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OGC Integrated Methane Sensor Web for Emissions Management Best Practice - Part I - Fugitive Emissions Management based on AER Directive 60

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Table of Contents

i. Abstract

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ii. Keywords

The following are keywords to be used by search engines and document catalogues.

ogcdoc, OGC document, sensor web, methane emissions, Internet of Things, SensorThings, climate change

iii. Preface

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iv. Submitting organizations

The following organizations submitted this Document to the Open Geospatial Consortium (OGC):

SensorUp Inc., the University of Calgary, TC Energy, Fraunhofer IOSB

v. Submitters

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- GeoConnections, Natural Resources Canada
- Cenovus Energy
- Canadian Natural Resources (CNRL)

- Alberta Innovates

Note: this does not imply a complete endorsement by these organizations.

Chapter 1. Scope

Methane (CH4) is one of the most potent greenhouse gases, and the comparative impact of methane is 25 times greater than CO2 over a 100-year period [IPCC 2007]. Methane is an invisible and odourless gas, and it is very labour intensive and time consuming in order to detect and repair leaks. Current methane emission management solutions are fragmented and developed without standards, ultimately leading to a complex network of incompatible sensing solutions that need to interrelate but are impossible. However, no single methane sensing technology can meet the accuracy, spatio-temporal resolution, and low-cost requirements. There is a need to interconnect the heterogeneous existing and emerging methane sensing technologies, ranging from satellites, drones, fixed-wing fly-overs, vehicle-based systems, and continuous in-situ monitoring stations to handheld Optical Gas Imaging (OGI) devices. An effective methane emissions management solution requires an integrated methane sensor web. OGC Sensor Web Enablement (SWE) provides the fundamental standard building blocks for the integrated methane sensor web.

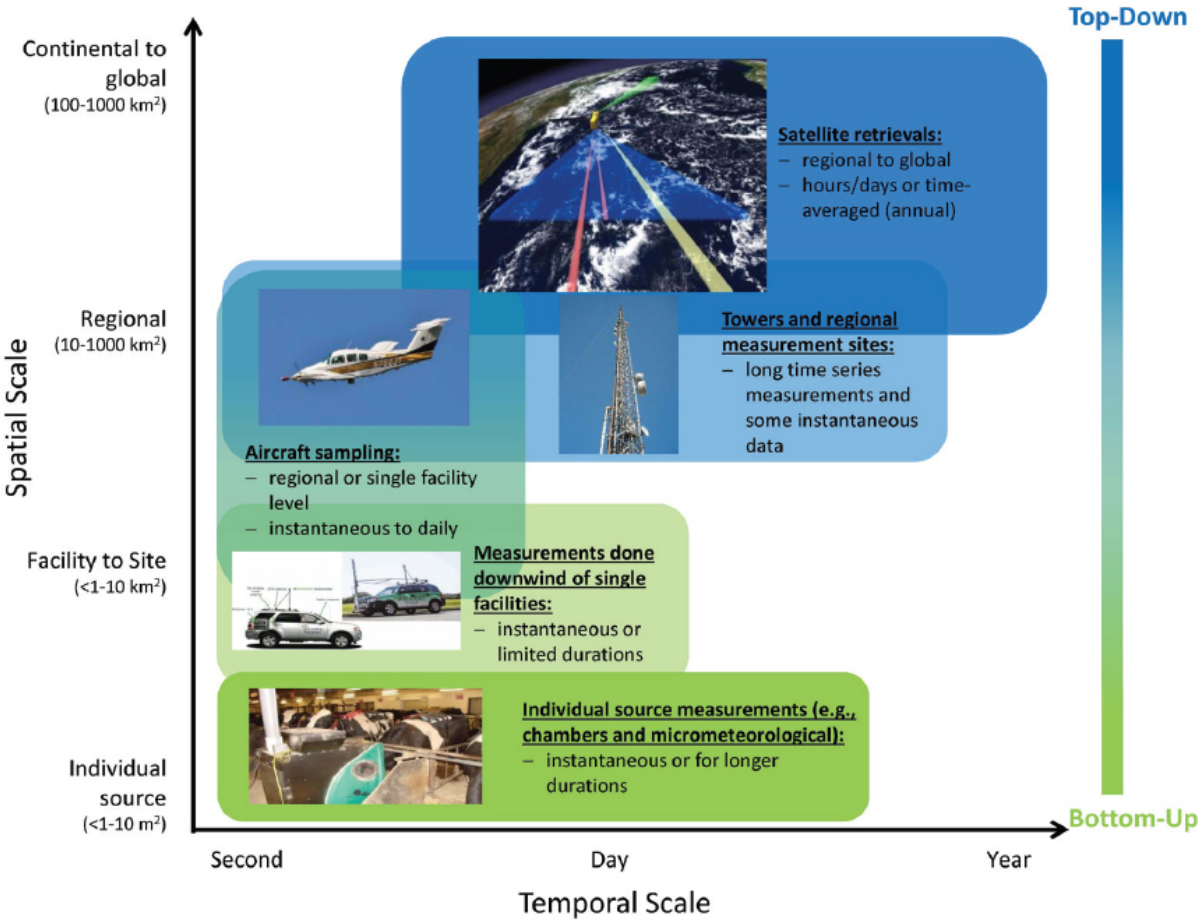

Figure 1. Examples of methane measurement platforms operating across a variety of spatial and temporal scales. (National Academies of Sciences, Engineering, and Medicine. 2018)

This OGC Best Practice (OGC BP) defines a SensorThings API for fugitive methane emissions management. Regulations play a critical role in methane emissions reduction, and how methane emissions are detected, repaired, and managed is highly dependent on local regulations. This OGC BP is designed based on the Alberta Energy Regulator's regulatory requirement for fugitive emissions management [AER Directive 60].

