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1. PURPOSE



This document presents the EPC scope of work for Digital Twin (D-TWIN) deployment on the Jafurah Field Gas Plant Phase II (JFGPII) project to be delivered to COMPANY. The JFGP project D-TWIN for the Gas Plant is captured in this scope of work. It outlines consistent and standardised processes and data sources to be implemented and utilised by CONTRACTOR during the complete solution of Project Execution, Construction, Handover and Operations and Maintenance phases of the Project.

2. SCOPE



The scope of this document covers the requirements for the development of the D-TWIN, **management of information** across the Engineering Procurement and Construction (EPC) Contractor(s), Handover to COMPANY and use in **Operations and Maintenance**, including information and data security, data quality and information data delivery in accordance with this document and standard document best practice SABP-Z-023.

The D-TWIN has been split into phases for consideration:

a. Project & Construction (Connected Design & Connected Build)

- i. Detailed Design
- ii. 3D Model
- iii. Process Simulation
- iv. Material Management
- v. Project Cost Management
- vi. Project Schedule Management
- vii. Quality Management
- viii. Risk Analysis
- ix. Construction Project Safety Solution
- x. Advanced Work Packaging (where applicable to aid construction)
- xi. Engineering Work Packaging (where applicable to aid construction)
- xii. Completion Management

b. Handover to Operation & Maintenance

- i. Interface between EPC packages

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- ii. Handover to COMPANY
- c. Operations & Maintenance (Connected Operate)
 - i. Simulations and Visualization
 - ii. Production Optimization
 - iii. Operations Management
 - iv. Prescriptive Maintenance

The Project will be executed by multiple EPC CONTRACTORS in parallel. Each CONTRACTOR will develop their design scope and D-TWIN portal independently and handover to COMPANY at the end of the project. The Digital PMC will be responsible for collating design data and document extracts as well construction status information required to maintain a "Program Wide" Digital Portal for COMPANY from all CONTRACTORS. All contractors shall provide such extracts on an agreed schedule.

3.

ASSUMPTIONS

A number of assumptions are made that shall be referred to within this document

- CONTRACTOR shall use technical and design systems as mandated by COMPANY based on SAES-A-202 which mandates the use of SmartPlant tools to underpin the Integrated Engineering and Design Environment for this project.
- CONTRACTOR shall undertake a technical and commercial evaluation of COMPANY approved vendors listed below and submit for approval prior to commencing work on the Digital Twin.
- CONTRACTOR will be supplied a SEED data class library in CFIHOS format for the development of the D-TWIN platform on COMPANY's preferred platform. In agreement with COMPANY through a robust change control process, CONTRACTOR can request to make changes to data class library during the project engineering and construction phase as referenced within Management of Change in section 10.11.
- CONTRACTOR to use COMPANY supplied SEED data and CONTRACTOR in-house Engineering Data warehouse platform as agreed with COMPANY to generate comprehensive data integration across multidisciplinary engineering data workflows and generate / extract up-to-date information at any given time.

4.

DEFINITIONS**D-TWIN Lifecycle**

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A lifecycle approach is required for creating the Project D-TWIN. Structured information for the D-TWIN will progress and mature throughout the Project Execution, Construction and Operations and Maintenance phase of the Project as the physical facility progresses through construction to completion via a progressive handover to COMPANY.

Structured digital information facilitates an efficient construction phase by enabling the use of integrated design and project tools and is the basis for structured, progressive data handover from CONTRACTOR to COMPANY.

CFIHOS: Recognised as an Industry Standard for the collection and management of Plant Information data in a form that that will be consistent and compatible with COMPANY's Operations and Maintenance systems. For further information see <https://www.jip36-cfihos.org/>

3D Model: Refers to employing an intelligent 3D digital/graphical representation of construction/operating facility assets. It serves as the portal and platform from which to access all physical asset information, analytics and solutions. During construction, it is used to overlook the project's activities that can include design, procurement, construction, cost, schedule, safety, asset performance, EPC and 3rd Party Licensor alignment, etc. During the Operation & Maintain phase, it is used analyse, train, and execute key work processes with regards to operations, maintenance and engineering from a single or multiple location without immediate need to physically being in the operating plant.

4D Model: Information Modelling associates schedule-related information to the various components of a 3D model. Enabling designs to be simulated using 3D construction models that are aligned against scheduling data.

5D Model: 5D enables to analyse the costs that will be incurred over time in the project activities during the Project and Construction phase of the project. Where it also allows the Operation and Maintenance phase during Turnaround and Inspection (T&I) activities to visualize, monitor, control and optimize schedule and cost.

