

Digital Monitoring, Reporting, and Verification for Digital Crude OilTM

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Digital Monitoring, Reporting, and Verification for Digital Crude OilTM

Asset Specification

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1.0 BACKGROUND AND APPLICABILITY

Xpansiv created the Digital FuelsTM Program² to enable producers, operators, consumers, and other market participants to define, register and transact the environmental attributes of natural gas, crude oil, aviation fuel, hydrogen and other energy fuels. As part of the Digital Fuels Program, Xpansiv has developed standardized digital asset specifications to claim the environmental impacts and risks associated with energy production, movement, refining and use.

Each Digital Fuel Asset has a standardized structure, two parts, starting with the digital measurement, reporting and verification (MRV) requirements for the that commodity group (i.e., natural gas, crude oil, aviation fuel, hydrogen and other energy fuels) along with a schedule of specifications for Products converted from Payload Datasets.

Digital Crude Oil[™] (DCO)

"An immutable digital record representing the complete physical and energy profile of a specific production or operations unit of crude oil through an immutable provenance chain back to the source."



Digital Crude Oil Attributes (example)

- Commodity
- Producer
- Field
- Lat/Long
- Asset Type
- API Gravity
- Sulfur Content
- Marketed Oil
- GHG Emissions Intensity
- Methane Emissions Intensity
- Water use
- NOx/SOx/PM emissions
- 3rd Party Facility Certification

1.1 Use of this Document

This document supports the **Digital Fuels Program Governance Framework** by specifying the minimum Measurement, Reporting and Verification standards and required data for that base commodity asset and all convertible Products.

- 1. Collecting and verifying a standardized set of environmental attributes from each unit of commodity production, storage, transport, refining and use.
- 2. Rules for conversion of Payload Datasets into digital assets.

1.2 Periodic Reviews and Revisions

Pursuant to the guidance and input from market stakeholders under the Digital Fuels Program, Xpansiv as market operator will continue to update the standards and methodologies used to generate and register digital assets. Xpansiv is engaging with industry representatives and other experts via the Digital Fuels Program Market Stakeholder Committee review and continuously improve the Program to support and build the market.

2.0 DIGITAL MRV FOR DIGITAL CRUDE OIL

2.1 Monitoring and Onboarding of Operations

Digital Crude Oil assets are generated from assessments of the environmental attributes of specific units of crude oil production and/or operations, grounded in continuously metered operations data, combined with supplemental environmental data (e.g., ground-level infrared cameras, air sniffers, satellites), 3rd party certifications, and advanced analytics and modeling. High quality data can be captured from multiple technologies and monitoring systems³ and verified to substantiate and authenticate property rights in environmental claims associated with physical crude oil.

2.1.1 Operations Data

- Operations data are captured from meters, scales, certified chemical analysis, sales records and other primary sources that are auditable/verifiable by a 3rd party, and from monitoring equipment calibrated to meet regulatory/technical specifications.
- Operations data should be measured using equipment calibrated to regulatory specifications, industry standards, and production accounting principles, along with any certified chemical analyses being regularly updated.

2.1.2 Supplemental Environmental Data

In addition to systems that capture and validate monitored primary data directly from meters and other instrumentation at facilities, primary production data can be supplemented by site-specific environmental monitoring, satellite measurements, modeling using established emission factors, independent third-party certifications, data-management systems, and other relevant sources.

Under the DF Governance Framework, all operations and supplemental environmental data are processed through an approved data refinery to identify and correct data fidelity errors and anomalies within reasonable variance limits.

³See for example, "Methane Quantification: Toward Differentiated Gas, An assessment of methane measurement and monitoring technologies. Coefficient, March 2022.

XPANSIV DIGITAL FUELS REGISTRY



Required Base DCO Attributes

This section identifies and details the required base DCO attributes, broken out by digital asset products corresponding to different production segments of physical crude oil (upstream, midstream and downstream). From the base DCO digital asset, owners can transact as-is-bi-laterally, or convert that digital asset into scheduled Products that may include "optional" Attributes listed in Table; see Schedule of Available DCO Products for data requirements for optional Attributes.

