PIP 4.3 Archive Generation, Validation, and Transfer Plan

Revision A

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Prepared by: Suzanne Smrekar, Sue LaVoie, Amy Culver and Susan Slavney

National Aeronautics and
Space Administration

Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

Signature Page (signatures have been obtained electronically)

Prepared by:

Suzanne Smrekar, InSight Deputy Principal Investigator	Date
Sue LaVoie, Co-I, PDS Imaging Node	Date
Amy Culver, PDS Imaging Node	Date

Approved by:

W. Bruce Banerdt, InSight Principal Investigator	Date
Suzanne Smrekar, InSight Deputy Principal Investigator	Date
Richard Welch, Insight Mission System Manager	Date
Robert Fogel, InSight Program Scientist	Date
Thomas Morgan, Planetary Data System Program Manager	Date

Concurred by:

Philippe Lognonné, SEIS PI	Date
Justin Maki, IDC/ICC	Date
Tilman Spohn, HP^3 PI	Date
Don Banfield, APSS Team	Date
Sami Asmar, RISE	Date
Chris Russell, IFG Lead	Date
Julie Rogez-Castillo, IDA	Date
José Antonio Rodriguez-Manfredi, TWINS PI	Date

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Change Log

Date	Sections Changed	Reason for Change	Revision
07/09/13	All	New document.	Initial Release
4/10/13	1.2, 1.3, 2.7, 3.4	Geoscope is now under the umbrella of the IPGP Data Center	
9/23/15	Signature page	Julie Rogez-Castillo now responsible for IDA data archiving so replaces Ashitey Trebi-Ollennu	2nd release
9/23/15	2.4	Add a paragraph describing our intent to archive spacecraft engineering data. The exact data to be archived will be specified after teams can assess what data is useful during Mars operations.	2nd release
8/16/17	2.1, 2.6	Updates reflect new launch date, project personnel	3rd release

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1 Introduction

1.1 Purpose

This plan provides for the timely generation, validation, and transfer of raw and reduced data products acquired by the Interior Exploration Using Seismic Investigations, Geodesy, and Heat Transport (InSight) project to the Planetary Data System (PDS) in complete, well-documented, permanent archives (archival data products).

1.2 Scope

This plan covers the policies and procedures for the specific generation, validation, and transfer to the PDS of archival data products, and expectations for access and distribution of those data products. The plan will specify the distribution and archiving of raw and reduced data sets, along with pertinent accompanying information to be acquired or derived during the InSight project. In addition to being archived in the Planetary Data System (PDS), Seismic Experiment for Interior Structure (SEIS) data will be delivered both to the Institut de Physique du Globe de Paris (IPGP) Data Center and Incorporated Research Institutions for Seismology (IRIS) for archiving and public distribution. The reason for delivery paths outside of PDS is that the global seismic community uses data in a standardized format, Standard for the Exchange of Earthquake Data (SEED), which is available for public access via IPGP and IRIS. We include a high level discussion of these additional deliveries for completeness. Specific aspects addressed in this plan are:

- Generation of high-level project, spacecraft, and instrument documentation; instrument calibration reports; and documentation of algorithms and/or software used to produce reduced data records.
- Reduction of science packet data in the spacecraft telemetry to raw data, calibrated data, and finally to derived data products. These will have associated documentation that records when and where the data were acquired and for what purpose.
- Generation of SPICE archives used to support mission operations and analysis and labeling of science data products.
- Generation and validation of archives containing InSight science and engineering data, software, algorithms, documentation, and ancillary information.
- Delivery of validated InSight archives to the PDS.
- Delivery of copies of validated InSight SEIS archives to the IRIS and IPGP data centers.

1.3 Organization

This plan begins with overviews of the InSight project, PDS, and IRIS and IPGP data centers, followed by a summary of roles and responsibilities for organizations and personnel associated with generation, validation, transfer, and distribution of InSight archival data. The document then discusses in detail the types of data products to be produced and archived to PDS during the InSight project. The document ends with a description of the InSight PDS archiving process, including data flow and delivery schedule.

1.4 Applicable and Reference Documents

1.4.1 Applicable Documents and Constraints

This plan is responsive to the following Discovery Program and InSight documents:

1. Discovery Program Plan, DISC-PLAN-001B, Rev. B, Sep. 16, 2008.
2. InSight Concept Study Report, in response to Discovery AO NNH10ZDA007O, March 19, 2012.
3. InSight Project Plan, Initial Release, JPL D-75275, May 29, 2014.
4. InSight Mission Plan, Revision A, JPL D-75260, October 16, 2015.

This plan is consistent with the principles delineated in the following National Academy of Sciences reports:

1. Data Management and Computation, Volume 1, Issues and Recommendations, 1982, National Academy Press, 167 pp.
2. Issues and Recommendations Associated with Distributed Computation and Data Management Systems for the Space Sciences, 1986, National Academy Press, 111 pp.
3. Ensuring the integrity, accessibility, and stewardship of research data in the digital age, 2009, Committee on Science, Engineering, and Public Policy, National Academies Press, http://www.nap.edu/catalog.php?record_id=12615.

This plan is also consistent with the following Planetary Data System documents:

1. Data Providers' Handbook, Archiving Guide to the PDS4 Data Standards Version 1.7.0, April, 2017; https://pds.nasa.gov/pds4/doc/dph/.
2. Planetary Data System Standards Reference, 1.8.0, March 21, 2017; https://pds.nasa.gov/pds4/doc/sr/.
3. PDS4 Data Dictionary, Abridged, version 1.8.0.0, March 31, 2017; https://pds.nasa.gov/pds4/doc/dd/.

InSight will strive to be consistent with future versions.

This plan requires the generation of the following project documents:

1. Interface Control Documents (ICD) specifying relationships between the InSight project, instrument science teams, and PDS nodes (finalized in Phase B).
2. Data Product and Archive Bundle Software Interface Specification (SIS) for all standard products (draft at beginning of Phase C, final in Phase D).

