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MEASUREMENT SYSTEM IDENTIFICATION

NASA DIGITAL ENGINEERING (DE) ACQUISITION FRAMEWORK HANDBOOK

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FOREWORD

This NASA Technical Handbook is published by the National Aeronautics and Space Administration (NASA) as a guidance document to provide engineering information; lessons learned; possible options to address technical issues; interpretative direction and techniques; and other guidance that may help the Government or its contractors in the acquisition, management, exchange, support, or use of digital engineering (DE) data, models, systems, products, processes, or services.

This Handbook provides guidance for establishing and tailoring NASA's DE acquisition framework, including recommended contractual language for Statements of Work (SOWs) and Data Requirements Descriptions (DRDs), data interoperability considerations, templates, examples, and related best practices. The recommended language is intended as a starting point for program/project and acquisition teams and should be selected, tailored, and coordinated with the appropriate contracting, legal, technical, security, and data-management organizations before use.

Submit requests for information via "Email Feedback" at https://standards.nasa.gov

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On Behalf of: *2026-10-26*

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Approval Date

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NASA DIGITAL ENGINEERING (DE) ACQUISITION FRAMEWORK HANDBOOK

1. SCOPE

1.1 Purpose

This NASA Technical Handbook provides guidance for planning and implementing a Digital Engineering (DE) acquisition framework. It assists programs and projects in identifying, selecting, and tailoring data, model, interoperability, access, and contractual considerations needed to support lifecycle decision-making and NASA's Digital Engineering Ecosystem.

The Handbook provides recommended practices and sample acquisition language for obtaining useful, accessible, interoperable, and reusable engineering information. It does not independently establish program/project or contractor requirements; requirements become binding only when imposed by an applicable directive, standard, contract, agreement, or other governing document.

Handbook Use of Requirement Language. As a general rule, this Handbook does not establish requirements. A NASA Technical Standard is intended to establish what is required to be accomplished, whereas a NASA Technical Handbook is primarily intended to provide guidance on how an objective may be accomplished, including recommended practices, methods, examples, lessons learned, and implementation options. Accordingly, this Handbook generally does not use "shall" statements to direct what a program, project, or contractor is required to do. Instead, such material is presented as guidance or recommended practice. Programs/projects should exercise discretion in selecting and tailoring the Recommended Contract Language (RCL) provided in this Handbook based on their specific technical and acquisition needs. The RCL does not independently establish a requirement. Once selected, RCL should be tailored for incorporation into a DRD, SOW/PWS, solicitation, contract, or other binding acquisition instrument, the appropriate acquisition and contracting organizations may use "shall," as appropriate, to clearly establish enforceable requirements.

1.2 Applicability

1.2.1 This Handbook is intended for use throughout the program/project lifecycle as guidance for NASA programs and projects performing or acquiring digital engineering activities. Its content should be selected and tailored to the acquisition strategy, lifecycle phase, technical scope, risk, data needs, and contractual environment of the individual program/project.

1.2.2 This Handbook is approved for use by NASA Headquarters and NASA Centers and Facilities. Portions of this Handbook may be cited in contract, program, project, grant, cooperative agreement, or other Agency documents when the selected guidance or recommended language is appropriate and has been tailored for the intended application.

1.2.3 References to "this Handbook" refer to NASA-HDBK-1004; references to other documents state the specific document information.

1.2.4 Recommended contract language is identified by the acronym "RCL" and numbered for selection and traceability. RCL statements are guidance, not requirements of this Handbook. Programs/projects should select and tailor only the RCL appropriate to the acquisition. Once incorporated into a DRD, SOW/PWS, solicitation, contract, or other binding acquisition instrument, the selected language may use "shall," as appropriate, to establish a clear and enforceable contractual requirement. Appendix A provides the Recommended Contract Language Selection Matrix.

1.2.5 This Handbook is a guidance document. The terms "may" and "can" denote discretionary privilege or permission; "should" denotes a recommended practice and is not a requirement; "will" denotes an expected outcome; and "is/are" denotes descriptive material or a statement of fact. Use of "must" is discouraged.

1.3 Tailoring

The guidance and recommended contract language in this Handbook should be selected and tailored to meet the needs of the specific program/project and acquisition. Tailoring should consider mission needs, technical risk, lifecycle phase, acquisition strategy, data rights, cybersecurity, interoperability, and the capabilities of NASA and contractor systems.

2. REFERENCE DOCUMENTS

2.1 General

Documents listed in this section provide references supporting the guidance in this Handbook. Latest issuances of referenced documents apply unless specific versions are designated. Access reference documents at https://standards.nasa.gov or obtain documents directly from the Standards Developing Body, other document distributors, information provided or linked, or by contacting the office of primary responsibility designee for this Handbook.

2.2 Government Documents

American Society of Mechanical Engineers

ASME Y14.5, Dimensioning and Tolerancing

ASME Y14.24, Types and Applications of Engineering Drawings

ASME Y14.34, Associated Lists

ASME Y14.41, Digital Product Definition Data Practices, Engineering Product Definition and Related Documentation Practices

ASME Y14.47, Model Organization Practices - Engineering Product Definition and Related Documentation Practices

ASME Y14.100, Engineering Drawing Practices

Department of Defense (DoD)

DoD Directive 8320.03, Unique Identification (UID) Standards for a Net-Centric Department of Defense

Office of the Deputy Assistant Secretary of Defense (Systems Engineering) [ODASD (SE), "DAU Glossary: Digital Engineering," Defense Acquisition University (DAU), 2017. [Online]. Available: https://www.dau.mil/glossary/pages/3626.aspx. [Accessed 6 November 2018].

MIL-STD-130, Department of Defense Standard Practices, Identification Marking of U.S. Military Property

MIL-STD-882E w/ C1, Department of Defense Standard Practice, System Safety

MIL-STD-31000, Technical Data Packages

MIL-HDBK-61A, Configuration Management Guidance

DD Form 250, Material Inspection and Receiving Report

DD Form 1149, Requisition and Invoice/Shipping Document

DFARS 252.227-7026, Deferred Delivery of Technical Data or Computer Software

DFARS 252.227-7027, Deferred Ordering of Technical Data or Computer Software

Federal

48 CFR § 252.227-7013 - Rights in technical data - Other than Commercial Products and Commercial Services

48 CFR § 252.227-7014, Rights in Other Than Commercial Computer Software and Other than Commercial Computer Software Documentation

48 CFR § 252.227-7015, Technical data – Commercial Products and Commercial Services

48 CFR § 252.227-7025, Limitations on the Use or Disclosure of Government-Furnished Information Marked with Restrictive Legends

48 CFR § 252.227-7037, Validation of Asserted Restrictions on Technical Data

48 CFR § 227.7103-6, Contract Clauses

48 CFR § 227.7103-7, Use and Non-disclosure Agreement

48 CFR § 227.7103-13, Government Right to Review, Verify, Challenge, and Validate Asserted Restrictions

48 CFR § 52.227-11, Patent Rights - Ownership by the contractor

48 CFR § 52.227-13, Patent Rights-Ownership by the Government

48 CFR § 52.227-14, Rights in Data — General

48 CFR § 52.227-15, Representation of Limited Rights Data and Restricted Computer Software

48 CFR § 52.227-16, Additional Data Requirements

48 CFR § 52.227-17, Rights in Data-Special Works

48 CFR § 52.227-18, Rights in Data-Existing Works

48 CFR § 52.227-19, Commercial Computer Software License

48 CFR § 52.227-20, Rights in Data-SBIR Program

Executive Office of the President Memorandum M-25-05, Phase 2 Implementation of the Foundations for Evidence-Based Policymaking Act of 2018: Open Government Data Access and Management Guidance, January 15, 2025 (https://www.congress.gov/crs-product/IN12502)

FIPS PUB 140-3, Security Requirements for Cryptographic Modules

NASA

NPD 1000.0, NASA Governance and Strategic Management Handbook

NPD 2810.1, NASA Information Security Policy

NPD 2800.1, Managing Information Technology

NPD 7120.4, NASA Engineering and Program/Project Management Policy

NPR 1441.1, NASA Records Management Program Requirements

NPR 2210.1, Release of NASA Software

NPR 2810.1, Security of Information Technology

NPR 7120.5, NASA Space Flight Program and Project Management Requirements

NPR 7123.1, NASA Systems Engineering Processes and Requirements

NPR 7150.2, NASA Software Engineering Requirements

NASA-STD-7009, Standard for Models and Simulations

NASA-STD-2804, Minimum Interoperability Software Suite

NASA-HDBK-1009, NASA Systems Modeling Handbook

NASA-HDBK-4008, Programmable Logic Devices (PLD) Handbook

NASA-HDBK-7009, NASA Handbook for Models and Simulations: An Implementation Guide for NASA-STD-7009A

NASA/SP-2016-6105, NASA Systems Engineering Handbook

NASA Earth Science Data Systems (ESDS) Program. "Data and Information Guidance." NASA Earth Data. https://www.earthdata.nasa.gov/engage/open-data-services-software-policies/data-information-guidance.

NASA Model-Based Systems Engineer (MBSE) Community of Practice (CoP). https://nasa.sharepoint.com/teams/NASAMBSECoP/SitePages/LearningTeamHome.aspx

NIMA-RPT-002, Data Integrity in NASA Programs and Projects (White Paper) (https://nen.nasa.gov)

National Institute of Standards and Technology (NIST)

NIST 800 Series Publications

NIST SP 800-53, VI and VII, Assessing Security and Privacy Controls in Federal Information Systems and Organizations - Building Effective Assessment Plans

NIST SP 800-60, Guide for Mapping Types of Information and Information Systems to Security Categories (https://csrc.nist.gov/publications/detail/sp/800-60/vol-1-rev-1/final)

2.3 Non-Government Documents

Institute of Electrical and Electronics Engineers (IEEE)

IEEE 24765, Systems and software engineering — Vocabulary

International Council on Systems Engineering (INCOSE)

INCOSE (2007) MBSE Initiative Presentation International Council on Systems Engineering (INCOSE), *Systems Engineering Vision 2020*, Version 2.03, TP-2004-004-02, September 2007.

International Organization for Standards

ISO 8879, Information processing - Text and office systems - Standard Generalized Markup Language (SGML)

ISO 10303, STEP (Standard for the Exchange of Product model data) - ISO global standard

ISO 10303-203, Industrial automation systems and integration - Product data representation and exchange - Part 203: Application protocol: Configuration controlled 3D design of mechanical parts and assemblies (AKA STEP 203)

ISO 10303-210, Industrial automation systems and integration - Product data representation and exchange - Part 210: Application protocol: Electronic assembly, interconnect and packaging design (AKA STEP 210)

ISO 10303-214, Industrial Automation Systems and Integration - Product Data Representation and Exchange - Part 214: Application Protocol: Core Data for Automotive Mechanical Design Processes (AKA STEP 214)

ISO 10303-233, Industrial automation systems and integration - Product data representation and exchange - Part 233: Application protocol: Systems engineering (AKA STEP 233)

ISO 10303-238, Standard for the Exchange of Product (STEP) Model Data, PART 238: Application interpreted model for computer numeric controllers (AKA STEP 238)

ISO 10303-239, Industrial automation systems and integration - Product data representation and exchange - Part 239: Application protocol: Product lifecycle support (AKA STEP 239)

ISO 10303-242, Industrial automation systems and integration - Product data representation and exchange - Part 242: Application protocol: Managed model-based 3D engineering (AKA STEP 242)

ISO 14306, Industrial automation systems and integration - JT file format specification for 3D visualization

ISO 14739-1, Document management - 3D use of Product Representation Compact (PRC) format, Part 1: PRC 10001

ISO/IEC 11578:1996, Information Technology - Open Systems Interconnection - Remote Procedure Call (RPC)ISO/IEC 19502, Information technology - Meta Object Facility (MOF)

ISO/IEC 19503, Information technology – XML Metadata Interchange (XMI)

ISO/IEC 19776-2, Information technology - Computer graphics, image processing and environmental data representation - Extensible 3D (X3D) encodings - Part 2: Classic VRML encoding - COLLADA (Collaborative Design Activity) - Khronous Group, collada.org, X3D (eXtensible 3D)(www.iso.org)

SAE International

SAE EIA-649, Configuration Management Standard

SAE EIA-649-2, Configuration Management Requirements for NASA Enterprises

SAE GEIA-859, Data Management

SAE GEIA-HB-649 Configuration Management Standard Implementation Guide

Other

Global Drawing Requirements Manual (GDRM) (Tenth Edition)

Requirements Exchange: ReqIF™ Requirement Interchange Format - Object Management Group™ standard (http://www.omg.org/spec/ReqIF/)

2.4 Order of Precedence

2.4.1 The guidance in this Handbook does not supersede or waive existing guidance found in other applicable Agency documentation.

2.4.2 Conflicts between this Handbook and other governing documents will be resolved by the delegated NASA Technical Authority.

3. ACRONYMS, ABBREVIATIONS, AND DEFINITIONS

3.1 Acronyms and Abbreviations

2D	Two-dimensional
3D	Three-dimensional
AAP	Acquisition Activity Plan
ADP	Acceptance Data Package
AKA	Also Known As
ALERT	Acute Launch Emergency Reliability Tip
AM	Additive Manufacturing
AoO	Announcement of Opportunity
API	Application Programming Interface
ASCII	American Standard Code for Information Interchange
ASoT	Authoritative Source of Truth
ATP	Acceptance Test Procedures
BOM	Bill Of Material
CAD	Computer-Aided Design
CAE	Computer-Aided Engineering
CAGE	Commercial and Government Entity
CAM	Computer-Aided Manufacturing
CAP	Contractor-Acquired Property
CCB	Configuration Control Board

CDR	Critical Design Review
CDRL	Contract Data Requirements List
CDM	Configuration and Data Management
CDMP	Configuration and Data Management Plan
CDMPA	Configuration and Data Management Process Audit
CFO	Chief Financial Officer
CFR	Code of Federal Regulations
CI	Configuration Item
CIO	Chief Information Officer
CMO	Configuration Management Office
COTS	Commercial Off-The-Shelf
CR	Change Request
CS	Computer Software
CSA	Configuration Status Accounting
CSCI	Computer Software Configuration Item
CSD	Computer Software Documentation
CSV	Comma-Separated Value
CUI	Controlled Unclassified Information
DE	Digital Engineering
DEE	Digital Engineering Ecosystem
DFAR	Defense FAR
DM	Data Manager
DMO	Data Management Office
DMP	Data Management Plan
DoD/DD	Department of Defense
DPD	Data Procurement Document
DR	Discrepancy Report
DRD	Data Requirements Description
ECAD	Electronic/Electrical Computer-Aided Design
ECP	Engineering Change Proposal
EIA	Electronic Industries Alliance
EIT	Electronic & Information Technology
EMAL	Engineering Models and Associated Lists
EO	Engineering Order
EVMS	Earned Value Management System
FAR	Federal Acquisition Regulation
FCA	Functional Configuration Audit
FFF	Form, Fit, and Function
FIPS	Federal Information Processing Standard
FOM	Federation Object Model
GFP	Government Furnished Property
GOTS	Government Off-The-Shelf
GSA	Government Service Administration
GSE	Ground Support Equipment
GWAC	Government-Wide Acquisition Contract
HDBK	Standard

HLA	High Level Architecture
HQ	Headquarters
HR	Hazard Report
IAE	Index of Ancillary Equipment
IAGP	Installation Accountable Government Property
ICD	Interface Control Document
ICWG	Interface Control Working Group
IDIQ	Indefinite Delivery Indefinite Quantity
IEC	International Electro-technical Commission
IEEE	Institute of Electrical and Electronics Engineers
INCOSE	International Council on Systems Engineering
IGE	Independent Government Estimate
IGCE	Independent Government Cost Estimate
IHCE	In-House Cost Estimate
IOCD	Index Of Configuration Documentation
IOTM	Index Of Technical Manuals
ISO	International Organization for Standardization
ISS	International Space Station
IT	Information Technology
ITAR	International Traffic in Arms Regulations
JPEG/JPG	Joint Photographic Experts Group
JPL	Jet Propulsion Laboratory
JT	Jupiter Tessellation
KDP	Key Decision Point
LLM	Large Language Model
LR	Limited Rights
LSP	Launch Services Program
M&S	Modeling and Simulation
MB	Model-Based
MBD	Model-Based Definition/Design
MBE	Model-Based Enterprise
MBSE	Model-Based Systems Engineering
MCAD	Mechanical Computer-Aided Design
MIL	Military
MMI	Maintenance-Managed Item
MOF	Meta Object Facility
MOU	Memorandum of Understanding
MRI	Master Record Index
NA	Not Applicable
NASA	National Aeronautics and Space Administration
NFS	NASA FAR Supplement
NIMA	NASA Integrated Model-Centric Architecture
NIST	National Institute of Standards and Technology
NPD	NASA Policy Directive
NPR	NASA Procedural Requirements
NRA	NASA Research Announcement

O&S	Operations and Sustainment
OCIO	Office of the Chief Information Officer
OMG	Object Management Group
OMIT	Operation, Maintenance, Installation, And Training
OPR	Office Of Primary Responsibility
PBC	Performance-Based Contract
PCA	Physical Configuration Audit
PCI	Product Configuration Information
PDD	Product Definition Data
PDF	Portable Document Format
PDF/A	Portable Document Format/Archivable
PDLM	Product Data and Lifecycle Management
PDM	Product Data Management
PDR	Preliminary Design Review
PIC	Procurement Information Circular
PLM	Product Lifecycle Management
PMI	Product and Manufacturing Information
PNG	Portable Network Graphics
PNT	Position, Navigation, Timing
PUB	Publication
PWS	Performance Work Statement
QAP	Quality Assurance Provisions
RA	Resource Analyst
RCL	Recommended Contract Language
REST	Representational State Transfer
RFI	Request for Information
RFP	Request for Proposals
RFQ	Request for Quotes
RFV	Request for Variance
RIF/ReqIF™	Requirement Interchange Format
RM	Requirements Management
ROM	Rough Order of Magnitude
RPT	Report
RR	Restricted Rights
SAT	Simplified Acquisition Threshold
SBIR	Small Business Innovative Research
SBU	Sensitive but Unclassified
SMT	Specification and Model Tree
SE&I	Systems Engineering and Integration
SGML	Standard Generalized Markup Language
SISO	Simulation Interoperability Standards Organization
SOAP	Simple Object Access Protocol
SOO	Statement of Objectives
SOW	Statement of Work
SP	Special Publication
SQL	Structured Query Language

SSP	Space Shuttle Program
STD	Standard
STEP	Standard for the Exchange of Product
STTR	Small-Business Technology Transfer
SysML™	Systems Modeling Language™
TBD	To Be Determined
TD	Technical Data
TDPL	Technical Data Package List
TDP	Technical Data Package
UAF	Unified Architecture Framework
UID	Unique Identification
UML	Unified Modeling Language
UR	Unlimited Rights
UUID	Universally Unique Identifier
VR	Variance Request
W3C	World Wide Web Consortium
WAD	Work Authorization Document
X3D	Extensible 3D
XMI	XML Metadata Interchange
XML	Extensible Markup Language
XSD	XML Schema Definition

3.2 Definitions

Authoritative Data: Data that have been designated as valid for specific official programs/projects. The designated data is controlled by processes. (Source: NPD 7120.4, NASA Engineering and Program/Project Management Policy)

Authoritative Source: An application or repository identified as the official source for specific authoritative data.

Authoritative Source of Truth (ASoT): an entity such as a person, governing body, or system that applies expert judgement and rules to proclaim a digital artifact is valid and originates from a legitimate source. (Source: OMG.org)

a. The ASoT for a digital artifact serves as the primary means of ensuring the credibility and coherence of the digital artifact that its creators share with a variety of stakeholders.

b. It gives stakeholders from diverse organizations and distributed locations the authorization to access, analyze, and use valid digital artifacts from an authoritative source.

c. The owners of digital environments or the community for DEEs provide stakeholders with an ASoT that assures confidence in the quality of the digital artifact across disciplines, domains, and lifecycle phases.

d. Structured information models and associated data schemas such that each data element is mastered (created and/or edited) in only one/single location (no duplication of data or documentation)

e. Any/all linkages to a data element (in other locations within the relational schema or in external federated databases) are by reference only (pushed/pulled data resides in one source and will update immediately upon source update),

f. Since all other usages of (locations of) the data element merely refer to the primary "source of truth" location, updates to that data element in the primary location are subsequently propagated through the entire system without possibility of a duplicate (non-referenced) value somewhere being forgotten.

g. Organizations with more than one information system, wishing to implement an ASoT (without modifying all but one master system to store pointers to other systems for all entities), typically utilize one or more of three supporting technologies, namely: enterprise service bus, master data management, or data warehouse.

Computer-Aided Design (CAD): Process of creating engineering designs defined by electronically produced multi-dimensional geometry using special software systems, the tools used by engineers to create geometric-based design definitions represented in a variety of formats, including two-dimensional (2D) drawings, three-dimensional (3D) models, envelopes, wireframes, and kinematics.

Configuration Management (CM): A management discipline applied over a product's lifecycle to provide visibility into and control changes to performance, functionality, and physical characteristics. (Source: NPR 7120.5, NASA Space Flight Program and Project Management Requirements). Also, a technical and management process for establishing and maintaining consistency of a product's functional and physical attributes with its requirements, design, and operational information throughout its life. (Source: SAE EIA-649, Configuration Management Standard)

Contract Data Requirements List (CDRL): A list of authorized required data requirements for a specific procurement that forms part of the contract/agreement. It is comprised of either a single or multiple Data Requirements Descriptions (DRDs) containing data requirements and delivery information. The CDRL is the standard format for identifying potential data requirements in a solicitation and deliverable data requirements in a contract. Use of the CDRL in solicitations is required when a contract will require delivery of data. CDRLs should be linked directly to Statement of Work (SOW) tasks and managed by the Program Management Office data manager. Data requirements can also be identified in the contract via Special Contract Clauses (e.g., Federal Acquisition Regulations [FARs] / NASA Supplements), which define special data provisions (such as Rights in Data, Warranty, etc.).

The purpose of the CDRL is to provide a standardized method for clearly and unambiguously delineating the Government's minimum essential data needs. The CDRL groups all of the data requirements in a single place rather than having them scattered throughout the solicitation or contract.

Data: The lowest level of abstraction from which information and knowledge are derived. Any collection of recorded facts, numbers, or datum of any nature that can be communicated, stored, and ultimately processed, using business rules, to form useful information. (Source: SAE EIA-649). For purposes of this Handbook, the term "data" will be used to cover data, information, and knowledge stored in an information system**.**

Data Architecture: Links information behavior (i.e., accessing, using, and sharing data), information management processes, and information support staff to other aspects of the Enterprise. Data Architecture provides an understanding of what information is needed to effectively execute the Enterprise's business processes and provides a framework for effectively managing the Enterprise's information environment.

Data Lifecycle: The series of states that a data object can take from its creation to its retirement or destruction; generally, these states represent maturity levels or indicate suitability for, or restrictions on, use.

Data Management: The process used to –

a. Provide the basis for identifying and controlling all types of digital and electronic data.

b. Provide the basis for identifying and controlling data requirements and specifications.

c. Responsively and economically acquire, access, and distribute data needed to develop, manage, operate, and support system products over their product-line life.

d. Manage and dispose data as records (Source: NPR 1441.1).

e. Analyze data use.

f. Ensure data integrity, fidelity, access, security, and proliferation.

g. Enforce data definition standards (naming, security, revisions, Configuration and Data Management [CDM]).

h. If any of the technical effort is performed by an external contractor, obtain technical data feedback for managing the contracted technical effort.

i. Assess the collection of appropriate technical data and information.

j. Effectively manage authoritative data that defines, describes, analyzes, and characterizes a product lifecycle.

k. Ensure consistent, repeatable use of effective DE processes, best practices, interoperability approaches, methodologies, and traceability. (Source: NPR 7123.1)

Data Model: Identifies the data, their attributes, and relationships or associations with other data. (Source: Department of Defense Directive 8320.03, Unique Identification (UID) Standards for a Net-Centric Department of Defense, March 2007)

Data Requirements Description (DRD): A DRD is the completed document that defines the data required of a contractor/offeror and is included in the CDRL. The DRD is used to specifically define the data content, format, and intended use.

Delivery: Applies to the hand-off, which may be physical or virtual in the case of data, at initial delivery of an item during development, for collaboration, in support of reviews, at the time of acceptance, and for subsequent modifications, maintenance, refurbishment, or any other activity that produces new data. (Source: IEEE 24765)

Design Activity: An organization that has, or has had, responsibility for the design of an item. The activity may be a government entity, a contractor, a vendor, or another organization such as a university. (Source: ASME Y14.100)

Digital Data: The level of abstraction from which digital (electronically defined) information and knowledge are derived. A collection of recorded facts, numbers, or datum of a digitized object that can be defined, annotated, characterized with non-graphical properties and definition, communicated, stored, and ultimately processed, using business rules, to form useful information. Also, information prepared by electronic means and made available to users by electronic data access, interchange, transfer, or on electronic/magnetic media. (Source: SAE GEIA-HB-649)

Digital Engineering (DE): Engineering performed in a digital collaborative environment which integrates stakeholders providing authoritative sources of data and models seamlessly across organizations and disciplines to support lifecycle activities from concept through disposal.

Digital Engineering Ecosystem (DEE): The interconnected infrastructure, environment, and methodology (process, methods, and tools) used to store, access, analyze, and visualize evolving systems' data and models to address the needs of the stakeholders. End-to-end digital enterprise. (Source: DAU Glossary). *Note: Can be used interchangeably with Digital Engineering environment.*

Digital Engineering Plan: A strategic document that outlines how an organization will use digital models, simulations, and data across a system's lifecycle to improve decision-making, reduce risk, and accelerate delivery. Based on DoD strategies and industry best practices, a comprehensive Digital Engineering Plan should contain strategic goals, vision, Digital Engineering Ecosystem (DEE) infrastructure, data management, authoritative source of truth (ASoT), methodologies, modeling approaches, data governance, workforce training, implementation, and execution.

Digital Transformation: The total and overall effect of transforming business models and associated information management from a document-centric approach to a data-centric approach (structured, human and machine-interpretable whenever possible), which results in stronger opportunities to transform and change existing business models, socio-economic structures, legal and policy measures, organizational patterns, cultural barriers, etc.

Digital Twin: A virtual representation of a physical object, system, or process that uses real-time data to accurately reflect its real-world counterpart's behavior and performance.

End Item: A product to be delivered under contract as an intact unit or to be assembled, completed, and made ready for use as a unit. (Source: IEEE 24765)

Engineering Release: An action whereby configuration information or an item is officially made available for its intended use. (Source: SAE EIA-649-2)

Enterprise System: Enterprises are highly complex, sociotechnical systems of systems that depend on intelligent interaction, creation, management and use of various forms of knowledge throughout their organizational policies, processes and structures. (Source: INCOSE)

Governance Model: The framework — principles and structures — through which the Agency manages the mission, roles, and responsibilities. (Source: NPD 1000.0, NASA Governance and Strategic Management Standard)

Metadata: Data about data, properties (title, document number, creation date, etc.) used to identify or define a data item. (Source: SAE EIA-649)

Model: A description or representation of a system, entity, phenomena, or process. (Source: NASA-STD-7009, Standard for Models and Simulations)

Modeling (verb): The activity of creating an abstract or digital object that represents a system, entity, phenomena, or process. (Source: NASA-STD-7009, Standard for Models and Simulations)

Model-Based (MB): An annotated model and its associated data elements that define a product, which can be used effectively without a drawing. It describes a technological approach where rigorous visual modeling principles and techniques form the technical foundation for an engineering or development process to increase its efficiency and productivity. The model is the source authority that drives all engineering activities.

Model-Based Definition (MBD): The practice of using 3D data sets containing the exact solid representation, associated 3D geometry and 3D annotations of a product's dimensions, tolerances, materials, finishes and other notes to specify a complete product definition. This model type is the source authority that drives all DE lifecycle usage. (Source: MIL-STD-31000; ASME Y14.47)

Model-Based Enterprise (MBE): An organization that uses digital methodologies as the foundation to enable deployment of products from concept to disposal (Source: ASME Y14.47)

Model-Based Manufacturing: Defines the desired end target state of the earlier defined model-based definition. Test and validation for compliance (model-based compliance) come into play to ensure manufacturing is executing to the proper and correct requirements, materials are developed or assembled per the proper specification, and process steps for formulation are followed and executed properly.

Model-Based Systems Engineering (MBSE): The formalized application of modeling to support system activities, including but not limited to requirements, design, definition, analysis, verification, and validation activities beginning in the conceptual design phase and continuing

throughout development and later lifecycle phases. (Source: International Council on Systems Engineering [INCOSE], *Systems Engineering Vision 2020*, Version 2.03, TP-2004-004-02, September 2007)

Product: A part of a system consisting of end products that perform operational functions and enabling products that perform lifecycle services related to the end-product or a result of the technical efforts in the form of a work product (e.g., plan, baseline, or test result). (Source: NPR 7123.1) Also, the following:

a. Hardware, e.g., engine mechanical part.

b. Software, e.g., computer program or model.

c. Processed materials, e.g., a lubricant.

d. Facilities, e.g., a laboratory or machine shop. (Source: SAE EIA-649-2)

Product Breakdown Structure: A hierarchical view of the relationship of products and component products.

Product Configuration Item (PCI): The structured data defining a product's attributes, components, and valid combinations, enabling tailored variations (like custom, configure-to-order or engineered-to-order items). It includes technical specifications, rules, pricing, and visuals that govern how components are selected and assembled to satisfy specific customer requirements.

Product Data and Lifecycle Management (PDLM): NASA's strategic business approach that consists of both PDM (product data management) and PLM (product lifecycle management). PDLM applies not only to a mechanism to store and retrieve data but also to manage the data over the product development lifecycle. PDLM leverages a consistent set of business solutions in support of the collaborative creation, management, dissemination, and use of product definition data/information across the extended enterprise from concept to end of life.

Product Data Management (PDM): The framework that enables organizations to manage and control engineering and technical information, specifically data surrounding the product's design, definition, and related engineering, manufacturing, and logistics processes and is a key element of PLM.

Note: From the product perspective, PDM organizes data required for design evolution, tracks versions and configurations of evolving design concepts, and manages archived data and other product-specific information. PDM tools provide access to product structures and other engineering data such as requirements, as-built data, and safety and mission assurance data. From the process perspective, PDM systems offer the capability to orchestrate controlled procedural events such as design reviews, approvals, product releases, and configuration audits.

Product Definition Information (PDI): Information that defines the product's requirements, documents the product attributes including the process information, and is the authoritative source for management of the product.

Related Terms: associated lists, configuration documentation, design basis, design documentation, design information, design output, engineering drawing, interface control document, interface document, model-based definition/product model, requirements document, software requirements specification, software design document, software product specification, specification, technical data, technical data package, Product Definition Data, Product Definition Element, Product Definition Data Set. (Source: SAE EIA-649)

Product Lifecycle: A series of states that generally defines the maturity level of a product and correlates with specific uses or users. Commonly, each state is represented by an agreed-to collection of information that identifies and establishes the attributes of a product at a point in time and that serves as the basis for defining change. *Note: A product's lifecycle begins with a concept and ends with disposal.*

Product Lifecycle Management (PLM): A strategic business approach that applies a consistent set of business solutions in support of the collaborative creation, management, dissemination, and use of product definition data/information across the extended enterprise from concept to end of life.

In product-dominated endeavors, PLM serves as the information backbone that extends outside the enterprise. PLM implementations may be composed of multiple elements, including foundation technologies and standards (e.g., XML), visualization, collaboration, and enterprise application integration), information authoring tools (e.g., mechanical computer-aided design, electrical computer-aided design, and technical publishing), core functions (e.g., data vaults, document and content management, workflow, and program/project management), functional applications (e.g., CDM), and business solutions built on the other elements.

Note: PLM integrates people/organizations, processes, and information.

Simulation: The imitation of the characteristics of a system, entity, phenomena, or process using a computational model. (Source: NASA-STD-7009)

Software[1]: (1) All or part of the programs, procedures, rules, and associated information of an information processing system; or (2) computer programs, procedures, and possibly associated information and data pertaining to the operation of a computer system.

Software can also be computer programs, procedures, scripts, rules, and associated documentation and data pertaining to the development and operation of a computer system. This definition applies to software developed by NASA, software developed for NASA, Commercial-off-the-shelf (COTS) software, Government-off-the-shelf (GOTS) software, modified-off-the-shelf software, reused software, auto-generated code, embedded software, the software executed on processors embedded in Programmable Logic Devices (see NASA-HDBK-4008), and open-source software components.

Note: Only for purposes of the NASA Software Release program, the term software, as redefined in NPR 2210.1, Release of NASA Software, does not include computer databases or software

[1] The definition of software is independent of the media on which the software is stored or the device in which the software executes (such as a programmable logic device) (Source: SAE EIA-649-2).

documentation. Definitions for the terms COTS, GOTS, heritage software, modified-off-the-shelf, legacy software, software reuse, and classes of software are provided in NPR 7150.2.