6D Model: Refers to health and safety information during the Project and Construction phase of the project to monitor workers safety at the site. Where it also allows the Operation and Maintenance phase to monitor and control the Plant workplace safety, and during T&I activities to monitor, and control workers safety during turn-around/shutdown maintenance activities.

7D Model: Refers to adding 4 Dimensions to the 3D Model which are Time Schedule, Cost, Safety and Performance Management. It enables the users to monitor, visualize and optimize the Project and Construction progress, logistics, and costs. Where it also allows the operations and maintenance to improve the schedule and cost during maintenance and T&I activities during the operation.

8D Model: Refers to adding additional Dimensions to the 7D Model which is environment for Operating Facility where it enables the user to maintain the operations safely while ensuring environmental compliance. It also allows for improving the asset performance and reliability using advanced analytics

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solutions. The cost and schedule in the 8D Model are used during the operation of facility T&I.



Tag: A unique identifier assigned to a Plant object that has an associated collection of data values that describe both functional and physical attributes of that object.

Class Library: Definition of data objects and associated attributes for structuring data and documents about assets

The below table contains abbreviations that are used throughout this document.

Abbreviation	Description
SA	Saudi Aramco
COMPANY	Saudi Aramco
PMT	Saudi Aramco Project Management Team
OPERATIONS	Saudi Aramco Operations Management Team
EPC	Engineering Procurement and Construction
CONTRACTOR	Engineering Procurement and Construction (EPC) Contractor for Package 1
D-TWIN	Digital Twin produced by Engineering Procurement and Construction Contractor
MTR	Master Tag Register
EDMS	Electronic Document Management System
FEED	Front End Engineering Design
PBS	Plant Breakdown Structure
CFIHOS	Capital Facilities Information Handover Specification

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5. REFERENCE DOCUMENTS

Document No	Title
Saudi Aramco Best Practice	
SABP-Z-023	Best Practice. Digital Twin System
Saudi Aramco Engineering Standard	
SAES-A-202	Saudi Aramco Engineering Drawing Preparation
SACS-003	Cloud Cybersecurity standard
Saudi Aramco Engineering Procedures	

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5.1 Conflicts and Deviations



Any inconsistency, conflict or disagreement between the requirements specified in these specifications, COMPANY Standards, industry standards and/or manufacturer's standards shall be brought to the attention of COMPANY for resolution.

COMPANY standards shall represent the minimum requirements to be met by the project. Any deviation from Mandatory COMPANY Engineering Requirements (MSAER) shall require written approval by COMPANY.

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6. ROLES AND RESPONSIBILITIES



Role	Responsibility
CONTRACTOR	<ul style="list-style-type: none"> Will be responsible for hosting, managing access (including COMPANY), maintaining, and supporting a D-TWIN environment that represents their scope of Project Engineering, Procurement, Schedule & Construction. Issue and maintain D-TWIN processes and procedures to manage the D-TWIN data quality and change control Ensuring the D-TWIN's data integrity is implemented across the Project i.e., validating & uploading legitimate data generated and provided by all project stakeholders. Ensuring the data submission to Digital PMC are completed accurately and on an agreed schedule. Ensuring the D-TWIN handover requirements are completed to COMPANY satisfaction. Ensure optimised D-TWIN performance for user base, including COMPANY and COMPANY approved third party stakeholders.
COMPANY PMT	<ul style="list-style-type: none"> Supply CONTRACTOR SEED data class library in CFIHOS format for the development of the D-TWIN platforms Monitor D-TWIN progress throughout the project Check and accept Project and Construction D-TWIN handover from CONTRACTOR
D-TWIN PMC	<ul style="list-style-type: none"> Will be responsible for hosting, managing access, maintaining, and supporting the Program D-TWIN environment that represents entire scope of Project Engineering & Construction status. Issue and maintain D-TWIN processes and procedures to manage the Program D-TWIN data quality and change control. Ensuring the Program D-TWIN's data integrity is implemented across the Project i.e., validating &

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Role	Responsibility
	<p>uploading legitimate data generated and provided by other CONTRACTORS.</p> <ul style="list-style-type: none"> Ensuring the Program D-TWIN handover requirements are completed to COMPANY satisfaction. Ensure optimised Program D-TWIN performance for user base, including COMPANY and COMPANY approved third party stakeholders

7. PROCEDURE DIGITAL TWIN (D-TWIN) INFORMATION SOURCES

7.1 Guiding Standards



The underlying requirement for the generation, collection and management of the Information and Data developed during the Project is to ensure that all data is generated in a consistent and progressive manner that shall form a complete digital description of the Plant.