Finally, this plan is consistent with the following:

1. The InSight Level-1 requirements.

2. The contracts negotiated between the InSight project, the Principal Investigator (PI), and Co-Investigators (Co-Is) in which archival data, software, algorithms, and documentation are explicitly defined as deliverables.
3. ITAR rules for release of information will be followed. Specifically, scientific and technical information, such as documents and presentations, will be reviewed under JPL procedures prior to being published, released external to the NASA, or to foreign persons outside of the project.

2 InSight Archive Generation, Validation, and Transfer to the PDS

2.1 The Project

InSight will launch in May 2018 and will place a geophysical lander on Mars on November 26, 2018, to study its deep interior. The Surface Phase consists of Deployment and Penetration, and Science Monitoring. It ends after one Mars year plus approximately 40 sols. The project timeline is shown in Figure 2-1.

The science payload comprises two instruments: the Seismic Experiment for Interior Structure (SEIS) and the Heat-Flow and Physical Properties Probe (HP^3). In addition, the Rotation and Interior Structure Experiment (RISE) will use the spacecraft's X-band communication system to provide precise measurements of planetary rotation. SEIS and HP^3 will be placed on the surface with an Instrument Deployment System (IDS) comprising an Instrument Deployment Arm (IDA), Instrument Deployment Camera (IDC), and Instrument Context Camera (ICC). There are also several supporting instruments. The Auxiliary Payload Sensor Subsystem (APSS) includes a pressure sensor, the InSight Flux Gate (IFG) magnetometer, and Temperature and Wind for InSight (TWINS) sensors. The SEIS team will use environmental data collected by APSS to reduce and analyze their data. Within the project, the IFG is considered part of the APSS. For the purposes of data archiving, the IFG data are listed separately as they will be delivered by the magnetometer lead, Chris Russell, to the PDS Planetary Plasma Interactions node. The wind, temperature, and pressure data will be delivered to the PDS Atmospheres node. The radiometer (RAD) data will be used to measure surface temperature and estimate thermal properties, and to support the HP^3 team data analysis. Table 2-1 summarizes the InSight payload and supporting instrumentation.

The JPL Advanced Multimission Operations System (AMMOS)/ Multimission Image Processing Laboratory (MIPL) processes raw InSight data and produces PDS4 raw data products for TWINS, the pressure sensor, IDA, and higher-level products for the ICC and IDC. MIPL will deliver CCSDS telemetry packets to the SEIS and HP3 teams, and SFDU telemetry packets to the IFG team. MIPL will generate PDS4-compatible, documented products for use by the instrument science teams and delivery to the PDS and distribution to the science community and public. All PDS4 products will contain PDS4 XML labels.

In addition, SEIS products delivered to PDS, IRIS and the IPGP Data Center will be in mini-SEED format and have SEED headers. The use of this international standard makes the products immediately accessible to the international research community and facilitates their use. The PDS archive for SEIS will contain two versions of each data product, one in SEED format and one in a standard PDS table format.