This OGC BP document provides a data model and API for the exchange of fugitive emissions observation data and the necessary metadata, both within and between different organizations. For example, it can be used for leak detection and repair service providers to prepare and exchange fugitive emissions observation data with the facility operators. Facility operators can also use the OGC BP to exchange fugitive emissions data within the organization and with regulators.

Venting and combustion methane emissions are out of scope in this BP. The development of BP for venting emissions and combustion emissions are on the roadmap.

1.1. Roadmap

This OGC BP is the first part of the OGC Integrated Methane Sensor Web for Emissions Management BPs. We plan to publish a series of OGC BPs for methane emissions management, ranging from data sources (e.g., different types of sensing systems) to data destinations (e.g., fugitive and venting emissions for regulatory reporting). The goal is to develop the building blocks for an integrated Methane Emissions Sensor Web, enabling seamless flows of observation data between various nodes: from SensorThings nodes with heterogeneous sensing sources (i.e., multiple disparate methane observation systems), to SensorThings nodes with analytics-ready data (i.e., an aggregated methane emissions datalake), and eventually to SensorThings nodes with compliance-ready data (i.e., data compliant to various regulatory organizations in different jurisdictions).

The figure below shows the roadmap of the different OGC BPs to be developed and their relationship.

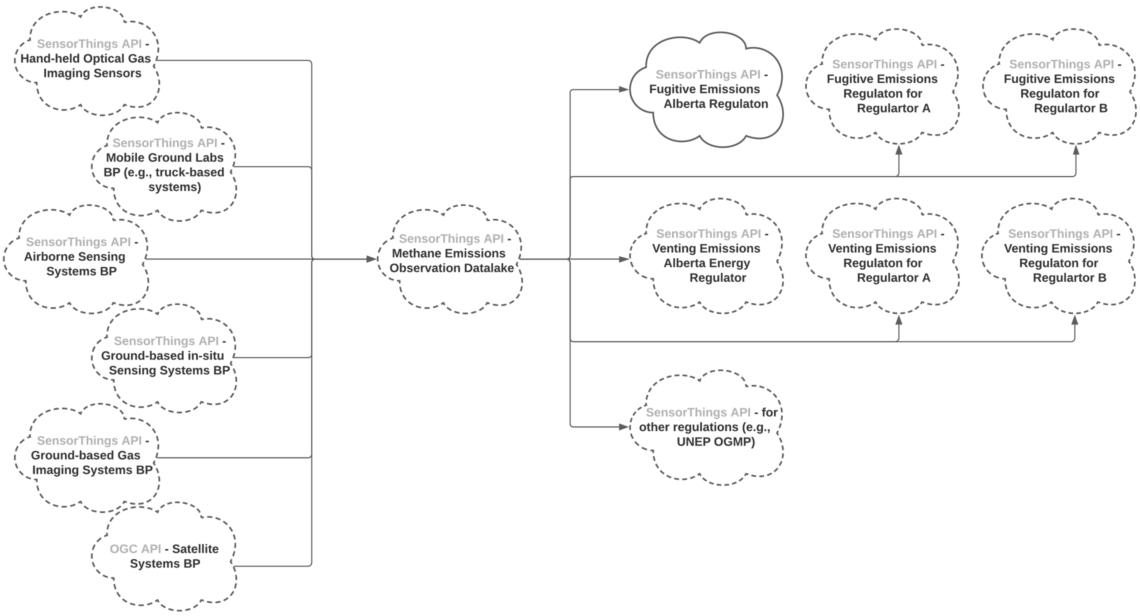

Figure 2. Integrated Methane Sensor Web Best Practice Roadmap

1.2. Design Goals

OGC BP and its series have the following design goals:

1. Modular: different parts of a methane emissions management system can be separated and reassembled, benefiting flexibility, future-proof, and variety in use;
2. Simple: the design is concise, easily testable, easy to implement, and developer-friendly;

3. Interoperable: whenever possible, it follows international open standards;
4. Scalable: it is able to grow in terms of the number of sensors, types of sensors, and volume of data without sacrificing performance.

Chapter 2. Conformance

This OGC Best Practice (OGC BP) defines a SensorThings API for fugitive methane emissions management based on the Alberta Energy Regulator's regulatory requirement for fugitive emissions management AER Directive 60 (2021).

Conformance with this OGC BP shall be checked using all the relevant tests specified in annex a (normative) of this document.

All requirement classes and conformance classes described in this document are owned by the document(s) identified.

The following table lists the requirement classes defined in this OGC BP.