To ensure that a consistent and comprehensive data set is developed, the Capital Facilities Information Hand Over Standard (CFIHOS) shall be used to define all Classes and associated attributes required for Handover to the Operations and Maintenance phase of the Project.

COMPANY Engineering Standard SAES-A-202, and Engineering Procedure SAEP-334 specify the minimum required data & drawing attributes to be populated. **SAES-A-202 Appendix E – “Data Centric 3D Model Specification”** specifies the requirement for the 3D Model design development.

D-TWIN shall be designed and based on a data-centric, ‘Single Source of Truth’ approach, containing the latest verified and published Project data, which will ensure that all teams across the Project are using the latest information.

7.2 Engineering Data



D-TWIN comprises a comprehensive set of Engineering and other data developed during the Project and Construction phase of the Project. Engineering data shall be mastered in approved intelligent systems configured to comply with the Class Library and data attribute requirements set out in the Guiding Standards, specifically CFIHOS and applicable COMPANY Standards. Documents generated in the intelligent systems, for example P&IDs, Line Lists, Plot Plans, Electrical Load Schedules, Instrument Indexes, shall be produced entirely from these systems, with no alteration to the native files.

D-TWIN shall comprise engineering data generated from but not limited to Smart tools for P&ID, 3D models, Instrumentation, Electrical, etc.

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7.3

Vendor Data



In addition to the Engineering data described above, D-TWIN shall include data generated by Vendors and Manufacturers providing equipment that forms the physical Plant. The collection of Vendor data in a digital environment is paramount to the development of the D-TWIN. As with Engineering data, Vendor data shall be mastered in approved intelligent systems configured to comply with the Class Library and data attribute requirements set out in the Guiding Standards.

All deliverables generated during the Project and Construction phase of the Project shall be managed within an Electronic Document Management System which shall form part of D-TWIN. The EDMS shall be used to issue documents generated by CONTRACTOR and to receive documents from third parties. All revisions of both issued and received documents shall be retained and will form part of the Digital Twin handover to COMPANY.

During project engineering and construction phase, all EDMS documentation will be copied & visualised into the D-TWIN on a daily frequency.

7.4

Project D-TWIN Solution



The project D-TWIN is an integrated central 'master' repository of data consolidated from multiple Project sources. The D-TWIN is not designed to replicate functionality that is supplied by other applications in use but to consume and contextualise data from the project delivery ecosystem and facilitate enhanced visualisation opportunities of KPI's for the project. It will contain a large amount of current and historical Project data, which will be collected and consolidated incrementally during the Project and Construction phase of the Project. Using its analytical tools, it will allow valuable Insights into the status of the project at any given time.

All Project data will be 'aggregated' from master sources into the D-TWIN Solution to be considered as the "Single Source of Truth" during the Project and Construction phase of the Project.

For Further Details See Section 11.1.

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- 8. CONTRACTOR REQUIREMENTS OVERVIEW**
- 8.1 General Requirements**
- 8.1.1 CONTRACTOR shall perform a technical and commercial evaluation of the approved software vendors & COMPANY's D-TWIN functionality (see sections 11.1, 11.2, 11.3, 11.4 & 11.5).
- 8.1.2 CONTRACTOR shall engage with COMPANY to determine COMPANY's preferred platform.
- 8.1.3 During the Project and Construction phase of the project, CONTRACTOR will host & web enable the D-TWIN platform for their associated scope using COMPANY's preferred platform. See section 11.1.
- 8.1.4 CONTRACTOR follow COMPANY processes, procedures & best practices for D-TWIN alignment throughout the Project and Construction phase of the Project
- 8.1.5 CONTRACTOR shall develop a D-TWIN Implementation Plan to document the strategies, systems, and activities to be agreed with COMPANY. All the D-TWIN systems and processes, and interfaces shall be described in the **D-TWIN Implementation Plan**, which is to be issued within 60 days of award.
- 8.1.6 CONTRACTOR shall develop the System and Technical Architecture of D-TWIN solution. System and Technical Architecture of D-TWIN shall include, but not limited to, the following:
- Project Management Business Process
 - Facility Life Cycle Information Strategy
- These must be in line with COMPANY mandated systems, Industry standard best practice and as required in this document. To be incorporated in the D-TWIN Implementation Plan.
- 8.1.7 CONTRACTOR shall develop D-TWIN integration Architecture & Handover Diagram, including integration framework, interface monitoring and all associated information. To be incorporated in the D-TWIN Implementation Plan.
- 8.1.8 CONTRACTOR shall develop a Data Exchange Diagram indicating data workflow between D-TWIN systems. To be incorporated in the D-TWIN Implementation Plan.
- 8.1.9 CONTRACTOR shall use COMPANY mandated systems where it is defined in COMPANY procedures, including, but not limited to SAES-A-202. Refer to SAES-A-202 for further details.
- 8.1.10 CONTRACTOR to develop a Smart® P&ID Execution Plan, Smart® Instrumentation Execution Plan, Smart® Electrical Execution Plan, **Smart3D Execution Plan** and 2D CAD Execution Plan.
- 8.1.11 CONTRACTOR shall deploy core solutions listed in section 11.4 with reference to the functional and technical specifications listed in COMPANY's

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shall be handed over to COMPANY for deployment to facilitate D-TWIN during Operations.