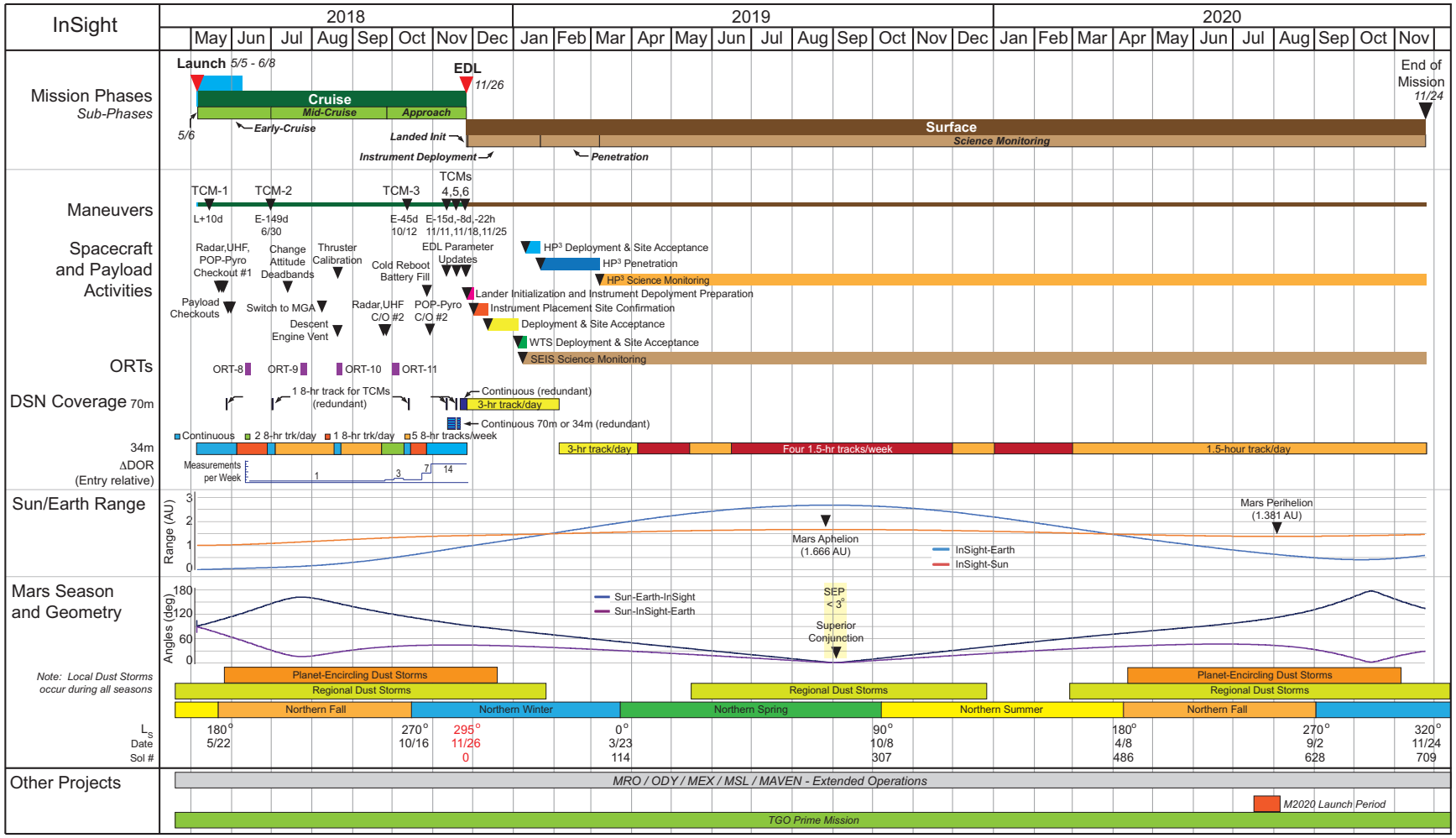

Figure 2-1: InSight project timeline.

Table 2-1: InSight payload and supporting instrumentation.

Payload Element/Investigation	Description	Instrument PIs and Leaders
Seismic Experiment for Investigating the Subsurface (SEIS)	Two three-axis seismometers, one Short-Period (SP), one Very-Broad-Band (VBB), to measure seismic waves traveling through the interior	PI: Philippe Lognonné (IPGP)
Rotation and Interior Structure Experiment (RISE)	Radiometric geodesy, to determine precession & nutation of the Martian rotation axis	Lead: William Folkner (JPL)
Heat-Flow and Physical Properties Probe (HP^3)	Subsurface heat probe, to measure the heat flux from the interior; also provides surface brightness temperature from the radiometer (RAD)	PI: Tilman Spohn (DLR)
Instrument Deployment System (IDS)	Arm (IDA): Deploys the SEIS and HP^3 to the surface; 2 Cameras (ICC/IDC): Support SEIS and HP^3 deployment	Leads: ICC/IDC: Justin Maki (JPL) and IDA: Ashitey Trebi-Ollennu (JPL)
Auxiliary Payload Sensor Subsystem (APSS)	Two booms, arrayed with wind and temperature sensors (TWINS) plus a single pressure sensor to monitor environmental conditions in support of SEIS	TWINS PI: José Antonio Rodriguez-Manfredi (CAB); Pressure sensor lead: Don Banfield (Cornell Univ.)
InSight Flux Gate (IFG)	Triaxial magnetometer to measure variations in the magnetic field from the martian ionosphere or the lander in support of SEIS; considered by the project to be part of APSS.	Lead: Chris Russell (UCLA)

2.2 Data Flow

InSight data products are generated in a data-driven automated fashion during project operations using well-understood, multiproject capabilities. Each data product will be described in a data product software interface specification (SIS) document. PDS4 definitions of processing levels for science data products are found in Table 2-2.

Table 2-2: Definitions of processing levels for science data sets.

Processing Level	Description
Telemetry	An encoded byte stream used to transfer data from one or more instruments to temporary storage where the raw instrument data will be extracted.
Raw	Original data from an instrument. If compression, reformatting, packetization, or other translation has been applied to facilitate data transmission or storage, those processes will be reversed so that the archived data are in a PDS approved archive format.
Partially Processed	Data that have been processed beyond the raw stage but which have not yet reached calibrated status.
Calibrated	Data converted to physical units, which makes values independent of the instrument.
Derived	Results that have been distilled from one or more calibrated data products (for example, maps, gravity or magnetic fields, or ring particle size distributions). Supplementary data, such as calibration tables or tables of viewing geometry, used to interpret observational data should also be classified as 'derived' data if not easily matched to one of the other three categories.
PDS and its data providers have used both the CODMAC and NASA systems to describe data processing levels, sometimes in the same data set; this has led to confusion. In developing PDS4, PDS has determined that a simpler system, relying on only a few categories, is sufficient. PDS adopted the above terms for broadly classifying archival data according to processing level. When making such classification, data providers (in consultation with the cognizant PDS node) will select the most appropriate term and give a detailed description of the processing in accompanying documentation.	

In addition to calibrated data products, higher-level, derived data products will be generated by instrument science teams. Each derived data product will be described in a SIS. Those derived

data products that are completed and validated in time for a scheduled release to PDS may be delivered along with the standard products. PDS will continue to accept derived data products after the end of the project as long as they are documented and validated according to PDS standards.

Figure 2-2 shows the flow of science data products from the InSight downlink through project operations and instrument science team operations to their ultimate delivery to the PDS. Downlink telemetry is received at Project Operations at JPL. MIPL generates PDS4 raw data for TWINS, the pressure sensor, IDA, ICC, IDC, and the full set of data products for the IDC and ICC. InSight instrument science teams generate all data products derived from the raw data for SEIS, RISE, and HP^3. All products will be generated under the cognizance of the relevant InSight instrument science teams and validated by those teams. Within the SEIS team, Renee Weber and the Marshall Flight Center Archive Assembly Team will be responsible for taking data from the IPGP Data Center in mini-SEED format, adding PDS labels, and delivering to PDS. Higher level SEIS data products will follow the same path to PDS. The Project Science Group (PSG) will make products available to science team members and the public. SEIS data will also be available to the public via the IRIS and IPGP data centers.