Attributes defining base upstream DCO:

Attribute Name	Attribute Description	Reference Data: Reporting source, inputs, models, protocol	
Operator Name	Legal name of operator entity	Retrieved from MSA	
Facility Name	Common name of the operational facility	Defined by client and data integration team to reflect operational and accounting boundaries	
Facility ID	Unique ID for operational facility	Determined by data integration team	
Country	Country of origin	Operator provided or public source	
State or Province	State or Province of origin	Operator provided or public source	
Field	Basin or Field of Origin	Operator provided or public source	
Production Start	Start date/time for given data set	Operator provided	

Production End	End date/time for given data set	Operator provided	
Commodity Type	DCO	Defined in data integration	
UOM	Energy, Unit or Volume measure of the commodity	Operator provided	
Marketed volume	Quantity of commodity units (BBL) within the given data payload	Sales volume to match physical marketing	
Assessment Boundary	Indication of the physical environmental boundary scope included in asset	Description of physical emissions assessment scope	

Required Facility and Well Attribute Sub-Components:

Attribute Name	Attribute Description	Reference Data: Reporting source, inputs, models, protocol
Туре	Well, Well Facility, Gathering Facility	Operator provided
ID	Well API number, Facility ID	Operator provided
Name	Permitted well/facility name	Operator provided
Lat/Long	Surface latitude and longitude of permitted well/facility	Operator provided
Volume	Well volume at point of allocation. (pre accounting)	Operator provided
Volume Unit	BBL at standard conditions	Operator provided

Optional DCO Attributes:

In addition to the minimum required Attributes, owners can include Attributes to substantiate environmental claim(s) associated with-each unit of marketed volume, and the inherent value of the digital asset and converted Products. Given the array of environmental impacts across the energy chain, the DFP provides flexibility in the form of "additional extensible attributes" to create digital assets having Product optionality across an array of environmental claims. This includes, but is not limited to: greenhouse gas emissions (i.e., carbon intensity), methane emissions intensity, water use, land use, chemical use, and waste management.

Attribute Name	Attribute Description	Reference Data: Reporting source, inputs, models, protocol	
API Gravity	Index of Density score using API formula [(141.5/Specific Gravity) - 131.5] following MPMS standards	Operator provided	
Sulfur	Weight percent of sulfur expressed in %wt as measured following MPMS standards	Operator provided	
Methane Emission Intensity	Amount of CH4 emission for a given dataset, calculated as (emission kgs / marketed oil kgs) expressed as a %.	Quantification body, protocol and if assessment and/or audit are independent parties	
Methane Emission Inventory	Absolute value of CH4 emissions associated with the given data set. (Numerator in 'intensity' calculation)	Third party quantification and independent verification	
CO2 Emission Inventory	Absolute value of CO2 emissions associated with the given data set, expressed in kgs	Can be broken out into model components, i.e., OPGEE V3 CO2 emission inventory by: Exploration, Drilling Development, Production to Extraction and first Transport leg.	
Intertek Certification	Indication that the dataset represents production certified to the Intertek standard and which.	URL or file attachment to Intertek certificate corresponding to Facility	
Canary Trustwell Certification	Indication that the dataset represents production certified to the Trustwell standard. Presented as standard score.	Data provider integration or URL or file attachment to Trustwell certificate corresponding to Facility	
eo100 Certification	Indication that the dataset represents production certified to the eo100 standard. Presented as standard score.	URL or file attachment to eo100 certificate corresponding to Facility.	
CO2 Emission Inventory	Absolute value of CO2 emissions associated with the given data set, expressed in kgs	Third party quantification and independent verification	
NOx Emission Inventory	Absolute value of NOx emissions associated with the given data set, expressed in kgs	Third party quantification and independent verification	
SOx Emission Inventory	Absolute value of SOx emissions associated with the given data set, expressed in kgs	Third party quantification and independent verification	
PM Emission Inventory	Absolute value of PM emissions associated with the given data set, expressed in kgs	Third party quantification and independent verification	