NOTE The text in the *Requirements class id* and *Requirements* columns in the following table is the path fragment that, when appended to the URI: http://www.opengis.net/spec/imsw-fm-aer60/1.0, provides the URI that can be used to unambiguously identify the requirement and the conformance class.

Requirements class id	Requirements	Description
/req/datamodel/thing	• /req/datamodel/thing/properties • /req/datamodel/thing/relations	Thing entity
/req/datamodel/location	• /req/datamodel/location/properties • /req/datamodel/location/relations	Location entity

Requirements class id	Requirements	Description
/req/datamodel/datastream	• /req/datamodel/datastream/number-of-fugitive-emissions-properties • /req/datamodel/datastream/number-of-fugitive-emissions-relations • /req/datamodel/datastream/fugitive-emissions-volume-properties • /req/datamodel/datastream/fugitive-emissions-volume-relations • /req/datamodel/datastream/fugitive-emissions-mass-properties • /req/datamodel/datastream/fugitive-emissions-mass-relations	Datastream entity
/req/datamodel/observed-property	• /req/datamodel/observed-property/properties	ObservedProperty entity
/req/datamodel/observation	• /req/datamodel/observation/properties	Observation entity
/req/datamodel/feature-of-interest	• /req/datamodel/feature-of-interest/properties	FeatureOfInterest entity
/req/datamodel/sensor	• /req/datamodel/sensor/properties	Sensor entity

Chapter 3. References

The following normative documents contain provisions that, through reference in this text, constitute provisions of this document. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. For undated references, the latest edition of the normative document referred to applies.

ISO 8601:2004 Data elements and interchange formats – Information interchange - Representation of dates and times, 2004

OGC 10-004r3 and ISO 19156:2011(E), OGC Abstract Specification Topic 20: Geographic information — Observations and Measurements, 2011

OGC 19-088, OGC SensorThings API Part 1: Sensing Version 1.1

OASIS OData Version 4.0 Part 1: Protocol Plus Errata 02

OASIS OData Version 4.0 Part 2: URL Conventions Plus Errata 02

OASIS OData JSON Format Version 4.0 Plus Errata 02

OASIS OData ABNF Construction Rules Errata 02

RFC 2046, Multipurpose Internet Mail Extensions (MIME) Part Two: Media Types

RFC 2616, Hypertext Transfer Protocol — HTTP/1.1

RFC 4627, the application/json Media Type for Javascript Object Notation (JSON), July 2006

RFC 7946, the GeoJSON Format, 2016

Unified Code for Units of Measure (UCUM) – Version 1.9, April 2015

Chapter 4. Terms and Definitions

This document uses the terms defined in Sub-clause 5.3 of [OGC 06-121r8], which is based on the ISO/IEC Directives, Part 2, Rules for the structure and drafting of International Standards. In particular, the word “shall” (not “must”) is the verb form used to indicate a requirement to be strictly followed to conform to this Best Practice.

For the purposes of this document, the following additional terms and definitions apply.

4.1. Facility ID

A unique facility identification code, with 4 letters and 7 numbers (e.g., ABWP1234567), assigned by Petrinex to each facility [AER Directive 60 (2021)].

4.2. Fugitive Emissions

Unintentional releases of hydrocarbons to the atmosphere [AER Directive 60 (2021)].

4.3. Fugitive Emissions Screenings

Site-wide evaluations where the primary purpose is to identify fugitive emissions (e.g., from open thief hatches). These are less comprehensive than fugitive emission surveys [AER Directive 60 (2021)].

4.4. Fugitive Emission Surveys

Site-wide evaluations that use equipment-based methods to detect and identify sources of fugitive emissions for repair. These surveys are considered comprehensive evaluations that can assist in reducing both small volumes and large volumes of fugitive emissions [AER Directive 60 (2021)].

4.5. Petrinex

Canada’s Petroleum Information Network

4.6. Site

The area defined by the boundaries of a surface lease for upstream oil and gas facilities and wells (pads counted as one lease) [AER Directive 60 (2021)].

4.7. Leak

A release of hydrocarbons from an equipment component is a leak if [Regulations Respecting Reduction in the Release of Methane and Certain Volatile Organic Compounds (2018)]

- (a) the release consists of at least 500 ppmv of hydrocarbons, as determined by an inspection conducted by means of an eligible portable monitoring instrument in accordance with EPA Method 21; or

- (b) the release is detected
  - (i) during an inspection conducted by means of an eligible optical gas-imaging instrument, or
  - (ii) by means of an auditory method, an olfactory method or a visual method, including the observation of the dripping of hydrocarbon liquids from the equipment component.

4.8. Local Regulation

The federal regulations that apply to methane in the upstream oil and gas sector aim to control methane emissions and also reduce the amount of volatile organic compounds (VOCs) released into the air [Canada’s methane regulations (2018)].

4.9. Fugitive Emissions Management Program

A plan and supporting systems to systematically detect and manage fugitive emissions. Fugitive Emissions Management Programs are intended to complement a duty holder’s overall emissions reduction strategy [AER Directive 60 (2021)].

4.10. Vent Emission

The intentional controlled release of un-combusted gases directly to the atmosphere [Oil and Gas Glossary and Definitions (2020)].