4. DIGITAL ENGINEERING (DE) ACQUISITION OVERVIEW

NPR 7120.5 and NPR 7123.1 integrate acquisition planning with the NASA program/project lifecycle and systems engineering processes. Within that framework, DE acquisition addresses how NASA identifies, acquires, controls, exchanges, and preserves the technical data and models needed for lifecycle decision-making and reuse.

Digital engineering is "an integrated digital approach that uses authoritative sources of systems' data and models as a continuum across disciplines to support lifecycle activities from concept through disposal" (Source: DAU Glossary). For acquisition, the emphasis is on obtaining the data and models NASA needs in usable, interoperable forms and enabling exchange among NASA, contractor, partner, and authoritative repositories.

A DE Ecosystem connects data, models, tools, repositories, people, and processes across disciplines and lifecycle phases. It may include model-based definition (MBD), computer-aided design (CAD), model-based systems engineering (MBSE), modeling and simulation (M&S), product data and lifecycle management (PDLM), and related capabilities that support authoritative data, digital threads, and lifecycle reuse.

NASA's data-centric approach relies on federated authoritative information sources and increasingly structured, machine-interpretable data. As DE has expanded from pilot efforts to broader program/project implementation, acquisition planning has become more important for defining how data and models will be created, exchanged, updated, protected, and delivered between information systems.
Data-centric acquisition favors models and machine-readable data that can be incorporated into appropriate NASA repositories and digital threads with minimal translation. This supports collaboration, information exchange, analysis, and risk-informed decision-making throughout the lifecycle.

DE planning should identify the activities, products, data, models, tools, interfaces, and acquisition considerations needed to support the program/project. DE acquisition planning may be documented within the DE Plan or as an extension to it and should align with the Project Plan, Systems Engineering Management Plan (SEMP), and applicable Acquisition Plan.

Because DE is multidisciplinary, programs/projects should consider assigning a DE lead or equivalent integrator to coordinate models, data sets, interfaces, and acquisition considerations. Effective implementation depends on clearly defined deliverables, data structures, schemas, relationships, and interoperability between NASA and contractor systems.

NASA acquisition should incorporate contractual guidance for the inclusion and use of digital tools, technologies, methodologies, and deliverables to maximize collaboration with NASA partnerships, both domestic and international. The purpose of a data-centric approach in acquisition is to ensure the delivery of digital models, machine-interpretable data instead of

traditional document-centric content which require an inordinate amount of labor to translate into the necessary format to feed the NASA DE digital thread.

5. LESSONS LEARNED

5.1 PURPOSE

Given the advances in technology over recent decades, it has become necessary to investigate new, more efficient approaches and business practices to achieve reasonable governmental access to data while simultaneously minimizing cost impacts associated with such requests. The lessons learned compiled in this in this section showcase times DE data acquisition was not fully considered on contracts and the risks and impacts associated. This context should be considered when assessing sections 6, 7, and 8.

Numerous lessons learned were identified while looking into the Space Shuttle Program (SSP), International Space Station (ISS), Launch Services Program (LSP), and various other contracts associated with Commercial Crew, Constellation, Orion, and other large NASA programs. The primary lesson learned was if one simply omits data rights requirements in a contract, access to the data during the contract and at contract end would then become only attainable at additional cost. Inclusion of tailored, template contract language can aid in mitigating this risk and ensure critical data access and integrity for the lifespan of the data/information.

5.2 SPACE SHUTTLE PROGRAM (SSP) LESSONS LEARNED

The SSP had numerous issues associated with data rights over the 30-year program. Data media varied from paper, to microfiche, to digital, making delivery, translation, and/or reuse over the program life a significant cost and effort. Additionally, the SSP did not have the data stewardship to ensure that downstream records management could be effectively and efficiently implemented (Source: NPR 1441.1). Security classifications for much of the documentation were not considered at the beginning for items such as export control — CUI (controlled unclassified information; formerly known as sensitive but unclassified [SBU]), International Traffic in Arms Regulations (ITAR), etc. As such, huge amounts of backlogged data could not be dispositioned.

The SSP design data and drawings were not contractual deliverables and, in most instances, were further complicated by multiple designs for various systems being developed across the program. This resulted in reference material not being available to multiple Centers across the program.

For the SSP, the resulting theme is the program neither defined nor added contract language to own data at the end of the contract, resulting in millions of dollars spent researching and obtaining lost data.

5.3 INTERNATIONAL SPACE STATION (ISS) LESSONS LEARNED

The ISS program continues to maintain multiple data systems for parts accounting, disposition, management, etc., because not one of their current systems can provide all functionality required; and the form of data does not lend itself to a single management system.

Both the SSP and ISS programs were stuck with huge balloon payments to purchase proprietary code that was required to run and maintain software systems formerly contractor owned and run. Without this code, the data would be unusable or require expensive conversion.

The ISS Payload Processing contractor was asked at the end-of-contract to turn over SSP work procedures at contract closeout. These work procedures were developed during the contract and were to be turned over to the incoming contractor; however, the contractor deemed many of the subject procedures to contain "trade secrets," making them proprietary. As such, many of the procedures developed during the life of the Payload Processing Contracts were never obtained and/or turned over. Again, the foresight to identify data required at end-of-contract was never considered at the beginning of the contract, or the contract specified the "best available data" that, while seeming the most economic path, turned out to be proprietary.

5.4 LAUNCH SERVICES PROGRAM (LSP) LESSONS LEARNED

The trend of moving from cost plus contracts to performance-based or fixed-price contracts, in many cases, encouraged contractors to develop and use their own data systems while their NASA counterparts became further disengaged in day-to-day activities. This continuing trend to convert more contracts to fixed-price can further exacerbate the issue of obtaining data rights as well as the possibility of more intellectual property being owned by the contractor.

The LSP, with the contract strategy of fixed-price to further reduce contract cost, has chosen to accept "existing contractor data" to the maximum extent possible. This strategy, although seeming the most cost effective, may become costly in the event the Government has a need to obtain the data at contract end or any time during the contract if specific contract language does not address the data rights at the inception of the contract.

The Commercial Crew Program requires very little data deliverables. Thus, the interfaces or interface control documents (ICDs) are only available for describing identified interfaces such as known touch points and enabling determination of safety assurance.

However, in contrast, a recent Office of the Chief Information Officer (OCIO) contract has contract language stating, "all contractor-developed applications shall be owned by NASA and fully transferable, including source code and documentation, to a new vendor at the conclusion of contract."

5.5 LESSON LEARNED SUMMARY

In summary, data rights standards vary across NASA programs from no standards to various attempts to establish a standard. Most program managers in the past have had the perception that data rights will cost a lot of money resulting in it not being addressed in most contracts, or data deliverables were removed during one of the many cost-cutting exercises. The most efficient and least expensive method of obtaining data rights is to include achievable requirements in the Request for Proposals (RFP) or front-end of the contract. Any end-of-contract changes will cost significantly more to obtain data.

6. NASA DIGITAL ENGINEERING (DE) ACQUISITION GUIDING PRINCIPLES

In the context of this Handbook, "digital engineering acquisition framework" should be interpreted as an approach, set of ideas, concepts, or recommendations for acquiring data products and services to support DE processes and systems, and not an operational system for the purposes of acquisition.

A digital engineering, data-centric, acquisition framework consists of approaches to acquire, receive, and control the interoperable flow of product definition information (PDI) and product configuration information (PCI), including associated product-related data (metadata) that includes systems engineering, product engineering, design, test, procurement, manufacturing planning, operational, maintenance, and sustainment information throughout the product and data lifecycles. A DE acquisition framework is the set of approaches to acquire associated engineering information used to manage and execute across the lifecycle of programs/projects.

It is critical and incumbent for the program/project to review, redefine, and reuse current and applicable NPRs as well as Standards and collaterals, including, but not limited to, DRDs, DE enterprise solutions, and systems engineering to accommodate the seamless flow of information across milestone delivery at key decision points (KDPs) in Pre-Phase A through Phase F.

NASA's guiding principles for data-centric engineering and applicability to a program/project's acquisition thereof are as follows:

a. Data as an essential enabler should be made visible, accessible, and understandable to any potential user as early as possible in the program/project's lifecycle, and throughout the lifecycle, to support project and mission objectives as constrained by security and access needs.

b. Data assets should be made adherent to the Findable, Accessible, Interoperable and Reuseable (FAIR) by creating and associating attributes and metadata ("tagging"), including, but not limited to, discovery of metadata for each asset.

c. Developed metadata standards should comply with applicable national and international consensus standards for metadata interoperability; all metadata should be retrievable using the NASA Centers' systems with requirements to access the metadata.

d. The digital engineering ecosystem should be Center-agnostic, utilizing Agency enterprise solutions, when possible, but it is recognized some solutions will need to be deployed and managed locally to the program/project.

e. Data assets should be accessible by making data available in shared spaces; all data assets should be accessible to all users at the appropriate NASA Center(s) except where limited by law, policy, or security classification.

f. Data that is accessible to all users at the appropriate NASA Center(s) should conform to that Agency's specified data publication methods that are consistent with the Agency's current and planned information systems capabilities.

g. To enable trust, data assets should have associated information assurance and security metadata and an identified authoritative contractor and/or Agency source for the data.

h. Data interoperability should be enabled through business and mission processes reusing the Agency's information system capabilities.

i. Semantic and structural agreements for data interoperability should be promoted through communities consisting of data users (producers and consumers) and system developers.

j. Data interoperability concepts and practices should be incorporated into education and awareness training and Center-level processes.

k. Programs/projects should acquire the minimum essential contractor-originated data required to meet with traceability to all program/project lifecycle requirements.

l. Program/project managers and delegated Technical Authorities should consider data requirements for future procurement needs in a manner that fosters competitive procurement opportunities.

7. DIGITAL ENGINEERING (DE) DATA ACQUISITION GUIDING QUESTIONS

7.1 PURPOSE

This section is intended to guide the reader to consider the most relevant information when determining which recommend contract language (RCL) statements provided in Appendix A to include. It also assumes the critical "Make/Buy" analysis has already been conducted per the FAR section 15.407-2.

7.2 QUESTIONS TO GUIDE PROCUREMENT PLANNING DISCUSSIONS

During the initial planning sessions, the following questions should be addressed to ensure all aspects of the acquisition are considered when developing your procurement strategy.

(1) What are we buying?

(2) What are the overarching goals for this acquisition?

(3) End Item/Service/Research & Development effort?

(4) Has it been done before (heritage)? Is it a new acquisition or a follow-on effort?

(5) For follow-on acquisitions:

a. What has changed or is now different from the last acquisition?

b. What are the lessons learned/best practices from past acquisitions?

(6) What worked well; what didn't work well?

(7) Would it be considered a commercial acquisition per FAR Part 12?

(8) Are there other items or services you'd like to include?

(9) What are the deliverables?

(10) Is any new technology involved?

(11) What data rights considerations do we need to make?

(12) What are the Level I/Mission Critical requirements vs. nice-to-haves (scope options/add-alternates/optional deliverables/task order options)?

(13) What is the current cost estimate (Rough Order of Magnitude [ROM])?

a. Who does this requirement support?

b. Who do you consider customers?

(14) If this is an Indefinite Delivery Indefinite Quantity (IDIQ) procurement, will the procurement's scope and maximum IDIQ ordering value be able to accommodate other NASA Centers' requirements in the future, if needed.

(15) What is the criticality level of this effort? (Source: MIL-STD-882E)

(16) What's the required schedule/period of performance?

a. What are the ramifications of missing the required schedule?

b. Are there risk levels or criticality considerations that should influence the acquisition's requirements for digital product exchange?

(17) Are there any political sensitivities related to the acquisition? What is the extent of NASA Headquarters (HQ) involvement?

(18) Are there risks associated with what we're doing under this contract, and if so, how can we minimize them?

(19) What are the performance targets? In other words, what does success look like?

(20) Are incentives for performance (cost, schedule, technical, etc.) important?

(21) How does this effort interact with other NASA contracts?

(22) Is funding available to support this effort? If not, when is funding expected to be available? Are the requirements of this procurement severable or non-severable?

(23) Are there any restrictions (money, schedule)?

(24) What is the place of performance? Onsite at the Government facility or offsite at the Contractor's facility?

a. Who are the potential contractors?

b. What is the extent of competition expected, if competitive?

c. If sole source, what is the rationale for the lack of competition?

d. What market research has been performed to support the expected level of competition?

e. To what extent are small businesses capable of performing this effort?

f. To what extent is an 8(a) (small business) company capable of performing this effort?

(25) Would using a General Service Administration (GSA) Schedule or Government-Wide Acquisition Contract (GWAC) acquisition be feasible?

(26) Could other existing contracts at my center fulfill this procurement need?

(27) What type of contract do we anticipate? hq.nasa.gov/office/procurement/forecast/NAF.html

(28) To what extent are current initiatives feasible for the acquisition (Performance-Based Contract [PBC], Fixed Price Contracts, Multiple Award IDIQ Contracts, etc.)?

(29) Will this procurement be subject to Earned Value Management System (EVMS) Reporting?

(30) Does this procurement involve Section 508 Electronic & Information Technology (EIT) Accessibility Standards? (www.section508.gov)

(31) What collaborative engineering activities will occur under the contract?

(32) What exchange of digital products is needed in the successful execution of the contract?

(33) Are there security, data protection, export, ITAR, CUI, etc., controls in place to properly receive, integrate, store, and use digital products from contractors?

7.3 STAKEHOLDERS

The list below includes the main stakeholders that should be considered throughout the lifecycle of the procurement. This is not meant as an all-inclusive list; however, this list should also be used to ensure the inclusion of important stakeholders when developing contract requirements and contract language. When assembling a team, it may be necessary to provide training to the

technical discipline subject matter experts on how a contract is put together and the relationship between the contract lifecycle stages and DE interfaces and products. Other subject matter experts may be required in order to establish contract requirements.

List of main stakeholders:

a. NASA Procurement/Acquisition

b. NASA Vendor liaisons

c. Your Organization/Program Business Resource Analyst (RA)

d. Program Managers

e. Configuration Management

f. System Engineers

g. Design and Analysis Engineers

h. Manufacturing Engineers

i. Operations and Sustainment (O&S) Engineers

j. Safety & Mission Assurance Engineers

k. Technical Subject Matter Experts

l. Quality Assurance/risk management

m. Technical Leads (machinists, operators, etc.)

n. Information Technology (IT)

o. Logistics

p. Training

q. Legal

Not all stakeholders will be explicitly covered by the DRDs and contract language contained in the appendices.

7.4 PURCHASE ORDER (PO) / PURCHASE REQUEST (PR) REQUIRED INFORMATION

Below is a list of required items for a purchase order based on best practices and is provided as a reference. Center specific forms and processes may be required. The list shows what the requiring organization provides to Procurement. These items are developed using an iterative

process and involving the aforementioned stakeholders. The following of these required items need to be established prior to entering any procurement:

a. Requirements contained within contract documents such as Statements of Work (SOWs) and DRDs

b. Special Approvals and Affirmations of Requisitions

c. Market Research

Table 1—PR Package Requirements

REQUIRED ITEM	DESCRIPTION
Purchase Request	Funding activity info (source/purpose), Fiscal Year of Appropriation, Length of Availability for Obligation
Requirement (SOW, Statement of Objectives [SOO], Performance Work Statement [PWS])	(SOW, SOO, PWS) Goods or Services, Severable/non-severable determines funding (Incremental or full respectively) involves (Resources/Chief Financial Officer [CFO]) -SOURCE should be Government! See restrictions on Advisory & Assistance Services FAR 37.2.See restrictions on Advisory & Assistance Services FAR 37.2
Government Furnished Property (GFP), if any	Includes Installation Accountable Government Property (IAGP) Will there be Contractor Acquired Property (CAP)? There is no profit/fee on CAP unless CAP is a deliverable on the contract
Form NF634 Structured Approach Profit/Fee Objective (NFS 1815.404-4)	Simplified Acquisition Threshold (SAT); uses cost analysis; and is: 1) Awarded on basis other than Full and Open; 2) Awarded under NASA Research Announcements (NRAs) and Announcement of Opportunities (AoOs); or 3) Awarded under Small Business Innovative Research (SBIR) or the Small-Business Technology Transfer (STTR) program
NF1739 Capitalization Determination Form	Mandatory for $1M of personal property, real property, internal use software.
NF1707 Special Approvals and Affirmations of Requisitions	Multi-Disciplinary Coordination Form (ex. Section 508, Environmental, Supply Chain Visibility [DRD], Foreign travel, Quality Assurance, etc.)
GSFC 23-59 Initiator's Acquisition Checklist (HQ / GSFC)	Center specific concerns on health and safety / Hazardous Material
Independent Government Estimate (IGE), Independent Government Cost Estimate (IGCE), In-House Cost Estimate (IHCE)	Government estimate of the cost of the requirement. Used to help determine reasonableness of proposed prices.

REQUIRED ITEM	DESCRIPTION
Limiting competition documentation, if necessary	(i.e., Justification for Other than Full and Open Competition (JOFOC) – FAR 6.3 Fair Opportunity Exception (FOE)-FAR 16.505(b)(1), Sole Source- FAR 13.501, Limited Source Justification (FAR 8.405-5); Brand Name Only (Multi) (Term can allude to process) $ amount drives level of review. Type of contracting drives process (ex. Simplified / Negotiated / Mandatory)
NF 1787A Market Research (Relationship: Collaborative Req. Activity and Procurement)	Considerations: Estimated $ Value Commercial (FAR 12) vs. Non-Commercial Inherently Govt.? Competitive vs. Non-Competitive (Limited Source/Brand Name/Fair Opp) Buy American Act Foreign Vendors Eligible? OIIR involvement after selection delays award. Unclassified IT Security Requirements (DRD) Procurement Class Deviation (PCD 21-01B) for NFS 1852.204-76 Organizational Conflicts of Interest (OCI) Plan (DRD) Sourcing (Mandatory Source?) / Product Service Line (PSL?) / Strategic Sourcing?
NF 1787 Small Business Coordination	Considerations: Small Business Subcontracting Plan mandated? NPD 5000.2 Synopsis/Public Notice (www.sam.gov) Socioeconomic preference/HubZone/Section8(a) New Purchase vs. Bundling vs. Consolidation vs. Follow on Small Business Administration involvement Waivers for no subcontracting opportunity If taking requirement out of existing SBA Programs

8. RECOMMENDED DIGITAL ENGINERING (DE) DATA ACQUISITION CONTRACT LANGUAGE AND BEST PRACTICES

The purpose of this section is to provide specific data requirements language to supplement the existing Federal Acquisition Regulations (FAR) and NASA FAR Supplement (NFS) clauses. This Handbook provides guidance, templates, and specific language to enable data integrity, and maintain control and access during and after the contract award. Factors such as the nature of the mission; mission class; the amount and types of data; data acquisition; sensitivity; retention needs; the location, timing, and duration of data access; and the organizational relationships of participants are important for characterizing the demands that programs/projects place on a contract to ensure they receive the information required to fulfill NASA Missions.

This Handbook compiles recommended contract language to ensure data are protected throughout the contract and transferred as required at contract end. This language has been reviewed at the Agency level to ensure validity and completeness. All recommended contract language supplied herein should be reviewed by the appropriate Legal, Procurement, and subject matter experts before placing on a contract.

The NASA Earth Science Program developed Data and Information Guidance that promotes the full and open sharing of all data with the research and applications communities, private industry, academia, and the general public. In general, the greater the availability of the data, the more quickly and effectively the user communities can utilize the information to address national and industry issues and challenges and provide the basis for developing innovative practical applications to benefit the general public. This Handbook applies that data availability concept, where programmatically appropriate, to form the basis on which the draft contract language was built.

8.1 Data and Information Needs Assessment

The content in this section provides DE areas of consideration for each project/programs acquisition needs. Use this section as reference to assess whether or not a particular subset of data acquisition is relevant to inform your selection of requirements as provided in Section 8.2. It is recommended projects/programs use sections 6 and 7 to identify additional DE procurement needs.

The purpose of the needs assessment is to determine the high-level requirements associated with data acquisitions and help tailor the contract language in Section 8.2. The content in this section was gathered through surveys and focus group discussions.

8.1.1 Digital Data Standardization

Digital data standardization, regardless of the file or data format used, is needed for all data deliverables. As such, future procurement solicitations are to address and place emphasis on, but not limit to, the following categories and include as deliverables along with addressing “how to” accomplish them within the SOW and other sections of the RFP:

a. Ensure consistency of data and data use across systems.

b. Ensure minimal redundant data collection and entry.

c. Ensure maximum utilization of relevant technology.

d. Ensure audit trail accessibility.

e. Ensure rapid retrieval of audit trail information for change processing.

f. Ensure effective analysis of metrics.

g. Ensure improved data acquisition timelines.

h. Ensure improved data review and integration.

i. Ensure minimal required translation between digital data formats.

j. Ensure explicit translation strategies are identified.

k. Ensure adequate data collection, generation, measurement, or analysis procedures.

l. Digital data standardization is considered and required when the following program requirements exist:

m. The potential for reuse of data in compliance with the Office of the Federal Chief Information Officer's Memorandum for the Heads of Executive Departments and Agencies M-25-05, Open Data Policy, in accordance with internal data clearance processes for release to the public.

n. A need exists for interoperability of standardized data among Centers, academia, industry, platforms, and contractors/programs.

o. There is a need to provide relationships between data for performing program management, systems engineering, and operational functions.

p. Contract closeout.

8.1.2 Data Definition and Interoperability

NASA should provide data definition and interoperability requirements written into program contracts to leverage a data-centric approach for digital asset data management. The requirements should be defined by NASA policies that generate content for inclusion in NASA Request for Quotes (RFQ), Request for Information (RFI), RFP, and SOW templates and preparation Standards. The following subsections provide examples of Data Definition and Interoperability.

8.1.2.1 Bill Of Materials (BOM) Product Breakdown Structure

A product breakdown structure is a hierarchical program/project view of the relationships of the hardware and software products and component products. Product structure provides a platform

on which an entire program/project product family can be based. Product structure involves decomposition of the overall functionality of a product into a set of defined functions, the component parts of the product that provide those functions, and the specification of the interface between the components (i.e., how components interact together in the product as a system). It is a product data structure that captures the end products, their assemblies, quantities, and relationships.

A bill of materials (BOM) is a functionally dependent view of a subset of the product structure that includes the physical items and is a formally structured list for an object (semi-finished or finished product) that lists all the component parts of the object with the name, reference number, quantity, and unit of measure of each component. DE should provide traceability of all changes to the BOM, including when and why it was changed, which documentation implemented the change, who approved the changes, and the disposition of the affected items. The remainder of this section is to highlight areas to be considered for data requirements and to be reflected in DRDs such as Appendix D.9, Engineering Models and Associated Lists (EMAL) Template

Problems occur with the development and use of BOMs because:

a. Only the “as-designed” BOM is managed in engineering.

b. The proposal BOM is created, then not carried forward.

c. Not all data delivered are related to part definition.

d. No product structure is delivered.

e. Effective BOM change is limited to a single change and by date only; most recent is all that is saved.

f. Substitutes and alternatives are managed as separate BOMs and products.

Programs/projects should implement a product structure and BOM development that can:

a. Manage product structure and BOM data.

b. Capture and manage substitutes and alternative parts.

c. Provide revision control and history of product (BOM) data.

d. Manage multiple views of the BOM, including as-proposed, as-designed, as-built, and as-launched.

e. Manage change effectiveness by event, date, lot, or serial number as necessary.

The product structure should be documented in the DE Plan. It provides a simple, concise view of the product that can be used as the central point of reference for all information describing and related to each element, subsystem, assembly, subassembly, and part comprised within the

structure. The complete product breakdown structure segment list should be defined, including design data for an assembly and/or subassembly such as as-designed (i.e., Engineering Bills of Materials), as-built or as-manufactured (i.e., Manufacturing Bills of Materials), as-manifested, as-flown, and as-disposed, beginning either at the highest level (i.e., system) or lowest level (i.e., component) to access all related data based on access privileges.

A good product structure should:

a. Be a decomposition/interrogation of the system into its parts.

b. Define the complete segment list, including design data for an assembly and/or subassembly that is:

(1) As-designed — a product structure representing the configuration after release, before manufacturing is started.

(2) As-built (as-manufactured) — a product structure that represents the configuration as it has been manufactured and delivered to the NASA inventory.

(3) As-manifested — a product structure representing a configuration designated for a specific flight.

(4) As-flown — a product structure representing a configuration that has flown.

(5) As-disposed — a product structure representing a configuration that has been decommissioned.

c. Provide the capability for an individual to start at the highest level (i.e., system) to access all related data (based on the individual's access privileges) by drilling down to the lowest component of the system, as well as walking up from the lowest component to the highest level. This includes, but is not limited to, access to supporting design documents such as analysis reports, test reports, requirements, and verification and validation checklists.

Components include hardware, software, and configurable logic devices as shown in the examples below:

a. System

b. Segment

c. Element

d. Subsystem

e. Assembly

f. Subassembly (component)

g. Part (piece part)

8.1.2.2 Data Item Source-To-Destination Mapping

Data Item Source-to-Destination State mapping is important to define clearly in the initial contract data requirements or negotiate early on as it defines/documents the mapping of data item states between NASA and Contractor systems. This ensures they are functionally the same since understanding the state of release for a data item is critical for maintaining a trusted program/project baseline (see Figure 1, Notional Data Item Source-to-Destination State Mapping).

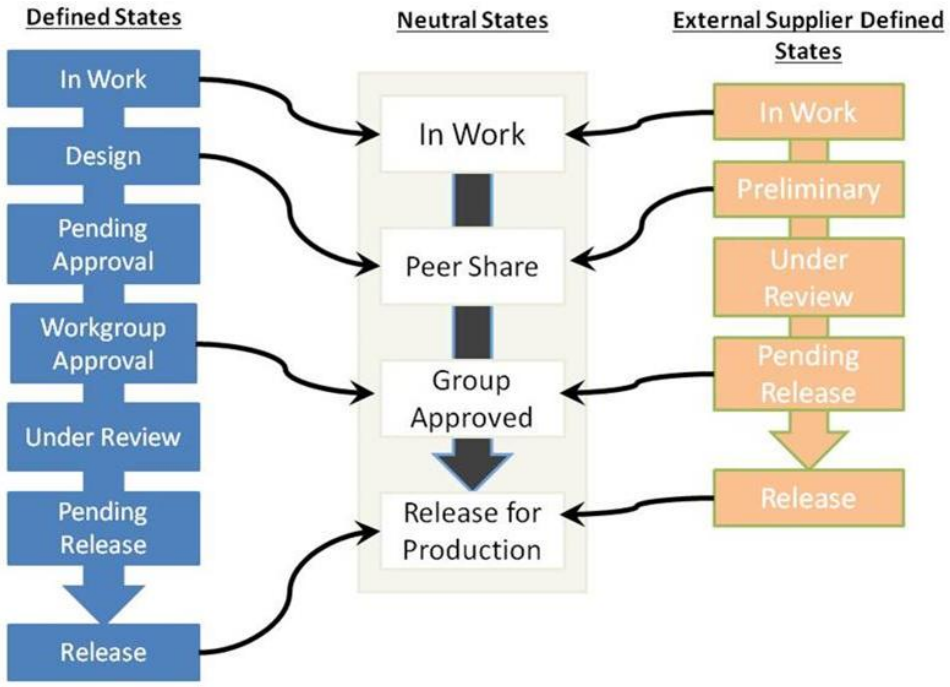


Figure 1—Notional Data Item Source-to-Destination State Mapping

8.1.3 Model-Based Systems Engineering (MBSE) and Systems Model Development

MBSE is a method to create system models to capture functions, requirements, systems definitions, and relationships throughout development and later lifecycle phases (i.e., concept definition through retirement). The intent of MBSE methodology is to facilitate traditional systems engineering (consisting of document-based and standalone digital tools) resulting in enhanced communications, specification and design, system design integration, and reuse of system artifacts and models. MBSE can support both engineering data and business data and can form the backbone of the digital thread.

A system model can enable integration of external abstract models to document design sets and help refine system requirements. It also provides graphical presentations of process flows that

enable group participation in concurrent engineering. This includes requirement mapping and process flows to CAD models, digital manufacturing models, as-built models, model-based testing, engineering analysis models, and O&S and logistics functions. System models provide the capability for these reviews to be conducted with a single-source interconnected model that provides viewing of the system models and their interactions from different perspectives (i.e., discipline-dependent views).

In the project development phase, a system model is at the center of the process, from concept and requirements development, to design, implementation, and testing and through the entire operational lifecycle of the program. System models can be used to conduct simulations of processes and associated data flow; for example, to test whether the process might function as planned as part of the overall system development. As part of the digital thread, system models can integrate with other 3rd party tools and generate project/program work products.

Within the DE environment, models will extend to domains to support complex, predictive, and effects-based modeling that include integration of engineering models with scientific and phenomenology models; social, economic, and political models; and human behavioral models[2]. For additional context of NASA system modeling methods see NASA Systems Modeling Standard for Systems Engineering (Source: NASA-HDBK-1009).

8.1.4 Data Acquisition

NASA should provide data acquisition requirements to enable the reference and reuse of data through a Program's full lifecycle. These data acquisition requirements should be present during RFP/RFQ development to establish integrated data architecture for a Program's information systems architecture, data architecture, and Information Systems capability roadmap. The ability to meet data exchange requirements should be a part of the contract performance metrics that the contractor should report on and be evaluated on throughout contract execution.

8.1.5 Data Interoperability Process

The need was recognized for NASA to adopt industry standards and approaches to enable data interoperability and move beyond the mere storage of raw, uncorrelated, or incompatible data. Interoperability enables capabilities for full lifecycle reusability, including efficient integration and modification. The following sections contain the contract language and the associated standards necessary to execute digital data interoperability, which benefits NASA, its contractors, and partners. This section provides guidance for establishing the proper data interoperability capability. To create a true collaborative digital environment, it is important to use industry standards and approaches for digital data interoperability.

The true benefit of a digital environment may not be always evident at the Center or authoring level; however, upstream and downstream users are hugely impacted as the amount of work required to validate or modify the completeness or correctness of the data being shared increases.

[2] MBSE State of Practice - 2020. Presented at the INCOSE 2007 Symposium. https://sdincose.org/wp-content/uploads/2011/12/SEVision2020_20071003_v2_03.pdf

Minimizing application customization and adapting industry interoperability standards can reduce the data flow complexity and will facilitate future upgrades and the exchange of data with parties internal and external to NASA.

Managing product design and facilitating its use also depends on the design data itself being compliant with a set of practices applied outside the tool. Most notably, the configuration, accuracy, identification, and other settings enacted by engineers within the same tool will affect the ability and effort required to share their data with each other; a perfect DE solution cannot overcome incompatibility choices made at the source, often on contracts. The list of processes that need to be discovered and assessed for interoperability begins outside the DE tool and extends into applications and system interfaces for manufacturing, procurement, logistics, operations, and sustainment.

One example where NASA has created an interoperability standard where no industry equivalent existed is NASA-STD-7009, Standard for Models and Simulations, which provides requirements for determining the credibility and integrity of modeling and simulation results and design application.

As part of the needs assessment, a program/project manager and the delegated Technical Authority need to address this list of questions that drives process interoperability:

a. How will peer engineers and designers be allowed to share data in support of detailed design?

b. What is sufficient and necessary to define for a specific need (e.g., design, verification, manufacturing):

(1) Part (hardware and software).

(2) Assembly or subsystem.

(3) Systems or products.

c. How are parts identified and named to avoid conflict, confusion, constraints, and reduce data redundancy?

d. What is the definition of models for a specific purpose (e.g., systems design, part design, envelope, interface checking, thermal and structural analysis, integration, and shrink-wrap)?

e. How are the alternate versions of models related and managed, and what is required to ensure traceability and sharing?

f. What practices and resources reduce the effort required to find, use, and integrate approved part definitions, including common hardware?

g. What state labels, descriptors, and process steps identify the allowed uses, authorized user, and change status of engineering design data during its lifecycle (e.g., engineering release, change control, and configuration definition)?

h. What defines a product structure for a given use/audience/lifecycle state; how is that product structure produced and approved; and how will it be used downstream?

8.1.5.1 Exchanging and Distributing Models

To ensure data transportability and integrity, it is important to use industry standards and approaches for data interoperability. This is only achieved through the identification of appropriate standards and the application of contractual methods to ensure compliance and implementation on all future NASA's programs/projects.