8.2.5

CONTRACTOR shall ensure that all specialist software tools utilised shall be Commercial Off the Shelf (COTS) applications which shall be agreed with COMPANY.

8.2.6

CONTRACTOR shall refer to COMPANY Best Practice SABP-Z-023 for further details of COMPANY requirements for D-TWIN Infrastructure.

8.2.7

CONTRACTOR shall be responsible to provide a E-Review Solution which shall include, but not limited to, the following:

- Conducting Document, 2D Drawing & 3D Design review as per key milestones during Detail Design and Construction (e.g., 30%, 60%, & 90%).
- Enabling information retrieval for process, equipment, and plant on Documents, 2D Drawings & 3D Model
- Allowing users to add mark-up and comments on Documents, 2D Drawings & 3D Model.
- Displaying integrated 2D & 3D to the user for review. Linking synchronized comments between 2D & 3D during review sessions.
- Updating the implemented comments on Documents, 2D Drawings & 3D Model and route it for approval.

8.2.8

Solution to enable D-TWIN remote review capability which shall include the design of approval and reviewer assignment workflows. This solution shall provide accessibility for COMPANY end users. Further requirements highlighted in COMPANY Standard Best Practice SABP-Z-023



8.3

Detailed Design

8.3.1

CONTRACTOR shall ensure that all relevant Engineering processes and procedures are fully engaged with the D-TWIN requirement throughout the Project and Construction phase of the Project.

8.3.2

CONTRACTOR shall establish a unified Engineering Platform for all Smart design documents and packages.

8.3.3

CONTRACTOR shall integrate systems to ensure consistent data flow for all design deliverables including, but not limited to all CONTRACTOR and vendor specs, design data, static data, etc.

8.3.4

CONTRACTOR shall ensure consistent data flow for all engineering data including but not limited to process, piping, electrical, civil, instrument,

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mechanical, flare and relief control valve monitoring, and stress analysis data to D-TWIN portal.

8.3.5 The CONTRACTOR shall validate that all smart drawings are developed based on Saudi Aramco Engineering Drawing Preparation SAES-A-202 & SAEP-334.

8.3.6 CONTRACTOR shall regularly share the required engineering data in the required format to DIGITAL PMC for Program D-TWIN upload

8.4 3D Model

8.4.1 CONTRACTOR shall demonstrate that Design systems shall ensure that Plant objects described in each of these systems are consistent, such that equivalent tags and naming of objects across multiple systems shall be consistent and without data duplication & inconsistency

8.4.2 CONTRACTOR shall use the 3D E-Review Solution for

- Conducting 3D Design review as per key milestones during Detail Design and Construction (e.g., 30%, 60%, & 90%).
- Enabling information retrieval for process, equipment, and plant on the 3D Model
- Allowing users to add mark-up and comments on the 3D Model.
- Displaying integrated 2D & 3D to the user for review. Linking synchronized comments between 2D & 3D during review sessions.
- Updating the implemented comments on the 3D Model and route it for approval.

Solution to enable D-TWIN remote review capability which shall include the design of approval and reviewer assignment workflows. This solution shall provide accessibility for COMPANY end users. Further requirements highlighted in COMPANY Standard Best Practice SABP-Z-023.

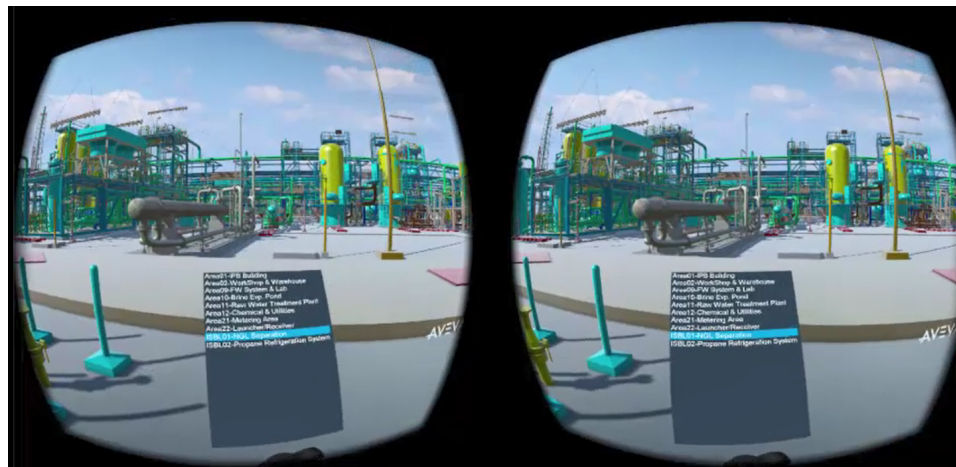
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8.4.3 CONTRACTOR shall schedule regular 3D Design reviews solution with COMPANY as part of Design Development and shall record any comments arising