PM2.5 Emission Inventory	Absolute value of PM2.5 emissions associated with the given data set, expressed in kgs	Third party quantification and independent verification	
H2S Emission Inventory	Absolute value of H2S emissions associated with the given data set, expressed in kgs	Third party quantification and independent verification	
Other air toxin Inventory	Absolute Value of other BTEX toxics (benzene, toluene, ethylbenzene and xylene) associated with the given data set, expressed in µg/m3	Third party quantification and independent verification	
Produced Water Inventory	Absolute Value of produced water associated with the given data set, expressed in cubic meters	Third party quantification and independent verification	
Other Hydrocarbon Inventory	Absolute Value of Other hydrocarbon production associated with the given data set, expressed in boe	Third party quantification and independent verification	
Other VOC Inventory	Absolute value of other VOC emissions associated with the given data set, expressed in kgs	Third party quantification and independent verification	
ISO Certification	Indication that the Facility or wells within that Facility have an ISO Certification and type	URL or file attachment to ISO certificate corresponding to Facility and/or well(s)	
Other Certification(s) not already mentioned	Extensible fields to indicate the dataset represents production certified by other standards, presented as: True or False; or grade and score	URL or file attachment to certificate corresponding to Facility and/or well(s)	
Carbon Capture and Sequestration Inventory	Absolute value of CO2 that was captured and sequestered in association with the marketed volume	Third party quantification and independent verification	
Associated Carbon Offsets	Absolute value (CO2eq) of retired carbon offsets associated with the marketed volume	Retirement certificate provided by client or integrated Offset registry	
Project list tied to Offsets	Extensible field array to provide unique Offset Project(s) ID	URL or file attachments to certificate corresponding to Retired Offsets from each Project	
Transport Emission Factors	Absolute value of CO2eq associated with transportation to delivery point	Type, mileage or point based indication of delivery leg(s) to sales point	
Storage Emission Factors	Absolute value of CO2eq associated with storage over Production/Delivery period	Time based emissions factors corresponding to storage type and activity level	

DCO JSON Payload Example (illustrative only, metadata and other fields not shown)

```
"attributional_profile": [
{
 "attribute_key": "facility_name",
  "attribute_value": "Operator Asset Sales Oil"
},{
  "attribute_key": "facility_id",
  "attribute value": "OPSFACI001XX"
},{
  "attribute_key": "producer_name",
  "attribute_value": "Operator X Energy Incorporated"
}.{
  "attribute_key": "country",
  "attribute value": "CA"
},{
  "attribute_key": "production_type",
  "attribute_value": "Crude Oil"
},{
  "attribute key": "production start",
  "attribute_value": "2022-MM-DD"
},{
  "attribute_key": "production_end",
  "attribute_value": "2022-MM-DD"
},{
  "attribute_key": "methane_emission_rate",
  "attribute_value": "0.02345678910"
},{
  "attribute_key": "methane_emission_assessment_provider",
  "attribute value": "Clearstone"
},{
  "attribute_key": "Intertek_certification",
  "attribute value": false
},{
  "attribute_key": "co2_emission_inventory",
  "attribute value": "651.5462655"
},{
  "attribute_key": "produced_water_intensity",
  "attribute_value": "1.2345678"
},{
  "attribute_key": "land_use_assessment_score",
  "attribute_value": "96.9"
},
],
"quantity": 9999999.8967420427,
"quantity unit": "BBL",
"source data type": "dco"
"assessment_boundary": "1A"}
```

{

For cases where multiple assessments apply against the same Attribute, we allow registration and presentation on the digital asset and converted Products. This includes supporting Reference Data contained in Proof-of-State (POS) workflow prior to registration event.

Example for Operator having multiple CO2eq assessments across same or overlapping assets:

Emissions MRV provider	GHG Emissions Intensity	Assessment Boundary	Model and/or protocol
Entity 1	0.15%	Drilling & Production	Model ABC v2.3
Entity 2	0.12%	Production	Bronze certification under program ABC
Entity N	0.21%	Production & Transport	Certification framework ABC valid 2022-2023

Reporting Source

Digital asset Attributes, Methane Emission Intensity for example, supporting reference data should conform to established protocols and standards such as:

- US EPA Greenhouse Gas Reporting Program (GHGRP)⁴
- Canadian Association of Petroleum Producers (CAPP)
- Energy Information Agency Natural Gas Liquids Data (Natural Gas Plant Production file)
- Oil and Gas Methane Partnership (OGMP) 2.0 Framework⁵
- ONE Future Methane Intensity Protocol⁶
- Natural Gas Sustainability Initiative (NGSI) Methane Emissions Intensity Protocol⁷
- IPIECA, API and IOGP practices
- 2021 IPCC Assessment Report (AR6)

Other sources can include established models like OPGEE, and published lifecycle assessments for specific production/operations facilities.