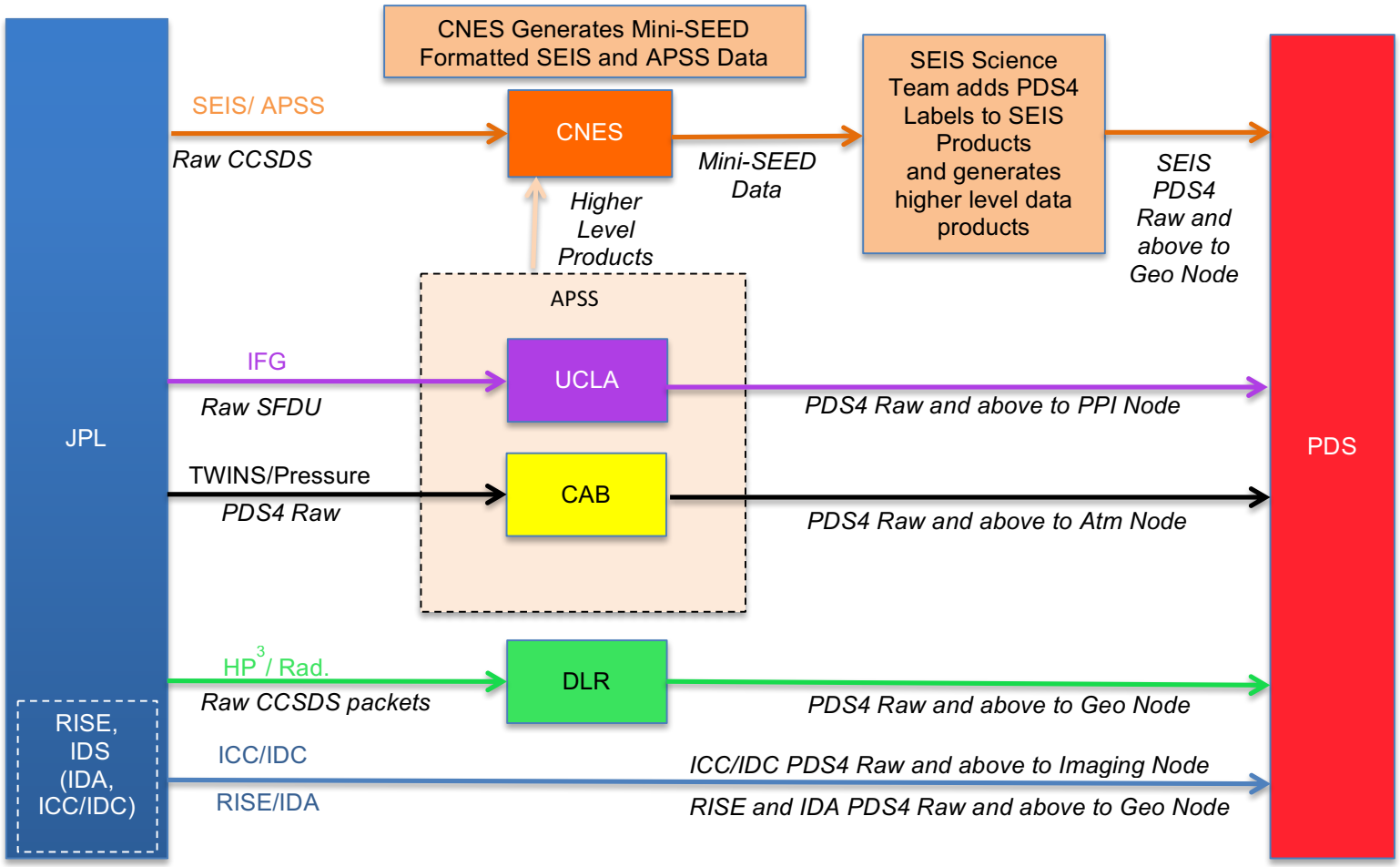

Figure 2-2: Data flow.

Complete archive bundles including data products, documentation, and ancillary materials are assembled, validated under InSight project auspices, and then delivered to the designated PDS nodes. PDS personnel will work closely with instrument science team members to ensure a smooth transfer. Table 2-3 lists the elements that comprise the InSight archives, and Table 2-4 provides a detailed list of all the data sets and their producers. All InSight archive collections will be assembled according to designs specified in archive bundle SIS documents.

Table 2-3: Components of InSight archives.

Component	Contents	Supplier
SPICE Archives	• SPICE kernels	NAIF
Instrument Data Collections	• Raw data products • Calibrated data products • Derived data products	MIPL & instrument science teams
Supporting Materials	• Ground calibration data files (safed—PDS archive format compliance not required) • High-level project, spacecraft, instrument, data set, software, and personnel descriptions for the PDS catalog • Data product SIS documents • Archive bundle SIS documents • Processing descriptions, algorithms, and software (to use in understanding reduced data product generation) • Instrument calibration plans and reports and associated data needed to understand Level-1 product generation • Verification and validation (V&V) reports • Characterization, calibration, cataloging (CCC) reports • Notes that describe uplink and downlink results	Instrument science teams
Engineering Archives	• SIS documents • Uplink/command sequences and notebook entries • Telemetry data	InSight project

Table 2-4: List of InSight data products to be archived.

Instrument —Sensor	Processing Level	Product/Data Set	Volume (Mbit)	Data Set Producer	Archive Producer	1st Release Date & Frequency	PDS Curator
SEIS—All	n/a	Calibration and Installation Report	10	SEIS Team	SEIS Team	Landing –1 m	Geo
SEIS—All	n/a	Ground calibration files	800	SEIS Team	SEIS Team	Landing –1 m	Geo
SEIS—VBB	Raw	Raw velocity	17,500	SEIS Team	SEIS Team	Start Monitoring Phase +3 m; quarterly	Geo
SEIS—VBB	Calibrated	Calibrated continuous and event data	22,500	SEIS Team	SEIS Team	Start Monitoring Phase +4 m; quarterly	Geo
SEIS—VBB	Derived	Instrument transfer function model for tide output	10	SEIS Team	SEIS Team	EOM +5 m	Geo
SEIS—SP	Raw	Raw velocity, temperature	8,500	SEIS Team	SEIS Team	Start Monitoring Phase +3 m; quarterly	Geo
SEIS—SP	Calibrated	Calibrated continuous and event data	11,000	SEIS Team	SEIS Team	Start Monitoring Phase +4 m; quarterly	Geo
SEIS-All	Derived	Geophysical structure and seismic velocities catalog, seismic source catalog	10	SEIS Team	SEIS Team	EOM +5 m	Geo