8.4.4 D-Twin Solution to facilitate Virtual Reality and Augmented Reality options to enhance internal and external reviews through immersive technology wherever applicable during the connected design phase of the project.



8.5 Material Management

8.5.1 CONTRACTOR shall cover the complete Material Management business process including but not limited to material cataloguing, material take off (MTO), surplus management, Request for Quotations (RFQ), purchasing, expediting, contract management, logistics, warehousing management, and inspection.

8.5.2 CONTRACTOR shall provide Digital Materials Tracking functionality via embedded RFID technologies, and equivalent market offerings to maximise coverage, as an automated means to track project material status with 3D

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representation including 4D and 5D representation via clear dashboards with live data.

8.5.3 CONTRACTOR shall provide links and connections to all material documents. (e.g., NMRs, drawings, etc.)

8.5.4 CONTRACTOR shall provide end-to-end material status tracking and warehouse material availability.

8.5.5 CONTRACTOR shall provide visibility over all materials required for the project, materials management lifecycle, logistics, allocation, surplus and spares management.

8.5.6 CONTRACTOR shall integrate with ERP Material Management system for updating the materials requisition and purchasing status.

8.5.7 CONTRACTOR shall ensure that start-up Spare Parts data and records are regularly passed to DIGITAL PMC to incorporate into D-TWIN solutions.

8.5.8 CONTRACTOR shall share the required Material Management data in the required format to DIGITAL PMC for Program D-TWIN upload on a weekly basis.



8.6 Construction and Schedule Monitoring

8.6.1 CONTRACTOR shall use a Construction software solution to capture construction status and verify it against the design intent in the 3D model. The solution must have the following minimum requirements:

- True 3D from circular aperture or single aperture
- High-definition resolution (mm to km)
- Provide Active and Passive 3D Modelling
- Allow identification and tagging for industrial equipment
- Construction simulation capability and ability to perform constructability reviews.
- Solution shall integrate all relevant deliverables to achieve 5D for the progress update.
- Facilitate full use of handheld devices allowing users to assign tasks, work from up-to-date drawings, and align the field and office, all from any device

8.6.2 CONTRACTOR shall evaluate and propose integrating construction safety system within D-TWIN (4S refer to Scope of works for NGL and GP).

8.6.3 CONTRACTOR to use Scheduling management based on COMPANY accepted scheduling software. Software must identify schedule improvement opportunities, and conflicts due to related requirement or activities delays.

8.6.4 CONTRACTOR shall share the required Construction and Scheduling Monitoring data in the required format to DIGITAL PMC for PROGRAM D-TWIN upload on a weekly basis.

8.6.5 CONTRACTOR shall deploy and utilise a combination of 3D Laser Scanning, Photogrammetry captured by a combination of Drones, Handheld and fixed-point scanner technology throughout the construction phase to capture up to

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the minute construction status in real life. All captured data and images shall be processed and loaded into the Digital Twin overlaid with the 3D model.

Accuracy of Data Collection

Tolerance	Detail Size
Level A	±3 mm Details to be identified 10 mm in diameter and above
Level B	±25 mm Details to be identified 20 mm in diameter and above
Level C	Residual resolution of scanner

Directional Field of View around an Item / Area

Directional Field shall generally be to the following levels.

Level 1

The item to be scanned on Multiple Faces, scanned from at least two locations.

Level 2

The item only requires to be scanned on a single Face, scanned from a single location.

Digital Data**Registration**

Sub-Contractor shall supply details of the survey control network used together with a redundancy analysis and least squares analysis. Sub-Contractor shall also provide a point cloud registration report.

The scans are to be located in space, to the plant coordinate system and elevation, upon completion of the scanning.