2.2 Data Management

See Digital Fuels Registry data onboarding guide for detailed information on data management in the context of the Xpansiv Proof of State (POS) subsystem outlined in Section 2.4.

- Operations data and secondary data must be managed, configured, processed, stored/secured, linked, and recorded to meet veracity/provenance requirements specified in relevant energy, environmental or climate MRV standards.
- Data management software must conform to an approved or certified data governance system or inter-operable data architecture with automatic and verifiable data reconciliation.
- Data is stored and where permitted, distributed, in an immutable format that ensures transparency and information security.

⁴ https://www.epa.gov/ghgreporting/subpart-w-rulemaking-resources;

⁵ https://www.ogmpartnership.com/

⁶https://onefuture.us/wp-content/uploads/2021/12/ONE-Future-Protocol-2021.pdf

⁷https://www.aga.org/about/financial-outreach/natural-gas-sustainability-initiative-ngsi/

• The data file format should enable asset registration and property right claims on approved platforms that do not compromise confidentiality, trade secrets, or personal privacy.

2.3 Verifications

Digital Crude Oil may be identified as independently verified provided that onboarding and processing of data includes the following⁸:

- Sources for each data item are identified including sources of cross-validation within the data set, or available from additional primary data, and confirmation of the timescale for all available data.
- Data gaps are analyzed and plugged based on receipts or conservative assumptions.
- Methods for receiving ongoing data are optimized based on a balance between timeliness and accuracy, e.g., automation, alerts on potential outliers.
- Operations data and digitized production infrastructure can be used in established Product specification to determine path-based⁹ emissions intensities (e.g.,methane).
- Quantification models should conform to foundational frameworks such as ISO Quantification and reporting of greenhouse gas emissions and removals (ISO 14064), Greenhouse Life Cycle Assessment standards (ISO 14040, 14044), The Greenhouse Gas Protocol¹⁰, IFC Performance Standards on Environmental and Social Sustainability¹¹, and the World Bank Group Environmental, Health and Safety Guidelines¹².
- Measurements from stationary devices, drone-based sensors, aerial laser scanning, and satellite monitoring are used where available to verify emission intensity calculations.
- Where a reasonable level of assurance is required¹³, the verification process should include the following:
 - Examine the accuracy and reasonableness of the applied methodological approach for each source type, and perform calculation checks to either confirm correct application of the selected methodology or determine emissions based on a more appropriate (refined) methodology for comparison.
 - 2. Identify and assess emission contributions for any unaccounted for sources.
 - **3**. Determine the materiality of the sum of the absolute values of all the identified discrepancies and unaccounted for emission contributions.

For each Attribute being assessed, operators should specify the entity that is providing quantification determinations and if an independent audit of that quantification has been performed.

Below are general reference data parameter examples required in verification of attribute values to achieve reasonable level of assurance. This list is for context only and is not exhaustive.

⁸For example, the ISO 14064 Part 3 verification process requires that the principles of impartiality, evidence-based approach, fair presentation, documentation, and conservativeness be applied. The program under which the verification is to be performed needs to establish the required type of engagement, level of assurance, objectives, criteria, scope and materiality threshold. ⁹For example, specific volumes of produced crude oil, tracked from well pad to transaction point.

¹⁰ghgprotocol.org

¹¹www.ifc.org/wps/wcm/connect/Topics_Ext_Content/IFC_External_Corporate_Site/Sustainability-At-IFC/Policies-Standards/Performance-Standards

¹²www.ifc.org/wps/wcm/connect/topics_ext_content/ifc_external_corporate_site/sustainability-atifc/policies-standards/ehs-guidelines

¹³In defining a reasonable level of assurance, independent verifiers should conform to ISO 14064-3, 3.6.6.

