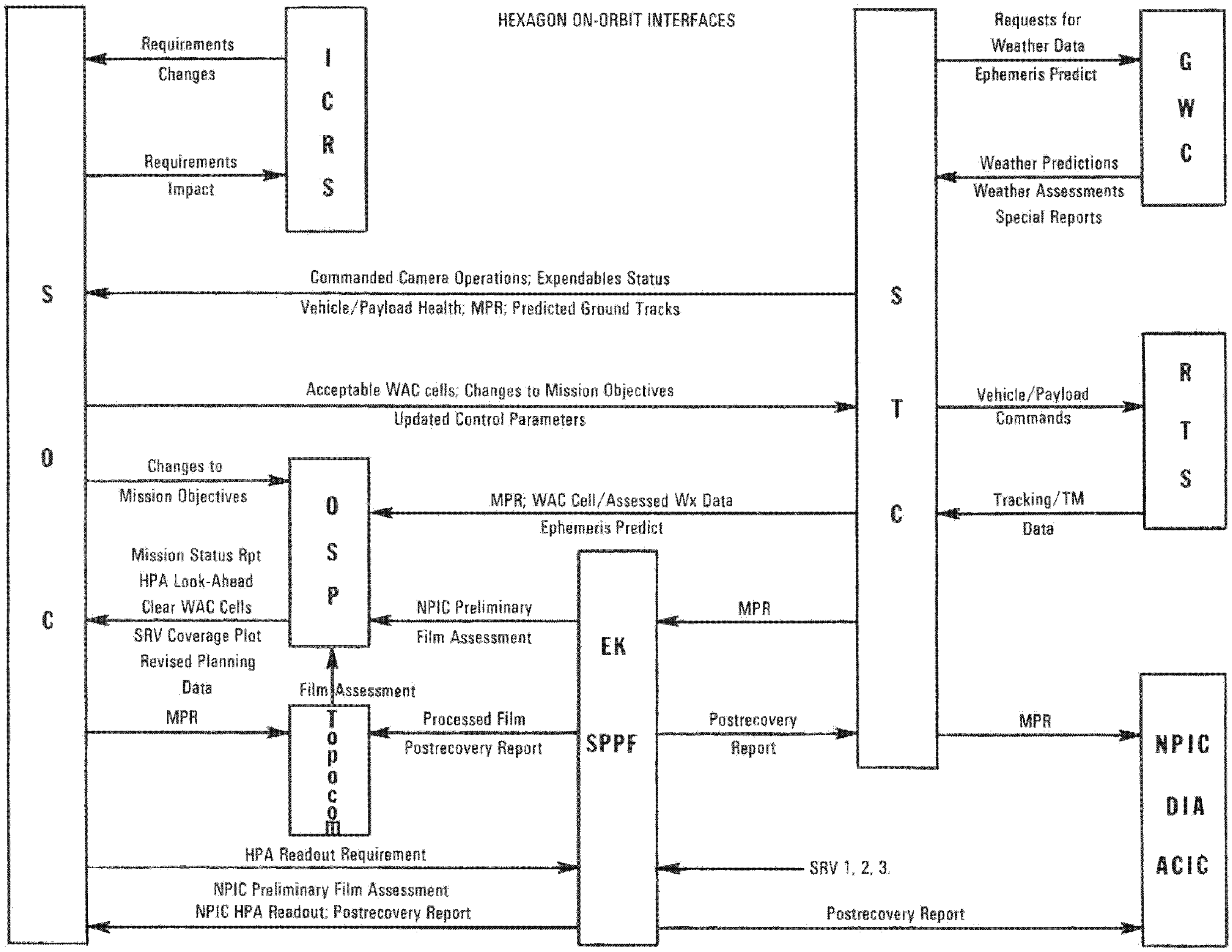

Figure 3-2. HEXAGON On-Orbit Interfaces

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The STC will receive a weather assessment from GWC, upon request, which indicates probabilistic cloud-cover conditions over those areas previously photographed. The assessment data are used by 'TUNITY to account for mission accomplishments in the mission objectives file, to implement WAC cell deweighting prior to future accesses to the areas already photographed, and to generate for OSP a listing of WAC cells photographed and the corresponding weather assessment for each cell. OSP will provide the SOC with a daily collection status report derived from the MPR, GWC weather assessments, and film readout, when available. The ACCOMP and Area Coverage Programs are used by OSP to process this information for the report.

GWC provides special weather reports and meteorological data to the STC upon request. The STC will provide predicted ephemeral data to GWC and OSP, as required, throughout the mission. The STC will also provide the SOC with predicted ground tracks derived from ephemeral data. OSP will update the HPA Look-Ahead, which was provided to the SOC prior to launch, as required, based on the latest ephemeral data.

After recovery, each of the first three SRV's will be delivered to one of the two processing sites -- EK or SPPF -- while on-orbit operations are continuing. After the first working prints are available, the NPIC team begins its preliminary film assessment to determine cloud conditions on the photography. A complete assessment of the coverage obtained from one camera is made and transmitted to the SOC and OSP. A target readout is performed on those targets previously designated by the SOC. The target cloud-cover information is obtained from the coverage of both main cameras and sent to the SOC. Concurrently, a postrecovery analysis of the film and sensor subsystem performance is conducted by SPO/SSPO.

OSP will process the film assessment data obtained from the NPIC team using the Area Coverage Program and provide the SOC with a listing of clear WAC cells and a computer plot depicting clear coverage. The listing and plot are reviewed in light of special mission requirements. Those clear WAC cells accepted as satisfying the mission objectives are sent to the STC to update the 'TUNITY mission objective file.