Instrument —Sensor	Processing Level	Product/Data Set	Volume (Mbit)	Data Set Producer	Archive Producer	1st Release Date & Frequency	PDS Curator
APSS-TWINS & PS	n/a	Calibration report	10	APSS Team	APSS Team	Landing –1 m	Atm
APSS-TWINS & PS	n/a	Ground calibration files	0.1	APSS Team	APSS Team	Landing –1 m	Atm
APSS-TWINS & PS	Raw	Raw pressure, temperature, wind speed	7,600	MIPL	APSS Team	Start Monitoring Phase +3 m; quarterly	Atm
APSS-TWINS & PS	Calibrated	Calibrated time series of pressure, temperature, wind speed	11,400	APSS Team	APSS Team	Start Monitoring Phase +4 m; quarterly	Atm
SEIS—ENG	Raw	Housekeeping, temperature	1200	MIPL	SEIS Team	Start Monitoring Phase +3 m; quarterly	Atm & Geo
SEIS—ENG	Calibrated	Housekeeping, temperature	1500	SEIS Team	SEIS Team	Start Monitoring Phase +4 m; quarterly	Atm & Geo
RISE	Raw	Doppler from DSN Tracking	1600	DSN to RISE Team	RISE Team	Start Monitoring Phase +4 m; quarterly	Geo
RISE	Derived	Rotation vector vs. time	10	RISE Team	RISE Team	EOM +5 m	Geo
RISE	Derived	Total and core moment of inertia (MOI), free core nutation period, core density and radius	1	RISE Team	RISE Team	EOM +5 m	Geo
HP^3—All		Calibration report	10	HP^3 Team	HP^3 Team	Landing –1 m	Geo
HP^3—All		Ground calibration files	0.1	HP^3 Team	HP^3 Team	Landing –1 m	Geo
HP^3—STATIL/TLM	Raw	Raw voltages vs. time	100	HP^3 Team	HP^3 Team	Start Monitoring Phase +3 m; one-time delivery	Geo
HP^3—STATIL/TLM	Calibrated	Voltages vs. time	120	HP^3 Team	HP^3 Team	Start Monitoring Phase +4 m; one-time delivery	Geo
HP^3—STATIL/TLM	Derived	Deployed tether length	120	HP^3 Team	HP^3 Team	9 m; one-time delivery	Geo
HP^3—TEM-A	Raw	Raw temperature vs. time	400	HP^3 Team	HP^3 Team	Start Monitoring Phase +3 m	Geo
HP^3—TEM-A	Calibrated	Temperature vs. time	230	HP^3 Team	HP^3 Team	Start Monitoring Phase +4 m	Geo
HP^3—TEM-A	Derived	Conductivity vs. depth	0.1	HP^3 Team	HP^3 Team	Start Monitoring Phase +6 m	Geo

Instrument —Sensor	Processing Level	Product/Data Set	Volume (Mbit)	Data Set Producer	Archive Producer	1st Release Date & Frequency	PDS Curator
HP^3—TEM-P	Raw	Raw temperature vs. time	710	HP^3 Team	HP^3 Team	Start Monitoring Phase +14 m; quarterly	Geo
HP^3—TEM-P	Calibrated	Temperature vs. time	20	HP^3 Team	HP^3 Team	Start Monitoring Phase +15 m; quarterly	Geo
HP^3—RAD	Raw	Raw voltages vs. time	291-1500	HP^3 Team	HP^3 Team	Start Monitoring Phase +3 m; quarterly	Geo
HP^3—RAD	Calibrated	Radiometric temperatures vs. time	56-271	HP^3 Team	HP^3 Team	Start Monitoring Phase +3 m; quarterly	Geo
HP^3—RAD	Derived	Surface temperature vs. time	400	HP^3 Team	HP^3 Team	Start Monitoring Phase +3 m; quarterly	Geo
IDC/ICC	n/a	Calibration report	10	IDC/ICC Team	IDC/ICC Team	Landing –1 m	Img
IDC/ICC	n/a	Ground calibration files	0.1	IDC/ICC Team	IDC/ICC Team	Landing –1 m	Img
IDC/ICC	Raw	Raw images	393	IDC/ICC Team	MIPL	Start Monitoring Phase +3 m; quarterly	Img
IDC/ICC	Calibrated	Calibrated images	2,360	IDC/ICC Team	MIPL	Start Monitoring Phase +4 m; quarterly	Img
IDC/ICC	Derived	DEMs, mosaics, stereo	3,540	IDC/ICC Team	MIPL	Start Monitoring Phase +4 m; quarterly	Img
IDA	Calibrated	Joint angles,	15	MIPL	IDA Team	Start Monitoring Phase +3 m; quarterly	Geo
IDA	Calibrated	Position in spacecraft coordinates	90	IDA Team	IDA Team	9m; one-time delivery	Geo
APSS-IFG	n/a	Calibration and Installation Report	1	MAG Team	MAG Team	Landing –1 m	PPI
APSS-IFG	Raw	Time series of 3 components of magnetic field	2500	MIPL	MAG Team	Start Monitoring Phase +3 m; Quarterly	PPI
APSS-IFG	Calibrated	Calibrated magnetograms	3750	MAG Team	MAG Team	Start Monitoring Phase +3 m; Quarterly	PPI
SPICE	Derived	Derived kernels	1,600	NAIF	NAIF	Start Monitoring Phase +3 m; quarterly	NAIF
		TOTAL	~130 Gb				

When data products have been posted on the PDS website, they are regarded as publicly available. It is expected that the data will be made available to the public online through the PDS online distribution systems and the Planetary Image Atlas and the Analyst's Notebook. SEIS data will also be available via the IRIS and IPGP data centers.

