Science Data Products and JSOC Documentation Requirements

The following are the sections of the HMI contract documents that specify required documents for the science data products and science operations center development.
This is the source information for the science and JSOC document tree.

Phase-A Concept Study Report:

4.7 Mission Operations, Ground and Data System

The revised and updated plan for the system architecture and the conduct of instrument mission and science operations will be described. This will include layout and interconnect of operational systems, and a description of the plans for the collection, routing and validation of the science data. The subsequent data processing plans to generate quality science data products to be shared and distributed with the scientific community will also be described. A brief description of the archival and distribution process and systems shall be provided.

Main section of Contract (Mod 13):

I.7.(b) The Contractor shall provide, implement, and maintain an IT Security Plan. This plan shall describe the processes and procedures that will be followed to ensure appropriate security of IT resources that are developed, processed, or used under this contract. The plan shall describe those parts of the contract to which this clause applies. The Contractor's IT Security Plan shall be compliant with Federal laws that include, but are not limited to, the Computer Security Act of 1987 (40 U.S.C. 1441 et seq.) and the Government Information Security Reform Act of 2000. The plan shall meet IT security requirements in accordance with Federal and NASA policies and procedures that include, but are not limited to:

(1) OMB Circular A-130, Management of Federal Information Resources, Appendix III, Security of Federal Automated Information Resources;
(2) NASA Procedures and Guidelines (NPG) 2810.1, Security of Information Technology; and
(3) Chapter 3 of NPG 1620.1, NASA Security Procedures and Guidelines.

Contract Performance Specification – CPS:

6.0 GENERAL HMI DATA PRODUCT REQUIREMENTS

The HMI investigation will provide sufficient computing capability to convert the raw HMI measurements and filtergram data sets into computed observables and derived data products that satisfy the HMI science objectives. The processed HMI data products will be accessible by the public and all interested investigators. The primary HMI observables (Dopplergrams, longitudinal and vector magnetograms, and continuum intensity images) will be constructed from the raw filtergrams and will be made available at full resolution and cadence. Other derived products such as subsurface flow maps, farside activity maps, and coronal and solar wind models that require longer sequences of observations shall be produced and made available to the public. The full set of data products to be defined and developed by the HMI team will be

documented in an HMI Science Implementation Plan prepared by the Contractor.

Statement of Work – SOW:

7.2 Ground Support Software

The Contractor shall design and provide all ground support software necessary to operate, monitor, test, and calibrate the instrument using Contractor-supplied EGSE. The EGSE software shall provide an effective operator interface for the operation and control of the instrument, provide algorithms and other computational means to analyze and interpret instrument housekeeping and science telemetry, and provide means for capture and archival of all relevant test data.

9.0 SCIENCE

The Contractor shall provide a Principal Investigator (PI) who shall oversee and direct the science elements of the investigation. The PI and his supporting science team shall define and control science requirements and science data products; determine and control essential instrument performance requirements needed to achieve the required science measurements; define and implement a flight calibration program; define and manage the required science data processing center including embedded operations software, science algorithms and other related computational software; manage and guide the affiliated Co-Investigator team; and participate in the SDO Science Working Group forum.

The Contractor's Project Management and Systems Engineering teams shall work closely with the PI, and his science support team, to assure proper integration of science requirements into the Contractor's hardware and science operations development efforts. In concert with the PI, the Contractor shall provide the manpower and resources necessary for the implementation of the investigation's science program, the design and development of the science operations and data processing center including operational interfaces with the SDO Mission Operations Center (MOC), and the formulation and execution of an Education and Public Outreach program to foster community and public awareness of the benefits of the PI's science program

9.3 Science Operations Control Center (SOC)

The Contractor shall design, develop and operate a Science Operations Center (SOC). The SOC will interface with the SDO Mission Operations Center (MOC) to provide operational interfaces for the on-orbit operation and monitoring of the instrument and the transfer of instrument housekeeping and science data collected by the spacecraft and transmitted to the MOC ground stations. The SOC shall subsequently convert this raw science data into valid research quality data and data products for archival and public access and distribution. Some key functions to be performed in the SOC include:

a. Instrument Flight Operations. The conduct of instrument on-orbit flight operations in concert with the SDO MOC and its associated Flight Operations Team (FOT). The Contractor shall be responsible for the command planning and the health and safety monitoring of the flight

instrument. The specific extent of command authority will be resolved during mission operations development dialogues with the SDO Project, but as a minimum, any command activity that constitutes a hazardous command activity or requires coordination with the FOT for reconfiguring of spacecraft resources or reconfiguring another instrument shall be planned, integrated and authorized by the FOT. The SOC shall provide all the required operator interfaces to display, monitor and analyze the instrument operating state, operating condition and trended behavior; support the instrument operation and observation planning and the build of associated commands and command loads; and provide effective communication means for contact and coordination with the MOC and among the instrument operations team members.

b. Science Data Processing. The receipt, sorting, quality checking and process of the instrument science data forwarded to the SOC by the SDO ground system. The Contractor shall provide the required software and computational algorithms to process this data into the required science data products on a regular, routine basis. This effort includes the need to monitor the calibration of the flight instrument and adjust the processing software accordingly. The Contractor shall store and archive the science data and perishable data products, and shall provide public access and distribution to the data and data products. The Contractor shall prepare and submit the plan for the architecture, data flow, processing, archival and distribution of the science data through the SOC (CDRL SD326).

Contract Data Requirements List – CDRL

SD301	Instrument Science Requirements	I	1H/E	9.2	Final: ICDR
SD326	Science Data Plan including SOC Plan; Science Data Analysis, Processing, Archive and Distribution Plan; and Functional Descriptions of Data Products	I I I	1E 1 E 1 E	9.3	Update: IPDR + 3 months Update: ICDR Update: OMRR

Mission Requirements Document – MRD

The mission requirements are gathered into the top level **Mission Requirements Document – MRD** found at html . The MRD section 5.4 contains the requirements for the JSOC. 5.4.1 specifies the operations component, 5.4.2 the archive component and 5.4.3 the science data products.