Example use cases for interoperability:

a. Exchanging System models (ex: MBSE Models) and exchanging data between system models and various discipline tools. As part of the digital thread, system models can integrate with other 3rd party tools and generate project/program work products.

b. Exchanging 3D data within engineering departments, between primes, and with other divisions and departments is critical to program/project development. Therefore, when parts are developed in 3D, the data are initially stored in the original format in the authoring system (or product lifecycle management [PLM]) of the software used to design the part; but, when the need to share/collaborate occurs, a neutral 3D format is necessary. In general, a neutral 3D format as the medium for collaboration should be selected.

c. Contractor delivers a file of requirements to NASA. NASA needs to understand the state of the requirement set with regard to the latest baseline release and thus needs to include appropriate metadata associated with the state and pedigree of the data or design, (e.g., draft, preliminary, baseline, update, model branch #, revision #, etc.).

d. Engineering release (the very beginning of design data in configuration and data management [CDM] where engineering designs are created, checked, and status is reported).

e. Integrated product structure (the core mechanism around which the relationships between detail product design elements are defined).

Note: The program/project manager and delegated Technical Authority have the responsibility to identify and acquire essential contractor-originated data with sufficient access and usage rights to support not only the full program/project lifecycle, but also the enterprise needs of the Mission Directorate and Agency as a whole. Contractor data interoperability is achieved through identification of appropriate standards and guidance on contract language.

8.1.5.2 Computer-Aided Design (CAD) Interoperability / Data Exchange Use Cases for Consideration:

In development processes, it may be necessary to exchange exact geometry and associated data between different authoring CAD systems. This is, for example, the case if a supplier is using a different CAD system than the one used by NASA or the manufacturer. What is needed is a typical and frequently used modeling method involving design in context of existing geometry and data and is defined as follows:

a. When exchanging exact geometry, additional information describing the product is often needed. In this context, a distinction is made between product and manufacturing information (PMI) and metadata. Metadata, typically called parameters, refers to descriptions that consist only of text (e.g., information about the author or the release status of a model). PMI, typically called attributes, is often added in the form of two- and/or three-dimensional (3D) annotations, manufacturing notes, material specifications, and other identifiers displayed with geometry. CAD geometry, metadata, and PMI embedded in two- and three- dimensional products constitute the full MBD. CAD formats and conversion requirements need to be defined upfront in a contract to mitigate interoperability issues.

b. Another frequent requirement is that the processing of PMI occurs subsequent to data exchange. The protection of intellectual property is also playing an increasingly important role in data exchange, and it should therefore be possible to take this aspect into consideration and reflect it properly in the DRD.

(1) The most important items to be considered are:

A. The data format and collaborative model definitions to ensure the transfer of exact geometry and the entire product structure.

B. The transfer of metadata, as well as PMI annotations (depending on the technical readiness level being executed and where a concrete use case is involved).

C. Ensuring data integrity, fidelity, and completeness, and a one-to-one correlation between the original model and the target model.

For naming standards see ASME Y14.100. For additional CAD definition standards see ASME Y14.47. For additional CAD data it is recommended to review NASA-HDBK-7009.

Error! Reference source not found., highlights common activities involving 3D CAD interoperability, and how to facilitate better planning, correct contract language, and acquisition of needed design data.

Table 2—System and CAD Model Interoperability Insights for Project Data Acquisition and Exchange

Desired Activity:	Required Digital Engineering Capabilities And Actions:
Perform design and design intent integrations	Pre-release models (systems and CAD) with data appropriate for the lifecycle phase at a defined (high) accuracy based on the negotiated agreement(s) between the Contractor and NASA.

Desired Activity:	Required Digital Engineering Capabilities And Actions:
Subcontract part of design work	Sending contractor requirements, skeleton files, start parts, approved parts lists, BOMs, etc., and receive back design files, component models, and other elements of the product definition package in the file format and interoperability as defined by NASA and/or delivered into specified location (product structure) with NASA baseline management system.
Take over design change authority	Full design history, systems, and CAD models for a given vehicle block, including skeletons, standard parts, start parts, models, configuration settings, and model-checking criteria via an agreed upon file format as defined by NASA.
Conduct design review	3D "viewable" of released models or external alternative representations that support annotations and analysis.
Do derivative designs such as ground support equipment (GSE)	Pre-release CAD and system models from source at defined maturity level, treated as "released" by users within their own environment with associated metadata appropriate for the lifecycle phase.
Do modeling and simulations	Pre-release alternative (system and analytical models) representations with full definition of items significant for modeling and simulation with data appropriate for the lifecycle phase.
Re-bid production	Release CAD models, drawings, material specifications, manufacturing processes, installation models, etc.
Do physical integration and verification (e.g., at Product Assembly Building)	Release alternative representations or source system definitions, requirements, and CAD with appropriate alternative representation substitutions with full definition of items at integration point (but lacking internal detail) with data appropriate for the lifecycle phase.
Define contents of acceptance data package	CAD needs based on defining requirements — who/what/when/how models will be used — to ensure that they are the right lifecycle/maturity state, format, and contain needed content. Release terminology used between NASA and the Contractor needs to be consistent and delivered Acceptance Data Package (ADP) artifacts should map and retain lineage to NASA BOM and product breakdown structure when delivered and as defined by NASA.
Perform concept development and refinement	Surface, shape, parametric, possibly detail design or as-is (for existing systems) and "will-be" (for future systems) model and simulation data.

8.1.5.3 Industry Standards for Data Interoperability

Error! Reference source not found., provides guidance for industry standard data interoperability formats and definitions that are well suited for relational and object model data interoperability implementations at the time of this document's release. For reference documents, see section 2..

Data Interoperability Formats:

a. Data interoperability refers not only to CAD data but also to non-CAD data used in innovation and preliminary designs and other pre-CAD domains (e.g., requirements analysis). All formats need attention and are considered part of interoperability. All data interoperability should follow standards where applicable (e.g., Standard for the Exchange of Product [STEP], Extensible Markup Language [XML]):

(1) Requirements interoperability should focus on STEP AP 233, 239, 242 in ISO 10303 and follow Regulated Qualifications Framework or Requirements Interchange Format (RIF) standards.

(2) CAD data interoperability formats should be chosen based on the need for interoperability or reuse after delivery. CAD model data should be delivered with or cleanly converted to formats which translate all PMI and metadata to enable downstream lifecycle usage of the models.

b. Currently, mechanical computer-aided design (MCAD) and electronic computer-aided design (ECAD) data formats may be selected from Table 3, although using the version of STEP which preserves the maximum amount of model-base definition is recommended.

c. SysML™ models – The SysML™ language is relatively new and still evolving rapidly as is the adoption of the evolving language release via the commercial software providers. As such, compliance with a specific SysML™ version will not be defined here. Therefore, it is very important that a program or project be very specific with the version of SysML™ and the desired vendor format to ensure maximum interoperability between NASA and the Contractor. Key plugins to extend the architecture (e.g. Unified Architecture Framework [UAF]) should be noted to ensure full use of delivered models.

The interoperability formats in Table 3 are based on the World Wide Web Consortium (W3C) Internet Standard: XML and supporting protocols.

Table 3—Target Industry Standards for Data Interoperability Formats

Standard by Domain	Short Description	Industry Organization
* XML, version 1.1	Facilitates enterprise-wide accessibility and alignment of product data • Why it helps: Provides a standardized, structured format that enables seamless data exchange and integration across tools.	World Wide Web Consortium, http://www.w3.org/XML/

Standard by Domain	Short Description	Industry Organization
OSLC (Open Services for Lifecycle Collaboration)	Provides a lightweight, Representational State Transfer (REST)-based approach to integrate disparate DE tools (requirements, design, simulation, testing, and configuration management) via common data models, enabling seamless data exchange without bespoke point-to-point adapters. • Why it helps: By exposing data as linked resources with shared vocabularies, OSLC supports end-to-end traceability and model-based engineering across multi-tool ecosystems while preserving each tool's native capabilities and governance.	https://open-services.net/
MCAD		
ISO 10303-242 - STEP AP 242	Managed 3D engineering data with semantics. • Why it helps: Core standard for embedding PMI, design intent, materials, tolerances, and lifecycle data directly in the 3D model. Enables semantic reasoning and MBSE workflows.	International Organization for Standardization (ISO) https://www.iso.org/
ISO 10303-203	Application protocol for Configuration controlled 3D design of mechanical parts and assemblies.	International Organization for Standardization (ISO) https://www.iso.org/
ISO 10303-214 - STEP AP 214	Core data for CAD data exchange. • Why it helps: Widely used for broad CAD data exchange; supports 3D geometry and related product data. PMI may be present via mappings to AP 242 in robust workflows.	International Organization for Standardization (ISO) https://www.iso.org/
ASME Y14.41	Digital Product Definition Data (PDD). • Why it helps: Specifies how digital product definitions are packaged and delivered, including PMI and semantic content; complements STEP data with a robust packaging model.	American Society of Mechanical Engineers (ASME)

Standard by Domain	Short Description	Industry Organization
ASME Y14.47	Model Organization Practice – Engineering Product Definition and Related Documentation Practices • Establishes a framework for organizing an MBD 3D CAD model and other associated information within the context of a product definition data set.	American Society of Mechanical Engineers (ASME)
Electronic Computer-Aided Design (ECAD):		
IPC-2581	Generic Interchange for Printed Circuit Assemblies and Bare Boards • Why it helps: A machine-readable, end-to-end data interchange format that can carry geometry, nets, BOM, test data, and manufacturing notes — ideal for fully annotated boards.	Association Connecting Electronics Industries (IPC) https://webstore.ansi.org
IPC-2221 / IPC-2222	Generic/Design requirements for printed boards • Why it helps: Provides domain-specific design requirements and terminology to ensure consistent interpretation across suppliers.	Association Connecting Electronics Industries (IPC) https://webstore.ansi.org
IPC-7351	Generic Footprint • Why it helps: Standardizes component footprint data (pads, pads geometry, and land patterns) to ensure consistent annotations across suppliers.	Association Connecting Electronics Industries (IPC) https://webstore.ansi.org
ISO 10303-210	Application protocol for electronic assembly, interconnect and packaging design	International Organization for Standardization (ISO) https://www.iso.org/
Systems Engineering:		
OMG SysML™	Enables SysML™-based modeling and traceability across domains, tying requirements to design and verification	https://www.omg.org/spec/SysML/
ISO/IEC 19503:2005, XMI	XMI is the format used by common MBSE modeling tools for model exchange without use of proprietary file formats. **a.** Why it helps: Standardizes component Why it helps: Provides production rules for transformation MOF-based metadata (Source: ISO/IEC 19502)	https://www.omg.org/spec/SysML/2.0

Standard by Domain	Short Description	Industry Organization
ReqIF	Provides a standardized, interoperable format for exchanging and managing requirements across different tools and lifecycle stages, ensuring consistent communication and traceability. • Why it helps: Supports the digital thread by enabling seamless integration and synchronization of requirements data throughout the product development and manufacturing processes, which enhances collaboration and reduces errors.	Object Management Group (OMG) https://www.omg.org/spec/ReqIF/
M&S (Modeling & Simulation):		
Functional Mock-up Interface (FMI)	Functional Mock-up Interface (Model Exchange and Co-Simulation) • Why it helps: Industry-standard for exchanging dynamic models (FMUs) and co-simulating across tools; widely adopted in automotive, aerospace, and control domains. For co-simulation, High Level Architecture (HLA) for distributed simulation.	Functional Mock-up Interface https://fmi-standard.org
High Level Architecture (HLA)	HLA is an IEEE standard used to maintain interoperability between distributed simulations at runtime. It does this by sharing a Federation Object Model (FOM) between the simulations. Space Mission Simulation uses the Space FOM, managed by the Simulation Interoperability Standards Organization (SISO).	Managing Body: https://www.sisostandards.org Publishing Body: https://standards.ieee.org/ieee/1516/6687/
ISO/ASTM 52900–52915	Modeling and simulation terminology and foundational concepts • Why it helps: Common vocabulary to improve cross-team communication; complements FMI/HLA usage.	International Organization for Standardization (ISO) https://www.iso.org/

* Extensible Markup Language (XML): XML is a simple, very flexible text format derived from Standard Generalized Markup Language (SGML), ISO 8879, Information processing — Text and office systems SGML. Originally designed to meet the challenges of large-scale electronic publishing, XML is also playing an increasingly important role in the interoperability of a wide variety of data on the Web and elsewhere.

8.1.5.4 Data Integrity

Programs/projects are formulated and implemented following various NASA directives through multi-disciplinary teams of engineers and other personnel, with systems engineers, program/project managers, and delegated Technical Authorities working across the other engineering disciplines to achieve integrated systems on schedule and within budget throughout the program/project lifecycle. (Refer to NIMA-RTP-002, Data Integrity in NASA Programs and Projects[3].)

A primary use of this data is for making informed decisions by individuals and teams, including decisions made at lifecycle reviews involving the evaluation of various aspects of the program/project. In each of the lifecycle phases and reviews, these multi-disciplinary teams work with a multitude of data related to the systems being developed, including requirements, verification requirements, test verification requirements, failure modes and effects, risks, hazards, and problem reports, among others, and are often linked to each other. In operations, the data becomes critical for determining the readiness of the systems, with the consequence of poor data integrity having potentially catastrophic effects, including loss of mission. DRDs will define the level of depth and detail needed, as well as how that information can be exchanged to ensure that integrity is enforced.

An associated use case would be in regard to the integrity of data if the Authoritative Source of Truth (ASoT) is the contractor system, where NASA should consider how long it wants to pay to have access to that data, versus the cost of taking receipt of the data from the contractor, management of data on NASA's side, and associated integrity issues with either option.

Two major forms of data integrity have been identified as follows:

a. Integrity of Data Relative to its Authoritative Source

   (1) Integrity of data relative to its authoritative source is defined by the information security domain as 'the property that data have not been changed, destroyed, or lost in an unauthorized or accidental manner'. In the context of NASA programs/projects, the most common and actionable form of this is the integrity of data relative to its authoritative source across and within a program/project.

   (2) The primary solution for improved data integrity is the use of information systems with change/configuration management functionality in addition to automating processes vs. manual processes of data integration and validation.

   (3) Automated Data Audits:

      A. Performing automated audits using information systems is a proven approach that has high utility and relatively low cost.

[3] The referenced white paper NIMA-RTP-002, Data Integrity in NASA Programs and Projects, traces requirements for data integrity to NASA Procedural Requirements and describes how data integrity is a critical factor for achieving integrity of the program's integrated design, as well as the readiness of the operational flight and ground data systems. It also provides data management lessons learned.

B. In the engineering realm, data audits can be performed daily or weekly to help drive convergence in design, and they can serve to ensure the integrity of the data that is used in baseline versions of a multitude of engineering artifacts. This can be done at the elemental level with a single piece of data, or at the composite level with multiple pieces of data.

b. Integrity of Data Relative to an ASoT

c. Integrity of data relative to an authoritative model is defined by the database systems domain as 'the property that data are an accurate reflection of the domain of discourse it is attempting to model'. In the context of NASA programs/projects, the most common and actionable form of this is the integrity of data relative to an ASoT.

d. Within programs/projects, authoritative sources exist for various types of data involving, in many cases, the use of various discipline-specific tools and varying instances of the same tool. To conduct integrated analyses and reviews using data from one or more disciplines or from one or more tools, data from authoritative sources need to be integrated. Existence of data discrepancies presents a program/project risk of incorrect decisions being made, inadequate integrity of the program/project integrated design being represented, or inadequate readiness of programs/projects and their associated systems being presented.

e. ASoTs of data exist, from a single piece of data relative to the model of a valid data type, range of data, or simple text rules (component data integrity), to more complex data involving multiple pieces of data relative to each other and an authoritative model (composite data integrity).

f. Lack of data integration of ASoTs has been identified as leading to cost and risk increases due to use of non-authoritative/out-of-date data, miscommunication of data, and missing data.

g. The primary solution for ensuring the accurate reflection of the system of interest, and to avoid the risk of duplicative or out of date information is the use of an ASoT or a federation of integrated ASoTs which support across the program/project lifecycle. With this approach, use of non-authoritative copies of data is minimized in addition to rates of engineering data discrepancies.

8.1.6 Data Rights and Accessibility

NASA will ensure access to technical data (recorded information used to define a design and to produce, support, maintain, or operate a system). This is critical to lifecycle sustainment of a system. Critical decisions made early in the acquisition process address data needs over the entire lifecycle of the system.

It is critical for the contractor to assess long-term data rights requirements and corresponding acquisition strategies, prior to initiating a response for a proposal to acquire systems, subsystems, or end items, to ensure they provide for rights, access, or delivery of technical data that the Government requires for systems' total lifecycle sustainment. Furthermore, the delivery of

technical data and associated rights should be reviewed, and documentation of the strategy of associated data planning should be addressed on NASA's side as well.

NASA will ensure science data is retrieved and accessible for open sharing. Science data products include datasets generated by the project that include the science data itself, associated ancillary data (e.g., aircraft navigation data, other metadata associated with the data gathering activities which may provide greater context to later findings). The contractor will summarize all science and mission-critical data products including schemas, affected systems, and associated documentation for correct and independent use of the data. The expected range of use supported by this documentation should be indicated. Some types of datasets that should be considered for inclusion are:

a. Metadata

b. Low-level processed data[4]

c. High-level processed data[5]

d. Scientific results

e. Science algorithm source code

f. Algorithm theoretical basic documents

g. Data quality documentation

h. Ancillary data types (e.g. audio, telemetry, video/imagery, commands, position/navigation/timing [PNT])

8.1.7 Proprietary Data and Intellectual Data Rights

NASA recognizes the right of suppliers to create and maintain a competitive advantage. However, NASA seeks access to or acquisition of relevant data for efficiency and safety reasons. Proprietary data and intellectual data rights should be addressed to the extent the contractor cannot label data as proprietary to avoid data sharing. NASA seeks to explore ways to access the necessary data while still respecting the legitimate intellectual property rights of the suppliers. This language is legal in nature and therefore approved language needs to be provided by Legal and Procurement once the DE data requirements are established.

8.1.8 Request for Proposal (RFP) Language

There are several areas of the RFP that need language to ensure program data acquisition downstream. In addition, creating a template that includes both prescriptive language and

[4] See the following link for definition of Data Processing Levels
https://www.earthdata.nasa.gov/learn/earth-observation-data-basics/data-processing-levels
[5] See the following link for definition of Data Processing Levels
https://www.earthdata.nasa.gov/learn/earth-observation-data-basics/data-processing-levels

guidance for organizations to describe their data and how they want to access it, allows the organization to customize their instructions to the potential offerors. Specific sections of the RFP include:

a. SOW – This is where the functional and technical requirements reside within the contract package, typically within Section C of the Government request package. The requirements will include the types of data the Government identifies for use throughout the life of the contract, how they want to access data, and the process of transferring the data at contract end. The Offeror provides this information in their proposal; however, the information may not be explicit in the contract but rather is contained within the DRD.

b. DRD – In this case the DRD is a template that requests details for the information that was requested in the SOW. It should be submitted with their proposal. The Offeror should provide the same approach to handling Data as they submitted in their proposal. This remains in the contract within the DRD.

c. Cost Volume – The cost of maintaining data in a centralized place, making it accessible to the Government, and then transferring the information at contract end has a price tag that is always more than expected. To get the best price, the cost should be set at contract start. To achieve this, the Offerors should submit their cost to the cost volume as a separate line item. This sets the cost at contract start because the cost volume is in the contract. This will be critical for fixed-price contracts.

8.1.9 Procurement Information Circular (PIC)

To have the data requirement pushed to all NASA procurements that have data requirements (e.g., not hardware or software purchases), a procurement information circular (PIC) needs to be put in place so all the Contracting Officers understand the need for the data language requirement. The PIC directs them to include it (if it requires data) in each Procurement. They will provide the requirement to the board chairs. The Contracting Officer will not be responsible for understanding the requirements or implementing them. That will be the responsibility of the chair/board member assigned to the action. A document with guidelines and the prescriptive language of how and when to use the data language will accompany the PIC.

8.1.10 Training

Each Center needs to appoint a point of contact from their Chief Information Officer's (CIO's) office who can work with the boards to guide them through the data needs assessment process. Each point of contact needs training on the process before working with the boards.

8.2 Contract Language for Data Management

Sections 8.2. 8.3, and 8.4 provide the technical context, considerations, and recommended approaches for developing acquisition requirements. The complete numbered Recommended Contract Language (RCL) is consolidated in Appendix A to provide a single authoritative location for selection and tailoring. Programs/projects should use the discussion in these sections

to determine which RCL statements are appropriate for the acquisition and then refer to Appendix A for the corresponding language.

This section contains each of the categories and requirements associated with Data Management in contracts. The intent is to choose each category and specific requirement(s) that applies to the contract's use of data. Contracts that have science or engineering as a core competency tend to use the data differently and have different requirements that need to be reflected in the SOW. The individual requirements found in these sections should be viewed as options to be selected as they apply to the contract and use them as appropriate to develop your SOW. New ways of thinking are needed about what it means to make a "delivery," to "receive" and/or "use" a model (or representation). This shift then needs to be properly reflected in the DRD clause to "release" a design and deal with ownership, change, and configuration control around complex data entities that are still actively being defined and do not behave like PDF files or drawings.

NASA should ensure that contractor data delivered to the appropriate NASA authoritative source (ideally an established Agency or institutional system) via the contract, and that DRDs specify data to be delivered in specified electronic data formats with specific data creation standards, in lieu of "contractor format acceptable" or similar language.

When NASA serves as systems integrator, engineering data will be shared with other engineering groups, including to and from primes, prior to formal engineering release. Additionally, vertical data movement (e.g., downward for requirements, upward for analysis results) needs to be considered as it supports decision-making but does not support the horizontal and diagonal flow of data, especially CAD and other specialized data. This highlights the question as to how to keep track of which version of the model was used and for what and ensure it is used by the right members of the team.

Contracts should specify the required delivered data transaction scope, data ownership, data delivery formats, metadata, naming standards, and data exchange standards. The definition of data formats and transaction sets should be independent of the method of access or delivery. Regardless of the format of acquired data, it is important to have the contractor mark data provided with less than unlimited rights with the appropriate legend as set forth in FAR 52.227-14, Alternates II and III. See the following sections for specific language for all contracts.

8.2.1 Digital Engineering (DE) Data Management Plan (DMP)

Recommended contract language for this topic is provided in Appendix A (RCL 1).

8.2.2 Data Rights[6]

Recommended contract language for this topic is provided in Appendix A (RCL 2-3).

8.2.2.1 Contract Language Requirement Statement

Recommended contract language for this topic is provided in Appendix A (RCL 4-5).

[6] Issuer's legal organization should be part of standard review process, including all specific binding language.

8.2.2.2 Flow Down of Requirements to Subcontractors:

Recommended contract language for this topic is provided in Appendix A (RCL 6).

Regarding FARs, government personnel preparing agreements (e.g., RFIs, SOWs, Performance Work Statement [PWS], etc.) need to understand the distinction between:

a. FAR parts and subparts that are guidance and direction to the Government and FAR Clauses, and

b. FAR Parts and Subparts incorporated by Reference, that are contractually binding upon the contractor and the Government.

Regarding the term "Data Rights," which is often used to refer to the Government's licensing rights in two major categories of valuable intellectual property:

a. Technical Data (TD) includes any recorded information of a scientific or technical nature (e.g., product design or maintenance data, and computer software documentation [CSD]).

b. Computer software (CS) includes executable code, source code, code listings, design details, processes, flow charts, and related material.

c. An Intellectual Property Strategy needs to be developed early to help program/project management to ensure that all TD, CS, and associated license rights required for procurement and sustainment of a system are available throughout the system's lifecycle.

d. Sustainment activities include re-bid/procurement, maintenance, repair, modifications or interfacing/interoperability activities, and upgrades or technology insertion.

e. A priced option may be used to address uncertainty regarding data deliverables or data rights that may be needed in the future but that are not ordered up front.

f. The deferred delivery clause (DFARS 252.227-7026, Deferred Delivery of Technical Data or Computer Software) and necessary contract data requirements lists (CDRLs) are used to delay delivery, when the specific data requirements are known, until the Government determines when the data deliverables should be provided.

g. The deferred ordering clause (DFARS 252.227-7027, Deferred Ordering of Technical Data or Computer Software) is used to delay the ordering of data generated in the performance of a contract until the Government determines what and when additional data is needed.

h. The Data Accession List is a useful tool to facilitate deferred ordering.

i. Data deliverables and data rights issues may be identified and resolved by:

j. Requiring Offerors to assert all restrictions on deliverable TD and CS – both commercial and noncommercial – up front, in their proposals,

k. Evaluating the data deliverables and data rights being offered, and

l. Negotiating for mutually agreeable special license rights where standard license categories do not meet both parties' needs.

The Government's license rights to a contractor's TD and CS generally depend upon the extent to which the Government funded the development of the technology, whether the technology is commercial or noncommercial, and any negotiations for mutually agreeable "special" license agreements. Some types of data qualify for Unlimited Rights (UR) regardless of development funding source such as "form, fit, and function (FFF) data" and data necessary for operation, maintenance, installation, and training (OMIT) purposes (excluding detailed manufacturing and process data).

The FAR clauses do not by default require delivery of TD or CS – the Government should include specific delivery requirements in each contract (refer to Table 4, Specific Contract Delivery Requirements). Mere access may not protect the Government's interests. If a product design (drawing or CAD model) is to be transferred to NASA, while unlimited rights does grant NASA the authority to modify the drawing or CAD model after delivery (reference FAR Clause 52.227-14), it may void the existing certification(s). Consider including FAR Clause 52.227-16 to ensure any data used throughout the contract that was not initially marked as a deliverable can be ordered for up to three (3) years after the close of the contract. Consider a priced option when needs for data delivery or data rights are uncertain.

Table 4—Specific Contract Delivery Requirements

Rights Category	Applies to These Types of TD or CS	Rights Criteria	Permitted Uses Within the Government	Permitted Uses by Third Parties Outside the Government[1]
Unlimited Rights (UR)	Noncommercial TD and CS	Developed exclusively at Government expense, and certain types of data (e.g., FFF, OMIT, CSD)	All uses; no restrictions	
Government Purpose Rights	Noncommercial TD and CS	Developed with mixed funding	All uses; no restrictions	For "Government Purposes" only; no commercial use[1]
Limited Rights (LR)	Noncommercial TD only	Developed exclusively at private expense	Unlimited; except may not be used for manufacture	Emergency repair or overhaul[1,2]
Restricted Rights (RR)	Noncommercial CS only	Developed exclusively at private expense	Only one computer at a time; minimum backup copies; modification[3]	Emergency repair/ overhaul; certain service/maintenance contracts[1,2]
Specifically Negotiated License Rights	Any/all TD and CS – including commercial TD and CS	Mutual agreement of the parties; use whenever the standard categories	As negotiated by the parties; however, should not be less than LR in noncommercial TD and should not be less that RR in noncommercial CS (consult with legal counsel as other limits apply)	

Rights Category	Applies to These Types of TD or CS	Rights Criteria	Permitted Uses Within the Government	Permitted Uses by Third Parties Outside the Government[1]
		do not meet both parties' needs		
SBIR Data Rights	Noncommercial TD and CS	All TD or CS generated under an SBIR contract	The equivalent of UR in OMIT and FFF data; the equivalent of LR in all other delivered TD; the equivalent of RR in CS	
Commercial TD License Rights	Commercial TD only	TD related to commercial items (developed exclusively at private expense)[4]	The equivalent of UR in OMIT and FFF data; the equivalent of LR in all other delivered TD	
Commercial CS Licenses	Commercial CS only	Any commercial CS or CS documentation	As specified in the commercial license customarily offered to the public[5]	

Notes:

[1] All third-party use under Government's license is subject to Government authorization. For rights categories other than UR, releases or disclosures to third parties should be accompanied by either the Non-Disclosure Agreement from 48 CFR § 227.7103-7, Use and Non-disclosure Agreement, or should occur under a contract containing 48 CFR § 252.227-7025, Limitations on the Use or Disclosure of Government-Furnished Information Marked with Restrictive Legends. A notice requirement also applies to releases of LR data and RR software.

[2] In addition to footnote 1, Non-Disclosure Agreement and notice requirements, all authorized Covered Government Support contractors with access to LR data or RR software should sign a Non-Disclosure Agreement directly with the owner of the data/software, if required by the owner.

[3] See 48 CFR § 252.227-7014(a), Rights in Noncommercial Computer Software and Non-commercial Computer Software Documentation, for more information.

[4] Commercial items are presumed to have been developed exclusively at private expense, except in the case of major systems [see 48 CFR § 227.7103-13(c)(2), Government Right to Review, Verify, Challenge, and Validate Asserted Restrictions, and 48 CFR § 252.227-7037(b), Validation of Restrictive Markings on Technical Data]. However, when the Government has paid for any portion of development, then the noncommercial TD clause (48 CFR § 252.227-7013, Rights in technical data - Noncommercial items) is used for TD pertaining to those portions, and the commercial TD clause 48 CFR § 252.227-7015, Technical data - Commercial items, is used for TD relating to the portions developed exclusively at private expense [48 CFR § 227.7103-6(a), Contract Clauses].

[5] Such licenses should be consistent with Federal procurement law and satisfy user needs.

8.2.3 Data Protection and Access

In the event the information resides in the contractor's system, recommended contract language for this topic is provided in Appendix A (RCL 7-14).

8.2.4 Data Requirements

8.2.4.1 Proprietary Formatted Data

RCLs 15-21 apply to data that is generated on a commercial off-the-shelf (COTS) solution or a custom-built application where the application's data format is proprietary to those systems.

Recommended contract language for this topic is provided in Appendix A (RCL 15-21).

8.2.4.2 Structured Digital Data from a Source Repository

RCLs 22-27 apply to digital data extraction from a source data repository provided in a computer-readable format that maintains the referential integrity of the data. The contractor should provide structured, computer-readable data, including all relationships between data, as follows in RCLs 22-27.

Recommended contract language for this topic is provided in Appendix A (RCL 22-27).

8.2.4.3 Document Formatted Data

Recommended contract language for this topic is provided in Appendix A (RCL 28-29).

It is critical to appropriately include examples of formats typical to the business area. RCLs 28-29 apply to documents created in text processing applications.

8.2.5 Metadata

Recommended contract language for this topic is provided in Appendix A (RCL 30-36).

8.2.6 Use of NASA Systems

The decision to require the contractor to use the NASA systems utilized by a program or project versus using the contractor systems and associated system/information governance is no longer just a question of cost savings or convenience of the government. Today the private sector can now provide the products and services which once could only be provided by NASA. Therefore, the nature of the contracts NASA is engaged in vary widely from ‘develop-and-deliver a widget’ to ‘deliver a NASA payload to another terrestrial body’. The information needed by NASA between the range of contract products and services also varies and should be well considered before writing the DRD requirements.

In the past, NASA took receipt of documents and drawings as DRD deliverables. However, in the modern digital engineering world, data, models, simulations, and digital twins are all connected via the flow of information across the lifecycle of the program/project by way of the digital thread. This digital thread, while providing capability never seen before, does complicate what NASA receives as a data deliverable and how it receives the data deliverable, while ensuring the digital thread is not broken and is made up of the latest baseline information.

Note: while a hybrid digital thread comprised of both NASA and contractor information systems is possible, the interoperability challenges and cybersecurity considerations tend to make this

option complicated and expensive. Therefore, depending on the contract type, careful consideration as to which system is primarily used should be taken, as well as limiting the hybrid nature of the resultant digital thread.

8.2.6.1 Direct Entry to NASA Systems

Recommended contract language for this topic is provided in Appendix A (RCL 37).

8.2.6.2 Upload (Manual Delivery) to NASA Authoritative Sources of Truth (ASoTs)

Recommended contract language for this topic is provided in Appendix A (RCL 38).

See Section 8.2.8.1, Artifact Metadata Linked to Bill of Materials (BOM), to address the importance of maintaining RCL 38 and associated complexities and costs which need to be considered and addressed in associated DRD requirements.

8.2.6.3 Use of NASA's Common Parts Library

Recommended contract language for this topic is provided in Appendix A (RCL 39-40).

8.2.7 Contractor Provided System Functionality

Data will be managed in/transmitted to NASA via one of the options in this section as defined in each DRD and RFP/SOW.

8.2.7.1 View Data in Contractor System

Recommended contract language for this topic is provided in Appendix A (RCL 41).

8.2.7.2 System-to-System Connection

Recommended contract language for this topic is provided in Appendix A (RCL 42).

8.2.7.3 Secured Transmittal

Recommended contract language for this topic is provided in Appendix A (RCL 43-44).

8.2.7.4 Search

The contractor must provide search criteria as stated in the SOW.

Recommended contract language for this topic is provided in Appendix A (RCL 45-55).

8.2.7.5 Browsing and Navigation

Recommended contract language for this topic is provided in Appendix A (RCL 56).

8.2.7.6 Viewing and Archiving Data

Recommended contract language for this topic is provided in Appendix A (RCL 57–65).

8.2.7.7 Stored Technical Data Packages (TDPs)

Recommended contract language for this topic is provided in Appendix A (RCL 66–72).