2.3 Data Volume

For planning purposes, the expected downlinked data volume from InSight is 40 Mb/sol (average) UHF link to MRO, which includes 39 Mb/sol for payload data, of which 38 Mb/sol is for SEIS/APSS. The total downlink for the 708-sol project should be approximately 28.3 Gb. The total volume of science data products (raw, reduced, and derived) is estimated to be ~130 Gb, based on evaluation of project scenarios and the experience of the Phoenix project. These estimates will be refined based on further project scenario development and data product definitions.

2.4 Generation

The InSight project will provide oversight on implementation of this plan and ensure timely generation, validation, and delivery of archives to the PDS. The Navigation and Ancillary Information Facility (NAIF) will generate an archive of all SPICE data.

InSight science operations will be geographically distributed, with a project-controlled operations database that contains telemetry data, SPICE files, and other information needed by the InSight PSG members. The project will implement a system that meets the timeliness requirements associated with operations, analysis, and archiving of data. The system will allow the PSG members to access the data and information and to transfer the files to their home institution facilities.

The raw data, SPICE files, and other required data sets will be used at the home facilities to generate higher-level data products for use by PSG members and for archiving. Data product type definitions are provided in Table 2-2. Each archival product will be defined in a data product SIS document. Instrument data products are but one component of PDS-compliant archives. Other elements are summarized in Table 2-3, including archives to be supplied by the Project Office.

The archives associated with instrument data will be assembled at the home institutions of the instrument PIs or relevant Co-Is. Archives produced by the Project Office, specifically telemetry files, SPICE files, engineering data sets, and any other relevant information, will follow the same procedures that are designated for the science archives.

Most instruments have identified the need for data from the spacecraft to assist in interpreting their data. Examples of the types of data include lander temperature, currents and voltages for better interpreting the thermal environment and fields that could affect the instruments. Although each team has identified possible data of interest, the choice of data to be archived will not be finalized until after nominal operations have begun. The rationale is that the spacecraft generates a large volume of data. It won't be clear what data is actually of value until the teams have gained experience routinely analyzing their data. At that point, which could come as late as the end of the nominal mission, the individual teams will make informed decisions about what engineering data should be included in the archive. Individual instrument teams will be responsible for the archive of these data.

2.5 Data Validation and Peer Reviews

InSight engineering, science, and SPICE archives will be validated before being released to the PDS. Validation is accomplished in two parts: 1) validation for scientific integrity and 2) validation for compliance with PDS standards and data usability. PSG members are expected to conduct validation for scientific integrity in the course of their analysis of the range of data products derived from the raw data. The details of the science validation process are the responsibility of the PI and instrument Co-Is.

Validation for compliance with PDS standards and data usability is also the responsibility of the PI and each instrument PI or Co-I, with help from the PDS node that will receive the data products. The PDS will provide software tools, examples, and advice to help make this part of the validation as efficient as possible. This validation includes a peer review of the design and labeling of data products as laid out in the data product SIS documents, and validation of the PDS4 XML labels using sample data. The review committee will consist of a small group of scientists who represent typical users of the data. The instrument science team and the relevant PDS node will also be represented on the review committee. The review period will last approximately one month and will be conducted mostly by email, culminating in a teleconference, if needed. The result of the review will be a list of liens, or problems, that the team must resolve before the product can pass the review. Another month (or more depending on the nature of the liens) will be allowed for the instrument science team to address the liens. All reviews will be completed and liens resolved before landing on Mars. The goal is to allow the teams enough time to correct any problems before systematic generation of standard products begins. After the start of operations, when generation of products has begun, each individual product will be validated by the instrument team to see that it conforms to the design specified in the SIS. Validation of individual products will be automated as much as possible.

2.6 Data Delivery Schedule

Table 2-5 shows important dates and events in the InSight archive and data release process. Included are dates for completion of required documents, peer review, delivery of ancillary products and software, as well as public and PDS delivery and release dates. The initial release of raw data archive products to the PDS will occur within three months of receipt of raw data from the spacecraft, with calibrated products and SPICE kernels following one month later. Following these initial releases, the raw, calibrated and SPICE data will be released by the PDS as a single release every three months. Public release of preliminary seismic velocity data will occur every two weeks beginning three months after initial receipt of data from the spacecraft.

Table 2-5: InSight archive generation, validation, and release schedule. Note that this table assumes a nominal timeline for the start of data acquisition.

Date	Phase	Event
Aug 2013	B	• Project PDR • Draft Archive Plan complete • Draft Interface Control Document (ICD) complete

Date	Phase	Event
Sep 2014	C	• MOS/GDS CDR • Draft data product SIS documents complete • Draft archive bundle SIS documents complete • Final Interface Control Document complete • Archive Plan complete • Science Data Management Plan complete • Peer Review begins
1 Dec 2015	D	• Science Data User Guide complete
15 Dec 2015	D	• Updated Archive Plan complete (if necessary) • Updated Science Data Management Plan complete (if necessary)
May 2018	D	• Launch • Final data product SIS documents complete • Final archive bundle SIS documents complete • Peer Review is complete
Aug 2018	E	• Calibration files and calibration reports delivered to PDS • PDS Analyst's Notebook prototype inputs • Utility software programs for working with data products released
Nov 2018	E	• EDL
26 Nov 2018–21 Jan 2019	E	• Surface Operations—Instrument Deployment Subphase, Commissioning and Penetration Subphase • Data product generation • Data product validation
Nov 2018–Nov 2020	E	• Surface Operations—Science Monitoring Subphase (see Figure 2-1) • Data product generation • Data product validation
22 Jan 2019	E	• Nominal start of science monitoring for all instruments (some will have already begun)
1 Apr 2019	E	• Delivery of raw products to PDS 3 weeks before Release 1A (see Table 2-4 for details) • Data acquired from EDL up to start of science monitoring
22 Apr 2019	E	• **PDS Release 1A**: raw data products and SPICE kernels • Begin 2 week cycle of public release of "uncertified" seismic velocity data and "uncertified" APSS data
1 May 2019	E	• Delivery of calibrated products to PDS 3 weeks before Release 1B • Data acquired from EDL up to start of science monitoring
22 May 2019	E	• **PDS Release 1B**: calibrated data products • For first release only, calibrated data will be released one month later than raw data.
1 Jul 2019	E	• Delivery of raw, calibrated and derived products to PDS 3 weeks before Release 2 • Data acquired 22 Jan 2019 through 21 Apr 2019 (3 months)
22 Jul 2019	E	• **PDS Release 2**: raw, calibrated and derived products and SPICE kernels
1 Oct 2019	E	• Delivery of raw, calibrated and derived products to PDS 3 weeks before Release 3 • Data acquired 22 Apr 2019 through 21 Jul 2019 (3 months) • One-time delivery of HP^3 and IDA derived products to PDS
22 Oct 2019	E	• **PDS Release 3**: raw, calibrated and derived products, SPICE kernels, HP^3 and IDA one-time derived products, released 9 months after start of science monitoring
1 Jan 2020	E	• Delivery of raw, calibrated and derived products to PDS 3 weeks before Release 4 • Data acquired 22 Jul 2019 through 21 Oct 2019 (3 months)
22 Jan 2020	E	• **PDS Release 4**: raw, calibrated and derived products and SPICE kernels