Chapter 5. Conventions

This sections provides details and examples for any conventions used in the document. Examples of conventions are symbols, abbreviations, use of XML schema, or special notes regarding how to read the document.

5.1. Identifiers

The normative provisions in this document are denoted by the URI

http://www.opengis.net/spec/imsw-fm-aer60/1.0

All requirements and conformance tests that appear in this document are denoted by partial URIs which are relative to this base.

5.2. Abbreviations

AER Alberta Energy Regulator

API Application Programming Interface

ATS Alberta Township Survey

BP Best Practice

CNRL Canadian Natural Resources

CH4 Methane

EPA Environmental Protection Agency

FEM-STA Fugitive Emissions Management - SensorThings API

FEMP Fugitive Emissions Management Program

GeoJSON Geographic JavaScript Object Notation

GPS Global Positioning System

IANA Internet Assigned Numbers Authority

IPCC Intergovernmental Panel on Climate Change

ID IDentity

LDAR Leak Detection and Repair

LSD Legal Subdivisions

OGC Open Geospatial Consortium

OGI Optical Gas Imaging

STA SensorThings API

SWE Sensor Web Enablement

URI Uniform Resource Identifierswe

VOC Volatile Organic Carbon

Chapter 6. Methane Emissions

Methane (CH4) is one of the most potent greenhouse gases, and the comparative impact of methane is 25 times greater than CO2 over a 100-year period [IPCC 2007]. Global anthropogenic methane emissions by 2020 are estimated to be 9,390 million metric tons of CO2 equivalent [Global Methane Initiative 2020]. Approximately 50~60% of the anthropogenic methane emissions come from the following five sources: (1) agriculture (enteric fermentation-27% and manure management-3%), (2) oil and gas (24%), (3) municipal solid waste (11%), (4) coal mining (9%), and (5) wastewater (7%). Figure below shows a pie chart of the global estimated methane emissions sources in 2020.

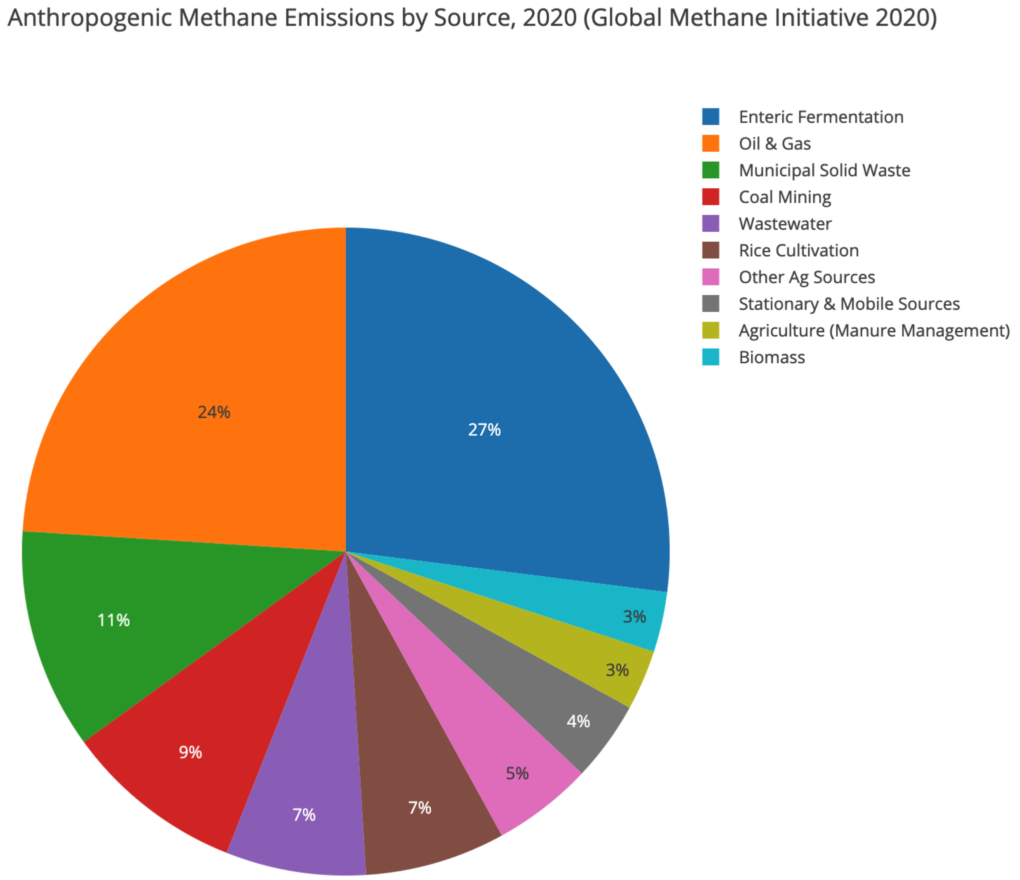

Figure 3. Anthropogenic methane emissions by source 2020 [Gobal Methane Initiative 2020]

In the oil and gas industry vent gas and fugitive emissions are the two major sources of methane emissions. Vent gas is un-combusted gas, that is released into the atmosphere. Fugitive emissions are the unintentional releases of hydrocarbons into the atmosphere. This BP focuses on the detection and quantification of fugitive methane emissions in the oil and gas industry.