8.2.7.8 Computer-Aided Design (CAD) Management Within Contractor System

Recommended contract language for this topic is provided in Appendix A (RCL 73–74).

Programs/projects should work to define, agree with, and implement a CAD data management environment in which:

a. CAD (parts and assembly) models and associated data are managed and accessible within the contractor system.

b. Relationships between all associated CAD parts and assemblies are defined.

c. The ability to rename to-be-determined (TBD) items prior to release exists or, if late, falls under a change control board for traceability.

d. Structured check-in/checkout process and revision control ensure data integrity.

e. Workflow and automatic notification capabilities enable adoption of product development best practices.

8.2.7.9 Unpackaged Data

Recommended contract language for this topic is provided in Appendix A (RCL 75–77).

8.2.7.10 Workflow and Notifications

8.2.7.10.1 Notifications

Recommended contract language for this topic is provided in Appendix A (RCL 78–83).

8.2.7.10.2 Digital Signatures

Recommended contract language for this topic is provided in Appendix A (RCL 84).

8.2.7.10.3 Change Log

Recommended contract language for this topic is provided in Appendix A (RCL 85).

8.2.7.11 Administration and Other System Functions

Recommended contract language for this topic is provided in Appendix A (RCL 86).

8.2.7.11.1 Administration

Recommended contract language for this topic is provided in Appendix A (RCL 87–94).

8.2.7.11.2 User Profile Data

Recommended contract language for this topic is provided in Appendix A (RCL 95–102).

8.2.7.11.3 Authentication and Security

Recommended contract language for this topic is provided in Appendix A (RCL 103–110).

These restrictions will be managed through use of user profile data in section 8.2.7.11.2 of this Handbook.

8.2.7.11.4 Transfer of Data to [Identify Name] Systems

Recommended contract language for this topic is provided in Appendix A (RCL 111–117).

8.2.7.11.5 Retrieval of Current Data from [Identify Name] Systems

Recommended contract language for this topic is provided in Appendix A (RCL 118–122).

8.2.7.12 Non-Functional Requirements

Recommended contract language for this topic is provided in Appendix A (RCL 123).

8.2.7.12.1 Availability

Recommended contract language for this topic is provided in Appendix A (RCL 124–127).

8.2.7.12.2 Flexibility

Recommended contract language for this topic is provided in Appendix A (RCL 128–129).

8.2.7.12.3 Software Integration

Recommended contract language for this topic is provided in Appendix A (RCL 130).

8.2.7.12.4 Platforms

Recommended contract language for this topic is provided in Appendix A (RCL 131).

8.2.7.12.5 Security

Recommended contract language for this topic is provided in Appendix A (RCL 132–134).

8.2.7.12.6 Network

Recommended contract language for this topic is provided in Appendix A (RCL 135–139).

8.2.7.12.7 Integrity

Recommended contract language for this topic is provided in Appendix A (RCL 140–141).

8.2.7.12.8 Scalability

Recommended contract language for this topic is provided in Appendix A (RCL 142–144).

8.2.8 Contractor Provided Information By Domain

8.2.8.1 Artifact Metadata Linked to Bill of Materials (BOM)

The intent of artifact management is to define a structured way via a PLM to properly associate data with the correct level of the BOM. The associated metadata which creates the BOM association should be 'attached' to the artifact so the connection to the associated information and models are available without having to open up the artifact to understand the BOM association.

When data, information, and models move from one system to another, often this linkage is lost and largely hampers the existence and usability of the digital thread and thus should be carefully assessed throughout regarding requiring the contractor to use the NASA system, and/or the cost of using the contractor's system and all that is required to retain artifact linkage to the BOM when moved/delivered into the NASA system.

8.2.8.2 Requirements

Recommended contract language for this topic is provided in Appendix A (RCL 145).

Requirements management in a model-based program/project environment provides a framework for defining, refining, documenting, and maintaining the requirements of the product(s) produced by the program/project.]

Program/project requirements are defined and documented by the program/project's systems engineering and integration functions, or their designees, and documented in the Systems Engineering Management Plan in accordance with NPR 7123.1.

Requirements should be defined in the DRD and should:

a. Allocate requirements to various program/project organizations for decomposition.

b. Define the relationship of requirements to other information in the DE environment.

c. Provide the framework for requirement derivation and a scheme for parent and child requirement relationships.

d. Provide links for access to authoritative requirement information.

e. Allow the definition and management of detailed information attached to the requirement, such as margins, technology readiness levels, risks, and cost data.

f. Be traceable to its source, downstream to its implementing product component, and verify and validate activity.

g. Be securely controlled and traceable from beginning to end of life (history and use).

h. Be captured in a virtual database that provides secure but easy access. Requirements management tools should provide automatic notification of requirement changes and impact to flow-down or linked requirements.

8.2.8.3 Computer-Aided Design (CAD) Data (Mechanical Computer-Aided Design [MCAD]/ Electronic Computer-Aided Design [ECAD]/Computer-Aided Engineering [CAE]/Computer-Aided Manufacturing [CAM]/Additive Manufacturing [AM])

Effective CAD data management enables immediate access to needed PDI but should define relationships between all associated CAD parts and assemblies. CAD management of MCAD, ECAD, and computer-aided manufacturing (CAM) parts and assemblies should include management of systems and software across the entire program/project lifecycle. For naming standards see ASME Y14.100. For additional CAD definition standards see ASME Y14.47. For additional CAD data it is recommended to review NASA-HDBK-7009.

Items to be considered while defining the DRD requirements with managing CAD:

a. Complete CAD information (all CAD objects come with CAD data packages).

b. CAD naming — to avoid naming conflicts (multiple names for the same parts) it is recommended that CAD model names be automatically assigned by the PLM. However, if a project wishes to have a specific naming convention, it needs to be well defined, and the guidance placed on contract at the beginning.

c. Change management — a critical capability to manage the change to the project baseline and easily facilitated by PLMs.

d. Data conversion — CAD models are converted to a defined standard for consistency (see Section 8.1.5 Data **Error! Reference source not found.** Process).

e. CAD links when moved manually — links and relationships are retained when CAD files are manually moved from one system to another, otherwise they are broken resulting in a loss of traceability.

f. Consistent CAD and model version/revision control between Contractor and NASA system, or within either depending on the contract agreement. Renumbering may be needed if contractor makes a significant change from NASA-provided model with linkage back to original model as appropriate.

g. Lightweight viewing of CAD models via a neutral file format which do not require any specialty software to view the contents, as agreed to by NASA. Note: Proprietary formats such as Creo View may be considered, depending on availability of free viewers with the needed capabilities.

h. Model-based manufacturing files (CAM/AM) – Any hardware fabricated using model-based methods should be delivered for configuration purposes as well as potential reuse for downstream repeat manufacturing. This includes CAM models, CNC output files, and/or Additive Manufacturing (AM, a.k.a. 3D-printing) digital files (e.g. STL, AMF, or 3MF).

i. Levy modeling standards as a DRD to ensure consistent adherence.

j. Design intent captured and shared.

8.2.8.4 Modeling And Simulation (M&S)

Results from modeling and simulation (M&S) are rich data used daily for making critical decisions in design, development, manufacturing, ground operations, and flight operations. The program/project manager and delegated Technical Authority (or Authorities) have the responsibility of ensuring the credibility of the results from these M&S activities (reference NASA-STD-7009, Standard for Models and Simulations, and NASA-HDBK-7009, NASA Standard for Models and Simulations: An Implementation Guide for NASA-STD-7009). Models and resulting simulations fall under the governance of the DRD to ensure all parties are working with the latest common data.

Confidence in M&S results is achieved by and should be factored in when writing DRD requirements for a contract:

a. Identification of best practices to ensure that knowledge of operations is captured in the user interfaces (e.g., users are not able to enter parameters that are out of bounds).

b. Development of processes for tool verification and validation, certification, re-verification, revalidation, and recertification based on operational data and trending.

c. Development/identification of standards for documentation, CDM, and quality assurance.

d. Identification of any training or certification requirements to ensure proper operational capabilities.

e. Development/identification of a plan for tool management, maintenance, and obsolescence consistent with modeling/simulation environments and the aging or changing of the modeled platform or system.

f. Development of a process for user feedback when results appear unrealistic or defy explanation.

b. Development of a standard method to assess the credibility of M&S presented to the decision-maker when making critical decisions (i.e., decisions that affect human safety or mission success) using results from M&S.

g. Assurance that the credibility of M&S meets the project requirements, and the appropriate documentation is captured and preserved.

h. Reinforced verification and validation models and practice.

8.2.8.5 Large-Language Friendly Tables and Tabulated Data

To fully utilize the capabilities of a Large Language Model (LLM), presenting information in a data file or a table requires it to be organized in particular approaches, with clarity, consistency, and structure for maximum readability by the LLM. Here are some best practices which should be used when defining data DRD requirements:

a. Use Simple, Clear Formatting

(1) Use plain text or Markdown tables.

(2) Avoid merged cells, nested tables, or complex formatting.

(3) Keep one row per record; one column per variable.

b. Add Clear and Consistent Headers

(1) Use descriptive, unambiguous column headers.

(2) Avoid abbreviations unless defined.

c. Be Consistent with Data Types

(1) Use the same data type within each column (all numbers, all text, etc.).

(2) Represent missing values clearly (e.g., use ‘N/A’ or ‘-’).

d. Avoid Special Characters and Symbols

(1) Stick to standard American Standard Code for Information Interchange (ASCII) characters.

(2) Avoid using emojis, images, or unusual symbols within table data.

e. Provide Context

f. Precede the table with a brief description of what the table contains.

(1) If using abbreviations, provide a legend or footnote below the table.

(2) For complex data (e.g., multi-level headers), simplify wherever possible or explain the structure before the table.

g. Use Markdown (Preferred for LLMs)

(1) Markdown is widely supported and easy to parse:

```markdown
| Name    | Age | Occupation   |
|---------|-----|--------------|
| Alice   | 30  | Engineer     |
| Bob     | 25  | Data Analyst |
| Charlie | 28  | Teacher      |
```

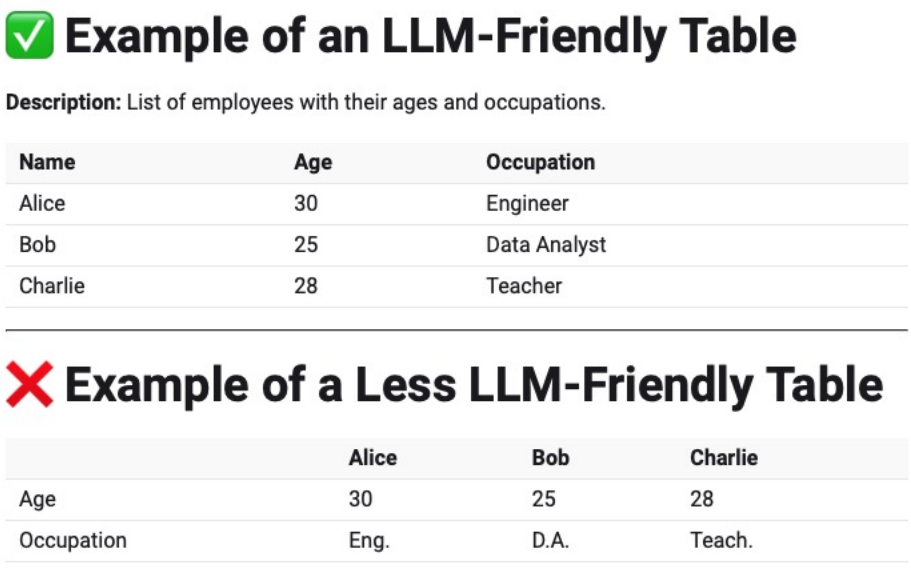
h. Keep Tables Manageable

(1) If the table is very large, consider splitting it into smaller logical sections.

(2) For very long tables, provide a sample and offer the full table as a downloadable file.

i. Avoid Vertical Text or Rotated Headers

(1) All text should be left-to-right and horizontally aligned.



✅ **Example of an LLM-Friendly Table**

Description: List of employees with their ages and occupations.

Name	Age	Occupation
Alice	30	Engineer
Bob	25	Data Analyst
Charlie	28	Teacher

❌ **Example of a Less LLM-Friendly Table**

	Alice	Bob	Charlie
Age	30	25	28
Occupation	Eng.	D.A.	Teach.

Figure 2—Examples of a LLM-friendly formatted table and one less-LLM friendly

8.2.9 NASA Earth Science Contract Considerations

For ongoing NASA Earth science contracts, continue to use the following guidance:

a. NASA will plan and follow data acquisition policies that ensure the collection of long-term datasets needed to satisfy the research requirements of NASA's Earth science program.

b. NASA commits to the full and open sharing of Earth science data obtained from NASA Earth-observing satellites, sub-orbital platforms, and field campaigns with all users as soon as such data become available.

c. There will be no period of exclusive access to NASA Earth science data. Following a post-launch checkout period, all data will be made available to the user community. Any variation in access will result solely from user capability, equipment, and connectivity.

d. NASA will make available all NASA-generated standard products along with the source code for algorithm software, coefficients, and ancillary data used to generate these products.

e. All NASA Earth science missions, projects, grants, and cooperative agreements should include DMPs to facilitate the implementation of these data principles.

f. NASA will enforce a principle of non-discriminatory data access so that all users will be treated equally. For data products supplied from an international partner or another agency, NASA will restrict access only to the extent required by the appropriate Memorandum of Understanding (MOU).

8.3 Contract Language for Data Acquisition and Interoperability

8.3.1 Data Acquisition

This section provides guidance for ensuring that NASA provides data acquisition requirements to enable the reference and reuse of data through a program/project's full lifecycle.

Data acquisition requirements should be initially presented during RFP/RFQ development to establish integrated data architecture for a program/project's information systems architecture, data architecture, and information systems capability roadmap. The ability to meet data interoperability requirements should be a part of the contract performance metrics on which the contractor has to report and be evaluated throughout contract execution. This recommended contract language should be applied to the Center's DPDs.

The following contract language is categorized based on the type of data interoperability being performed.

NOTE: NASA should drive the proposing contractor to use COTS software solutions and industry standard file formats and data exchange protocols whenever possible and cost effective, or in the Governments best interest versus a custom, bespoke proprietary solution.

Also included is contract language pertaining to metadata and data transmittal:

a. Proprietary Formatted Data includes data that is generated on a COTS or custom-built application where the application's data format is proprietary to those systems. The contractor should provide or deliver the following:

(1) A definition of the application and version that produced the file.

(2) The native proprietary file itself.

(3) A commonly readable representation of the file (JPEG, JPG, PNG, or machine-readable PDF/A).

(4) The application (source code and executable), with the concurrence of the NASA Contracting Officer's Representative, required to read the native file format for file types where there is no commonly readable representation of the file.

(5) OMG, 2D/3D formats, videos, neutral and/or 3D PDF files.

b. Structured Digital Data from a Source Repository is digital data extraction from a source data repository provided in a computer-readable format that maintains the referential integrity of the data. Recommended contract language for this topic is provided in Appendix A (RCL 146).

c. Document-Formatted Data describes documents created in established text-processing applications. Document data should be delivered in digital form in one of the following formats:

(1) Text-searchable (machine-readable) PDF (rather than scanned PDF).

(2) Microsoft® Word® and Microsoft® Excel® files.

(3) Other commonly readable format (e.g., .txt or .rtf) approved by NASA.

d. Metadata describes the contents of digital files. Metadata should be defined in a computer-readable data format to support automation and facilitate data interoperability.

(1) Descriptive metadata describes an information resource for identification and retrieval through elements such as title, author, and abstract.

(2) Structural metadata documents relationships within and among objects through elements such as links to other components (e.g., how pages are put together to form chapters).

(3) Administrative metadata helps to manage information resources through elements such as version number, archiving date, and other technical information for purposes of file management, rights management, and preservation.

(4) Metadata should be cataloged and published for reuse by all program/project teams to facilitate proper data interoperability.

(5) Acceptable metadata formats include:

A. CSV format

B. XML format

C. Other fully documented, standards-based format approved by NASA such as embedded PDF/A documents

(6) Metadata should be delivered with the file to which it is related and reference the filename or other identifying features (e.g., timestamp).

(7) The contractor should apply ISO 10303-233, Industrial automation systems and integration - Product data representation and exchange - Part 233: Application protocol: Systems engineering, as a foundation for defining common system engineering metadata.

(8) The contractor should apply ISO 10303-239, Industrial automation systems and integration - Product data representation and exchange - Part 239: Application protocol: Product lifecycle support, for common systems engineering metadata.

(9) Metadata used during a program/project phase should be defined more than 90 days prior to its first use.

e. Transmittal of data should be via one of the following options below; the data transmission method should be defined in each DRD and SOW/PWS:

(1) View data in contractor systems should support viewing data within the contractor's electronic system in a format readable by a standard NASA workstation or otherwise approved by NASA. This action will be deemed as a delivery of data in place, and such data will be maintained within the contractor's system.

(2) Direct entry to NASA's system should include direct user entry of data into a NASA-owned system, including fields, values, or other information as required by the NASA system.

(3) Upload to NASA file repository should include uploading files, whether document-formatted data or structured data (e.g., SQL output), and completing any associated data as required by the formats (above) and the file repository, including Center, program/project, or other specific repository specified in the DRD.

(4) A system-to-system connection should provide an automated capability to pass computer-readable data between a contractor and NASA system, across contractor and NASA firewalls, via one of several mechanisms, including, but not limited to:

A. REST API for digital data delivery via Internet-based communication (data defined by either a NASA or contractor standard data exchange format).

B. SOAP API for digital data delivery via Internet-based communication.

C. Fully documented, standards-based API supported by contractor tools approved by NASA.

f. The contractor should encrypt sensitive information during transmission.

(1) The contractor should utilize the National Institute of Standards and Technology (NIST) 800 Series Publications and FIPS PUB 140-3, Security Requirements for Cryptographic Modules, to meet data encryption requirements.

8.3.2 Data Interoperability

Section 6 establishes NASA's guiding principles for data-centric acquisition and interoperability. Rather than repeat those principles here, this section provides recommended acquisition language and implementation considerations for applying them in RFPs, SOWs/PWSs, DRDs, and other acquisition documents, as appropriate.

To allow for data interoperability, program/project managers and delegated NASA Technical Authorities should ensure that contractor data delivered to authoritative sources are acquired through the contract and that DRDs specify data to be delivered in specified digital data formats in lieu of the not-recommended "contractor format acceptable" or similar language:

a. Contracts should specify the required delivered data transaction scope, data delivery formats, metadata, naming standards, and data interoperability standards. The definition of data formats and transaction sets should be independent of the method of access or delivery.

b. Regardless of the format of acquired data, the contractor should mark any data provided with less than unlimited rights with the appropriate legend as set forth in FAR 52.227-14, Alternates II and III, Rights in Data — General.

c. Contractors should obtain approval from the NASA Contracting Officer for all proposed contractual deviations from existing data standards and specifications.

Program/project managers and delegated Technical Authorities should ensure that data is acquired with sufficient access and usage rights to support the full range of program/project needs. This includes, but is not limited to, the following:

a. The need for data to be used by organizations outside NASA (e.g., support contractors and companies bidding on new procurements).

b. In instances when NASA acquires data with less than unlimited rights, the impact to the full program/project is to be assessed.

c. The Contracting Officer and the cognizant legal office should be consulted to develop a strategy to mitigate any adverse impacts associated with limited or restricted data rights.

d. Program/project managers and delegated Technical Authorities should include language in the statement of work to address the marking of data (e.g., “The contractor should determine the data restriction that applies to each data deliverable and mark or transmit the data restriction in accordance with section X.X of the DPD.”).

If a NASA-/Center-level common vocabulary, common program/project data dictionary, or common namespace standard exists, then the contract should ensure that developed solutions use these common architecture elements. If any of these do not already exist for the current program/project, incrementally define a:

a. Common vocabulary to support each phase of the program/project lifecycle as exit criteria for a program/project lifecycle phase.

b. Common program/project data dictionary to support each phase of the program/project lifecycle. This activity should be performed as program/project phase exit criteria to support the startup of the next phase.

c. Common namespace standards to support each phase of the program/project lifecycle as exit criteria for a program/project lifecycle phase.

8.4 Recommended Configuration and Data Management (CDM) Statement of Work (SOW) Sections for Contracts (DRDs To Be Referenced/Added As Required)

8.4.1 CDM001 - Configuration and Data Management

8.4.1.1 Configuration and Data Management Planning

Recommended contract language for this topic is provided in Appendix A (RCL 147–151).

8.4.1.2 Configuration and Data Identification

Recommended contract language for this topic is provided in Appendix A (RCL 152–154).

8.4.1.3 Configuration and Data Baselines

Recommended contract language for this topic is provided in Appendix A (RCL 155).

8.4.1.4 Configuration and Data Control

Recommended contract language for this topic is provided in Appendix A (RCL 156–163).

8.4.1.5 Configuration Status Accounting (CSA)

Recommended contract language for this topic is provided in Appendix A (RCL 164–166).

8.4.1.6 Configuration and Data Audits

Recommended contract language for this topic is provided in Appendix A (RCL 167–175).

The [Enter Center] CDM Representative(s) will audit the contractor's and its suppliers' processes to ensure that each organization is compliant with the CDM requirements of the contract and that the configuration baselines are correctly defined, controlled, accounted for, and verified, and any required corrective actions resulting from CDMPAs are implemented.

8.4.1.7 Interface Control

Recommended contract language for this topic is provided in Appendix A (RCL 176–184).

Note to Offeror: NASA [Enter Center] expects to manage the system interface design process through the Interface Control Working Group (ICWG) forum or prior agreed-to process.

Whenever possible, the contractor is encouraged to liaise directly with third party contractors and use the ICWG forum for final agreement or dispute resolution.

The parties, Offeror and Tenderer, agree to bear their own costs arising out of any level of effort in excess of the expected ICWG level of effort detailed in RCL 184.

8.4.1.8 General

Recommended contract language for this topic is provided in Appendix A (RCL 185–197).

RCL 185-197 apply without limitation to every end item of the contractor delivery to the Government under this contract regardless of whether or not such item is a COTS item, catalog item, build-to-print item, contractor-designed item, Government-designed item, or any combination thereof. As a result, the contractor is responsible for and these requirements apply without limitation to any and all items, parts, assemblies, COTS items, catalog items, or any combination thereof, etc., that the contractor may include in the end item it delivers to the Government under this contract.

8.4.2 CDM002 - Configuration and Data Management – Components

Recommended contract language for this topic is provided in Appendix A (RCL 198–206).

Reference Only

The following DRDs are cited in the above clauses and thereby form part of these contractual requirements:

a. STD-CDMP

b. STD-CR

c. STD-CSA

d. STD-AD

e. STD-CDMPA

8.5 CONCLUSION

Programs/projects should use the acquisition planning, tailoring, and recommended contract language in this Handbook to address data integrity, access, interoperability, protection, and transfer in a manner appropriate to the specific acquisition. The selected approach should be coordinated across relevant technical, acquisition, legal, security, and data-management organizations.

NASA should acquire the minimum essential contractor-originated data needed to support lifecycle objectives and should document the rationale for contract data deliveries. Integrated planning across functional disciplines can reduce redundant or inconsistent data requirements and improve reuse of authoritative data.

Because contracts vary substantially in scope, product, service, risk, and acquisition strategy, the guidance and templates in this Handbook should be tailored to the nature of the acquisition so that NASA obtains needed information without imposing unnecessary data-delivery cost or burden.

APPENDIX A: RECOMMENDED CONTRACT LANGUAGE (RCL) AND SELECTION MATRIX

A.1 PURPOSE

The Recommended Contract Language Selection Matrix identifies the RCL provided in this Handbook and may be used by programs/projects to document which provisions are selected for a specific acquisition. Enter "Yes" when an RCL provision is selected and "No" when it is not. Use the "Comments" column to document tailoring, application instructions, or the rationale for not selecting a provision. The phrase "insert requirements language" is provided as a stand-in for the terms "shall", "should", and "will". When tailoring the RCL to a specific acquisition, programs/projects may add the term best suited to their needs.

Table A-1—Recommended Contract Language Selection Matrix

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Section	**Description**	**Recommended Contract Language (RCL)**	**Selected (Enter Yes or No)**	**Comments**
6.2.1	**Digital Engineering (DE) Data Management Plan (DMP)**	[RCL 1] The contractor [insert requirements language] provide a DE Data Management Plan (DMP) to be approved by the Government for all contracts requiring data deliverables.		
6.2.2	**Data Rights**	[RCL 2] NASA [insert requirements language] obtain and maintain appropriate data rights for all data produced by the contractor to be provided to NASA during and at Contract end.		
6.2.2	**Data Rights**	[RCL 3] NASA [insert requirements language] address intellectual property rights on an individual basis in conjunction with Procurement and Legal Offices.		
6.2.2.3	**Contract Language Requirement Statement**	[RCL 4] NASA owns the rights to all data and records produced as part of this contract. All deliverables under the contract are the property of the U.S. Government for which NASA [insert requirements language] have unlimited rights to use, dispose of, or disclose such data contained therein as it determines to be in the public interest.		

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Section	**Description**	**Recommended Contract Language (RCL)**	**Selected (Enter Yes or No)**	**Comments**
6.2.2.3	**Contract Language Requirement Statement**	[RCL 5] Any contractor rights in the data or deliverables [insert requirements language] be identified as required by 48 CFR § 52.227-11, Patent Rights-Ownership by the contractor; 48 CFR § 52.227-12, Reserved; 48 CFR § 52.227-13, Patent Rights-Ownership by the Government; 48 CFR § 52.227-14, Alternates II and III, Rights in Data — General; 48 CFR § 52.227-15, Representation of Limited Rights Data and Restricted Computer Software; 48 CFR § 52.227-16, Additional Data Requirements; 48 CFR § 52.227-17, Rights in Data-Special Works; 48 CFR § 52.227-18, Rights in Data-Existing Works; 48 CFR § 52.227-19, Commercial Computer Software License; and 48 CFR § 52.227-20, Rights in Data-SBIR Program.		
6.2.2.4	**Flow Down of Requirements to Subcontractors**	[RCL 6] The contractor [insert requirements language] incorporate the substance of this clause, its terms and requirements including this paragraph, in all subcontracts under this [contract vehicle], and require written subcontractor acknowledgment of the same. Violation by a subcontractor of any provision set forth in this clause will be attributed to the contractor.		
6.2.3	**Data Protection and Access**	[RCL 7] The contractor [insert requirements language] provide secure storage and protection of the data, information, and knowledge that have been developed by the contract, including historical data. All data will be backed up every 30 days at a minimum with data backup retentions for [X] months.		
6.2.3	**Data Protection and Access**	[RCL 8] The contractor [insert requirements language] provide access to the data, information, and knowledge that have been developed by the contract, including historical data, to the Government throughout the life of the contract and at the termination of the contract. [State the requirement].		
6.2.3	**Data Protection and Access**	[RCL 9] The contractor [insert requirements language] ensure that information is collected in a way that supports downstream processing, and that systems are built to support interoperability and information accessibility, including regular access or exporting of the data as a standard requirement of such systems.		
6.2.3	**Data Protection and Access**	[RCL 10] The contractor [insert requirements language] provide public access to the data [state the requirement] as approved by the Government. The contractor will use the approved internal clearance processes established by the agency OCIO in compliance with the Open Data Policy-Managing Information as an Asset (M-25-05).		
6.2.3	**Data Protection and Access**	[RCL 11] The contractor [insert requirements language] provide the capability to support [state the number or classification] users. The access includes [define access, usage, and storage capacity].		

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Section	**Description**	**Recommended Contract Language (RCL)**	**Selected (Enter Yes or No)**	**Comments**
6.2.3	**Data Protection and Access**	[RCL 12] Any contractor-developed applications, funded by the Government, [insert requirements language] be owned by NASA and fully transferable, including source code and documentation, to a new vendor at the end of this contract as deemed necessary by the Government.		
6.2.3	**Data Protection and Access**	[RCL 13] The contractor and Government will meet [state the number] days prior to the end of the contract to determine the schedule for transferring the data, information, and knowledge to the Government. At the end of the contract, all data, information, and knowledge [insert requirements language] be transferred to the Government.		
6.2.3	**Data Protection and Access**	[RCL 14] The contractor [insert requirements language] protect all data produced by the contract in accordance with the IT security policies and procedures in NASA Policy Directive (NPD) 2810.1, NASA Information Security Policy.		
6.2.4.1	**Proprietary Formatted Data**	[RCL 15] The contractor [insert requirements language] obtain approval from NASA for the use of a custom-built application, a COTS solution which stores the information in a proprietary format, or a modified COTS solution.		
6.2.4.1	**Proprietary Formatted Data**	[RCL 16] The contractor [insert requirements language] provide justification as to why there is no other cost-effective alternative and/or why the recommended proprietary solution is in the best interest of the Government.		
6.2.4.1	**Proprietary Formatted Data**	[RCL 17] The contractor [insert requirements language] provide a definition of the application and version that produced the file.		
6.2.4.1	**Proprietary Formatted Data**	[RCL 18] The contractor [insert requirements language] provide the native proprietary file itself.		
6.2.4.1	**Proprietary Formatted Data**	[RCL 19] The contractor [insert requirements language] provide a commonly readable representation of the file approved by the Government [Agency] (e.g., Joint Photographic Experts Group [JPEG, JPG], Portable Network Graphics [PNG], Comma-Separated Value [CSV], STEP, XMI etc.).		
6.2.4.1	**Proprietary Formatted Data**	[RCL 20] The contractor [insert requirements language] validate the integrity of data if a conversion is required to provide a commonly readable representation of the file.		
6.2.4.1	**Proprietary Formatted Data**	[RCL 21] The contractor [insert requirements language] deliver the application (source code and executable) required to read the native file format for file types where there is no commonly readable representation of the file, and with the concurrence of the NASA Contracting Officer's Representative.		

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Section	**Description**	**Recommended Contract Language (RCL)**	**Selected (Enter Yes or No)**	**Comments**
6.2.4.2	**Structured Digital Data from a Source Repository**	[RCL 22] The contractor [insert requirements language] manage the associated project information in an architecture that complies with the applicable NASA IT Standards and enables digital data sharing within NASA Agency domains, [state the specific standard] (e.g., W3C XML, W3C Namespaces for XML, and W3C XML Schema for XML data).		
6.2.4.2	**Structured Digital Data from a Source Repository**	[RCL 23] The contractor [insert requirements language] respond to Government requests for data items via [state specific formats] (e.g., W3C XML, W3C, XML Namespaces, W3C XML Schema, and Object Management Group [OMG] XML Metadata Interchange (XMI) for Models for XML data).		
6.2.4.2	**Structured Digital Data from a Source Repository**	[RCL 24] The contractor [insert requirements language] ensure digital data descriptions are usable, and all producers and consumers of digital data [insert requirements language] reference a common data dictionary as defined by NASA for standard [state type/domain/discipline] data. If a NASA standard is not applicable or available, digital data should reference a common data dictionary as defined by the contractor and approved by NASA.		
6.2.4.2	**Structured Digital Data from a Source Repository**	[RCL 25] The contractor [insert requirements language] ensure a database output format is provided based upon widespread industry usage (e.g., Structured Query Language [SQL] output).		
6.2.4.2	**Structured Digital Data from a Source Repository**	[RCL 26] The contractor [insert requirements language] ensure structured database output files include the database type and version (e.g., MySQL, version 5.5.1).		
6.2.4.2	**Structured Digital Data from a Source Repository**	[RCL 27] The contractor [insert requirements language] provide computer-readable definitions of record structure (schema) for both XML and database output formats.		
6.2.4.3	**Document Formatted Data**	[RCL 28] The contractor [insert requirements language] ensure data delivered in digital form is provided in text-searchable Portable Document Format/Archivable (PDF/A) (rather than scanned or raster PDF), or native Microsoft® Word® and Microsoft® Excel® files [state any other formats].		
6.2.4.3	**Document Formatted Data**	[RCL 29] The contractor [insert requirements language] obtain NASA approval prior to digital data delivery of an item not meeting standard formats listed above (e.g., scanned PDF, text file [.txt], rich text format [.rtf], etc.).		
6.2.5	**Metadata**	[RCL 30] Metadata [insert requirements language] be defined in a machine-readable data format to support automation and to facilitate data exchange. Metadata [insert requirements language] be cataloged and published for reuse by all program teams to facilitate proper data exchange.		