8.6.6

Contractor to maximise the use of VR and AR to train personnel in all relevant aspects of Construction techniques where available with on-field equipment in a simulated environment to build their situational awareness. Examples of this opportunity are as, (but not limited too), the list below:

- Virtual Welding
- Critical Lift Simulations
- Maintenance Simulation

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- Emergency Evacuation simulation

Contractor to utilise Augmented reality scanning technology including and AI to acquire and analyze obtained data from the subjected equipment to ease the inspection and reduce construction rework.



9. CONTRACTOR REQUIREMENTS FOR HANDOVER

9.1 General Requirement

9.1.1 CONTRACTOR shall review, validate, extend - as required and agreed by the COMPANY - the functional requirements for Handover D-TWIN specified in this document and standard document best practice SABP-Z-023.

9.1.2 CONTRACTOR shall align D-TWIN Implementation Plan, Deviations and Exceptions, Customisation documentation for all systems, including Smart systems to final Handover status and configuration. These documents are required as part of the final project handover.

9.1.3 D-TWIN shall be fully integrated and compliant with Company drawings standards and systems during Handover. Prior to project handover, D-TWIN shall be compatible for integration with COMPANY iPlant system to enable handover of all required data and documentation.

9.1.4 CONTRACTOR shall implement common systems (using the same preferred software supplier) such that all data and documents can be collated and managed in preparation for Handover to COMPANY as per Appendix 8.2

9.1.5 CONTRACTOR shall detail the steps required in establishing the Handover Plan, which shall include, but not limited to, the following:

- Handover requirements including responsibilities and timings
- Project Information Handover Plan
- Handover implementation and information quality management

These must be in line with COMPANY mandated systems, Industry standard best practice and as required in this document.

9.1.6 CONTRACTOR's handover plan shall include engagement with COMPANY to ensure continuity of systems licensing into the Operation and Maintenance phase of the project.

9.1.7 COMPANY reserve the right upon completion of the Project and Construction phase, all CONTRACTOR IT Systems comprising of the D-TWIN (Hardware / Software / Licencing / Data) shall be transferred and handed-over to COMPANY for use in Operations and Maintenance phase.



9.2 CFIHOS

9.2.1 CONTRACTOR shall configure D-TWIN systems to comply with the Capital Facility Information Handover Specifications (CFIHOS). CFIHOS standard to be used to identify the facility life cycle information strategy, handover

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requirements, project information handover plan and implementation. This shall include the:

Export of all related raw data and built up information to comply with CFIHOS to enable Operate & Maintain D-TWIN. Data to be exported shall include, but not limited to:

- Detailed 3D design of all assets with the integrated and linked tags, equipment number, drawing, specification, sheet, standards and history. (e.g. P&ID, Isometrics, Data Sheets, Instrument List, etc.).
- Process simulation data used in the design phases.
- Spare Parts Data Packages.

**9.3****Building Information Management**

All building design data consumed by D-TWIN shall comply with the Building Information Modelling (BIM) Specifications listed in SAES-A-202 and shall use ISO 19650 as reference guidelines.

9.4**As-Built**

CONTRACTOR shall ensure that all systems and documentation in D-TWIN is revised to as-built status using the Source authoring system. This shall include updating 3D models and other intelligent systems to as-built status. All deliverables shall be extracted and intelligently linked to the master authoring system such that they can be re-extracted without any external modification.

The complete D-TWIN system (as-built) to be handed over to Operations and Maintenance to include all documentation and data from EDMS this includes all engineering, 3D, MRs, POs, vendor documents, etc.

9.5**Interface between EPC packages**

CONTRACTOR shall ensure that all D-TWIN systems to be enabled to facilitate efficient and seamless handover to COMPANY including full compatibility with COMPANY's systems including but not limited to iPlant. Digital PMC Program platform must be provided to COMPANY in parallel.

Digital PMC shall collate all D-TWIN design data and construction documents into a Program engineering platform from all other CONTRACTORS.

CONTRACTOR shall transfer to Digital PMC all company mandated data extracts or software in native formats. Digital PMC to audit Program mandated design systems in native format i.e. Smartplant databases as supplied by CONTRACTORS and feed back findings for resolution.

CONTRACTORS shall provide and facilitate handover of all D-TWIN systems at as-built status to COMPANY for Operations and Maintenance phase of the Project.

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**10. D-TWIN SOLUTIONS****10.1 Class Library**

10.1.1 CONTRACTOR shall design and configure all D-TWIN systems to conform to the Aramco-CFIHOS Class Library detailing the classes and attribute definitions for required Plant Items.

10.1.2 CONTRACTOR shall ensure they have an agreed and documented Change control process to manage the Class Library changes

10.1.3 CONTRACTOR shall populate Classes and Attributes within D-TWIN systems to ensure compliance with the CFIHOS Class Library in agreement with COMPANY.