Methane is an invisible and odourless gas, as a result it is very labour intensive and time consuming in order to detect and repair the leaks. Current methane emissions management solutions are fragmented and being developed without standards, ultimately leading to a complex network of incompatible sensing solutions that need to interrelate but are not possible. However there is no single methane sensing technology that can meet the accuracy, spatio-temporal resolution, and low-cost requirements. There is a need to interconnect the heterogeneous existing and emerging methane sensing technologies, ranging from satellites, drones, fixed-wing fly-overs, vehicle-based systems, continuous in-situ monitoring stations, to handheld Optical Gas Imaging (OGI) devices. An effective methane emissions management solution needs an integrated methane sensor web. OGC Sensor Web Enablement (SWE) provides the fundamental standard building blocks for the integrated methane sensor web.

6.1. Methane Emissions Sensing Technologies

Methane emissions sensing technologies can be categorized by the methane sensor types or by the methane sensing platforms. Based on its sensing principles, methane sensors can be categorized into the following types: (1) optical sensors, (2) calorimetric sensors, (3) pyroelectric sensors, (4) semiconducting metal oxide sensors, and (5) electrochemical sensors. Readers interested in the details of different methane sensing principles can refer to [Aldhafeeri 2020], and it provides a comprehensive review of methane gas detection sensors, including the recent development and future perspectives. For the leak detection and repair applications, optical sensors, either laser spectroscopy or imaging spectrometry, are the most common sensor type being used. The following table summarize their advantages and disadvantages.

Table 1. Methane sensor types, their advantages and disadvantages adapted from [Aldhafeeri 2020] - Table 1

Methane Sensor Types	Advantages	Disadvantages
Optical sensors	Non-destructive; immune to electromagnetic interference; operate without oxygen	Expensive; high power consumption; lack of significance and distinctiveness of methane optical absorption region
Calorimetric sensors	Low cost; simple; portable; easy to manufacture; good selectivity for methane; can operate in harsh environmental conditions	Low detection accuracy; susceptible to cracking, catalyst poisoning and oversaturation; high power consumption; short lifespan; require high temperature
Pyroelectric sensors	Non-destructive; operate without oxygen; good sensitivity and responsivity; wide measuring range; operate at room temperature	High cost; high power consumption; immobile; difficult to manufacture
Semiconducting metal oxide sensors	Low cost; lightweight and robust; long lifespan; resistant to poisoning	Poor selectivity; small and high operational temperature range; slow recovery rate; significant addictive dependency; affected by temperature; susceptible to degradation; sensitive to changes in humidity

Methane Sensor Types	Advantages	Disadvantages
Electrochemical sensors	Three different sub-types: AE, IL, and SE. AE-based: low cost. IL-based: non-hazardous materials; high boiling points and low volatility; good selectivity for methane; can detect small leaks. SE-based: no leakage; safe; robust; good selectivity for methane; can detect small leaks	AE-based: susceptible to leakage and evaporation; hazardous materials; slow response time. IL-based: susceptible to leakage; slow response time. SE-based: require high temperature; unable to detect low gas concentrations; susceptible to degradation or loss of electrolyte.

In terms of the methane sensing platforms, it can be categorized into the following types: (1) handheld instruments, (2) stationary in-situ or remote sensing sensors, (3) terrestrial mobile methane mapping systems , (4) airborne remote sensing systems, and (5) spaceborne remote sensing satellites. The following sections briefly introduce each methane sensing platform.

6.1.1. Handheld Instruments

For many years the standard leak detection practice has been EPA method 21: Determination of Volatile Organic Carbon Leaks. EPA method 21 requires that components be surveyed using a method 21 compliant portable instrument that can measure the volatile organic carbon (VOC) concentration near each component with high accuracy. However, method 21 is the most labor intensive and time consuming method. For example, it may take four to eight hours to complete surveying the components of a well pad. As a result, there are multiple attempts to develop new sensing technologies/platforms to replace method 21. Optical gas-imaging (OGI) cameras is the other type of handheld instrument, and it has been approved by many regulatory bodies. OGI cameras are a close-range remote sensing cameras that provide images and videos of methane leaks that are invisible to the human eye. It is intuitive to communicate and easy to document and report. OGI cameras are also twice more efficient than method 21. It is worth to note that method 21 and OGI cameras are the only methods that are able to accurately locate methane leaks at the component level. Locating leaking components are critical because the leaks can only be stopped by either repairing or replacing the components.

Figure 4. A field technician performs methane emission survey with an optical gas imaging camera [Zimmerle et al., 2020]

6.1.2. Stationary methane sensing systems

Stationary sensors are deployed near the potential methane emissions sources, and provide continuous methane concentration observations. Based on the sensor type, it can be further categorized into close-range remote sensing systems and in-situ sensing systems. Example of close-range methane remote sensing systems include Rebellion Photonics (acquired by Honeywell), Kuva systems, etc. Examples of in-situ methane sensing systems include Aeris Sensors, Project Canary, Eco-esolutions, Quanta3, Scientific Aviation, Teledyne, Troposphere and more. Low-cost in-situ methane sensor networks has a potential to be the future of methane leak detection technology, because it can potentially operate at a cost comparable to or even lower than currently periodic, manual inspections that tyically using the handheld instruments described in the section above. However, peer-reviewed researches and validations of the existing commercial systems are currently missing. There are multiple research projects, such as UT Astin's Project Astra or University of Calgary's Emissions Testing Centre, focusing on validating the performances of these low-cost sensing systems.