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Section	**Description**	**Recommended Contract Language (RCL)**	**Selected (Enter Yes or No)**	**Comments**
6.2.5	**Metadata**	[RCL 31] The contractor [insert requirements language] ensure metadata is based on latest NASA-approved industry standard such as, but not limited to, CSV or XML format and consistent with requirements defined in the Structured Digital Data section.		
6.2.5	**Metadata**	[RCL 32] The contractor [insert requirements language] obtain NASA approval for fully documented, standards-based formats not listed above (e.g., embedded PDF documents).		
6.2.5	**Metadata**	[RCL 33] The contractor [insert requirements language] ensure metadata is delivered with the file to which it is related and will reference the filename or other identifying features (e.g., timestamp).		
6.2.5	**Metadata**	[RCL 34] The contractor [insert requirements language] apply the International Standards Organization (ISO) 10303-233, Industrial automation systems and integration - Product data representation and exchange - Part 233: Application protocol: Systems engineering, as a foundation for defining common program metadata.		
6.2.5	**Metadata**	[RCL 35] The contractor [insert requirements language] apply the International Standards Organization (ISO) 10303-239, Industrial automation systems and integration - Product data representation and exchange - Part 239: Application protocol: Product lifecycle support, for common systems engineering metadata.		
6.2.5	**Metadata**	[RCL 36] The contractor [insert requirements language] ensure metadata used during a program phase is defined 90 days prior to its first use.		
6.2.6.1	**Direct Entry to NASA Systems**	[RCL 37] The contractor [insert requirements language] enter data directly into a NASA-owned system, including mandatory fields, values, or other information as required by the NASA system.		
6.2.6.2	**Upload (Manual Delivery) to NASA Authoritative Sources of Truth (ASoTs)**	[RCL 38] The contractor [insert requirements language] upload files, whether document-formatted data, or structured data (e.g., SQL output), and fill any associated data as defined by the required formats and the file repository, including Center, project, or other repository as specified in the DRDs.		
6.2.6.3	**Use of NASA's Common Parts Library**	[RCL 39] The contractor [insert requirements language] use the NASA Common Parts Library whenever appropriate or in NASA’s best interest as these parts have been certified and tested by NASA and thus reduce new-development design, schedule and budget risk.		
6.2.6.3	**Use of NASA's Common Parts Library**	[RCL 40] The contractor [insert requirements language] show traceability back to the NASA Common Part Library part/model.		

NASA-HDBK-1004				
Section	**Description**	**Recommended Contract Language (RCL)**	**Selected (Enter Yes or No)**	**Comments**
6.2.7.1	**View of Data in Contractor System**	[RCL 41] The contractor [insert requirements language] support the viewing of data within the contractor's electronic system in a html-based format readable by a web browser on a standard Government workstation or otherwise approved by NASA. This action will be deemed as a delivery of data in-place, and such data will be maintained within the contractor's system.		
6.2.7.2	**System-to-System Connection**	[RCL 42] The contractor [insert requirements language] provide an automated capability to pass computer-readable data between a contractor and NASA system to enable automated delivery of data items in the desired formats, locations, and associated metadata (e.g., object's release state, material properties, etc.) and across contractor and Agency firewalls, via one of several mechanisms including: c. Representational State Transfer (REST), Application Programming Interface (API) or Web APIs (interface defined mutually by NASA and contractor). a. APIs supported by middleware, e.g., Simple Object Access Protocol (SOAP) API. b. Fully documented standards-based API supported by contractor tools to be approved by NASA.		
6.2.7.3	**Secured Transmittal**	[RCL 43] The contractor [insert requirements language] encrypt sensitive information during transmission (in transit).		
6.2.7.3	**Secured Transmittal**	[RCL 44] The contractor [insert requirements language] utilize the Government standards (NIST 800 Series Publications) to meet data encryption requirements.		
6.2.7.4	**Search**	[RCL 45] The contractor [insert requirements language] prevent the public from searching and gaining access to controlled content.		
6.2.7.4	**Search**	[RCL 46] Keyword-based search, similar to widely available web-based search engines, [insert requirements language] retrieve the term entered where found among the metadata and unpackaged data.		

NASA-HDBK-1004				
Section	**Description**	**Recommended Contract Language (RCL)**	**Selected (Enter Yes or No)**	**Comments**
6.2.7.4	**Search**	[RCL 47] The contractor [insert requirements language] ensure the following search functions are available [choose as required]: d. The system search function will support the use of wild cards, case sensitivity selection, and phrase definition (i.e., the use of quotations around multi-word phrases to specify that the words in the phrase collectively constitute a single search term). a. The system will support the use of Boolean operators (AND, OR, NOT) to allow the user to search based on multiple criteria. b. The system will index and return the contents of attached text-searchable documents (based on the indexers available for various document types). e. The system will provide a field-based filter that returns all the records that contain the value(s) in only that field. f. The filter will support searching for multiple values in a single field (e.g., part number = #X AND #Y) as well as multiple fields (title contains “ding” AND part number = #X AND #Y).		
6.2.7.4	**Search**	[RCL 48] All the metadata fields listed in RCL 30-36 [insert requirements language] be available as criteria for filtering.		
6.2.7.4	**Search**	[RCL 49] Search performance [insert requirements language] be sufficiently high to return search results within [Insert Number] seconds after a query is submitted.		
6.2.7.4	**Search**	[RCL 50] If a complete search results set cannot be returned within [Insert Number] seconds, the system [insert requirements language] present results as they become available.		
6.2.7.4	**Search**	[RCL 51] Results for a keyword (or key phrase) search [insert requirements language] provide context related for each result, including the name of the item, record, document, or package where the keyword was found, the date last modified, the field or section where the keyword was found, and up to 25 words of text that immediately surround the keyword.		
6.2.7.4	**Search**	[RCL 52] The system [insert requirements language] suggest correct spellings or other probable search terms when a common typographical error or misspelling appears in a keyword search.		
6.2.7.4	**Search**	[RCL 53] Search results [insert requirements language] be restricted based on permissions within user profiles.		

NASA-HDBK-1004				
Section	**Description**	**Recommended Contract Language (RCL)**	**Selected (Enter Yes or No)**	**Comments**
6.2.7.4	**Search**	[RCL 54] If the user has insufficient permissions to see a search result, the system [insert requirements language] provide sufficient feedback (e.g., "access restricted to Jan 1, 2006, problem on X subsystem") so the user can request permission to view the data.		
6.2.7.4	**Search**	[RCL 55] The system [insert requirements language] allow users to store search queries (e.g., data on X subsystem, of Y severity, between dates A and B, etc.) so that a query may be built once, then stored and reused.		
6.2.7.5	**Browsing and Navigation**	[RCL 56] The contractor [insert requirements language] ensure the following browsing and navigation criteria [choose as required]: a. The system will allow users to browse the Data Archive/Repository. b. The browsing interface will support sorting and filtering based on metadata content and the time/date of uploads or downloads. g. The system will allow users to select particular files or metadata for detailed viewing within the system. c. The system will allow users to view the content of files, packages, or metadata in a Web browser.		
6.2.7.6	**Viewing and Archiving Data**	[RCL 57] The system [insert requirements language] allow users to construct new data packages (integrated data views) by assembling files that reside in the Acceptance Data Package (ADP) Data Archive/Repository.		
6.2.7.6	**Viewing and Archiving Data**	[RCL 58] The system [insert requirements language] allow users to create a "snapshot" of a data package that can be retrieved later and will act as a historical record of how the data in that package appeared at the time the snapshot was created.		
6.2.7.6	**Viewing and Archiving Data**	[RCL 59] Archived data packages [insert requirements language] include additional metadata that specify the time/date of archival and the identity of the user who created the archived package.		
6.2.7.6	**Viewing and Archiving Data**	[RCL 60] The system [insert requirements language] allow for the control of access to data files and packages dependent on user profile information (see section 8.2.7.11.2, User Profile Data, of this Handbook).		
6.2.7.6	**Viewing and Archiving Data**	[RCL 61] The system [insert requirements language] allow provider personnel to upload data files and packages to the system without making those files and packages visible or accessible to any user outside the provider's organization.		
6.2.7.6	**Viewing and Archiving Data**	[RCL 62] The system [insert requirements language] provide configurable workflow support for provider approval processes that employ electronic notifications and digital signatures.		

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Section	**Description**	**Recommended Contract Language (RCL)**	**Selected (Enter Yes or No)**	**Comments**
6.2.7.6	**Viewing and Archiving Data**	[RCL 63] The system [insert requirements language] allow provider personnel to change the visibility and accessibility of their own uploaded data files and packages such that, once approved by the provider, users outside the provider organization (i.e., NASA personnel) may view and access those files and packages.		
6.2.7.6	**Viewing and Archiving Data**	[RCL 64] The system [insert requirements language] prevent provider personnel from restricting access to data files and packages once they have been approved by the provider and released to NASA unless NASA personnel give explicit approval (e.g., one or more digital signatures) concurring with such restrictions.		
6.2.7.6	**Viewing and Archiving Data**	[RCL 65] Once a user has created a data package, the system [insert requirements language] support sharing that package with other users who have the required access based on their user profile information.		
6.2.7.7	**Stored Technical Data Packages (TDPs)**	[RCL 66] The system [insert requirements language] allow users to specify, construct, and store Technical Data Packages (TDPs).		
6.2.7.7	**Stored Technical Data Packages (TDPs)**	[RCL 67] The system [insert requirements language] explicitly tag, label, or otherwise represent with metadata or data that a package is a TDP, not an ADP.		
6.2.7.7	**Stored Technical Data Packages (TDPs)**	[RCL 68] The system [insert requirements language] treat TDPs as static, historical documents.		
6.2.7.7	**Stored Technical Data Packages (TDPs)**	[RCL 69] Each TDP [insert requirements language] include metadata requirements as described in this document.		
6.2.7.7	**Stored Technical Data Packages (TDPs)**	[RCL 70] Each TDP [insert requirements language] include metadata specifying the time and date of creation, the user who created the package, and the criteria used to construct the package.		
6.2.7.7	**Stored Technical Data Packages (TDPs)**	[RCL 71] The contractor [insert requirements language] allow users to store the criteria used to construct a TDP without saving the particular content of the TDP.		
6.2.7.7	**Stored Technical Data Packages (TDPs)**	[RCL 72] In concurrence with RCL 71, the system [insert requirements language] allow users to specify a “view” of data that is dynamically updated each time it is invoked.		
6.2.7.8	**Computer-Aided Design (CAD) Management Within Contractor System**	[RCL 73] The system [insert requirements language] allow lightweight viewing of CAD models via the web interface or via a neutral file format which can be downloaded and does not require any specialty software to view or analyze the contents, as agreed to by NASA.		
6.2.7.8	**Computer-Aided Design (CAD) Management Within Contractor System**	[RCL 74] The contractor [insert requirements language] appropriately mark and protect data within the contractor system (e.g., CUI, ITAR, etc.).		

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Section	**Description**	**Recommended Contract Language (RCL)**	**Selected (Enter Yes or No)**	**Comments**
6.2.7.9	**Unpackaged Data**	[RCL 75] The system [insert requirements language] allow users to store data files that are associated with no particular data package.		
6.2.7.9	**Unpackaged Data**	[RCL 76] Each data file [insert requirements language] conform to the data format requirements described below: [State Requirements.]		
6.2.7.9	**Unpackaged Data**	[RCL 77] Each data file [insert requirements language] include metadata described below: [State Requirements.]		
6.2.7.10.1	**Notifications**	[RCL 78] The contractor [insert requirements language] ensure a notification system exists to provide users with updates either based on their affiliation/role (e.g., contact for responsible organization) or user data (e.g., Jane Smith) as described in the section on user profiles [choose as required].		
6.2.7.10.1	**Notifications**	[RCL 79] The system [insert requirements language] allow notifications to be sent based on a variety of triggering events. For example, requests for action (e.g., review of an ADP or file is requested, etc.), status changes (e.g., a new ADP or ADP component is delivered), and other events might trigger system-generated notifications or emails to users.		
6.2.7.10.1	**Notifications**	[RCL 80] Notification [insert requirements language] be available in both an automated (e.g., system sends notification when action item is created) and user-initiated manner (e.g., a user requests a signature, and an email is sent to inform another user of the request).		
6.2.7.10.1	**Notifications**	[RCL 81] The system [insert requirements language] provide the capability to notify users via email.		
6.2.7.10.1	**Notifications**	[RCL 82] Defaults [insert requirements language] be provided for both time-based (e.g., X hours before an action is due) and activity-based (e.g., when a user has marked an action complete) notification triggers that are modifiable by the system administrator.		
6.2.7.10.1	**Notifications**	[RCL 83] Users [insert requirements language] have the capability to modify their configuration of time-based and activity-based notification triggers within their personal settings attached to their user profile.		
6.2.7.10.2	**Digital Signatures**	[RCL 84] The contractor [insert requirements language] ensure the following digital signature criteria [choose as required]: h. The system will include digital signature authority, and that authority will be based on roles specified in the user profile (e.g., only certain classes of users can submit an ADP for NASA review/approval). a. The system will provide the capability for users to request digital signatures of specific individuals or roles within the system.		

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Section	**Description**	**Recommended Contract Language (RCL)**	**Selected (Enter Yes or No)**	**Comments**
6.2.7.10.3	**Change Log**	[RCL 85] The contractor [insert requirements language] ensure the following change log criteria [choose as required]: i. The system will log information about changes or updates to the data in the system (i.e., uploads or downloads of data or metadata, archival of data packages or package definitions, drops of data to the dropbox) by user and time stamp at the level of the individual field for metadata and at the level of data files otherwise. a. Change log information will include all workflow data (requests for signatures, signatures, etc.). j. The system will support authorized Internet access initiated from any off-site data provider, any NASA Center, and/or inquiries from any authorized source location (e.g., an authorized user's home workstation).		
6.2.7.11	**Administration and Other System Functions**	[RCL 86] The contractor [insert requirements language] ensure administration and other system functions (choose from RCL 87-110 as required).		
6.2.7.11.1	**Administration**	[RCL 87] The system [insert requirements language] provide an interface that allows metadata schema modification by a system administrator and is abstracted above the code level.		
6.2.7.11.1	**Administration**	[RCL 88] The interface for metadata schema modification [insert requirements language] be textual and appropriate for use by a system administrator using a text or XML-type editor.		
6.2.7.11.1	**Administration**	[RCL 89] The system [insert requirements language] provide an interface that allows a system administrator to specify and modify workflow requirements (e.g., required signatures).		
6.2.7.11.1	**Administration**	[RCL 90] The system [insert requirements language] provide an interface that allows a system administrator to create, modify, and delete user accounts, including user profile information as described in RCLs 95-102.		
6.2.7.11.1	**Administration**	[RCL 91] The system [insert requirements language] provide an interface that allows an administrator to create, modify, and delete sets of field-relevant information over time (e.g., update the values available in drop-down menus for metadata collection).		
6.2.7.11.1	**Administration**	[RCL 92] The system [insert requirements language] provide an interface that allows an administrator to create, modify, and delete user groups.		

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Section	**Description**	**Recommended Contract Language (RCL)**	**Selected (Enter Yes or No)**	**Comments**
6.2.7.11.1	**Administration**	[RCL 93] The system [insert requirements language] allow an administrator to create, modify, and delete permissions, customizations, and access to the system and system data and metadata for user groups.		
6.2.7.11.1	**Administration**	[RCL 94] The system [insert requirements language] allow an administrator to create logical relations among groups (e.g., to relate groups hierarchically, to declare that user groups are mutually exclusive).		
6.2.7.11.2	**User Profile Data**	[RCL 95] User profile data [insert requirements language] contain the user's full name, username, affiliation data, and role data.		
6.2.7.11.2	**User Profile Data**	[RCL 96] Usernames [insert requirements language] be unique identifiers that may link users to system actions or to workflow elements such as action items assigned or signatures pending.		
6.2.7.11.2	**User Profile Data**	[RCL 97] Affiliation data [insert requirements language] include employer and organization code (where applicable).		
6.2.7.11.2	**User Profile Data**	[RCL 98] Role data [insert requirements language] include the user's title or position and the user's level of signatory authority as described in the digital approval authority requirements in RCL 78-85 to facilitate workflow management.		
6.2.7.11.2	**User Profile Data**	[RCL 99] Customization data [insert requirements language] include modifications the user has made to system settings/defaults, which may include functions that vary widely from stored search queries to user interface settings.		
6.2.7.11.2	**User Profile Data**	[RCL 100] Permissions rules [insert requirements language] apply to information access based on user profile data to determine: a. The accessible dataset (e.g., X project only or contractor A sees NASA data only but not contractor B's data), and b. The type/level of access (e.g., read only versus write).		
6.2.7.11.2	**User Profile Data**	[RCL 101] Users [insert requirements language] be able to control customization data directly within the system through their settings.		
6.2.7.11.2	**User Profile Data**	[RCL 102] User profile data [insert requirements language] include information about the user groups to which the user belongs.		
6.2.7.11.3	**Authentication and Security**	[RCL 103] A single login and password [insert requirements language] be used for access to all components of the ADP system. In cases where the system links to data in external systems (e.g., as described in RCL 84 on integration with external systems), a second authentication/login will not be required where possible.		
6.2.7.11.3	**Authentication and Security**	[RCL 104] The system [insert requirements language] not allow users to perform any actions anonymously or in another user's name.		

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Section	**Description**	**Recommended Contract Language (RCL)**	**Selected (Enter Yes or No)**	**Comments**
6.2.7.11.3	**Authentication and Security**	[RCL 105] RCL103 [insert requirements language] apply to all levels of access, including system administrators with the most broadly defined permissions.		
6.2.7.11.3	**Authentication and Security**	[RCL 106] Authentication [insert requirements language] engage the customized features outlined in RCLs 95-102 on user profile data.		
6.2.7.11.3	**Authentication and Security**	[RCL 107] All authentication information [insert requirements language] be passed using a minimum of 256-bit encryption.		
6.2.7.11.3	**Authentication and Security**	[RCL 108] All data being sent over networks not controlled by NASA [insert requirements language] be encrypted to protect against data theft during transmission.		
6.2.7.11.3	**Authentication and Security**	[RCL 109] The system [insert requirements language] be capable of blocking access to data and metadata based on user profile information.		
6.2.7.11.3	**Authentication and Security**	[RCL 110] The system [insert requirements language] allow data and metadata to be defined as modifiable only by certain groups or individuals.		
6.2.7.11.4	**Transfer of Data to [Identify Name] Systems**	[RCL 111] The system [insert requirements language] provide the capability to transfer/route any TDP or unpackaged data file to the appropriate [Identify Name] data source(s) or system(s).		
6.2.7.11.4	**Transfer of Data to [Identify Name] Systems**	[RCL 112] The system [insert requirements language] decompose TDPs into their constituent unpackaged data files prior to routing.		
6.2.7.11.4	**Transfer of Data to [Identify Name] Systems**	[RCL 113] The system [insert requirements language] allow an administrator to specify rules or information required for routing to [Identify Name] data sources. For example, an administrator would be able to write a rule that says, “If metadata field F has value V, then route the associated data to system S.”		
6.2.7.11.4	**Transfer of Data to [Identify Name] Systems**	[RCL 114] The system [insert requirements language] allow an administrator to add, update, and delete information required for routing to [Identify Name] data sources.		
6.2.7.11.4	**Transfer of Data to [Identify Name] Systems**	[RCL 115] The system [insert requirements language] allow an administrator to add, update, and delete any special data format requirements needed to enable routing to [Identify Name] data sources.		
6.2.7.11.4	**Transfer of Data to [Identify Name] Systems**	[RCL 116] The system [insert requirements language] allow an administrator to update, alter, add, and remove any special data format requirements needed to enable routing to [Identify Name] data sources.		

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Section	**Description**	**Recommended Contract Language (RCL)**	**Selected (Enter Yes or No)**	**Comments**
6.2.7.11.4	**Transfer of Data to [Identify Name] Systems**	[RCL 117] When no electronic link with a [Identify Name] data source is available/possible, the system [insert requirements language] provide the capability to send email or other notification to a point of contact for the unavailable data source so that a person may assist with the transfer/routing of data into that data source.		
6.2.7.11.5	**Retrieval of Current Data from [Identify Name] Systems**	[RCL 118] The system [insert requirements language] allow users to retrieve current data from [Identify Name] Information Systems.		
6.2.7.11.5	**Retrieval of Current Data from [Identify Name] Systems**	[RCL 119] The system [insert requirements language] distinguish contractor-submitted data from NASA-generated data.		
6.2.7.11.5	**Retrieval of Current Data from [Identify Name] Systems**	[RCL 120] The system [insert requirements language] store data retrieved from [Identify Name] Information Systems in the Data Archive/Repository as unpackaged data as stated in RCL 57-65 only when one or more of the following conditions are met: a. Those data are part of a TDP, and not otherwise. b. Those data belong in a [Identify Name] Information System that is unavailable (i.e., not integrated with the ADP system).		
6.2.7.11.5	**Retrieval of Current Data from [Identify Name] Systems**	[RCL 121] Whenever the system displays data to the user that were retrieved from an [Identify Name] Information System, the system [insert requirements language] provide a clear visual indication of the time and date that the displayed data were retrieved.		
6.2.7.11.5	**Retrieval of Current Data from [Identify Name] Systems**	[RCL 122] Whenever the system displays data to the user that were retrieved from an [Identify Name] Information System that uses a version control scheme other than the time and date stamping, the system [insert requirements language] provide a clear visual indication of the version or revision of the displayed data.		
6.2.7.12	**Non-Functional Requirements**	[RCL 123] The contractor [insert requirements language] ensure the following non-functional requirements exist when the data is stored in contractor systems [choose from the following sub-sections in this Handbook as required].		
6.2.7.12.1	**Availability**	[RCL 124] The system [insert requirements language] be available at least 99 percent of the time on a 24-hour, 7-day-per-week basis.		
6.2.7.12.1	**Availability**	[RCL 125] Planned outages [insert requirements language] be scheduled with agreement from the system administrator to ensure that they do not coincide with peak usage times (e.g., when hardware is being delivered and accepted ahead of integration testing).		

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Section	**Description**	**Recommended Contract Language (RCL)**	**Selected (Enter Yes or No)**	**Comments**
6.2.7.12.1	**Availability**	[RCL 126] All functionality [insert requirements language] be available to authorized users on any authorized computer that has the necessary software (an acceptable Web browser).		
6.2.7.12.1	**Availability**	[RCL 127] The server environment [insert requirements language] provide one of the following: a. Backup server(s) that are geographically separate from the primary server(s) to take the load if there are problems with the primary server(s). k. Spare server that can replace part or all of the primary server to take over the full load of the system. l. Backup server(s) can reside in approved cloud environments as deemed appropriate by NASA.		
6.2.7.12.2	**Flexibility**	[RCL 128] Software [insert requirements language] employ standardized abstraction layers in connections to any database, data repository, data warehouse, or other storage structure.		
6.2.7.12.2	**Flexibility**	[RCL 129] The system [insert requirements language] not rely on commands or code specific to any single database, data repository, data warehouse, or other storage structure.		
6.2.7.12.3	**Software Integration**	[RCL 130] The following elements [insert requirements language] be replaceable and updatable and [insert requirements language] do so with no update to the software code for the rest of the elements: a. Database technology b. Applications software c. Data integration layers Any changes to the communication specifications used to connect software elements must be approved by all applications that use them, and agreements will be reached to ensure any needed changes to individual systems are made in time.		
6.2.7.12.4	**Platforms**	[RCL 131] The system [insert requirements language] be compatible with the operating systems specified as Agency standards in NASA-STD-2804, Minimum Interoperability Software Suite (i.e., no functionality will be restricted or unavailable to users of any of the standard operating systems).		
6.2.7.12.5	**Security**	[RCL 132] The required security level for the system [insert requirements language] be determined using the criteria defined in NIST SP 800-60, Guide for Mapping Types of Information and Information Systems to Security Categories.		

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Section	**Description**	**Recommended Contract Language (RCL)**	**Selected (Enter Yes or No)**	**Comments**
6.2.7.12.5	**Security**	[RCL 133] The system [insert requirements language] comply with the requirements set forth in NPD 2810.1 and NPR 2810.1, Security of Information Technology.		
6.2.7.12.5	**Security**	[RCL 134] The system [insert requirements language] be tested against security controls for the defined security level as mandated by NIST SP 800-53, VI & VII, Recommended Security Controls for Federal Information Systems.		
6.2.7.12.6	**Network**	[RCL 135] Rules for allowable connections to the system [insert requirements language] be maintained by system administrators to ensure that the proper balance between security and access to data is maintained.		
6.2.7.12.6	**Network**	[RCL 136] The system [insert requirements language] be able to block specified services if the user's network connection is deemed unsecure.		
6.2.7.12.6	**Network**	[RCL 137] All servers [insert requirements language] be protected by a firewall allowing access only to the ports used by the ADP system and its approved sibling applications.		
6.2.7.12.6	**Network**	[RCL 138] The firewall [insert requirements language] also use allowed Internet protocol lists for ports that are specifically opened to connecting servers together.		
6.2.7.12.6	**Network**	[RCL 139] The system [insert requirements language] be capable of encrypting data up to 256 bits.		
6.2.7.12.7	**Integrity**	[RCL 140] All data and related software [insert requirements language] be automatically backed up daily with a minimum of 1 month of roll-back capability.		
6.2.7.12.7	**Integrity**	[RCL 141] All backups [insert requirements language] be stored on two distinct types of media (e.g., hard drive and tape).		
6.2.7.12.8	**Scalability**	[RCL 142] The system [insert requirements language] accommodate up to [Insert Number] concurrent users (estimate based on percentage of total [Insert Number] users).		
6.2.7.12.8	**Scalability**	[RCL 143] The system [insert requirements language] support on the order of [Insert Number] user accounts (estimate based on number of users per contractor by number of primes plus percentage of NASA personnel).		
6.2.7.12.8	**Scalability**	[RCL 144] The system [insert requirements language] store and process on the order of [State Number] terabytes of data and metadata combined (estimate based on average file size by number of files).		
6.2.8.2	**Requirements**	[RCL 145] The requirements [insert requirements language] be maintained and managed throughout the entire lifecycle of the project.		

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Section	**Description**	**Recommended Contract Language (RCL)**	**Selected (Enter Yes or No)**	**Comments**
6.3.1	**Data Acquisition**	[RCL 146] The contractor [insert requirements language] provide structured, computer-readable data, including all relationships between data, in one of the following formats: m. Where XML is applied, the contractor should implement an architecture that complies with the applicable NASA IT standards and enables digital data interoperability within NASA domains, W3C, XML, W3C Namespaces for XML, and W3C XML Schema. a. Where XML is applied, the contractor should respond to NASA's requests for IT data items via W3C XML, W3C XML Namespaces, W3C XML Schema, and OMG XMI for Models. b. For standard XML digital data descriptions to be usable, all producers and consumers of digital data should reference a common data dictionary as defined by NASA. If a NASA standard is not applicable or available, digital data should reference a common data dictionary as defined by the contractor that includes the following: (1) Database output format (e.g., SQL output). (2) Structured database output files should include the database type and version (e.g., MySQL, version [XYZ]). (3) The contractor should provide computer-readable definitions of record structure (schema) for both XML and database output formats.		
6.4.1.1	**Configuration and Data Management Planning**	[RCL 147] The contractor [insert requirements language] develop, deliver, and update a CDMP in accordance with DRD No. STD-CDMP.		
6.4.1.1	**Configuration and Data Management Planning**	[RCL 148] The contractor [insert requirements language] manage and coordinate all contractor and subcontractor CDM activities.		
6.4.1.1	**Configuration and Data Management Planning**	[RCL 149] The contractor [insert requirements language] conduct all CDM activities for the contract in accordance with the approved CDMP.		
6.4.1.1	**Configuration and Data Management Planning**	[RCL 150] The contractor [insert requirements language] ensure that all subcontractors comply with the requirements of the CDMP and are integrated into the contractor's CDM activities.		
6.4.1.1	**Configuration and Data Management Planning**	[RCL 151] The contractor [insert requirements language] conduct its CDM activities in accordance with SAE GEIA-859, Data Management, SAE EIA-649-2, Configuration Management Requirements for NASA Enterprises, or a NASA [Enter Center]-approved equivalent, as tailored by the approved CDMP.		

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Section	**Description**	**Recommended Contract Language (RCL)**	**Selected (Enter Yes or No)**	**Comments**
6.4.1.2	**Configuration and Data Identification**	[RCL 152] The contractor [insert requirements language] identify all recommended CIs that constitute the contractual end item and support system components for NASA's review and approval during the conceptual level.		
6.4.1.2	**Configuration and Data Identification**	[RCL 153] The contractor [insert requirements language] uniquely identify all documents that disclose the performance, functional, and physical attributes for each of the approved CIs so that they may be accurately associated with the Configuration Baselines for these systems.		
6.4.1.2	**Configuration and Data Identification**	[RCL 154] The contractor [insert requirements language] utilize the Government's CAGE Code and supplied drawing formats and numbers ensuring Government's unlimited data rights.		
6.4.1.3	**Configuration and Data Baselines**	[RCL 155] The contractor [insert requirements language] develop and maintain at least each of the following configuration and data baselines for each Mission System and the Support System during the contract: a. Functional Baseline b. Allocated Baselines c. Product Baseline		
6.4.1.4	**Configuration and Data Control**	[RCL 156] The contractor [insert requirements language] manage configuration and data changes and variations, including their: a. Identification, n. Process CRs and submit proposed engineering changes for evaluation and disposition by the appropriate Configuration and Data Approval Authority in accordance with DRD No. STD-CR, b. For configuration changes only, classification as Major Changes or Minor Changes per SAE EIA-649-2, c. Evaluation and coordination, and d. Implementation and verification of the changes.		
6.4.1.4	**Configuration and Data Control**	[RCL 157] The contractor [insert requirements language] submit CRs supplemented by ECPs in accordance with the approved CDMP to implement changes to Approved Functional, Allocated, and Product Baselines.		
6.4.1.4	**Configuration and Data Control**	[RCL 158] All changes to a Functional Baseline [insert requirements language] be classified as a Major Change.		
6.4.1.4	**Configuration and Data Control**	[RCL 159] The contractor [insert requirements language] classify changes to a Product Baseline as either a Major Change or a Minor Change.		

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Section	**Description**	**Recommended Contract Language (RCL)**	**Selected (Enter Yes or No)**	**Comments**
6.4.1.4	**Configuration and Data Control**	[RCL 160] The contractor [insert requirements language] submit all proposed Major Changes to the Product Baseline to the NASA [Enter Center] CMO Representative for approval as CRs supplemented by ECPs.		
6.4.1.4	**Configuration and Data Control**	[RCL 161] The contractor [insert requirements language] submit all proposed Minor Changes to the Product Baseline to the NASA [Enter Center] CMO Representative for review.		
6.4.1.4	**Configuration and Data Control**	[RCL 162] At the request of the NASA [Enter Center] CMO Representative, the contractor [insert requirements language] resubmit a proposed Minor Change to the Product Baseline as a proposed Major Change to that Product Baseline in accordance with appropriate Project Baseline submittal requirements on contract.		
6.4.1.4	**Configuration and Data Control**	[RCL 163] The contractor [insert requirements language], for any proposed change to a Configuration or Data Baseline, ensure that all Configuration and Data Baselines will be mutually consistent and compatible.		
6.4.1.5	**Configuration Status Accounting (CSA)**	[RCL 164] The contractor [insert requirements language] establish and maintain, in accordance with the approved CDMP, a CSA system that correlates, stores, maintains, and provides readily available views of all configuration information relating to the CIs' components and their respective Configuration Baselines.		
6.4.1.5	**Configuration Status Accounting (CSA)**	[RCL 165] The contractor [insert requirements language] provide all facilities and assistance reasonably required by the NASA [Enter Center] CDM Representative(s) for the NASA [Enter Center(s)] to access the contractor's CSA system for the duration of the contract.		
6.4.1.5	**Configuration Status Accounting (CSA)**	[RCL 166] The contractor [insert requirements language] deliver reports to the NASA [Enter Center] CDM Representative(s) from the contractor's CSA system in accordance with DRD No. STD-CSA.		
6.4.1.6	**Configuration and Data Audits**	[RCL 167] The contractor [insert requirements language] develop, deliver, and update a FCA and PCA Documentation Plan in accordance with DRD No. STD-AD.		
6.4.1.6	**Configuration and Data Audits**	[RCL 168] The contractor [insert requirements language] conduct a Mandated System Review, the FCA, on each delivered CI.		
6.4.1.6	**Configuration and Data Audits**	[RCL 169] The contractor's entry criteria, exit criteria, and objectives for FCA [insert requirements language] include those defined in SAE GEIA-HB-649, Configuration Management Standard Implementation Guide, or NASA-provided FCA template (e.g., DRD No. STD-AD).		