Date	Phase	Event
1 Apr 2020	E	• Delivery of raw, calibrated and derived products to PDS 3 weeks before Release 5 • Data acquired 22 Oct 2019 through 21 Jan 2020 (3 months)
22 Jul 2020	E	• **PDS Release 5**: raw, calibrated and derived products and SPICE kernels
1 Jul 2020	E	• Delivery of raw, calibrated and derived products to PDS 3 weeks before Release 6 • Data acquired 22 Jan 2020 through 21 Apr 2020 (3 months)
22 Jul 2020	E	• **PDS Release 6**: raw, calibrated and derived products and SPICE kernels
1 Oct 2020	E	• Delivery of raw, calibrated and derived products to PDS 3 weeks before Release 7 • Data acquired 22 Apr 2020 through 21 Jul 2020 (3 months)
22 Oct 2020	E	• **PDS Release 7**: raw, calibrated and derived products and SPICE kernels
24 Nov 2020	E	• End of mission operations (EOM)
1 Jan 2021	E	• Delivery of raw, calibrated and derived products to PDS 3 weeks before Release 8 • Data acquired 22 Jul 2020 through 21 Oct 2020 (3 months)
22 Jan 2021	E	• **PDS Release 8**: raw, calibrated and derived products and SPICE kernels
1 Apr 2021	E	• Delivery of raw, calibrated and derived products to PDS 3 weeks before Release 9 (last of the quarterly deliveries) • Data acquired 22 Oct 2020 through 24 Nov 2020 (EOM; almost 5 weeks)
22 Apr 2021	E	• **PDS Release 9**: raw, calibrated and derived products and SPICE kernels
1 July 2021	E	• Delivery of final revisions and end-of-mission derived products to PDS 3 weeks before Release 10 • Data acquired throughout mission
24 May 2021	E	• **PDS Release 10**: final release of raw, calibrated and derived products from all instruments • Completion of mission closeout

2.7 Integrated Archives

The InSight PSG and the general science community will require access to science data archives that are integrated across instruments by time and location, at a minimum. Two complementary PDS systems will provide access to the archives: the Planetary Image Atlas and Analyst's Notebook. In addition, for the researcher familiar with seismic formatting standards and access to standardized processing tools, the IRIS and IPGP Data Centers will provide access to all SEIS data in SEED format (including raw data). SEIS data in SEED format and in standard PDS table format will be available via PDS. In addition to being available in standard formats in PDS, APSS raw data will also be distributed in SEED format, in order to provide to seismologists the complete data set necessary for decorrelation.

The Planetary Image Atlas is a Web-based system for locating and downloading image and other data from planetary projects. It allows cross-instrument and cross-project selection based on various search criteria, browsing of data, and downloading in various formats. The system will be adapted to support InSight data products and can be used both by project personnel and by the general science community. The Planetary Image Atlas is developed, maintained, and operated by the PDS Imaging Node at JPL.

The Analyst's Notebook is a Web-based tool for capturing daily scientific activities and their basis. It will record the goals for specific scientific operations, as well as the reasoning and discussion leading to them. It will help in correlating data products from various InSight

instruments based on time, location, observation target, and other criteria. The Notebook will provide detailed views into daily logs, science working group meeting minutes, operational decisions, results, and access to raw and derived data and instrument calibration information. Using the Notebook, a scientist can virtually replay project events to better understand and select data products of interest. The Analyst's Notebook will be designed and implemented at the PDS Geosciences Node at Washington University, based in part on similar Notebooks built to support analyses of data collected during the Phoenix, Mars Exploration Rover, and Mars Science Laboratory projects.

Both IRIS and IPGP data centers offer a variety of tools for requesting and viewing processed and calibrated seismograms in SEED format. The SEED headers include key information necessary for seismic analysis (time, sampling rate, ID and station position, pole and zero of transfer functions, calibration information, etc.), and enable the use of numerous analysis and mapping tools available through the data centers and across the community.

3 Roles and Responsibilities

This section summarizes the roles and responsibilities for personnel and organizations involved in InSight archive generation, validation, transfer, and distribution.

3.1 Project Responsibilities

The InSight project has overall responsibility for generation and validation of archives for release to the PDS. The project is also responsible for distribution of data and associated information to InSight personnel.

The Principal Investigator (PI), working with the Deputy Principal Investigator (Deputy PI), provides oversight of the archiving process. They will review data analysis plans to ensure timely and adequate analysis of spacecraft data and delivery of documented, complete data to the PDS. They are responsible for the administrative management of data archive planning and implementation.