Comparing to other sensing platforms, one unique advantage of stationary sensors is its high temporal resolution. A network of methane stationary sensor networks has the potential to detect fugitive emissions almost instantaneously, and that means leaks can potentially be repaired before the regular visits (typically three times a year, depends on site types and regulations). Stationary methane sensing systems are well suited for facilities with high component density, such as refineries, gas plants, compressor stations, and multi-well pads.

6.1.3. Terrestrial mobile methane mapping systems

Terrestrial vehicles equipped with methane sensors and anemometers to account for atmospheric conditions can be used to screen methane emissions over a large area very efficiently. For example, Atherton et al (2017) demonstrated that over 1600 well pads were surveyed across nearly 8000 km of roads. Comparing to other sensing platforms, terrestrial mobile methane mapping systems have the following advantages: (1) do not require site access, (2) less time spent at each site, (3) minimal coordination with facility operators required, and (4) provide an efficient approach for regulators to audit the reports submitted by facility operators. However, these systems are constrained by road access and weather conditions, especially wind directions. Without sufficient wind or if wind is blowing in the wrong directions, methane plumes may not reach the roads and thus methane leaks cannot be detected by the terrestrial mobile methane mapping systems.

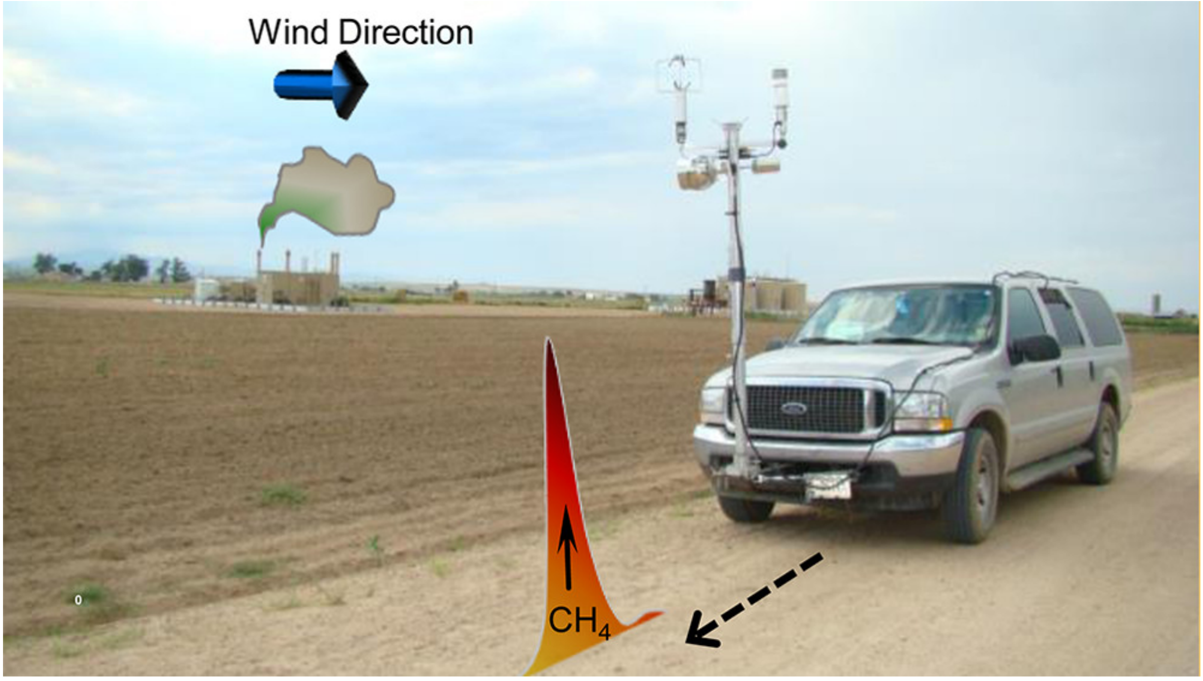

Figure 5. A methane measurement mobile ground lab system [Brantley, et al. 2014]

6.1.4. Airborne methane remote sensing systems

Airborne methane remote sensing systems can be further categorized into two types: (1) piloted aircraft, including helicopter and fixed wing airplanes, and (2) Unmanned Aerial Vehicles (UAVs). Different types of methane sensors can be mounted on the airborne vehicles to detect emissions over large areas in a short amount of time. Some airborne systems, such Scientific Aviations [Conley et al, 2016], use in-situ sensors, that are similar or identical to terrestrial systems, to process air samples for methane concentrations. Some airborne systems, such as Bridger Photonics [Johnson, et al. 2021], uses remote sensing technologies such as LiDAR, to detect emissions on the ground. The main advantage of piloted airborne systems is that it is able to cover a large area very efficiently, and unlike terrestrial systems airborne systems they are not constrained by roads. However, the operational cost is higher comparing to the terrestrial systems.