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Section	**Description**	**Recommended Contract Language (RCL)**	**Selected (Enter Yes or No)**	**Comments**
6.4.1.6	**Configuration and Data Audits**	[RCL 170] The contractor [insert requirements language] conduct a Mandated System Review, the PCA, on each delivered contractual end item and support system components.		
6.4.1.6	**Configuration and Data Audits**	[RCL 171] The contractor's entry criteria, exit criteria, and objectives for PCA [insert requirements language] include those defined in SAE GEIA-HB-649 or NASA-provided FCA template.		
6.4.1.6	**Configuration and Data Audits**	[RCL 172] The contractor [insert requirements language] invite the NASA [Enter Center] Representative to witness all Materiel System FCAs and PCAs.		
6.4.1.6	**Configuration and Data Audits**	[RCL 173] Unless otherwise notified in writing by the NASA [Enter Center] CDM Representative(s), the NASA [Enter Center] CDM Representative or appointed representative(s) [insert requirements language] witness configuration and data audits that are conducted for the purposes of acceptance.		
6.4.1.6	**Configuration and Data Audits**	[RCL 174] Unless the NASA [Enter Center] Representative has notified that it will not witness a configuration and data audit in accordance with previous requirement, the contractor [insert requirements language] not conduct that configuration and data audit in the absence of NASA [Enter Center] witnesses.		
6.4.1.6	**Configuration and Data Audits**	[RCL 175] The contractor [insert requirements language] plan for and support the NASA [Enter Center] CDM Representative(s) performing CDMPAs in accordance with DRD No. STD-CDMPA.		
6.4.1.7	**Interface control**	[RCL 176] The contractor [insert requirements language] conduct NASA [Enter Center]-sponsored ICWGs to establish and refine the Materiel System external interfaces and the platform integration and installation design.		
6.4.1.7	**Interface control**	[RCL 177] The contractor [insert requirements language] provide sufficient design information to the ICWG, including provision to third parties, to enable the interface details to be established.		
6.4.1.7	**Interface control**	[RCL 178] The contractor [insert requirements language] organize and conduct the ICWGs as extraordinary-/additional meetings in accordance with associated clauses for: o. Each external interface identified. p. Any other external interfaces identified during system design.		
6.4.1.7	**Interface control**	[RCL 179] Membership of ICWGs [insert requirements language] include the NASA [Enter Center] CMO, the contractor, and the relevant interface [Enter Interface Name, e.g., Electrical Ground Support System] Program Office.		

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Section	**Description**	**Recommended Contract Language (RCL)**	**Selected (Enter Yes or No)**	**Comments**
6.4.1.7	**Interface control**	[RCL 180] The contractor [insert requirements language] develop, deliver, and update a design document in accordance with DRD No. STD-SMEM, detailing the interface design for each of the relevant external interfaces.		
6.4.1.7	**Interface control**	[RCL 181] The contractor [insert requirements language] submit the relevant draft design document detailing the interface design to the NASA [Enter Center] Representative prior to the ICWG.		
6.4.1.7	**Interface control**	[RCL 182] Unless otherwise agreed by the NASA [Enter Center] Representative, the contractor [insert requirements language] obtain endorsement of the relevant design document detailing the interface design from each ICWG prior to CDRs.		
6.4.1.7	**Interface control**	[RCL 183] ICWGs [insert requirements language] be held at venues to be determined by the NASA [Enter Center] CMO. Note to Tenderers: It is the NASA [Enter Center] CMO's intention that ICWGs be held at [Enter Center].		
6.4.1.7	**Interface control**	[RCL 184] The expected level of effort required by the contractor [insert requirements language] be: q. Attendance at approximately 12 ICWG meetings annually. r. For each ICWG meeting, no more than five (5) representatives of the contractor will be required to attend; and a. The maximum duration of each ICWG is expected to be no more than two days with one-day duration typical. The contractor acknowledges that no statements, representations, or undertaking by the ICWGs or any failings of the ICWGs to meet the requirements detailed above shall affect or undermine the contractor's requirement to fulfill the Contract.		
6.4.1.8	**General**	[RCL 185] The contractor [insert requirements language] maintain engineering, manufacturing, and quality controls such that all items scheduled for delivery under this contract conform to the CDM requirements set forth below in this clause.		

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Section	**Description**	**Recommended Contract Language (RCL)**	**Selected (Enter Yes or No)**	**Comments**
6.4.1.8	**General**	[RCL 186] The contractor [insert requirements language], at any time after contract award, secure the written consent of the Government prior to making any major change to the item (Refer to SAE EIA-649-2, section 3.3.3, Major and Minor Changes), if one or more of the following is affected: a. The function, installation, item's interfaces, or the physical or operational interchangeability of the item, reparable parts, and/or the spares support. s. Current applicable installation, operation, or other procedures with respect to the use thereof. t. Certification(s) (e.g., Technical Standard Orders, Certificates of Conformance, Certificates of Compliance, etc.). u. The specified requirements of performance, weight, safety, reliability, service life, and maintainability. v. Delivered items (rework, replacement, or maintenance). w. Qualification status (e.g., item does not meet original qualification requirements; or contractor makes a change because of component obsolescence, productivity improvement, etc., that requires re-qualification).		
6.4.1.8	**General**	[RCL 187] The contractor [insert requirements language] give written notice to the Government using DRD No. STD-CR or Government-approved contractor's change form, describing any proposed change as described in previous requirements in sufficient detail (including technical, cost, risk, and schedule impact analysis) to enable an understanding by Government of the total impact of the change.		
6.4.1.8	**General**	[RCL 188] Supplemental documentation (exhibits, sketches, drawings, draft retrofit information, etc.) [insert requirements language] be included with the DRD No. STD-CR or Government-approved contractor's change form used in RCL 187. The Government will, within 30 days after the receipt of such CR/proposal, advise the contractor of its consent to, its rejection of, or the status of the change under consideration.		
6.4.1.8	**General**	[RCL 189] In no event [insert requirements language] the contractor proceed to incorporate such change into the items ordered by this contract prior to receipt of written consent from the Government.		
6.4.1.8	**General**	[RCL 190] A new contractor part number identification [insert requirements language] be assigned to all items to be delivered to the Government when an approved Major change affects interchangeability.		

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Section	**Description**	**Recommended Contract Language (RCL)**	**Selected (Enter Yes or No)**	**Comments**
6.4.1.8	**General**	[RCL 191] The contractor [insert requirements language] have the right to make [XX] Minor changes under this contract, without obligation to make such changes in any delivered items, without an increase in price, and without prior approval, if the change does not affect any of the factors outlined in previous associated requirements.		
6.4.1.8	**General**	[RCL 192] Changes made under RCL 191 [insert requirements language] require the Government's concurrence in classification.		
6.4.1.8	**General**	[RCL 193] The contractor [insert requirements language] revise and furnish all data (models, drawings, catalogs, technical manuals, etc.) submitted under this contract that are affected by any change.		
6.4.1.8	**General**	[RCL 194] Minor changes requiring concurrence in classification [insert requirements language] be submitted immediately to the Government's Authorized Procurement Representative using DRD No. STD-CR or Government-approved contractor's change form and revised data.		
6.4.1.8	**General**	[RCL 195] Changes [insert requirements language] not be incorporated in the item within 30 days prior to shipment to the Government. Changes made in DCLR 194 and 195 may be released at the same time for incorporation by the contractor at the contractor's facility. Note: All changes incorporated in the item prior to the Government's concurrence are done so at the contractor's risk.		
6.4.1.8	**General**	[RCL 196] The contractor [insert requirements language] be notified within 30 days after receipt if the Government rejects the change classification. After concurrence in the classification review of the contractor's revised data, the Government reserves the right to reclassify the change and return to the contractor for processing. No response denotes the Government's concurrence.		
6.4.1.8	**General**	[RCL 197] The [Enter Center/Program Form Number], Contractor Request for Information/Clarification, or Government-approved contractor equivalent, [insert requirements language] be used by contractors to submit inquiries and/or request clarification.		
6.4.2	**CDM002 -- Configuration and Data Management -- Components**	[RCL 198] The provisions in RCL 199-206 [insert requirements language] apply to all qualified or qualifiable components ordered under this contract for delivery to the Government or its customers:		

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Section	**Description**	**Recommended Contract Language (RCL)**	**Selected (Enter Yes or No)**	**Comments**
6.4.2	**CDM002 -- Configuration and Data Management -- Components**	[RCL 199] The contractor [insert requirements language] maintain configuration and data control of the design and manufacture of the components ordered hereunder, including, but not limited to, formal initial identification of the configuration of the components and controlled internal approval and accountability of changes to drawings, procedures, and other control documents.		
6.4.2	**CDM002 -- Configuration and Data Management -- Components**	[RCL 200] The contractor [insert requirements language] give written notice to the Government describing any proposed change to a component, including the effect of such proposed change, proposed by the contractor to be implemented subsequent to the establishment of the baseline component configuration. Changes include those affecting form, fit, or function of the component; changes to the contractor's design, procedures, and other control documents; changes involving a substitution of material; and changes in Government-approved manufacturing processes.		
6.4.2	**CDM002 -- Configuration and Data Management -- Components**	[RCL 201] Any such proposed change [insert requirements language] be submitted to the Government's Authorized Procurement Representative for processing and review.		
6.4.2	**CDM002 -- Configuration and Data Management -- Components**	[RCL 202] A contractor Certificate of Conformance [insert requirements language] be included with each shipment.		
6.4.2	**CDM002 -- Configuration and Data Management -- Components**	[RCL 203] The contractor [insert requirements language] insert the substance of this clause in each lower-tier subcontract for functional components/parts. Noncompliance with the change notification requirement of this clause may result in subsequent rejection of delivered items.		
6.4.2	**CDM002 -- Configuration and Data Management -- Components**	[RCL 204] The contractor [insert requirements language] be responsible for all reasonable costs incurred by the Government or Government's customers as a result of the contractor's failure to comply with the provisions of this clause.		
6.4.2	**CDM002 -- Configuration and Data Management -- Components**	[RCL 205] Nothing contained in this clause [insert requirements language] excuse the contractor from performing in strict compliance with the terms, conditions, delivery schedule, specifications, or any other provision of this contract.		
6.4.2	**CDM002 -- Configuration and Data Management -- Components**	[RCL 206] In the event of a conflict between this clause and any other provision of this contract, the conflict [insert requirements language] be resolved by the Government's Authorized Procurement Representative.		

APPENDIX B: RECOMMENDED DATA REQUIREMENTS DESCRIPTION (DRD) TEMPLATES

B.1. PURPOSE

This appendix provides recommended example Data Requirements Descriptions (DRDs) for digital and model-based acquisitions, including instructions and sample content. Programs/projects should select and tailor only the DRDs and content appropriate to the acquisition, add other DRDs as needed, and favor Agency-approved or endorsed standards and neutral formats over vendor-specific or proprietary formats wherever practical.

Use of "Shall" in DRD Examples: The DRDs in this appendix are recommended acquisition templates. Consistent with NPR 7120.10B Appendix A, NASA handbooks are guidance documents and are not intended to be requirements documents, although they may contain "shall" statements. Accordingly, "shall" is retained within the example DRD clauses to illustrate the enforceable contractor language that may apply when a program/project selects, tailors, and incorporates a DRD into a solicitation, contract, task order, SOW/PWS, or other binding acquisition instrument. The appearance of "shall" in an example DRD does not, by itself, establish a requirement of this Handbook. Programs/projects should select and tailor the example DRD language appropriate to the specific acquisition and coordinate its use with the Contracting Officer and other appropriate acquisition organizations.

This appendix contains the following subsections:

a. DRD Purpose and Instructions (Refer to B.2)

b. Technical Data Package (TDP) Template (Refer to B.3)

c. Structural and Manufacturing Engineering Models and Associated Data Template (Refer to B. 4)

d. Configuration Management Templates (Refer to B.5 – B.11)

e. Requirements Exchange Format (REF) Template (Refer to B.12.)

f. Master Records Index (MRI) Template (Refer to B.13.)

B.2. DATA REQUIREMENTS DESCRIPTION (DRD) PURPOSE AND INSTRUCTIONS

B.2.1. PURPOSE OF THE DATA REQUIREMENTS DESCRIPTION (DRD)

The DRD defines the requirements that the contractor and/or supplier are contractually obligated to meet when preparing and submitting the required data identified in the DRD. The DRD should fully describe a deliverable data item (e.g., model, digital twins, database, item/object, document, report, etc.) by providing the specified purpose, content, format, compliance standards, maintenance, and submittal requirements levied upon the contractor. Within the digital engineering digital thread, these data items have requirements associated with each, including interoperability to enable assimilation into the receiving organizations' information systems and tools with little-to-no post-receipt processing (beyond the data item's verification).

The DRD examples provided in this appendix are for specific areas that need to be addressed within a procurement package: Engineering, Safety and Mission Assurance, Configuration Management, IT and Cybersecurity. A DRD may be used for an inter-agency (supplier) agreement with some tailoring. All DRDs for a particular contract are combined/assembled in one Data Procurement Document (DPD). The DPD is an attachment to the contract and a companion document to the SOW or PWS. Each DRD should be invoked by relevant SOW or PWS language included in its applicable section.

B.2.2. EXPLANATION OF DRD SECTIONS

DPD/ Data Requirements List NO.: Indicates the unique number assigned to the DPD/Data Requirements List of which this DRD is part. DPD/ Data Requirements List numbers for each contract DPD are obtained from the Agency/Program Data Requirements Manager. Control Processes/Approval Authority for Data Requirements Lists are defined in the DMP and/or Statement of General Requirements for that program/project.

DPD STATUS: Indicates the status of the DPD/ Data Requirements List (e.g., Draft, RFP, New, Subsequent Revision).

DRD NO.: Indicates the unique DRD identification number, which is comprised of a (1) three- or four-digit DPD number; (2) two- or three-letter Data Category designation (refer to Table B-1, Data Category Designations); and (3) three-digits assigned sequentially within the Data Category. Data Categories may be tailored per task application.

DATA TYPE: Provides a code number(s) that corresponds to the approval requirements for the submitted data item. Enter the type of data (refer to Table B-2, Data Types for Contractor Deliverables) according to the contractually applicable requirements, e.g., 1, 2, 3, etc. Data Types and approval requirements for each data type are defined in the DPD Statement of General Requirements.

DATE REVISED: Indicates the date the DRD was revised after contract award via contract modification. "Date Revised" will contain a date only if the DRD was revised after contract award. Prior to contract award, this item should be blank.

PAGE: Indicates the current DRD page number and total number of pages in the DRD.

TITLE: Indicates the title of the data requirement described by this DRD.

DESCRIPTION/USE: Indicates a brief description and/or purpose for the data item described by this DRD. One or two sentences are often adequate.

OPR: Indicates the Office of Primary Responsibility (OPR) organization designated to exercise technical or administrative control over the data requirement. The OPR code does not necessarily indicate the organization code for the data item reviewer(s), typically the subject matter expert(s) (SME) for data item(s).

DM: Indicates the organization code for the Data Manager (DM) (for program/project) or Center organization procuring the data. Enter the appropriate DM code, e.g., ENB XX, CM YY, QUAL ZZ, etc. The DM is usually selected by the project office and represents this office on formal data requirements. The DM organization typically receives and subsequently processes (distributes, etc.) the submittals.

DISTRIBUTION: Indicates the distribution requirements for the delivered data item. Individual organization codes or a separate distribution matrix may be referenced here for specific DRD deliverables. If "Per Contracting Officer's letter" is indicated, the Contracting Officer will provide specific distribution requirements to the contractor via a separate letter. This method is preferable because it does not necessitate a contract modification to change distribution requirements.

INITIAL SUBMISSION: Indicates the submittal due date for the first submission of the data item to be prepared in response to this DRD. The due date should be a milestone rather than a specific calendar date (e.g., "30 days after contract award" instead of "January 5, 2006") to better accommodate schedule changes.

SUBMISSION FREQUENCY: Indicates when the submission is due (e.g., "Critical Design Review") or frequency (e.g., monthly, quarterly) for subsequent submissions of the data item to be prepared/delivered in response to this DRD. These due dates should also be milestones instead of calendar dates.

REMARKS: Provides reference/guideline documents/information and special instructions/ remarks to the contractor/supplier not included elsewhere on this DRD. It is acceptable to have no entry or "NA" (not applicable) under "Remarks."

INTERRELATIONSHIP: Indicates SOW or PWS paragraph numbers, other portions of the contract, or other DRDs in the DPD that reference or interrelate with this requirement (e.g., "SOW paragraph 4.3," "DRD XXXMP-001").

B.2.3. EXPLANATION OF DATA PREPARATION INFORMATION SECTIONS

SCOPE: Provides a short summary of the content of the data item to be prepared and submitted in response to the DRD.

APPLICABLE ITEMS: Provides items applicable to the preparation of the data item requested by the DRD, e.g., documents, sources, templates, etc. Applicable items should provide content and/or format requirements for the deliverable data item in accordance with specified standards

or provided templates. The applicable items should be referenced in the respective DRD sections to indicate how they apply to the preparation of the item.

CONTENTS: Defines the required scope and contents of the data item to be prepared in response to the DRD. Applicable items providing content requirements may be referenced here or specific content requirements may be delineated. Applicable items should be referenced here, if appropriate, with specific application, i.e., "The data shall be prepared in accordance with YYY-STD-XXXX, Section X, paragraph X.X.X."

FORMAT: Provides the required format of the data item to be prepared in response to the DRD. Applicable items providing format requirements may be referenced here or specific format requirements may be delineated. Applicable items should be referenced here, as appropriate, with specific application, i.e., "The data shall be prepared and submitted in accordance with YYY-STD-XXXX, Section X, paragraph X.X.X." or "The data shall be prepared and submitted using Government-provided template YYY.YY."

NOTE: "Contractor format is acceptable" should almost never be used — only if/when there is no specific Government format required and only after it has been approved in advance by the Government.

MAINTENANCE: Indicates if and how the data item will be maintained as current (e.g., "Changes shall be incorporated by change page or complete reissue" for plans). If the data item is a recurring report, the maintenance statement will be "None required," because reports are replaced by the next report submission. If the data item is a plan or specification that will be maintained current, the maintenance statement should be "Changes shall be incorporated by change page or complete reissue."

Other items such as Related Data Deliverables may be added.

Table B-1—Data Category Designations

Designation	Definition
CD	Contractual Date
CM	Configuration Management
D&DE	Design and Development Engineering
DM	Data Management
EE	Environmental
HE	Human Engineering
LS	Logistics Support
MA	Management
MP	Materials and Processes
OP	Mission Operation
QE	Quality Engineering
RM	Reliability and Maintainability
SA	Safety
SE	Systems Engineering

	NPR 7120.10, Technical Standards for Nasa Programs and Projects

Table B-2—Data Types for Contractor Deliverables

Data Type	Level of Government Control to Be Applied
Type 1	All issues and interim changes to those issues require written approval from the requiring organization before formal release for use or implementation. *APPLICATION NOTE: Because Type 1 data requires Center approval before use, if contractor-produced data is to be placed under Center CDM control as part of the Center baseline, the data should be designated as Type 1.*
Type 2	NASA reserves a time-limited right to disapprove in writing any issues and interim changes to those issues. The contractor should: a. Submit the required data to NASA for review no less than 45 calendar days** prior to its release for use. The submittal is considered approved if the contractor does not receive a disapproval or an extension request from NASA within 45 calendar days**. b. Clearly identify the release target date in the "submitted for review" transmittal***. If the data is unacceptable, NASA will notify the contractor within 45 calendar days** from the date of submission, regardless of the intended release date***. c. Resubmit the information for reevaluation if disapproved. ***APPLICATION NOTE: This 45-day time limit may be tailored for individual DRDs to meet the requirements of the procuring activity.* ****APPLICATION NOTE: If the contractor does not identify a release target date or if the intended release date is shorter than 45 calendar days from the date of submission, the 45-calendar-day review cycle stands (or the tailored Type 2 time limitation for the specific procurement).*
Type 3	These data should be delivered by the contractor as required by the contract and do not require NASA approval. However, to be a satisfactory delivery, the data should satisfy all applicable contractual requirements and be submitted on time.

Data Type	Level of Government Control to Be Applied
Type 4	These data are produced or used during performance of the contract and are retained by the contractor. They are delivered only when NASA requests in writing and in accordance with the instructions in the request. The contractor should maintain a list of these data and should furnish copies of the list to NASA when requested. *APPLICATION NOTE: FAR 48 CFR §52.227-16, Additional Data Requirements, should be included in the contract for delivery of this data.*
Type 5	These data are incidental to contract performance and are retained by the contractor in those cases where contracting parties have agreed that formal delivery is not required. However, the Contracting Officer or the Contracting Officer's Representative should have access to and can inspect this data at its location in the contractor's or subcontractor's facilities or in an electronic database accessible to the Government.

NOTE: The instructions on DRD applicability in the following sections are not a part of the DRD and should not be included in a DPD.

B.3. TECHNICAL DATA PACKAGE (TDP) TEMPLATE

DATA REQUIREMENTS DESCRIPTION (DRD)

DPD NO.: XXX

DPD STATUS: Draft

DRD NO.: STD-TDP

DATA TYPE: 2/3

DATE REVISED:

PAGE: 1/8

TITLE: Technical Data Package (TDP)

DESCRIPTION/USE: The TDP consists of the technical description of an item suitable for use as the basis for engineering activities, competitive acquisition, production, installation, modification, operations, maintenance, and logistics support of Government material or property developed by or for the Government. The TDP defines the required design configuration ("as-designed" product configuration information), performance requirements, and procedures required to ensure an item's performance. It consists of applicable digital technical data such as models, drawings, associated lists, specifications, standards, performance requirements, Quality Assurance Provisions (QAPs), software, and memory device documentation and packaging/handling details. For outsourced/complex components, it can be valuable to also incorporate the vendor provided TDP as part of the NASA provided TDP. The TDP data are input into the Government's digital environment and serve as the basis for the as-received ("as-sustained") product baseline. This DRD relies heavily on the Department of Defense's (DoD's) Technical Data Package standard (MIL-STD-31000) to provide requirements for the deliverable TDP data products and its related TDP data management products:

a. Conceptual TDP: A conceptual package is a collection of sketches, low fidelity CAD models, and text that document basic concepts of how an item may be developed to meet operational requirements. The TDP is used to determine if the requirements are feasible.

b. Developmental TDP: A developmental package is a collection of data intended to document a specific design approach and the fabrication of a developmental prototype for test or experimentation. These data elements capture the basic design of equipment/systems developed from a concept. They are not intended, nor are they adequate, for use in the competitive procurement of component parts.

c. Product TDP: A product level TDP shall consist of those TDP elements necessary to provide the design, performance requirements, engineering, manufacturing, safety, inspection, packaging and quality assurance provision information and other product and manufacturing information necessary to fully define the item, and that enables the procurement or manufacture of an item. The product shall be defined to the extent necessary for a competent manufacturer to produce an item, which duplicates the physical, interface, and functional characteristics of the original product, without additional design engineering effort or recourse to the original or current design activity. Product data shall reflect the approved, tested, and accepted configuration of the defined delivered item.

d. Commercial TDP: A commercial package is for end items developed by the contractor prior to the award of the contract at the contractor's own expense. Unless the Government purchases rights for these CAD models, these datasets provide the contractor's proprietary engineering and design information for commercially developed items, off-the-shelf items, or items not developed at Government expense.

(1) This DRD contains the format and content preparation instructions for TDPs resulting from the work task described in MIL-STD-31000C, section 5.3.3.

(2) When this DRD is incorporated, in whole or in part, in a contract, DRDs applicable to individual parts of a TDP shall not be incorporated as separate requirements.

OPR: NASA Systems Engineering and Integration (SE&I) Office

DM: NASA Configuration Management Office (CMO)

DISTRIBUTION: TBD

INITIAL SUBMISSION: For the Conceptual TDP, submit within 30 days of the contract award.

SUBMISSION FREQUENCY: This is relative to each major milestone representing NPR 7120.5 lifecycle reviews and MIL-STD-31000, section 4.2 TDP levels (conceptual, developmental, production, and commercial). These are leveraged to identify the level and type of data package. Interim submittals should be made available per request up to 90 days prior to a scheduled delivery, with contracted deliveries due 30 days prior to the respective major milestone.

a. Conceptual TDP. The initial TDP is due within 30 days post contract award with updates due 30 days prior to the System Requirements Review and the System Definition Review. Minimally annotated 3D models alone may be sufficient.

b. Developmental TDP. Due 90 days prior to the Preliminary Design Review (PDR).

c. Product TDP. Due 90 days prior to the Critical Design Review (CDR).

d. Commercial TDP. An initial list of potential contractor proprietary end items is due 30 days post contract award for the Government to identify and select potential procurement/ data rights items. TDPs for selected items are due 30 days prior to the PDR.

REMARKS: NASA will provide draft TDP delivery schedule and provide interim requests through the Contracting Officer's Representative to the contractor within 90 days post contract award.

INTERRELATIONSHIPS:

DRDs (may include the following as specified):

a. DRD No. STD-SMEM – Structural and Manufacturing Engineering Models and Associated Data.

b. DRD No. STD-SMT – Specification and Model Trees.

c. DRD No. STD-EMAL – Engineering Models and Associated Lists.

DATA PREPARATION INFORMATION:

SCOPE: TDPs contain the required datasets (CAD, analyses, models, metadata, etc., and supporting product configuration information) necessary to support the building of an integrated model set representing the program's top level end items of the integrated system.

APPLICABLE ITEM:

MIL-STD-31000 Technical Data Packages

CONTENTS:

The following items provide a technical description of the items necessary for supporting an acquisition, production, engineering, and logistics support (e.g., Engineering Data for Provisioning, Training, Maintenance, and Technical Manuals). TDPs contain multiple elements, described by levels and types, and typically have associated metadata and supplementary technical data. The description defines the required design configuration and/or performance requirements and procedures required to ensure adequacy of an item's performance. It consists of applicable technical data such as fully annotated models, drawings, associated lists, specifications, standards, performance requirements, QAPs, software documentation, and packaging details. The following contents shall be in accordance with the contract if specified — otherwise with MIL-STD-31000. (Note: The preparer should refer to MIL-STD-31000 for guidance, as well as reference Figure 5, TDP Option Selection Worksheet, of MIL-STD-31000 as feasible. MIL-STD-31000, Figure 5 is attached in this Handbook as figures D-1 and D-2).

REFERENCE DOCUMENTS: The applicable issue of the documents cited herein, including their approval dates and dates of any applicable amendments, notices, and revisions, shall be as specified in the contract.

CONTENT: The TDP shall include one or more of the following:

a. Conceptual design drawings/models in accordance with MIL-STD-31000C, section 5.4.1.1.

b. Developmental design data and associated lists in accordance with MIL-STD-31000C, section 5.4.1.2.

c. Product engineering design data and associated lists in accordance with MIL-STD-31000C, section 5.4.1.3. The following shall be documented directly or by reference, as applicable:

(1) Details of unique processes (i.e., not published or generally available to industry, when essential to design and manufacture), critical manufacturing processes, and assembly sequences.

(2) Performance ratings.

(3) Diagrams, mechanical and electrical connections, dimensional and tolerance data, tolerance input and output characteristics.

(4) Physical characteristics, including form, finishes, and protective coatings.

(5) Details of material identification, including material condition and mandatory treatments and coatings.

(6) Inspection, test, and evaluation criteria.

(7) Equipment calibration requirements.

(8) Quality assurance requirements.

(9) Hardware marking requirements.

(10) Requirements for reliability, maintainability, environmental conditioning, shock and vibration testing, and other operational or functional tests.

(11) Vendor substantiation data when required by the contract or purchase order.

(12) Requirements for programming software into devices or assemblies, including a description of the input media and the procedures for validating that the software has been installed correctly.

(13) Special consideration items and processes.

A. Commercial drawings/models and associated lists in accordance with MIL-STD-31000C, section 5.4.1.4.

B. Special inspection equipment drawings/models and associated lists in accordance with MIL- STD-31000C, section 5.4.2.

d. Special Tooling drawings/models and associated lists in accordance with MIL-STD-31000C, section 5.4.3.

e. Specifications in accordance with MIL-STD-31000C, section 5.4.4.

f. Software documentation in accordance with MIL-STD-31000C, section 5.4.5.

g. Special Packaging Instruction documents, drawings/models, and associated lists in accordance with MIL-STD-31000C, section 5.4.6.

h. Quality assurance provisions in accordance with MIL-STD-31000C, section 5.4.7.

i. Required manufacturing processes and descriptions in accordance with MIL-STD-31000C, section 5.4.8.

j. Additive manufacturing (AM) data file in accordance with MIL-STD-31000C, section 5.4.9.

k. Technical Data Package List (TDPL). A TDPL shall be prepared as an index to identify all content contained in the TDP. The TDPL format shall be as described in the contract and, at minimum, shall list all content in the TDP by nomenclature, document number, Commercial and Government Entity (CAGE) code, document revision, and date.

FORMAT: The contractor shall ensure that the following standards are implemented to sufficient conformance levels, including industry recommended practices:

a. ASME Y14.41, “Digital Product Definition Data Practices, Engineering Product Definition and Related Documentation Practices.”

b. ASME Y14.47, “Model Organization Practices - Engineering Product Definition and Related Documentation Practices.”

c. ISO 10303, Part 209, edition 2, “Industrial automation systems and integration - Product data representation and exchange - Part 209: Application protocol: Multidisciplinary analysis and design.”

d. ISO 10303-238, “Standard for the Exchange of Product (STEP) Model Data, PART 238: Application interpreted model for computerized numeric controllers.”

e. ISO 10303-239, “Industrial automation systems and integration - Product data representation and exchange - Part 239: Application protocol: Product lifecycle Support.”

f. ISO 10303-242, “Industrial automation systems and integration – Product data representation and exchange – Part 242: Application protocol: Managed model-based 3D engineering.”

Lightweight 3D CAD model representations shall be provided in one or more of the following:

a. ISO 10303-242, “Industrial automation systems and integration – Product data representation and exchange – Part 242: Application protocol: Managed model-based 3D engineering.”

b. ISO 14306, “JT file format specification for 3D visualization.”

c. ISO 14739-1, “3D use of Product Representation Compact (PRC) format”

MAINTENANCE: Changes/updates post-delivery and models are available upon request.

TDP OPTION SELECTION WORKSHEET

SYSTEM:		DATE PREPARED:	
A. CONTRACT NO.	B. EXHIBIT/ATTACHMENT NO.	C. CLIN	D. CDRL DATA ITEM NO.

1. TDP LEVEL (CHOOSE ONLY ONE PER WORKSHEET). Note: The level selected must coincide with the requirements of the elements selected in block 5.

A. ☐ CONCEPTUAL LEVEL
☐ DEVELOPMENTAL LEVEL
☐ PRODUCT LEVEL

B. REMARKS:

2. TYPE AND FORMAT (X all that apply and complete as applicable.)

A. ☐ TYPE 2D: 2D DRAWINGS(describe in detail in remarks below or in block 11):

☐ NATIVE 2D CAD (SPECIFY TYPE): _____
☐ ISO 32000 PDF
☐ HARD COPY
☐ OTHER FORMAT (SPECIFY TYPE): _____

REMARKS :

B. ☐ TYPE 3D: 3D MODEL BASED (describe in detail in remarks below or in block 11):

☐ NATIVE 3D CAD (SPECIFY TYPE): _____
☐ 3Di VIEWABLE* FORMAT DERIVED FROM 3D NATIVE MODELS (Specify type, i.e. ISO 32000 PDF etc.).
☐ NEUTRAL FORMAT DERIVED FROM 3D NATIVE MODELS (Specify type, i.e. STEP AP203, AP 214 etc.).
☐ 2D DRAWINGS DERIVED FROM 3D NATIVE MODELS (Specify type, i.e. ISO 32000 PDF etc.).
☐ OTHER FORMAT (SPECIFY TYPE): _____

NOTE: 3Di viewable will be in ISO 32000 pdf format unless otherwise specified.