As soon as the analysis of the working print is completed at the processing site, the print is shipped to TOPOCOM for a final cloud-cover assessment. The TOPOCOM assessment is treated as an update to the NPIC assessment and is processed similarly at OSP and the SOC.

Changes to the prelaunch intelligence requirements are expected during the 30-day mission duration, and the SOC is prepared to implement such changes on short notice. When such changes are received from ICRS/COMIREX, the SOC will update the weighting and control parameters previously sent to the STC. If the changes are significant and appear to seriously impact on the mission objectives, the SOC will request a rerun of HAMPER or HSIM, as required. This will not preclude implementing the change immediately when such changes are urgent. OSP will provide the SOC with necessary data to conduct replanning and to advise ICRS/COMIREX of the impact of the change, either before or after the change is implemented. The on-orbit phase of the mission terminates upon recovery and delivery of the fourth SRV to the processing site.

Postmission Information Flow. The postmission phase of the operation begins after arrival of the final SRV to either processing site. The postflight analysis of the film and payload performance is conducted at the processing site by SPO/SSPO using one of two working prints. This print is sent to TOPOCOM for assessment following the postrecovery analysis. The second working print is sent directly to NPIC.

After OSP has processed all TOPOCOM SRV assessments, a mission accomplishments tape is generated by the Area Coverage Program which provides the SOC with a final mission status report and provides TOPOCOM with both the clear coverage obtained, by frame, and a computer plot of the total mission accomplishment. These data are used by TOPOCOM to produce a mission performance graphic and a requirements status or "holiday" graphic for the SOC. The SOC will provide a requirements status report to ICRS/COMIREX. OSP continues to provide study and simulation data on request to the SOC for mission evaluation and future mission planning.

Operations-Exploitation Interface. The Mission Performance Report (MPR) is provided daily throughout the mission to organizations requiring mission performance data for exploitation planning purposes. The TOPOCOM cloud-cover assessment of the film, as processed by OSP, is also available to organizations requiring this information for photo indexing or mission analysis purposes. Two such organizations, GWC and DIA, are depicted in Figure 3-3.

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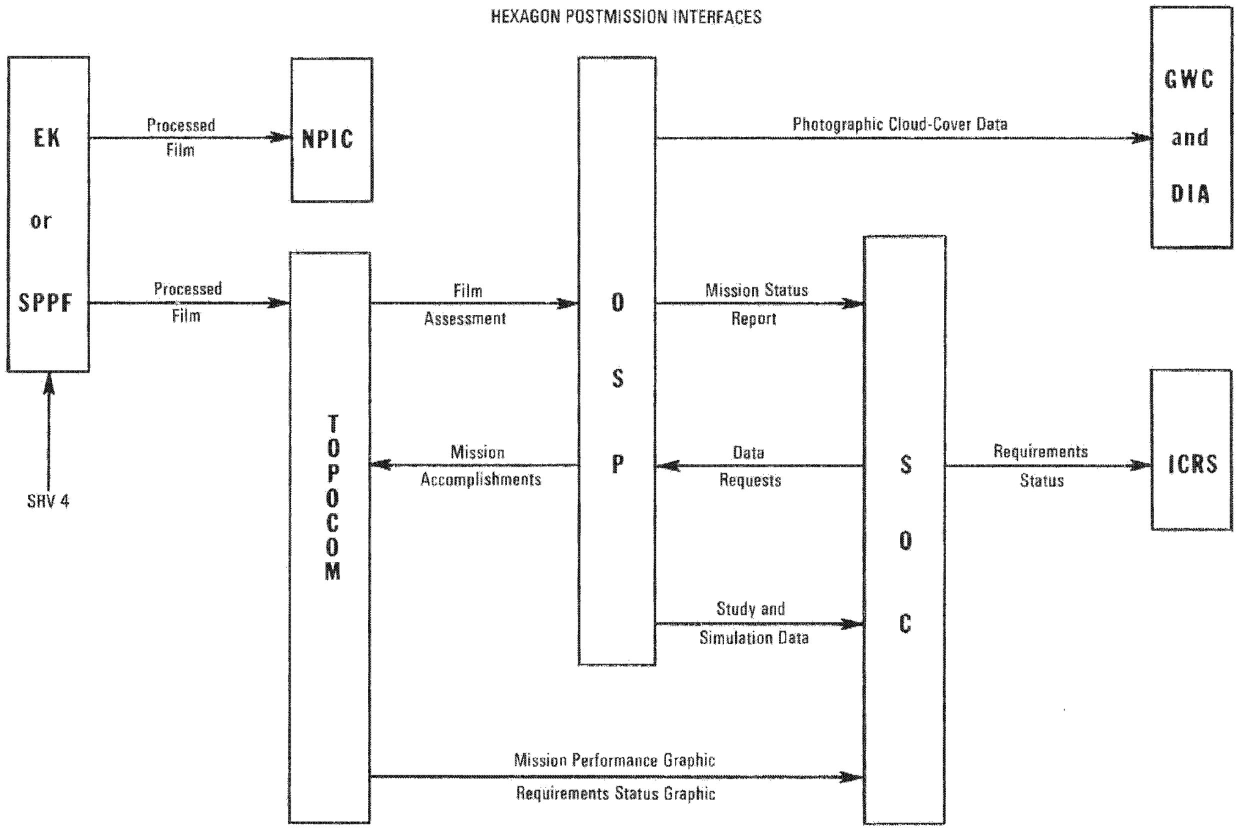

Figure 3-3. HEXAGON Postmission Interfaces

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