Figure 6. Example data of Bridger Photonics [Johnson, et al. 2021]

Comparing to piloted airborne systems, UAV-based systems can perform observations very close to the potential emissions sources, as a result they can detect methane emissions with much lower emissions rates. However, many methane sensors are power-hungry and not suitable for UAVs, that are constrained by the battery capacity and weight. Further innovations, such as lightweight and power-efficient sensors, are required in order for UAVs to become a suitable methane sensing platform.

6.1.5. Methane Remote Sensing Satellites

Similar to all Earth Observation (EO) satellites, methane remote sensing satellites provides much larger spatial coverage comparing to other sensing platforms. However, existing methane remote sensing satellites capture low-resolution images and cannot detect methane emissions with a low emissions rate. Methane remote sensing satellite is well suited for detecting large emission sources. Example methane remote sensing satellites includes GOSAT, TROPOMI, GHGSat, and Carbon Mapper.

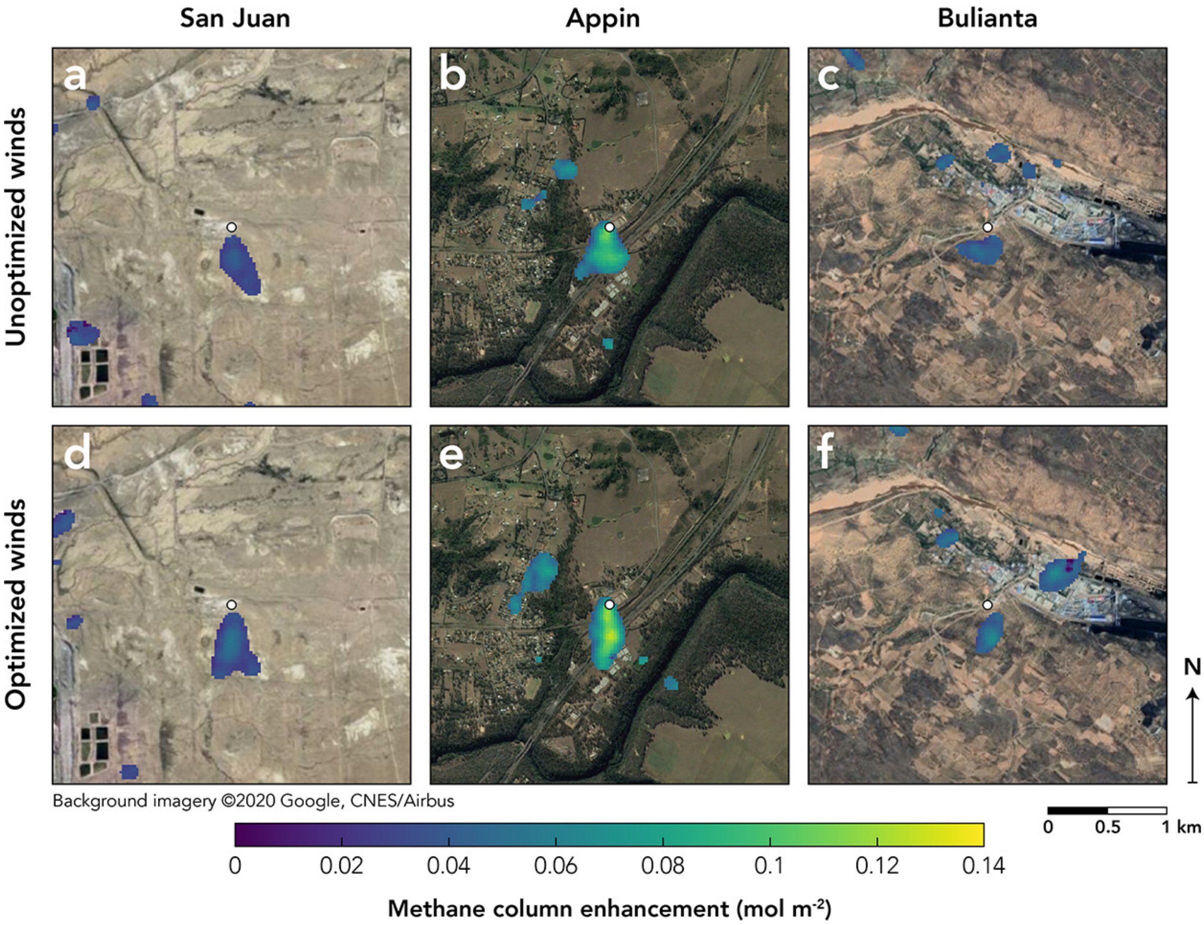

Figure 7. Example data of GHGSat [Varon et al., 2020]

Chapter 7. Fugitive Emissions Management SensorThings API Specification - Part I - AER Directive 60

This chapter describes the entities, their properties and values, and their relations for fugitive emissions reporting requirements based on AER Directive 60.

The SensorThings API Entities of this Best Practice are depicted in the following figure.