REMARKS :

3. CAGE CODE AND DOCUMENT NUMBERS	A. ☐ CONTRACTOR CAGE & DOCUMENT NUMBERS ☐ GOVERNMENT CAGE & DOCUMENT NO. (COMPLETE 3B, 3C, AND 3D)	
B. USE CAGE CODE:	C. USE DOCUMENT NUMBERS:	D. TO BE ASSIGNED BY:

4. DRAWING FORMATS AND/OR 3Di PDF FORMAT (X one and complete as applicable)

☐ CONTRACTOR FORMAT ☐ GOVERNMENT FORMAT
REMARKS:

5. TDP ELEMENTS REQUIRED (X all that apply)

☐ ELEMENTS REQUIRED TO BE DETERMINED BY CONTRACTOR

OR THE FOLLOWING ARE REQUIRED:

☐ CONCEPTUAL ENGINEERING DESIGN DATA
☐ DEVELOPMENTAL ENGINEERING DESIGN DATA AND ASSOCIATED LISTS
☐ PRODUCT ENGINEERING DESIGN DATA AND ASSOCIATED LISTS
☐ COMMERCIAL ENGINEERING DESIGN DATA AND ASSOCIATED LISTS
☐ SPECIAL INSPECTION EQUIPMENT (SIE) ENGINEERING DESIGN DATA AND ASSOCIATED LISTS
☐ SPECIAL TOOLING ENGINEERING DESIGN DATA AND ASSOCIATED LISTS
☐ SPECIFICATIONS
☐ SOFTWARE DOCUMENTATION
☐ SPECIAL PACKAGING INSTRUCTIONS (SPI) ENGINEERING DESIGN DATA AND ASSOCIATED LISTS
☐ QUALITY ASSURANCE PROVISIONS (QAPs)

6. APPLICABILITY OF STANDARDS. The following Standards apply: (X as applicable)

☐ ASME Y14.100 ENGINEERING DRAWING PRACTICES WITH APPENDICES: ☐ B ☐ C ☐ D ☐ E Company stds permitted? Y/N	☐ ASME Y14.24 TYPES AND APPLICATIONS OF ENGINEERING DRAWINGS ☐ ASME Y14.34 ASSOCIATED LISTS ☐ ASME Y14.35 REVISION OF ENGINEERING DRAWINGS AND ASSOCIATED DOCUMENTS ☐ ASME Y14.41 DIGITAL PRODUCT DEFINITION DATA PRACTICES ☐ ASME Y14.5 DIMENSIONING AND TOLERANCING	☐ OTHER STANDARDS APPLY AS DESCRIBED:

Figure B-1—TDP Option Selection Worksheet (pg. 1), Reference MIL-STD-31000C, Figure 5

TDP OPTION SELECTION WORKSHEET
PAGE 2

A. CONTRACT NO.	B. EXHIBIT/ATTACHMENT NO.	C. CLIN	D. CDRL DATA ITEM NO.

7. ASSOCIATED LISTS (X all that apply and complete as applicable.)

A. ☐ PARTS LISTS (X ONE)*	☐ (1) INTEGRAL	☐ (2) SEPARATE		☐ (3) CONTRACTOR SELECT
B. ☐ DATA LISTS	☐ REQUIRED (Specify Levels of ASSY) _____			
C. ☐ INDEX LISTS	☐ REQUIRED (Specify Levels of ASSY) _____			
D. ☐ WIRING LISTS	☐ (1) INTEGRAL	☐ (2) SEPARATE		☐ (3) CONTRACTOR SELECT
E. ☐ APPLICATION LISTS	☐ (1) INTEGRAL	☐ (2) SEPARATE	☐ (3) PLM MAINTAINED	☐ (4) CONTRACTOR SELECT
F. ☐ OTHER	☐ REQUIRED(Specify Levels of ASSY) _____			

**NOTE: USE OF SEPARATE PARTS OR WIRING LISTS ARE NOT RECOMMENDED ESPECIALLY WITH TYPE 3D TDPS.*

8. TDP DATA MANAGEMENT PRODUCTS

A. ☐ TECHNICAL DATA PACKAGE LIST (TDPL)
☐ SOURCE CONTROL APPROVAL REQUEST
☐ DOCUMENT NUMBER ASSIGNMENT REPORT
☐ PROPOSED CRITICAL MANUFACTURING PROCESS DESCRIPTION
☐ ENGINEERING DRAWING TREE
☐ TO LOWEST REPAIRABLE UNIT (LRU) LEVEL
☐ TO LOWEST COMPONENT LEVEL
☐ OTHER (DESCRIBE): _____

B. REMARKS:

9. TDP METADATA

☐ TDP METADATA REQUIRED (describe requirements):

10. TDP SUPPLEMENTARY DATA

☐ TDP SUPPLEMENTARY DATA REQUIRED (describe requirements):

11. OTHER TAILORING (Attach additional sheets as necessary

12. PROCURING ACTIVITY TITLE, SIGNATURE AND DATE

TITLE:	SIGNATURE:	DATE:

Figure B-2—TDP Option Selection Worksheet (pg. 2), Reference MIL-STD-31000C, Figure 5 (cont.)

B.4. STRUCTURAL AND MANUFACTURING ENGINEERING MODELS (SMEM) AND ASSOCIATED DATA TEMPLATE

DATA REQUIREMENTS DESCRIPTION (DRD)

DPD NO.: XXX

DPD STATUS: Draft

DRD NO.: STD-SMEM

DATA TYPE: 3

DATE REVISED:

PAGE: 1/4

TITLE: Structural and Manufacturing Engineering Models and Associated Data

DESCRIPTION/USE: To provide digital engineering data utilizing model-based definitions/designs (MBD) by defining the required design, analyses, and manufacturing models to the extent required to support integration of engineering, manufacturing, assembly/test, operations, and maintenance workflows, and sustaining functions of the integrated products and the resultant operational systems. Engineering models, datasets, and associated metadata shall be sufficient to build/assemble the detailed configuration of all deliverable system, subsystem, and component levels for the given purpose (e.g., models, simulations, digital prototypes, operational digital twin, etc.) from the component to the fully integrated system. CAD, computer-aided engineering (CAE) (e.g., finite element method/finite element analysis, etc.), and CAM models shall be prepared and submitted in their agreed-to standards and templates. An indentured product structure shall be submitted for each configuration item (CI) that graphically depicts the hierarchical structure of parts from the CI down to assemblies, subassemblies, and components.

OPR: NASA SE&I

DM: NASA CMO

DISTRIBUTION: Per Contracting Officer's letter

INITIAL SUBMISSION: Submit 30 days prior to the PDR. The Parts Marking Plan should be submitted 60 days after the contract award.

SUBMISSION FREQUENCY: Submit four (4) weeks prior to each major review, as part of a TDP. In addition, engineering models, along with updated product structure, shall be submitted between milestones as requested by the procuring activity for the related CIs.

REMARKS: None

INTERRELATIONSHIPS:

ASME Y14.41	Digital Product Definition Data Practices
ASME Y14.47	Model Organization Practices
ISO 10303, Parts 233, 239, 242, etc.	Refer to Appendix K

DATA PREPARATION INFORMATION:

SCOPE: The customer or designated Lead Systems Integrator shall develop integrated model sets, assembling the various engineering model sets utilizing the agreed upon standards and formats.

APPLICABLE ITEMS: None.

CONTENTS: Refer to Data Deliverable section.

FORMAT: Determined by specific program/project/activity.

MAINTENANCE: Refer to Data Deliverable section.

DATA DELIVERABLES:

The supplier shall deliver:

a. Their integrated engineering models representing the contractor's deliverable end items — system and assembly models identifying changes since prior submittal.

b. The integrated system digital model assembly shall be an independent model that combines elements from the installation model and the contractor's end item models.

(1) The integrated system, subsystem, or element top assembly digital model shall not contain simplified model representations.

(2) The integrated system of systems digital model (highest level assembly) shall use a common skeleton structure definition for placement of major elements and their derivative model representations, i.e., a simplified representation.

c. Simplified representations of the contractor's system top assemblies and primary integrated ground support equipment (GSE) with the integrated element, if created.

(1) A simplified representation is an accurate single surface, ‘water-tight’ contiguous body representing the nominal “as-designed” configuration or structure. A simplified representation is not a Creo Parametric™ (or other CAD) native simple representation.

(2) A simplified representation used for space and weight shall determine weight and center of gravity, either as computed or assigned.

(3) Keep-out zones and other volume simulators shall be separate models located per the common skeleton structure.

d. A light-weight viewable derived from the integrated top assembly model set.

(1) A light-weight viewable is a CAD-derived product that is used to view CAD graphical data with a standard personal computer and Web downloadable software. Lightweight viewables can be used by those with little or no CAD experience and/or without access to CAD software/licenses. Light-weight viewable files shall contain approximate (faceted) data, exact boundary representation surfaces (non-uniform rational basis spline), product and limited PMI, and metadata.

(2) Lightweight viewables shall be delivered in formats such as 3D PDF and/or Jupiter Tessellation (JT) in addition to the native 3D CAD.

e. All associated models used in the assembly model.

f. Creo Parametric™-driven modeling files of the design/ modifications suitable for a construction fabricator.

g. Subsystem model assemblies (i.e., fluid panels, enclosures, umbilicals, etc.) will be provided to the architect and engineer.

The architect and engineer shall deliver:

a. Modified assemblies in the same format as they were received.

b. Simplified representation of the base structure, tower levels, and primary integrated GSE with the integrated mobile launcher assembly, if created.

(1) A simplified representation used for space and weight shall determine weight and center of gravity, either as computed or assigned.

(2) Keep-out zones and other volume simulators shall be separate models located per the common skeleton structure.

c. A light-weight viewable derived from the integrated mobile launcher assembly model.

(1) A light-weight viewable is a CAD-derived product that is used to view CAD graphical data with a standard personal computer and Web downloadable software.

(e.g., Light weight viewables can be used by those with little or no CAD experience and/or without access to CAD software/licenses.)

d. Interface Detail Product

(1) The Interface Detail Product contains only the CAD files necessary to construct the ICD views. The Interface Detail Product CAD dataset should be located in vehicle or element coordinates.

(2) An ICD should be as generic as possible. To the extent possible, an Interface Detail Product should not reflect “background detail” that is subject to change.

e. Provide a reference document detailing any name changes (i.e., “WAS”, “IS”) if necessary.

B.5. CONFIGURATION AND DATA MANAGEMENT PROCESS AUDIT (CDMPA) TEMPLATE

DATA REQUIREMENTS DESCRIPTION (DRD)

DPD NO.: XXX

DPD STATUS: Draft

DRD NO.: STD-CDMPA

DATA TYPE: 3

DATE REVISED:

PAGE: 1/3

TITLE: Configuration and Data Management Process Audit (CDMPA)

DESCRIPTION/USE: To ensure that the supplier's organization is compliant with the configuration management (CM) requirements of the contract and that the configuration baselines are correctly defined, controlled, accounted for, and verified, and any required corrective actions resulting from the audit are implemented.

OPR: [Enter Agency organization with technical responsibility for the supported data.]

DM: [Enter Agency organization acquiring the data for a specific program/project/activity.]

DISTRIBUTION: Per Contracting Officer's letter.

INITIAL SUBMISSION: Per program/project/activity in contract; otherwise, submit within 30 days of the supplier's Configuration and Data Management Plan (CDMP) (DRD No. STD-CDMP) delivery.

SUBMISSION FREQUENCY: Per NASA/supplier jointly approved audit plan.

REMARKS: None

INTERRELATIONSHIP: None

DATA PREPARATION INFORMATION:

SCOPE: The CDMPA will ensure that the audited organization is compliant with the CDM requirements of the project.

APPLICABLE ITEMS:

Program/Project/Activity-specific CDM Process Audit Plan

CONTENTS: The CDMPA is a joint NASA/supplier activity that is conducted to verify the adequacy of the supplier's implementation and execution of CDM requirements and identify areas that need correction or improvements. The supplier shall provide data to support the CDMPA as defined in the Program/Project/Activity-specific Audit Plan, including the following:

a. CDMP.

b. Configuration Status Accounting (CSA) Reports.

c. Deviation and Waiver Approval Requests.

d. Engineering Models, Drawings, and Associated Lists.

e. Engineering/Project Change Proposals.

f. Release Records.

g. Manufacturing Records (including Work Authorization Documents (WADs), Non-Conformances (NCs), Open Work items, etc.).

h. Acceptance Data Package Documentation.

i. Functional Configuration Audit/Physical Configuration Audit (FCA/PCA) Review Findings.

j. Agenda.

k. Presentation Charts.

l. Supplier Self-Assessment Results.

m. Minutes.

n. Findings (Generated at Reviews).

o. Follow-up Closure Status.

FORMAT: NASA-approved supplier format is acceptable.

MAINTENANCE: Discrepancies found during the audit shall be documented as Findings Observations, or equivalent, and corrective action assigned for each finding.

B.6. CONFIGURATION AND DATA MANAGEMENT PLAN (CDMP) TEMPLATE

DATA REQUIREMENTS DESCRIPTION (DRD)

DPD NO.: XXX

DPD STATUS: Draft

DRD NO.: STD-CDMP

DATA TYPE: 1

DATE REVISED:

PAGE: 1/6

TITLE: Configuration and Data Management Plan (CDMP)

DESCRIPTION/USE: To describe the approach for accomplishing how the supplier shall implement CDM requirements into plans, processes, and procedures in compliance with the overall Agency, program, and project's requirements, policies, and procedures; and address configuration and data management (CDM) planning and organization, configuration identification, configuration control and interface management, CSA, and configuration verification and audits along with their correlating data access controls/security.

OPR: NASA CMO or their representative.

DM: NASA Data Management Office (DMO) or their representative.

DISTRIBUTION: Per Contracting Officer's letter.

INITIAL SUBMISSION: Submit 90 days post contract award.

SUBMISSION FREQUENCY: Submit annual updates as well as necessary submittals due to contract changes.

REMARKS: None.

INTERRELATIONSHIP: All related CDM scope and DRDs.

DATA PREPARATION INFORMATION:

SCOPE: The CDMP will identify how the supplier will implement CDM to provide consistency among the product requirements, PCI, and the product throughout the applicable phases of the product lifecycle. The CDMP reflects the supplier's planned application of the CDM principles and practices to the Government's identified product context and environment. The CDMP and its sub-tiered policies, processes, and procedures shall define the supplier's entire collective CDM processes and enable CDMPAs (e.g., STD-CDMPA).

APPLICABLE ITEMS:

SAE GEIA-859	Data Management
SAE EIA-649	Configuration Management Standard
SAE EIA-649-2	Configuration Management Requirements for NASA Enterprises

CONTENTS: The CDMP shall define and explain how the supplier implements a CDM Program to meet the requirements of GEIA-859, SAE EIA-649, and SAE EIA-649-2, including the following:

Configuration Management Planning and Organization -

a. Purpose and Scope:

(1) The purpose and objectives shall be stated along with a brief description of the supplier's management policy and methods as applied to the CDM Program.

(2) A brief description of the system or system products, including the top-level hardware, software, etc., with lower-level component CIs for which the supplier is responsible for supplying to the Government and to which the CDMP pertains.

(3) Any applicable limitations and assumptions (e.g., time constraints, known risks, customer participation level, resource availability, etc.) that may impact the supplier's ability to perform the defined CDM activities or impact the proposed budget and/or schedule shall be identified.

(4) The supplier shall describe the persons, boards, and groups within and external to the supplier's organization having decisional authority over the planning, implementation, and execution of the CDMP.

(5) Reference and other applicable documents: All specifications, standards, manuals, and other documents, including policy directives, shall be specified in the plan by title, document number, revision, issuing authority, and when applicable, change notice, amendment number, and date of issue. All applicable CDM-related documents (e.g., separate software and sub-supplier CDMPs and risk management plans) and their interrelationships shall be identified and listed in the plan by title, number, issuing authority, and when applicable, revision, change notice, amendment number, and date of issue.

b. Organization: Describe and graphically illustrate the organizational context within which the planned CDM activities will be implemented, including:

(1) All organizations, whether internal or external to the supplier's organization, that will participate in or are responsible for any CDM activity.

(2) Responsibility and authority for CDM and all participating groups and organizations, including their roles in Configuration Control Boards (CCBs).

(3) Description of the supplier's CDM organization to include how CDM responsibilities shall be allocated and any unique qualifications or training methods and materials required.

(4) The organizational interface points for both the hardware and the software products and the interfaces required to implement these relationships.

(5) The functional integration of CDM activities into other program activities such as technical, management, and design reviews.

c. Configuration Identification:

(1) List of CIs and Computer Software Configuration Items (CSCIs) managed under this CDMP and the criteria for the establishment of CIs and CSCIs.

(2) Establishment and management of PCIs.

(3) Establishment of configuration baselines (functional, allocated, and product) and definition of the configuration documentation required for each, including graphic illustration of configuration documentation relationships and describe any other baselines that are required to be tracked by CDM.

(4) Assignment, application, and control of unique identifiers for each PCI and revisions.

(5) Identification of release procedures for PCI.

d. Configuration Control and Interface Management:

(1) Organization, functions, responsibility, and authority of the CCBs.

(2) Identification of the membership roles for each authorized CCB.

(3) Classification of changes and the level of authority for change disposition.

(4) Identification of procedures for processing different types of changes such as Request for Change, Request for Variance (RFV), Field Engineering Changes, modification kit authorization, issuance, and tracking and included processes and responsibilities for receiving, recording, evaluating, distributing, and maintaining changes through implementation and closure.

(5) Identification of the interrelationship between any interface working groups and the configuration control process.

(6) Identification of the interrelationship between the nonconformance disposition process and the change management process.

e. Configuration Status Accounting:

(1) Methods for collecting, recording, processing, maintaining, and safeguarding data necessary to provide the status accounting information via reports and/or database access.

(2) Description of the content and formation for all configuration accounting reports or information system content as related to the identified data elements including:

A. Identification of currently approved PCI and configuration identifiers associated with each CI.

B. Status of request for change from initiation to implementation.

C. RFV.

D. Traceability of changes to released document through implementation.

E. Results of configuration audit; status and disposition of discrepancies.

F. Effectivity and installation status of approved configuration changes to all CIs at all locations.

G. Methods of access to information in status accounting systems and/or frequency of reporting and distribution.

f. Configuration Verification and Audits:

(1) Plans, procedures, documentation, and schedules for functional and physical configuration audits.

(2) Plans, procedures, documentation, and schedules for conducting CDM system audits and reporting results, and to define the expectations and responsibilities of organizations in sufficient detail to allow for planning and funding.

(3) Plans, procedures, and schedules for reviews necessary for the establishment of functional, allocated, and product baselines.

(4) Description of the format for audit reports and the method for tracking status and disposition of discrepancies.

g. Configuration data management shall describe the methods for meeting the CDM technical data requirements under the computer-aided transmission and distribution requirements for the project. The following lists areas to be considered when addressing this subject in the CDMP (this list is not comprehensive):

(1) How data deliverables, including CDM identification data and changes, are delivered, verified, stored, and maintained.

(2) How data is processed and the type of records, hardcopy or digital.

(3) How CUI and Limited Rights (LR) information is protected.

(4) Method of notification/acknowledgement of receipt, return, or acceptance.

(5) Indication of time constraints, if any, or automatic data acceptance.

(6) Data status accounting.

(7) How data is accessed.

(8) Methods of indicating acceptance, provisional acceptance, approval, or rejection, as applicable.

h. Records: Identify and maintain CDM-related records.

FORMAT: CDMP template available from the Government; supplier format accepted upon approval by the Government.

MAINTENANCE: Changes shall be incorporated by complete revision/reissue and submitted at least annually.

B.7. CONFIGURATION STATUS ACCOUNTING (CSA) TEMPLATE

DATA REQUIREMENTS DESCRIPTION (DRD)

DPD NO.: XXX

DPD STATUS: Draft

DRD NO.: STD-CSA

DATA TYPE: 3

DATE REVISED:

PAGE: 1/4

TITLE: Configuration Status Accounting (CSA)

DESCRIPTION/USE: To provide accurate and timely information concerning a product and its product configuration information throughout the product lifecycle.

OPR: NASA CMO

DM: [Enter Agency organization acquiring the data for a specific program/project/activity.]

DISTRIBUTION: Per Contracting Officer's letter

INITIAL SUBMISSION: Submit three (3) weeks prior to the PDR.

SUBMISSION FREQUENCY: Resubmit at major design reviews and configuration audits, and as requested

REMARKS: None

INTERRELATIONSHIP: DRD No. STD-CDMP

DATA PREPARATION INFORMATION:

SCOPE: The CSA will provide a status of configuration baseline changes and record of accurate and timely product configuration information that will be captured as it is created over the product lifecycle.

APPLICABLE ITEMS:

SAE EIA-649	Configuration Management Standard
SAE EIA-649-2	Configuration Management Requirements for NASA Enterprises

CONTENTS: The CSA shall meet the requirements of SAE EIA-649 and SAE EIA-649-2. The supplier shall provide the following reports as required by the contract:

a. The Dispositioned Change Activity Report shall list all proposed changes, including variances that have been received and the customer disposition action, arranged in a change proposal number sequence. The following data elements shall be included:

(1) Identification of the change proposal, including the basic number, revision level, title, and associated change package number.

(2) Identification of the CI affected, including the number, nomenclature, and CI effectivity by serial number(s).

(3) Identification of contractual change authorization, including number and date.

(4) Disposition of the change proposal, i.e., “Approved”, “Approved with Changes”, or “Disapproved”.

(5) Identification and date of the supplier’s internal authorization documentation.

b. The Pending Change Activity Report shall list all change requests (CRs) that are pending, either for internal supplier or customer approval, and shall be arranged in a change proposal number sequence. The following data elements shall be included:

(1) Identification of the change action, including the basic number, revision level, title, and associated change package number.

(2) Identification of the CI affected, including number, nomenclature, and CI effectivity by serial number(s).

(3) Depending on the processing status, enter the actual or estimated date of submittal to the customer.

c. The Configuration Identification Report shall identify the baseline configuration and all configuration change actions for each CI. Hardware and software changes shall be listed separately from Variance Request (VR) actions. The following data elements shall be included:

(1) Contract and contractor identification.

(2) CI identification, including, as appropriate, CI number and nomenclature, part number, and specification number.

(3) Configuration change data, including the following:

A. Change proposal identification, including type of action (e.g., CR or VR), number, title, and associated change package number (if applicable).

B. Change application, including item(s) affected (e.g., hardware, software, or documentation), first and total effectivities, and the incorporation or installation points.

C. Change disposition, including the identification of contractual change authorization.

d. The Change Incorporation Status Report shall list the status of CR incorporation into CIs and shall be organized by CI number. The following data elements shall be included:

(1) CI identification number and serial number.

(2) CR number, title, type of change, and associated change package number.

(3) Change effectivity, engineering release date, and incorporation point.

(4) In-line incorporation completion date – scheduled and actual – as appropriate.

(5) Mod Kit data shall include identification, authorization, effectivity, man-hour estimates and status, installation location, shipping date (scheduled and actual), and completion date(s) for installation and retest, if required.

e. The As-designed/As-built Comparison Report describes the differences between the as-designed and as-built configurations.

f. The Software CSA Reports shall provide reports as follows:

(1) Released documentation, including specifications and interface information.

(2) Problem reporting, deviation/waiver activity, including dispositions and open actions.

(3) Promotion tracking of code for each file through development, testing, validation/verification, and operational deployment.

(4) Build records and version control that provide data for the Version Description Document.

FORMAT: supplier format is acceptable provided the requirements of SAE EIA-649-2 are addressed for each report.

MAINTENANCE: None required.

B.8. SPECIFICATION AND MODEL TREES (SMT) TEMPLATE

DATA REQUIREMENTS DESCRIPTION (DRD)

DPD NO.: XXX

DPD STATUS: Draft

DRD NO.: STD-SMT

DATA TYPE: 3

DATE REVISED:

PAGE: 1/2

TITLE: Specification and Model Trees (SMT)

DESCRIPTION/USE: A specification tree is a generation breakdown of the specifications with interrelationships, as applicable, to the CIs. A model tree is a generation breakdown of the engineering models that depict the allocation of requirements of the CI specification.

OPR: [Enter Agency organization with technical responsibility for the supported data.]

DM: [Enter Agency organization acquiring the data for a specific program/project/activity.]

DISTRIBUTION: Per Contracting Officer's letter

INITIAL SUBMISSION: Specification trees are due three (3) weeks prior to the PDR. Model trees are due three (3) weeks prior to the CDR.

SUBMISSION FREQUENCY: The specification tree is updated for the CDR. The specification and model trees are updated for the PCA.

REMARKS: None

INTERRELATIONSHIP: None

DATA PREPARATION INFORMATION:

SCOPE: SMTs depict the hardware and software CIs in top down or generation breakdown form.

APPLICABLE ITEMS: None

CONTENTS: The SMTs shall consist of an indentured or generation breakdown listing of all specifications or drawings applicable to a CI(s).

FORMAT: Contractor format is acceptable upon Government approval.

MAINTENANCE: Changes shall be incorporated by complete reissue.

NOTE to STD-SMT

Sample Statement of Work Words:

Specification and Model Trees. Specification and drawing trees shall be provided in accordance with DRD No. STD-SMT.

NOTE:

The applicability/tailoring instructions on this DRD are not a part of the DRD and should not be included in a DPD.

B.9. ENGINEERING MODELS AND ASSOCIATED LISTS (EMAL) TEMPLATE

DATA REQUIREMENTS DESCRIPTION (DRD)

DPD NO.: XXX

DPD STATUS: Draft

DRD NO.: STD-EMAL

DATA TYPE: 3

DATE REVISED:

PAGE: 1/6

TITLE: Engineering Models and Associated Lists (EMAL)

DESCRIPTION/USE: To provide engineering data defining the design to the extent required to support manufacturing, test, and logistics support of the vehicle and payload systems and required spare parts. EMALs shall be sufficient depictions of the detailed configuration of all system, subsystem, and component levels and include GSE, electrical GSE, and airborne support equipment. Two-dimensional (2D) and 3D CAD models shall be submitted as primary information. A Product Breakdown Structure and drawing tree shall be submitted for each CI that graphically depicts the hierarchical structure of all parts (components, assemblies, etc.) from the top-level CI down to assemblies, subassemblies, and components.

OPR: NASA CMO or their representative

DM: NASA DMO or their representative

DISTRIBUTION: Per Contracting Officer's letter

INITIAL SUBMISSION: Submit three (3) weeks prior to the PDR.

SUBMISSION FREQUENCY: Submit three (3) weeks prior to each major review, as part of a TDP, and as requested. In addition, 3D CAD models shall be submitted between milestones as requested by the procuring activity; and updated Product Structure and/or Model Trees shall be submitted for the related CIs' PCA.

REMARKS: None.

INTERRELATIONSHIP:

DRD No. STD-TDP – Technical Data Package Template

DRD No. STD-MRI – Master Records Index

DATA PREPARATION INFORMATION:

SCOPE: EMALs disclose (directly or by reference) the physical and functional requirements of an item by means of graphics or textual presentation or combinations of both, as implemented by 3D models. Product Structure Reports and Model Trees depict the hardware and software CIs in graphic, top down, hierarchical structures.

APPLICABLE ITEMS:

Global Drawing Requirements Manual (GDRM) (Tenth Edition)

ASME Y14.5	Dimensioning and Tolerancing
ASME Y14.100	Engineering Drawing Practices
ASME Y14.24	Types and Applications of Engineering Drawings
ASME Y14.34	Associated Lists
ASME Y14.41	Digital Product Definition Data Practices
ASME Y14.47	Model Organization Practices
MIL-STD-130	Department of Defense Standard Practices, Identification Marking of U.S. Military Property

CONTENTS: EMAL requirements shall include:

Part I. Engineering models, analyses, and associated lists shall meet the requirements of ASME Y14.100. Geometric dimensioning and tolerancing shall be implemented in accordance with ASME Y14.5. Supplemental 2D/3D CAD shall meet the requirements of ASME Y14.41 and ASME Y14.47. EMALs of end items, elements, and/or all components and assemblies shall be provided to define the details necessary for the manufacture, test, inspection, operations, and logistic support of the system. This definition shall:

a. Reflect the end-product at its current level of design maturity.

b. Provide the engineering data for logistics support products.

c. Provide the necessary data to permit manufacture and/or acquisition of items identical to the original item(s).

Document directly or by reference the following:

a. Details of unique processes (i.e., not published or generally available to industry) when essential to design and manufacture.

b. Performance ratings.

c. Dimensional and tolerance data (geometric dimensioning and tolerancing for all external and major internal interfaces shall have geometric dimensioning and tolerancing applied.)

d. Critical manufacturing processes, assembly sequences, and rigging procedures.

e. Diagrams.

f. Mechanical and electrical connections.

g. Physical characteristics, including form and finish.

h. Details of material identification, including heat treatment and protective coatings.

i. Inspection, test, and evaluation criteria.

j. Equipment calibration requirements.

k. Quality assurance requirements.

l. Hardware marking requirements.

m. Requirements for reliability, maintainability, environmental conditions, shock, vibration testing, and other operational or functional tests.

Limited rights-in-data items: Engineering data for items that the Government does not have unlimited rights in data shall specify the form, fit, and function requirements of the item and conform to the requirements for a control drawing as defined in ASME Y14.100 or a specification prepared in accordance with project requirements.

Part II. Cable interconnect diagrams, electrical system schematics, cable harness assembly models/drawings, wiring lists, and fluid system schematics shall be prepared in accordance with ASME Y14.100. Part I models/drawings shall be utilized to the maximum extent possible in providing the design definition. The models/drawings shall include the following:

a. Cable interconnect diagrams shall graphically depict the arrangement of external electrical cabling that interconnects electrical assemblies and/or equipment. The cable interconnect diagrams shall show all cable runs and terminations; each cable shall be identified by reference designation number. The connector short sign shall be identified.

b. Electrical system schematics shall illustrate and describe circuit items with symbols placed such that a circuit may be traced from item to item in the sequence of its function. The placement and arrangement of these circuits shall follow a logical presentation sequence to provide a clear description of the distribution.

c. Cable harness assembly models/drawings shall meet the requirements of the Global Drawing Requirements Manual (10th edition) and ASME Y14.24.

d. Component Level Documentation – Schematics and/or wiring lists for components, including interconnecting cable harnesses, shall be provided.

e. Overall Grounding Documentation – The grounding schematic shall show the details of all grounds and power returns from source to loads. All connections shall be shown. It shall also show details of all electrical GSE interconnections to facility and safety grounds. Grounding schematics shall meet the requirements of the Global Drawing Requirements Manual (10th Edition).

f. The fluid system schematic shall illustrate and describe all components with symbols and flow designators such that the fluid system may be traced from component to component (such as pumps, valves, meters, regulators, and filters). The schematics shall document the range requirements (flow, temperature, and pressure) for all component external interfaces and line sizes. The placement and arrangement of these components shall follow a logical sequence of presentation to provide a clear description of the flow of fluids in the system. The schematics shall reference EMALs for configuration details.

g. Engineering models/drawings shall specify marking criteria and methods for identification of parts produced or procured. Markings shall be compliant with MIL-STD-130 with compliant unique identification marking (UID)/item unique identification (IUID) 2D codes. All parts shall be physically marked. When physical marking or tagging causes a deleterious effect, labels, tags, and nameplates may be considered. MIL-STD-130 shall be used for paper labels, tagging, and nameplates.

h. A Product Breakdown Structure and drawing tree shall be submitted for each CI that graphically depicts the hierarchical structure of drawings/parts from the CI down to assemblies, sub-assemblies, and components.

FORMAT: The format for engineering CAD models shall be in accordance with ASME Y14.41 and ASME Y14.47 and delivered in the Government's specified native and neutral formats. The format of engineering drawings shall be in accordance with ASME Y14.100. In addition, formats for electrical engineering drawings shall be in accordance with the Global Drawing Requirements Manual (10th Edition). All drawings shall be delivered in native CAD, machine-readable PDF, and other agreed to neutral formats. Additionally, any native file formats used to create the PDF drawings shall be delivered (e.g., *.VSD or *.DWG). Two-dimensional (2D) and 3D CAD models shall be in accordance with ASME Y14.41/ASME Y.14.47, in the current version of native-developed CAD, fully parametric and associative. Native format and machine-readable PDFs are acceptable for model trees. The contractor shall deliver Creo Parametric™ compatible 3D models of the components. Alternate formats may be acceptable upon negotiation. All documentation/data shall include the contractor's CAGE code and document numbers. The contractor may submit electronic files of drawings and CAD models via portable, high-capacity storage medium, or direct electronic transfer into the NASA [XXX] PLM environment as specified by the Government.

For all electronic deliveries, the contractor shall include a listing of the creating environment to include the following:

a. CAD product name/version/patches.

b. Subordinate (plug-in) software/version/patches.

c. Description of hardware (e.g., minimum/desired requirements for central processing unit, graphics processing unit, random access memory [RAM], and storage).

d. Operating system/version/patches.

MAINTENANCE: All documents produced under this DRD shall be maintained with a status of "current". Changes to and/or updating of engineering models, associated lists, product structures, and model trees shall be in accordance with the contractor's approved model management system and the provisions herein. Changes to engineering models under the Government's Class I change control shall be submitted by an Engineering Change Proposal (ECP). The contractor shall maintain the capability to restore and modify any engineering data used in the design throughout the project lifecycle.

B.10. CHANGE REQUEST (CR) TEMPLATE

DATA REQUIREMENTS DESCRIPTION (DRD)

DPD NO.: XXX

DPD STATUS: Draft

DRD NO.: STD-CR

DATA TYPE: 1

DATE REVISED:

PAGE: 1/3

TITLE: Change Request (CR)

DESCRIPTION/USE: To process and submit proposed engineering changes for evaluation and disposition by the appropriate Configuration Approval Authority.

OPR: NASA CMO.

DM: NASA CMO.

DISTRIBUTION: Per Contract Schedule

INITIAL SUBMISSION: Per Contract Schedule

SUBMISSION FREQUENCY: Resubmit as required

REMARKS: None

INTERRELATIONSHIP: None

DATA PREPARATION INFORMATION:

SCOPE: The CR will document information by which a change is proposed, described, justified, and submitted with impact assessment to the Approval Authority.