First versions of documents responding to the above requirements:

ID	Revised	Title	Author	Viewable	Source
HMI-S006	13-Mar-03	Instrument Systems Requirements Review	HMI	pdf	html
HMI-S014	17-Nov-03	HMI Science Plan – SU	SU-HMI	pdf	html
HMI-S015	1-Jul-03	HMI SOC Ground System Plan	Jim Aloise	pdf	html

The data product requirements are better described (than in HMI-S006) in the HMI Requirements link on the HMI web site. The data section of the HMI-S014 is also a snapshot of the information from the Requirements link.

The data product section is here:

- **HMI Observables:** The observations in step 4 are built from disk-image maps of basic HMI observables. The observables are built from short sequences of filtergrams made in various polarizations and tuning passbands across the spectra line. The basic observables are line-of-sight surface velocity from Doppler shift measurements, line-of-sight magnetic field from Zeeman split line components in circular polarization, vector components of magnetic fields from Stokes parameter measurements of the Zeeman split components of the line, and continuum brightness measurements. The cadence, sensitivity, linearity, acceptable measurement noise, image stability and related requirements for the observables are derived from the HMI observations requirements. The following list points to a description of the observables and a chart showing which data products are generated from which observables.

    - **HMI Observables :** Table of HMI basic observables. These observables are made from short sequences of filtergrams made in various polarizations and tunings across the spectral line.
    - **HMI Filtergram Sequence:** Chart showing the sequence of filtergrams needed to build the HMI observables.
    - **Data_Analysis_Pipeline:** Chart showing more detailed flow of data from raw data to science data products. The data products are in the rightmost column. Also available as **.ppt**

- **HMI Science Data Products:** The analyses in step 2 require specific data products as input to detailed analyses. These data products are not raw instrument observables but are rather often (usually for HMI) the result of substantial processing of time series of varying lengths. Examples are maps of subsurface flows, far-side active region maps, models of coronal fields, etc. A summary of these data products, a table showing the flow from science objectives to the data products and a chart showing the derivation of the data products from the processing pipeline are in the following list.

    - **HMI Science_Data_Products :** Summary of HMI science data products
    - **Required Analysis/Processing Algorithm Development**
    - **HMI_Objectives-Data_table :** Matrix showing tie between objectives to data products. Entries in this table show the observation sequence types required.

- **HMI science pipeline chart**: Chart showing the flow of data from raw data to science data products to science objectives. Each arrow in this figure represents a matrix element from the above HMI Objectives-Data table. Also available as **.ppt**

In February 2004 the concept of a Joinc Science Operations Center – JSOC – for HMI and AIA was formed. This was described in a draft document and two *powerpoint* presentations. These are:
Conceptual Description of Joint HMI-AIA Science Operations Center
and HMI_JSOC_Townsend.ppt for HMI and Hope.ppt for AIA.

NOTE on names:

At one recent SOWG telecom we agreed on terminology for the JSOC data component – **Science Data Processing – SDP.** The SDP includes the data capture through to distributed "standard" science data products. I.e. everything shown in the **Data_Analysis_Pipeline.**

The SDP does not include science analysis computing which is implicit in the arrows or right-hand boxes in the **HMI science pipeline chart** .

The SDP would then be the same scope as the **GDS** – **Ground Data System** – described in the HMI Concept Study Report. I suggest using the term: **SDPS** for **Science Data Processing System** if we are to replace the GDS term. Then the full nomenclature would be the **SDO HMI-AIA JSOC SDPS**. We could omit the leadin and simply refer to the **JSOC-SDPS** when discussing with the SOWG or other pan-SDO forums or just the **SDPS** internally. It is hard to say. Perhaps we would shorten it to **DPS**.

Documents Needed:

The three documents specified in the CDRL SD-326 then are:

Science Data Plan including SOC Plan:
This is the first part of the present "HMI-S015: HMI SOC Ground System Plan" but needs updating for the JSOC. The JSOC Concept document is a good first draft for this new plan. I suggest a new document that starts with the JSOC Concept document and covers terminology, overall concept and plan for the JSOC, but not the list of data products or the detailed implementation. It might grow to 15-20 from the present 9 pages. This will be a document that changes little with time. Phil would be the lead author.

Science Data Analysis, Processing, Archive and Distribution Plan:
This is the rest of the present "HMI-S015: HMI SOC Ground System Plan". I suggest this be the primary document describing implementation of the JSOC. It should have the JSOC Requirements Document as its Appendix A. The document should grow into a detailed discussion of the JSOC and how it works with appendices as needed for details of CVS, data formats, header archive, DSDS server, storage architecture (SAN/NAS, HDS, etc), processor architecture (clusters, SMP, etc.), OS decisions, export tools, etc. It should have the development plan updated from that in the HMI-S015 document as an appendix. It should be a "live"

document with a snapshot delivered at CDR. Jim would be the lead author but various appendices would have other lead authors.

Functional Descriptions of Data Products:
This will be derived from the requirements part of the HMI Science Plan. This should be derived from the tables of products and flow diagrams of products. It should be the place where specs of products including estimates volumes are found. It should include lists of FDS products needed for data processing and science analysis. There should be sections for common products, for HMI, and for AIA products handled by the Stanford. Rasmus would be the lead author.

We should develop the table of contents and list of appendices for these documents.

Also the table of contents for the Science Plan document (HMI-S014) can be discussed. It should have the data products removed with a reference to the new Data Products document.