The InSight Data Archive Working Group (DAWG) will coordinate the planning of the generation, validation, and release of PDS-compliant archives to the PDS. The DAWG is a subgroup of the InSight PSG. The DAWG Chair is the Deputy PI who will, under the direction of the PI, ensure that archives are planned, validated, and delivered. DAWG membership includes the PI, the Deputy PI, the Project Science Systems Engineer, the instrument Co-Is, representatives from NAIF, and project personnel selected to ensure that raw packets, engineering data sets, and documentation are included in the archives. Representative PDS personnel will be liaison members of the DAWG. During the active project, the DAWG will provide the coordination needed to ensure that archives are assembled, validated, and delivered according to schedule.

MIPL is responsible for generating PDS-compatible raw data products for ICD, ICC, IDA, TWINS, the pressure sensor, and calibrated and derived products for the ICC and IDC, as specified in Table 2-4. The InSight instrument teams are responsible for validating the data products.

The InSight instrument teams are responsible for generating validated, PDS-compatible collections containing raw (except for the MIPL-produced IDC/ICC products), calibrated and derived data for their instruments as specified in Table 2-4. PDS-compatible archives include

documentation, algorithms or software for generating derived data products, calibration data and reports, and other supporting materials in addition to science data products.

3.2 PDS Responsibilities

The PDS is the designated point of contact for InSight on archive-related issues. The PDS is also the interface between InSight and the National Space Science Data Coordinated Archive (NSSDCA). The PDS will work with the DAWG to ensure that the InSight archives are compatible with PDS standards and formats. Personnel from the PDS Geosciences, Imaging, Atmospheres, Planetary Plasma Interactions (PPI), NAIF, and Engineering nodes will be liaison DAWG members.

The PDS will distribute and maintain InSight archives for the NASA planetary science community once the archives have been delivered by InSight.

The PDS Geosciences Node will provide overall coordination of PDS activities for InSight. The individual nodes will archive InSight data sets as designated in Table 2-4.

Primary responsibility for archiving InSight data will rest with the Geosciences Node. The PDS nodes involved with InSight data archiving will work together to archive data products from all of the InSight science instruments as a set of integrated archives using the PDS online services (e.g., Planetary Atlas and Analyst's Notebook).

The InSight Data Engineer from the Engineering Node will work with the PDS discipline nodes involved with InSight throughout the archive planning, generation, and validation phases.

3.3 NSSDCA Responsibilities

The National Space Science Data Coordinated Archive will maintain an archive of InSight data for long-term preservation and for filling large delivery orders to the science community. The PDS will deliver at least one copy of InSight archive bundles to NSSDCA. NSSDCA may also provide support for distribution of InSight data to the general public, although this is beyond the domain of this plan.

3.4 IRIS and IPGP Data Center Responsibilities

The U.S. IRIS Data Center and the French IPGP Data Center will distribute SEIS raw data, calibrated data and derived data to the international seismic community. Raw and calibrated data will be in SEED format. APSS raw data will also be transferred in SEED format under the responsibility of SEIS. For SEIS derived data, Eidgenössische Technische Hochschule Zürich (ETHZ) will coordinate the production of the seismic source catalog, and IPGP will coordinate the production of the geophysical/seismic velocity catalog and instrument transfer function for tide output. After project completion, each data center will also maintain an archive of InSight data for long-term preservation.

4 Appendices

4.1 Appendix A: Acronyms

AMMOS	Advanced Multimission Operations System
APSS	Auxiliary Payload Sensor Subsystem

Atm	PDS Atmospheres Node
CAB	Centro de Astrobiología
CCC	characterization, calibration, cataloging
CDR	Critical Design Review
CNES	Centre National d'Etudes Spatiales (French Space Agency)
CODMAC	Committee on Data Management and Computation
Co-I	Co-Investigator
D	document
DAWG	Data Archive Working Group
DEM	digital elevation model
DLR	Deutsches Zentrum für Luft- und Raumfahrt (German Aerospace Center)
DSN	Deep Space Network
EDL	entry, descent, and landing
EOM	end of mission
ETHZ	Eidgenössische Technische Hochschule Zürich (ETHZ)
GDS	Ground Data System
Geo	PDS Geosciences Node
HK	housekeeping
HP^3	Heat-Flow and Physical Properties Probe
ICC	Instrument Context Camera
ICD	Interface Control Document
ID	identification
IDA	Instrument Deployment Arm
IDC	Instrument Deployment Camera
IFG	InSight Flux Gate
Img	PDS Imaging Node
InSight	Interior Exploration Using Seismic Investigations, Geodesy, and Heat Transport
IPGP	Institut de Physique du Globe de Paris
IRIS	Incorporated Research Institutions for Seismology
ITAR	International Traffic in Arms Regulations
JPL	Jet Propulsion Laboratory
Mb	megabit
MIPL	Multimission Image Processing Laboratory
MOI	moment of inertia
MOS	Mission Operations System
MRO	Mars Reconnaissance Orbiter
NAIF	Navigation and Ancillary Information Facility
NASA	National Aeronautics and Space Administration

NSSDCA	National Space Science Data Coordinated Archive
PDR	Preliminary Design Review
PDS	Planetary Data System
PDS4	Planetary Data System Standard 4
PI	Principal Investigator
PIP	Project Implementation Plan
PPI	PDS Planetary Plasma Interactions Node
PSG	Project Science Group
RAD	radiometer
RISE	Rotation and Interior Structure Experiment
SEED	Standard for the Exchange of Earthquake Data
SEIS	Seismic Experiment for Interior Structure
SIS	Software Interface Specification
sol	martian solar day
SP	Short-Period Seismometer
SFDU	Standard Formatted Data Unit
SPICE	spacecraft ephemeris, planetary/satellite ephemeris and constants, instrument, C-pointing (attitude/orientation) matrix, and event information
STATIL	static tilt meter/sensor
TEM-A	thermal excitation measurement—active
TEM-P	thermal excitation measurement—passive
TLM	tether-length monitor
TWINS	Temperature and Wind for InSight
UCLA	University of California at Los Angeles
UHF	ultrahigh frequency
V&V	verification and validation
VBB	Very Broad Band Oblique Seismometer
XML	Extensible Markup Language