APPLICABLE ITEMS:

SAE EIA-649-2 Configuration Management Requirements for NASA Enterprises

CONTENTS: The CR shall document a proposed engineering change meeting the requirements of SAE EIA-649-2 and contain the following minimum information:

a. CR number

b. CR revision-version

c. Creation date

d. CR title

e. Change package number

f. Originator name

g. Originator company and organization code

h. CAGE code required for contractor or external agreement

i. Contact or agreement number required for contractor or external agreement

j. Recommended priority: routine, urgent, or emergency

k. Change description

l. Change classification

m. Change type (hardware, software, or documentation)

n. Impacts (cost, schedule, risk, and technical)

o. Justification or reason for change

p. Programs and projects affected

q. Affected baselines, documents, and data

r. Affected CI(s) and effectivity

s. Modification Kit information (if required)

t. The following information is recommended for inclusion: Related models/data (per DRD No. STD-SMEM); schedule need dates; originator's e-mail and telephone; CUI restrictions; consequences if not incorporated; Contracting Officer; OPR; owning Center; and authorization to submit/initiate document number

FORMAT: An agreed-to supplier format is acceptable as long as it meets the content requirements of the Contents section above.

MAINTENANCE: All requested CR changes require submittal of a CR revision.

B.11. FUNCTIONAL CONFIGURATION AUDIT AND PHYSICAL CONFIGURATION AUDIT (FCA/PCA) DOCUMENTATION TEMPLATE

DATA REQUIREMENTS DESCRIPTION (DRD)

DPD NO.: XXX

DPD STATUS: Draft

DRD NO.: STD-AD

DATA TYPE: 2/3

DATE REVISED:

PAGE: 1/6

TITLE: Functional Configuration Audit (FCA) and Physical Configuration Audit (PCA) Documentation.

DESCRIPTION/USE: To support the FCA and PCA. The FCA is an audit to verify performance of the CI or CSCI against approved configuration documentation. The PCA is an audit of the configuration documentation and quality control records to ensure the "as-built" configuration complies with the "as-designed" configuration defined in the documentation.

OPR: [Enter Agency organization with technical responsibility for the supported data.]

DM: [Enter Agency organization acquiring the data for a specific program/project/activity.]

DISTRIBUTION: Refer to Table B-4, FCA/PCA Documentation Distribution and Availability of Data.

INITIAL SUBMISSION: Refer to Table B-4.

SUBMISSION FREQUENCY: Per configuration audit schedule.

REMARKS: NASA will document the audit details and schedule and provide it to the contractor within 90 days post award.

INTERRELATIONSHIP: None.

DATA PREPARATION INFORMATION:

SCOPE: FCA/PCA documentation contains the required documentation necessary to support the configuration audit for a CI and a CSCI.

APPLICABLE ITEMS:

SAE/EIA-649-2 Configuration Management Requirements for NASA Enterprises

CONTENTS: Requirements specifications, verification planning documentation, and other required data for the FCA shall be collected for the CI/CSCI that is to be formally accepted. The PCA verifies that the "as-built" configuration reflects the required characteristics documented in the "as-designed" configuration. Configuration and quality control records and other documents defining the "as-built" or "as-coded" configuration defined in the documentation shall be provided.

SAE/EIA-649-2 provides guidelines on documentation required for the FCA and PCA. See Table B-3, Configuration Audit Required Data, for documentation required for the audits.

Additional documentation requirements to be provided are:

a. Agenda — The agenda shall specify the date, time, and place for the scheduled audit, specific review items, supporting documentation, and key participants. Submit approved copies at the review. See Table B-4.

b. Presentation Charts — Presentation charts shall be submitted at the start of the audit. They shall summarize the details contained in the data package and identify compliance with the contract requirements. See Table B-4 for distribution and availability of data.

c. Plan — A plan shall be submitted prior to initiating the audit stating CIs to be reviewed, data required to perform the review, how audit action items are recorded and tracked, defining success criteria, and providing for formal approval of the audit. The plan shall also define the extent of contractor and Government participation in the review.

d. Audit Minutes Package — The official Audit Minutes Package (not to be confused with the daily audit minutes) shall contain a description of the audit with sufficient detail to enable the audit to be made a matter of record. The Audit Minutes Package shall include the presentation charts, a listing of Findings, audit action items identified with action and suspense data, approved FCA/PCA certification sheets, any daily audit minutes, and any record of other findings, conclusions, and recommendations as applicable. See Table B-4 for distribution and availability of data.

e. Findings — The findings shall show audit action items identified with actions and suspense data, and closure status shall be submitted. See Table B-4 for distribution and availability of data.

FORMAT: NASA-approved contractor format is acceptable.

MAINTENANCE: As required to correct errors and to maintain findings closure status.

Table B-3—Configuration Audit Required Data*

Documentation required for the FCA (As Applicable)	Documentation required for the PCA (As Applicable)
• Requirement Specifications (including ICDs). • Drawings and parts list. • List of approved Drawing Engineering Orders (EOs). • Verification Compliance Report (provides traceability for all requirements to associated verification objectives/requirements and to evidence of compliance which can include raw data). • Approved Change Requests (CRs) and Variance Requests (VRs) (i.e., deviations/waivers) incorporated and pending. • An account of CRs incorporated and tested as well as proposed. • Specification and drawing tree(s). • Materials Usage Agreement. • Material Identification Usage List. • Certification of Qualification(s). • Qualification Test Deficiencies List. • Verification requirements and procedures. • Software (CSCI)-specific data: o Software verification data. o Records that reflect the changes made to design release configuration for the CSCI. o Software Version Description Document. o Findings of all internal CDM and software (including field-programmable gate array devices that contain software that runs executable code) QA audits of the CSCI. o List of field-programmable gate array devices that contain software that runs executable code. • CDR review item discrepancies and dispositions. • Hazard Reports (HR) and HR open issues.	• Acceptance Data Package (ADP). • Final version of all requirement specifications (including ICDs). • Configuration Status Accounting (CSA) reports as requested at the audit. • Software (CSCI)-specific data: o Final version of all software operating and support manuals. o Final version of software Version Description Document. o Software release and build records. • All FCA findings (audit action items) for each CI/CSCI (i.e., official Audit Minutes Package). • List of approved and outstanding CRs and VRs. • All approved contract Directives. • Copies of CRs and VRs as requested at the audit. • Data defining “as-designed” configuration: o Drawing and specification tree. o Product drawings and parts list as requested at the audit. o Indentured Parts List. o Lists of all outstanding EOs that have been incorporated into the CI (and are awaiting incorporation into information). • Acceptance test procedures (ATP) and associated ATP reports. • As-run test procedures (when applicable, include any test discrepancy records). • Identification of all changes made during test. • Identification of any approved and required changes not completed.

Documentation required for the FCA (As Applicable)	Documentation required for the PCA (As Applicable)
• Failure Mode Effects Analysis open issues. • List of open issues for internal or external interfaces. • Test plans and procedures. • Test reports. • Acute Launch Emergency Reliability Tips (ALERTs) tracking log.	• Copy of parts tags or verification closure for verification items verified by inspection method. • Data defining "as-built" configuration: o As-Built Configuration List. o Manufacturing and inspection (build) records as requested at the audit. • Discrepancy Reports (DRs). • Summary and Status of Open Materials Review Board actions including list of open actions. • Proposed DD Form 250, Material Inspection and Receiving Report (for transfer from external supplier to NASA). • D Form 1149, Requisition and Invoice/Shipping Document (for Government-to-Government transfer). • Complete shortage list. o ALERTS tracking log.

**NOTE: This list may require tailoring for a specific contract and its deliverables. Examples would be supplementation with models/datasets, deletion of software requirements if no software was required per the contract.*

Table B-4—FCA/PCA Documentation Distribution and Availability of Data*

Document	Data Type	FCA Copies/Availability	PCA Copies/Availability
Agenda	2	One/15 days prior to audit/approved copies at audit.	One/15 days prior to audit/approved copies at audit.
Data Package	3	One/Two weeks prior to audit.	One /Two weeks prior to audit.
Presentation Charts	3	One for each attendee at audit.	One for each attendee at audit.

Audit Minutes Package	2	One at audit/copy to each attendee within two weeks.	One at audit/copy to each attendee within two weeks.
Findings (generated at Reviews)	2	Provided as hardcopy or electronically per the project-specific Audit Plan.	Close out to be as specified in the project-specific Audit Plan.

**NOTE: This list may require tailoring for a specific contract and its deliverables.*

NOTE to STD-AD

Functional Configuration Audit and Physical Configuration Audit (FCA/PCA) Documentation

Sample Statement of Work Words (*See SOW Tailoring Note below.)

Functional Configuration Audit (FCA) and Physical Configuration Audit (PCA): FCA/PCA shall be conducted in accordance with the requirements specified in SAE/EIA-649-2. The data required to support the FCA and PCA shall be provided as defined in DRD No. STD-AD.

The contractor shall provide the facilities and administrative support necessary for the audits. The requirements for the necessary support are defined in SAE/EIA-649-2 and as follows: (1) provide support for maintaining a system for recording, processing, tracking, and reporting the status of all findings (FCA/PCA Action Items) identified during the audit, corrective action, and closeout status; and (2) provide facilities and administrative support to the audit team(s).

*SOW Tailoring Note

Tailoring of SOW Words to Include Contractor Self-Assessment FCA/PCA: Although the Government normally conducts and approves the FCA/PCA, it may be beneficial to the Government to limit personnel involvement in the detailed reviews and delegate to the contractor additional responsibility for the conduct of the FCA/PCA on a project-by-project basis. It is incumbent upon the NASA Project Manager and the Project CDM representative to assure that the project-specific additional responsibility is tailored into the SOW and that DRD No. STD-AD is tailored to reflect the additional documentation to be supplied.

Application Data: FCA/PCA audits certify that CIs/CSCIs meet criteria for establishing the *Product Baseline* as defined in SAE/EIA-649-2. The FCA/PCA may be included within the scope of the Systems Acceptance Review so long as specific FCA/PCA certifications are obtained.

***Sample complete CDM SOW ***

NOTE:

The applicability/tailoring instructions on this DRD are not a part of the DRD and should not be included in a DPD.

B.12. REQUIREMENTS EXCHANGE FORMAT (REF) TEMPLATE

DATA REQUIREMENTS DESCRIPTION (DRD)

DPD NO.: XXX

DPD STATUS: Draft

DRD NO.: STD-REF

DATA TYPE: 2/3

DATE REVISED:

PAGE: 1/10

TITLE: Requirements Exchange Format (REF)

DESCRIPTION/USE: To facilitate digital integration and interoperability of requirements by defining deliverables (content, format, etc.) for requirement objects enabling the exchange between stakeholders during the full systems' lifecycle. Data delivered from a Requirements Management (RM) System or exchanged between disparate RM systems shall share the following minimum set of requirement attributes for integration purposes. This DRD contains the format and content preparation instructions for Requirement Objects and should be tailored for given contract. RIF/ReqIF™ (Requirements Interchange Format) is an XML file format that can be used to exchange requirements, along with their associated metadata, between software tools from different vendors. The REF and DRD also define a workflow for transmitting the status of requirements between supplier chains.

OPR: NASA SE&I.

DM: NASA CMO.

DISTRIBUTION: TBD

INITIAL SUBMISSION: Due within 30 days of contract award.

SUBMISSION FREQUENCY: Submit 30 days prior to each Contract Major Milestone. Interim submittals shall be made available per request up to 60 days prior to a scheduled delivery.

REMARKS: NASA will provide draft delivery schedule and interim requests through the Contracting Officer's Representative to the contractor within 60 days of contract award.

INTERRELATIONSHIP: None.

DATA PREPARATION INFORMATION:

SCOPE: The supplier shall deliver requirement datasets necessary to support the building of an integrated requirement set representing the program's top level end items representing the integrated system.

APPLICABLE ITEMS:

SAE/EIA-649-2	Configuration Management Requirements for NASA Enterprises
RIF/ReqIF™	Requirements Interchange Format
ISO 10303-233	Part 233: Application protocol: Systems engineering
ISO/TS 10303-1348	Requirement management

CONTENTS: The following items provide a technical description of the items necessary for supporting an acquisition, production, engineering, and logistics support (e.g., requirements data for the entire lifecycle [initial design through retirement]).

The TDP shall include one or more of the following:

UUID — Universally Unique Identifier is a 16-octet (128-bit) number. In its canonical form, a UUID is represented by 32 hexadecimal digits, displayed in five groups separated by hyphens, in the form 8-4-4-4-12 for a total of 36 characters (32 alphanumeric characters and four hyphens). (Source: In accordance with ISO/IEC 11578:1996, Information Technology – Open Systems Interconnection – Remote Procedure Call [RPC])

For example: 550e8400-e29b-41d4-a716-446655440000

Datetime — The combination of a date and a time. Its value space is described as a combination of date and time of day in Chapter 5.4 of ISO 8601. Its lexical space is the extended format:

[-]CCYY-MM-DDThh:mm:ss[Z|(+|-)hh:mm]

The time zone may be specified as Z(UTC) or (+|-)hh:mm. Time zones that are not specified are considered undetermined.

For example: 2013-04-25T23:54:32.000Z

Object Type — REQUIREMENT

A requirement is defined as the agreed upon need, desire, want, capability, capacity, or demand for personnel, equipment, facilities, or other resources or services by specified quantities for specific periods of time or at a specified time expressed as a "shall" statement. Acceptable form for a requirement statement is individually clear, correct, feasible to obtain, unambiguous in meaning, and can be validated at the level of the system structure stated. In pairs of requirement statements or as a set, collectively, they are not redundant, are adequately related with respect to terms used, and are not in conflict with one another.

Required Attributes:

Requirement ID number — A system identifier unique to and assigned by the owning RM system.

- Property type = fixed string
- Cardinality = single
- Max length = 60 characters

Requirement UUID — Universally Unique Identifier (see above)

- Property type = UUID
- Cardinality = single
- Max length = 36 characters (32 alphanumeric characters and four hyphens)

Requirement Name — Short text/title of the requirement object.

- Property type = string
- Cardinality = single
- Max length = unlimited *

Requirement Text (Description) — The "shall" statement defining the specific requirement.

- Property type = string
- Cardinality = single
- Max length = unlimited *

Lifecycle Status/State — Lifecycle status or state of the requirement.

- Legal values =
    - In-Work – Initial stage of an item that has not been through any review process.
    - Completed – Item that has been reviewed and approved but has not been baselined.
    - Accepted – Item that has been reviewed and approved by a panel/board and is ready for baseline.
    - Obsolete – Item that has been overcome by events, canceled, or deleted, and is no longer valid.
- Property type = string
- Cardinality = single

Previous Version UUID — The UUID of the previous version of the specified requirement. If no previous version exists, use the current version UUID.

- Property type = UUID
- Cardinality = single
- Max length = 36 characters (32 alphanumeric characters and four hyphens)

Last Modified Date — The date this object was last modified.

- Property type = datetime
- Cardinality = single

System Id—The identification of the sender/source system that is unique and constant throughout the life of system. The system assigned string with input from system owner.

- Property type = constant unique string
- Cardinality = single
- Max length = 36 characters

Optional Attributes – (include as applicable)

Requirement Type — The initial classification of a requirement that is mandatory for correct requirements definition and relationship definition.

- Constraint — Requirement associated with a limitation or implied requirement that constrains the design solution or implementation of the systems engineering process, is not changeable by the enterprise.

- Functional — Requirement associated with identifying, describing, and relating the functions a system shall perform to fulfill its goals and objectives.

- Interface — How two or more systems, subsystems, or components interact, specifying the functional, physical, or performance constraints at their boundary.

- Performance — How well these functions shall be performed (used in terms of quantity, quality, coverage, timeliness, or readiness), along with the conditions under which the function is performed.

- Physical — A requirement that specifies a physical characteristic that a system or system component shall possess.

- TPM (Technical Performance Measure) — The identification, prediction, measurement, and demonstration of the achievement of key technical objectives that reflect the ability of the system design to satisfy the system effectiveness objectives.

- Verification — Requirements that specify the verification events needed to prove the satisfaction of the product requirements and help to define the verification process and environment.

- Operational — Requirements associated with identifying, describing, and relating the operations of a system shall perform to fulfill Mission Objectives.

- Maintenance — Requirements that define the actions necessary for retaining an item in or restoring it to a specific condition.

- Property type = string

- Cardinality = single

Rationale — Contains Rationale of why and what of the internal and external requirement. Intended to clarify or give additional information that may be needed for the user to better understand the scope of the requirement.

- Property type = string

- Cardinality = single

- Max length = unlimited *

Comment — Additional text about the object.

- Property type = string
- Cardinality = single
- Max length = unlimited *

Upstream UUID — The UUID of the requirement from which this requirement was derived. This information will allow for validation of traceability.

- Property type = UUID
- Cardinality = multi

Downstream UUID — The UUID of the requirement(s) that are derived from this requirement (the "children" of this "parent").

- Property type = UUID
- Cardinality = multi

Verification Method – The method by which this requirement will be verified.

- Legal values =
    - Test — The verification of a product or system using a controlled and predefined series of inputs, data, or stimuli to ensure that the product or system will produce a very specific and predefined output as specified by the requirements.
    - Demonstration — The manipulation of the product or system as it is intended to be used to verify that the results are as planned or expected.
    - Inspection — The nondestructive examination of a product or system using one or more of the five senses (visual, auditory, olfactory, tactile, taste). It may include simple physical manipulation and measurements.
    - Analysis — The verification of a product or system using models, calculations, and testing equipment. Analysis allows predictive statements to be made about the typical performance of a product or system based on the confirmed test results of a sample set or by combining the outcome of individual tests to conclude something new about the product or system. It is often used to predict the breaking point or failure of a product or system by using nondestructive tests to extrapolate the failure point.
- Property type = string
- Cardinality = multi
- Object type = REQUIREMENT SPECIFICATION

Required Attributes:

Specification UUID—UUID of the specification.

- Property type = UUID
- Cardinality = single

Specification Name—Short text/title of the specification object.

- Property type = string
- Cardinality = single
- Max length = unlimited *

Specification number — A system identifier assigned by the owning RM system which is unique to the owning RM system.

- Property type = fixed string
- Cardinality = single
- Max length = 60 characters

Lifecycle Status/State—Lifecycle status or state of the specification.

- Legal values =
    - In-Work — Initial stage of an item that has not been through any review process.
    - Completed — Item that has been reviewed and approved but has not been baselined.
    - Accepted — Item that has been reviewed and approved by a panel/board and is ready for baseline.
    - Obsolete — Item that has been overcome by events, canceled, or deleted, and is no longer valid.
    - Property type = string
    - Cardinality = single

Specification Description—A description of the requirement specification.

- Property type = string

- Cardinality = single
- Max length = unlimited *

Specification Effectivity—Defines the applicability of a specific revision of a specification to specific end item(s) (i.e., to which specific hardware or software item instance does this specification apply).

- Property type = string
- Cardinality = multi
- Max length = unlimited *

Optional Attributes – (include as applicable)

Upstream UUID—The UUID of the requirement specification from which this specification was derived. This information will allow for validation of traceability.

- Property type = UUID
- Cardinality = multi

Downstream UUID—The UUID of the requirement specifications that are derived from this specification (the “children” of this “parent”).

- Property type = UUID
- Cardinality = multi

Previous Version UUID—The UUID of the previous version of the specification. If no previous version exists, use the current version UUID.

- Property type = UUID
- Cardinality = multi

Last Modified Date—The date this object was last modified.

- Property type = datetime
- Cardinality = single

System Id—The identification of the sender/source system that is unique and constant throughout the life of system. System assigned string with input from system owner.

- Property type = constant unique string

- Cardinality = single
- Max length = 36 characters

FORMAT: As specified (RIF/ReqIF™ compatible, preferably in/via the XML template provided).

MAINTENANCE: Keep as long as there are requirements — entire lifecycle/as changed/ modified/updated.

B.13. MASTER RECORDS INDEX (MRI) TEMPLATE

DATA REQUIREMENTS DESCRIPTION (DRD)

DPD NO.: XXX

DPD STATUS: Draft

DRD NO.: STD-MRI

DATA TYPE: 1

DATE REVISED:

PAGE: 1/11

TITLE: Master Records Index (MRI)

DESCRIPTION/USE: Defines the standard of build of the System or End Item, including all associated CIs. The index comprises a key to the approved models, drawings, and associated records and lists all design changes introduced by amendments and modifications. The MRI is used by the contractor to define the system product "as-delivered". The MRI is used by the Government to ensure that the system product meets its build standard and requirements.

OPR: NASA CMO or their representative.

DM: NASA DMO or their representative.

DISTRIBUTION: Per the Contracting Officer's letter

INITIAL SUBMISSION: Submit 90 days post start of build.

SUBMISSION FREQUENCY: Submit quarterly updates and, when necessary, due to contract changes.

REMARKS: This DRD is written for use in procurements involving deliveries of digital datasets (involving documents as well as models).

INTERRELATIONSHIPS:

The MRI is subordinate to the following data items, where these data items are required under the Contract:

a. CDMP

b. Systems Engineering Management Plan

c. Integrated Support Plan

The MRI inter-relates with the following data items, where these data items are required under the Contract:

a. Engineering Models/Drawings

b. Master Equipment List

DATA PREPARATION INFORMATION:

SCOPE: The data item shall include a traceability matrix that defines how each specific content requirement, as contained in this DRD, is addressed by sections within the data item.

APPLICABLE ITEMS:

SAE EIA-649	Configuration Management Standard
SAE EIA-649-2	Configuration Management Requirements for NASA Enterprises

CONTENTS:

As a minimum, the MRI shall consist of the following items and be consistent with SAE EIA-649 and SAE EIA-649-2:

a. Cover Sheet.

b. Index of amendments and modifications.

c. Index of Subsidiary/subcontractor Master Record Indices.

d. Index of CIs.

(1) The Index of CIs shall be developed from data in the Configuration Item List.

(2) The Index of CIs shall list, in hierarchical form, all the CIs constituting the Mission System.

(3) The Index of CIs shall be sorted in System and then Subsystem order.

(4) The Index of CIs shall detail the following information for each CI:

A. CI Reference Number. This field shall detail the reference number allocated to the CI by the contractor. This number is to relate the CI to the higher-level assembly to which it belongs in a hierarchical manner to system level.

B. CI Nomenclature. This field shall detail the name allocated to the CI.

C. CI Type. This field shall detail whether the CI is a Hardware Configuration Item or a CSCI.

D. Hardware Configuration Item. This field is applicable to CSCIs that reside on Hardware Configuration Items and shall detail the items in which the CSCI resides.

E. Subsystem. This field shall detail the CI's parent Subsystem.

F. System. This field shall detail the CI's parent System.

G. Design Organization. This field shall detail the organization responsible for design of the CI.

H. Headings. Headings shall be positioned in the Index of CIs to identify where each System and Subsystem begins.

e. Index of Components

(1) The Index of Components shall detail, in hierarchical form, the physical build structure of the System, going down to and including piece parts.

(2) The Index of Components shall be sorted in System, then Subsystem, and then CI order.

(3) The Index of Components shall detail the following information for each item in it:

A. Indenture Level. This field shall document the indenture level of the item; the System is indenture level 1.

B. Part Number. This field shall document the item's Part Number.

C. Variant Number. When more than one variant of an item has been used in the construction of the System, the Part Number of each variant is to be given a variant number (e.g., 1, 2, 3). This field shall default to one (1) when only one variant of an item has been used.

D. Part Number Status. This field shall contain the status of the Part Number (e.g., Proposed, Current, Obsolete, or Historical).

E. Quantity Fitted. This field shall document the quantity of the item fitted to the item's next higher assembly.

F. Drawing Number. This field shall document the Drawing Number of the item.

G. Nomenclature. This field shall document the item's nomenclature.

H. Headings. Headings shall be positioned in the Index of Components to identify where each System, Subsystem, and CI begins.

f. Indentured Drawing List

(1) The Indentured Drawing List shall list, in hierarchical form, all the drawings constituting the System design, including subcontractor drawings.

(2) The Indentured Drawing List shall detail the following information for each drawing:

A. Indenture Level. This field shall document the indenture level of the drawing.

B. Drawing Number. This field shall document the drawing number.

C. Revision Letter. This field shall document the latest revision letter of the drawing applicable to the System.

D. Drawing Title. This field shall document the title of the drawing.

E. Drawing Type. This field shall document the drawing type to which the drawing belongs, e.g., Detail Assembly Drawing, Specification Control Drawing, Wiring List, etc.

F. Drawing Size. This field shall document the sheet size of the drawing, e.g., A2, A3, etc.

G. Number of Sheets. This field shall document the number of sheets making up the drawing.

H. Revision Date. This field shall document the date of the latest revision.

g. Index of Configuration Documentation (IOCD)

(1) The IOCD shall list the Configuration Documentation describing the functional, allocated, and product baselines for the System (drawings shall be excluded from the IOCD, as they have been listed elsewhere).

(2) The IOCD shall be divided into two (2) sections as follows:

A. Sort Section 1 in System, then Subsystem, then CI order.

B. Sort Section 2 in Document Type and then Document Reference Number order.

(3) The IOCD shall detail the following information for each document:

A. CI Reference Number. This field shall detail the CI Reference Number to which the document is applicable.

B. CI Nomenclature. This field shall detail the CI's nomenclature.

C. Document Reference Number. This field shall detail the document's reference number.

D. Document Revision Number. This field shall detail the revision number/level of the document.

E. Document Type. This field shall detail the type of document to which the document belongs and include the following types of Configuration Documentation, as a minimum, where produced:

i. System Specifications.

ii. Development Specifications.

iii. Product Specifications.

iv. Interface Control Documents (ICDs).

v. Software Requirements Specifications.

vi. Interface Requirements Specifications.

vii. Software Product Specifications.

viii. Software Version Descriptions.

ix. Software Design Descriptions.

x. Interface Design Descriptions.

xi. Database Design Descriptions.

xii. Materials Specifications.

xiii. Process Specifications.

F. Revision Date. This field shall document the date of the latest revision.

G. Headings. Headings shall be positioned as follows:

i. In Section 1 to indicate where each System, Subsystem, and CI begins.

ii. In Section 2 to indicate where each Document Type begins.

h. Index of Technical Manuals (IOTM)

(1) The IOTM shall list the technical manuals developed under the Contract.

(2) The IOTM shall be divided into two (2) sections:

A. Sort Section 1 in System, then Subsystem, then CI order.

B. Sort Section 2 in Acquisition Activity Plan (AAP) Number, then contractor Reference Number order.

(3) The IOTM shall detail the following information for each Technical Manual:

A. Publication Number or Equivalent. This field shall detail the Publication Number or equivalent allocated to the Technical Manual. Where there is no need to allocate a Publication Number to a Technical Manual, this field is to contain the following entry: NOT REQUIRED.

B. Contract CAGE Code Number. This field shall detail the authoring contractor's CAGE Code Number for the Technical Manual.

C. Title. This field shall detail the title of the Technical Manual.

D. Related CIs. This field shall detail the CIs to which the Technical Manual is applicable.

E. Headings. Headings shall be positioned as follows:

i. In Section 1 to indicate where each System, Subsystem, and CI begins.

ii. No headings need to be positioned in Section 2.

i. Index of Major (Class I) ECPs

(1) The Index of Major ECPs shall document all Major ECPs raised against the System and its constituent items during the Contract, including those raised by the subcontractors.

(2) The Index of Major ECPs shall detail the following information for each ECP:

A. ECP Number. This field shall document the unique ECP identification number.

B. ECP Revision Letter. This field shall document the revision level of the ECP.

C. ECP Justification Code. This field shall document the ECP Justification Code. (Refer to information defined in MIL-HDBK-61A, Configuration Management Guidance.)

D. ECP Title. This field shall document the title of the ECP.

E. Date Raised. This field shall document the date the ECP was raised.

F. ECP Status. This field shall document the status of the ECP.

G. Status Change: This field shall document the date the status of the ECP changes.

H. CCB Decision. This field shall document the decision made by the CCB.

I. Decision Date. This field shall document the date of the CCB decision.

J. Impacted CIs. This field shall document the CIs impacted by the ECP.

K. Affected Part Numbers. This field shall document the CI Part Number variants impacted by the ECP.

L. New Part Numbers. This field shall document the new CI Part Number variants introduced by the ECP. Where the new Part Number is simply a re-identification of an existing Part Number, this relationship shall be clearly shown.

M. Production Effectivity. This field shall document the production effectivity of the ECP.

N. Retrofit Effectivity. This field shall document the retrofit effectivity of the ECP.

j. Index of Minor (Class II) ECPs

(1) The Index of Minor ECPs shall document all Minor ECPs raised against the System and its constituent items during the Contract, including those raised by the subcontractors.

(2) The Index of Minor ECPs shall detail the following information for each ECP:

A. ECP Number. This field shall document the unique ECP identification number.

B. ECP Revision Letter. This field shall document the revision level of the ECP.

C. ECP Title. This field shall document the title or a brief description of the ECP.

D. Date Raised. This field shall document the date the ECP was raised.

E. ECP Status. This field shall document the status of the ECP.

F. Approval Authority. This field shall document who approved or rejected the ECP.

G. Decision Date. This field shall document the date the approval authority approved or rejected the ECP.

H. Impacted CI. This field shall document the CI impacted by the ECP.

I. CI Part Numbers. This field shall document the CI Part Number variants impacted by the ECP.

J. Production Effectivity. This field shall document the production effectivity of the ECP.

k. Index of RFVs

(1) The Index of RFVs shall document all RFVs raised against the System and its constituent items during the Contract, including those raised by the subcontractors.

(2) The Index of RFVs shall be divided into three sections as follows:

A. List RFVs classified as Critical in Section 1.

B. List RFVs classified as Major in Section 2.

C. List RFVs classified as Minor in Section 3.

(3) Each section shall be further subdivided into two subsections as follows:

A. Sort subsection 1 in RFV Reference Number order.

B. Sort subsection 2 in System, then Subsystem, then CI order.

(4) The Index of RFVs shall detail the following information for each RFV:

A. RFV Reference Number. This field shall document the unique RFV identification number.

B. RFV Title/Description. This field shall document the title or provide a brief description of the RFV.

C. RFV Class. This field shall document the class of the RFV, i.e., Critical, Major, or Minor.

D. Date Raised. This field shall document the date the RFV was raised.

E. RFV Status. This field shall document the status of the RFV.

F. Approval Authority. This field shall document who approved or rejected the RFV.

G. Decision Date. This field shall document the date the approval authority approved or rejected the RFV.

H. Impacted CI. This field shall document the CI impacted by the RFV.

I. CI Part Number. This field shall document the CI Part Number variant impacted by the RFV.

J. Affected Part Number. This field shall document the Part Number of the item subject to the RFV.

K. Affected Serial Number(s). This field shall document the Serial Number(s) of the item(s) subject to the RFV.

L. Maintenance-Managed Item (MMI) Part Number. If the affected item is not an MMI and does not build directly to the CI, then this field shall document the Part Number of the higher level MMI.

M. MMI Serial Number(s). This field shall document the Serial Number(s) of the MMI specified at subparagraph L above.

N. Headings. Headings shall be positioned in Subsection 2 to indicate where each System, Subsystem, and CI begins. No headings need to be positioned in Subsection 1.

l. Index of Ancillary Equipment (IAE)

(1) The IAE shall list the support and test equipment, and training equipment (hereinafter known as Ancillary Equipment) required to support the maintenance/operation of the System and its constituent items.

(2) The IAE shall be divided into two (2) sections as follows:

A. Sort Section 1 by Ancillary Equipment Type, then by Ancillary Equipment Designation.

B. Sort Section 2 by Supported CI, then Ancillary Equipment Type, then Ancillary Equipment Designation order.

(3) The IAE shall detail the following information for each piece of Ancillary Equipment:

A. Ancillary Equipment Designation. This field shall document the designation of the Ancillary Equipment.

B. Nomenclature. This field shall document the nomenclature of the Ancillary Equipment.

C. Ancillary Equipment Type. This field shall document the support equipment type to which the Ancillary Equipment belongs (e.g., GSE, Automatic Test Equipment, Special Tool Type Tooling, etc.)

D. Supported CI(s). This field shall document the CI(s) supported by the Ancillary Equipment.

E. CI Part Number Variant(s). This field shall document the CI Part Number Variant(s) supported by the Ancillary Equipment.

F. Affected Part Numbers. If the item(s) supported by the Ancillary Equipment is/are below the CI level, then this field shall document the Part Number(s) of the item(s) supported by the Ancillary Equipment.

G. Headings. Headings shall be positioned as follows:

    i. In Section 1 to indicate where each Ancillary Equipment Type begins.

    ii. In Section 2 to indicate where each CI begins.

FORMAT: An MRI template will be made available from the Government, supplier digital formats (e.g., Microsoft® Excel®, CSV, XML, etc.) acceptable upon approval by the Government.

MAINTENANCE: Changes shall be incorporated by complete revision/reissue and submitted per item 13, SUBMISSION FREQUENCY, in this DRD.