For data based Operational Attributes:

- Facility Network map
- Data Network map
- Equipment types and specifications
- Monthly receipts and dispositions
- Oil quality analysis
- Midstream balance reconciliation
- Fuel use volumes
- Vent and flare volumes
- Other hydrocarbon production volumes
- Other optional Reference Data points could include: factors used against network map, calculation assumptions made, uncertainty factors, etc.
- Equipment type
- Scope of measurement fidelity
- Temporal references if not continuous monitoring and/or data aggregation methods used
- Completed OPGEE, GREET or other model and model input assumptions

In addition to the verification processes described above, the technical documents¹⁴ that specify data management processes and protocols and data quality standards associated with DCOs, undergo expert peer review, are published for "open source" use and feedback. The operational matrix underlying the Digital Fuels Program including the use of the digital assets and associated environmental attributes and claims, can be regularly assessed in independent audits.

2.4 Proof of State Auditability

Proof of State (POS) system (see Digital Fuels Registry data onboarding guide for details): a) establishes standard protocols for how data is collected, contextualized, and transferred; and b) records the full lifecycle of the digital assets (e.g., DCOs and environmental attributes) in an ecosystem-wide, immutable digital provenance chain, referenced on the retirement certificate, providing a forensic trail to how the ESG attributes and other assets are derived.

Each "data partner" (e.g., crude oil producer, operator, data refinery, monitoring system provider, buyer) operates according to a consistent set of APIs, enabling visibility for permissioned participants, including the registry operator or 3rd party auditors. Requirements for all data partners operating at each stage of the DCO asset lifecycle are available via the Xpansiv platform.

Registration of DCO Units enables the operator to request the reservation and verified conversion of the packaged attributes into issuance of standard Products (e.g., Intertek CarbonClear and CarbonZero Products). Given the flexibility in conversion of standard Products from digital assets, owners of resulting Products inherit data visibility rights to supporting reference data captured in the POS workflow.

¹⁴Including the Digital Fuels Governance Framework.

2.6 DCO Conversions

- An eligible oil operator may request conversion by the independent market operator (1) an amount of DCO units to one or more Product(s) or (2) an amount of Products(s) back into DCO Units, in either case in accordance with the terms of the applicable Product Schedule¹⁵, provided that in either case, such DCO Unit or Products has not been transferred, canceled, retired or otherwise used at the time of conversion on any interconnected Registry.
- Upon conversion and verified issuance of Products, all corresponding DCO Units substantiating such Products shall be reserved and locked in the eligible fuel operators' applicable Interconnected Registry Account and may not be transferred, canceled, retired or otherwise claimed or used by any entity except as part of the transfer, cancellation, retirement or other property right claim to the applicable Product.
- Each converted Product shall be given a unique digital identifier traceable to the underlying DCO Units and verified attributes.

Schedule of Available Products from DCO Digital Assets

Every Product will have a detailed Quantification Method specifying additionality, deviation and/or extension required beyond base digital assets. This will include specifications for minimum MRV standards, Product data model, and required Reference Data. (See Appendix A).

¹⁵Products may be derived and issued from certain DCO Units and authenticated by application of a standardized quantification methodology as further identified and described in the applicable Product Schedule. The Products of an amount of DCO Units is calculated based on the applicable Standard & Benchmarks for such Products as contained and described in the Eligible Fuel Digital Fuel Asset.

APPENDIX A

Schedule of DCO Derived Contracts

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A1. Placeholder CBL traded contracts derived from DCO

• Details included in SIP guide and explicated here for cases where derived performance calculations require explication

APPENDIX B

Quantification Methodology for Placeholder Net-Zero Bundled Products

ANNEX I

DEFINITIONS & ACRONYMS

Please reference **Digital Fuels Program Governance Framework** for terms in this document not defined below.

API stands for American Petroleum Institute, and is one component of well identification normally consisting of three parts: operator name, well number and lease name.

Emissions intensity outlines the volume of emissions associated with a unit of energy or dataset, expressed as a percentage or absolute value.

Internet of Things (IoT) refers to the network of physical objects ("things") that can be embedded with sensors, software and other technologies to connect and exchange data over the internet.