10.1.4 CONTRACTOR shall ensure that all VENDORS supply data that conforms to the CFIHOS Class Library classes and attribute definitions for required Plant Items in agreement with COMPANY.

10.1.5 CONTRACTOR shall review and assess requirement for Classes and attributes in addition to the CFIHOS Class Library where such additions are required to fully define Plant items. CONTRACTOR shall seek approval from COMPANY for all such additions.

10.1.6 CONTRACTOR shall require approval from COMPANY for any exceptions to the population of attributes where CONTRACTOR is unable to populate all attributes defined in the Class Library. Such exceptions shall be documented and formally issued by CONTRACTOR in a 'Deviations and Exceptions' document.

10.1.7 Where CONTRACTOR wishes to deviate from procedure, any such deviation shall be agreed with COMPANY and shall be documented and formally issued by CONTRACTOR in a 'Deviations and Exceptions' document.

10.2 Plant Breakdown Structure (PBS)

CONTRACTOR shall ensure that all Intelligent systems share a common Plant Breakdown Structure (PBS). The PBS to be agreed with and approved by COMPANY.

- Plant Hierarchy

CONTRACTOR will work with COMPANY to understand and embed the Plant Hierarchy requirements within the D-TWIN to ensure that is aligned with COMPANY requirements, on project.

- System Hierarchy

The system hierarchy will be developed and implemented as per the requirements of SAES-A-202 and the project specific requirements.

This will be embedded in every system, so its fully aligned with the Digital strategy.

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10.3

Master Tag Register

CONTRACTOR shall provide a Master Tag Register (MTR) for incremental population during the Project and Construction phase of the Project. CONTRACTOR shall obtain approval from COMPANY for the structure and content of the MTR.

This will control tags naming of objects across multiple systems to be consistent and without data duplication & inconsistency.

The Master Tag Register shall be used for the management of all tags generated on the Project.

- Tags shall be unique
- Tag format and coding (tag letters) shall comply with COMPANY standards and to the Tagging Philosophy/Equipment Numbering Procedure issued during the FEED scope.
- Tags shall not be re-used. Tags that are no longer required shall be marked as deleted in the Master Tag Register and shall not be removed.
- Tags shall be requested from COMPANY where applicable.
- Tags not sourced in Smart tools that are outside COMPANY specifications shall be agreed with COMPANY.
- All VENDORS must comply with COMPANY Tagging Philosophy/Equipment Numbering Procedure



10.4

Data Relationships

CONTRACTOR shall include in data records populated in D-TWIN relationships between items, including all Vendor tags. Relationships shall include the following:

- Tag to tag (Parent to Child tag)
- Tag to document (all tags associated with a document shall be included in the data record for the document)
- Document to Document (e.g. Off Page Connectors (OPCs) on P&IDs, reference documents listed on drawings and in documents)
- Tag to Unit
- Document to Unit
- Tag and Document to Construction Area
- Tag association to 3D model

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10.5

D-TWIN Decision Support & Visualization (DSV)

DSV solution shall provide a single window access to all the key information contained within Project Execution, Construction and Operations and Maintenance phase of the D-TWIN Project.

CONTRACTOR shall design DSV to meet the required functionality described in the standard document best practice SABP-Z-023. It shall include, but not be limited to interfaces, 3D Model, dashboards, displays, reports, workflows, notifications, manual data entry screens, associated navigation, security configuration.

CONTRACTOR shall analyse and streamline the business processes under the project scope, especially from the visualization, collaboration, and decision support perspective, to eliminate information silos and/or communication gaps and streamline information flows to provide the right users with the right information at the right time to support making informed decisions.

CONTRACTOR shall ensure scalability in all applications across multiple business process of Project D-TWIN to make the data generated by one EPC Contractor/Vendor is available to other D-TWIN applications.

CONTRACTOR shall compile, validate, optimize the overall DSV requirements across all the specifications for D-TWIN.



10.6

Reporting Requirements

CONTRACTOR shall provide a report generation tool to allow users to generate and configure user defined customized reports with any data and data aggregates from all data sources in D-TWIN during Project Execution and Construction phase of the D-TWIN Project.

Report formats shall be agreed with COMPANY

The system must include easy to use reporting tools that allow administrators and end users to build custom reports

The tools should provide features to allow easy layout and formatting of reports, including:

- 1) Selection, positioning, and ordering of information presented
- 2) Fonts and styles
- 3) Headers and footers
- 4) Logos (company, customer, project etc.)

Report generation tool shall allow for data representation in text, table, and graphical format

The system must allow reports to be exported to a range of formats including:

- 1) PDF
- 2) MS Office
- 3) TIFF

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10.7

Vendor Systems

CONTRACTOR shall ensure that Vendor data complies with all appropriate Project Standards and Procedures in accordance with Contract requirements.

Vendor systems shall comply to the following, but not limited to

- Conform to CFHIOS
- Conform to Project tag naming in the mandated tag formats based on the Equipment Numbering Procedure.
- Data shall be supplied in the mandated handover formats
- Data supplied shall meet minimum data attribute requirements in accordance Project Specifications and shall be CFIHOS compliant.



10.8

KPI Reporting

CONTRACTOR shall provide Key Performance Indicator (KPI) reports in agreement with COMPANY requirements at the start of the Project that will be generated incrementally during the Project and Construction phase of the Project to aid effective management of the Project through to handover to COMPANY.

KPI reports shall include, but not limited to

- Project Data Completeness
- Project Data Quality
- Data maturity Status
- Construction Quality and Safety Monitoring
- Procedures Status
- Cost and Schedule (4D / 5D)

10.9

Project Controls

CONTRACTOR shall ensure in agreement with COMPANY that Project Controls Cost and Schedule status is available to be visualised & reported upon in the D-TWIN (4D / 5D scheduling).

10.10

Procurement / Construction

CONTRACTOR shall ensure in agreement with COMPANY that all Supply Chain Material Allocation, Schedule and status information is available to be visualised & reported upon in the D-TWIN. All deliverables shall be extracted and intelligently linked to the master authoring system such that they can be re-extracted without any external modification. Further requirements highlighted in COMPANY Standard Best Practice SABP-Z-023.

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DIGITAL TWIN SCOPE OF WORK	DOC	861	A	PP-104915	26 OF 29	A
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10.11

Management of Change

CONTRACTOR shall maintain a rigorous management of change process through a request and approval process which shall document all changes to D-TWIN systems, reference data (e.g. 3D catalogue, P&ID symbology, Class Library classes and/or attributes). CONTRACTOR shall not implement any requested changes until approved by COMPANY. A Reference data Change Request Form detailing the requested change shall be submitted to Digital PMC/COMPANY, for review and approval by COMPANY. The requested change can be implemented only once approval from COMPANY has been received.

The above does not replace or remove any Contractual requirements for the Management of Change.



10.12

Validation and Auditing

10.12.1

CONTRACTOR shall ensure that all tag and data values are validated on entry to Intelligent Design systems, including, but not limited to Tag format, valid tag codes, engineering values, including Units of Measure (UoMs) as defined by COMPANY.

10.12.2

CONTRACTOR shall further ensure that all tag and data values sourced from other systems and documents, including Vendor systems and documents are validated including, but not limited to Tag format, valid tag codes, engineering values, including Units of Measure (UoMs) as defined by COMPANY.

Where tags or data fail such validation, CONTRACTOR shall correct the source. Any conflicts with tag numbering shall be resolved with COMPANY.

10.12.3

CONTRACTOR shall submit D-TWIN and associated systems for regular scheduled Technical Audits during the Project and Construction Phase by the Digital PMC. Format and schedule for audits to be confirmed by COMPANY.

10.12.4

At each scheduled Technical Audit, CONTRACTOR shall provide to Digital PMC all requested system databases, system reports, files, and documents, including, but not limited to Smart Engineering databases, reports from Smart Engineering systems, current Deviations and Exceptions and Customisation documents.

10.12.5

CONTRACTOR shall implement internal processes to ensure that consistency checks are undertaken between the Smart tools. CONTRACTOR shall document all such consistency checks for review and inclusion in technical audits.

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11.4 Digital Twin Functionality

Digital Twin Functionality

No.	Item Description
1	Connected Design & Build D-TWIN
1.1	Connected Design and Build Core Solutions
1.1.1	Detailed Design
1.1.2	Work Share Management (i.e., multi centre execution)
1.1.3	Collaborative 3D Model Reviews (any associated visualisation functionality)
1.1.4	Process Simulation
1.1.5	E-Review
1.2	Supply Chain D-TWIN
1.2.1	Logistics & Warehouse Management
1.2.2	Lifecycle Cost Management
1.2.3	QA/QC Management
1.2.4	Risk Analysis/Quantification and Management
1.2.5	Construction Safety Solution
1.2.6	Advanced Work Packages (AWP)
1.2.7	Engineering Work Packages (EWP)
1.2.8	4D/5D
1.2.9	Commissioning & Completions Management

No.	Item Description
2	Common Items
2.1	Visualisation & Dashboarding
2.2	Data Management
2.3	3D Asset Virtualization
2.4	As-Built Data Capture

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