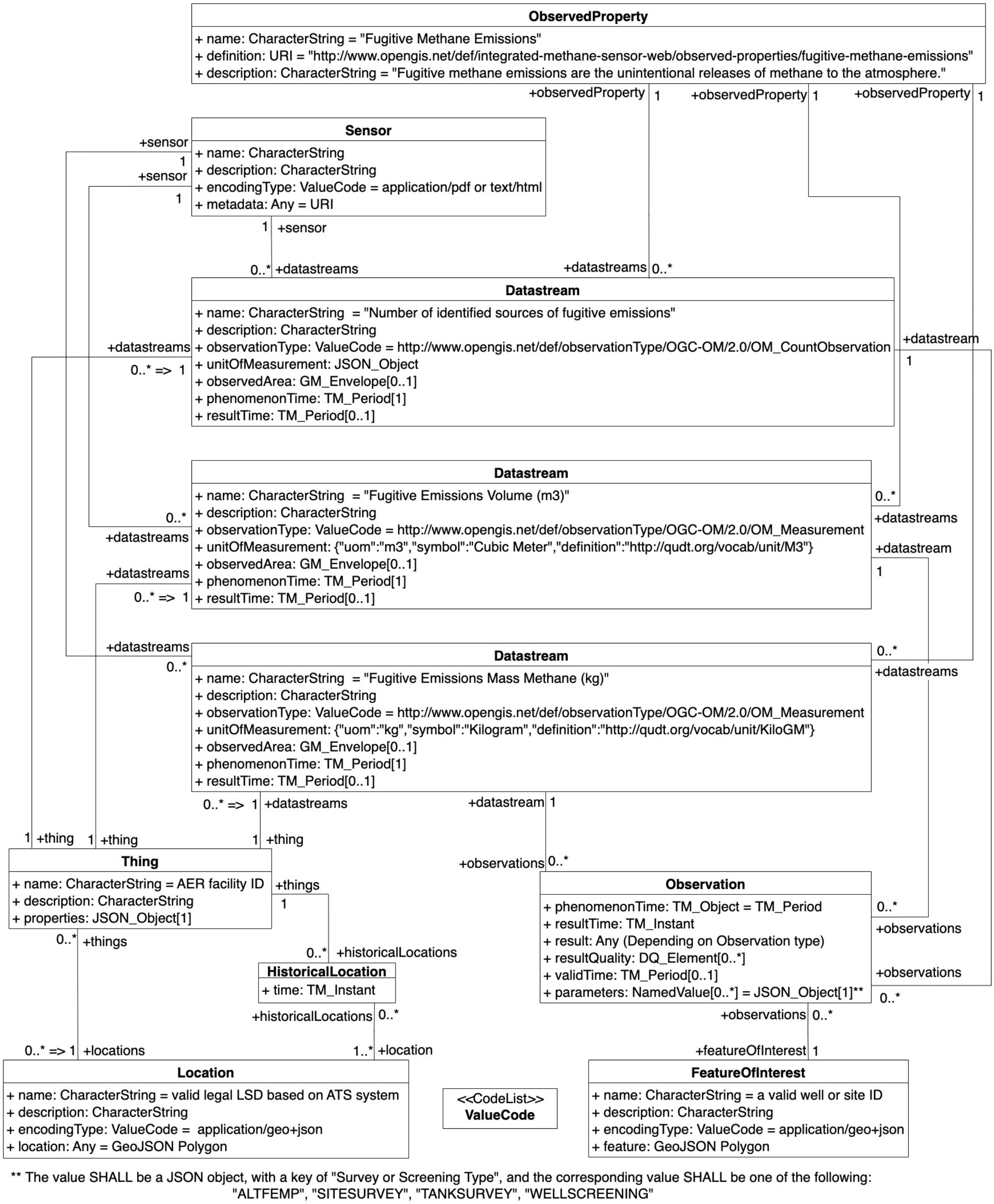

Figure 8. SensorThings API Entities for the Fugitive Emissions AER 60 Best Practice

7.1. Requirement Class: Thing

Requirements Class	
http://www.opengis.net/spec/imsw-fm-aer60/1.0/req/datamodel/thing	
Target type	JSON Object Instance

Dependency	http://www.opengis.net/spec/iot_sensing/1.1/req/datamodel/thing
Requirement 1	http://www.opengis.net/spec/imsw-fm-aer60/1.0/req/datamodel/thing/properties This requirement defines the mandatory properties of a *reporting facility* (as a Thing).
Requirement 2	http://www.opengis.net/spec/imsw-fm-aer60/1.0/req/datamodel/thing/relations This requirement defines the direct relation between the "Thing" entity and the "Location" and "Datastream" entities.

7.1.1. Requirement 1

This requirement defines the mandatory properties of a *reporting facility* (as a Thing).

Requirement 1	/req/datamodel/thing/properties The SensorThings SHALL have a "Thing" entity that has the properties with the corresponding value and multiplicity listed in Table 2.

Table 2. Properties of a reporting facility "Thing" entity

Name	**Definition**	**Data types and values**	**Multiplicity and use**
name	The facility ID of the *reporting facility*	Character string type, and the value shall be a valid AER facility ID	One
description	A short description of the facility	Character string type	One
properties	The well ID or site ID that is associated with the facility ID	A JSON object that has a key of "well or site id" and the corresponding value shall be a valid AER well ID or site ID	One

7.1.2. Requirement 2

This requirement defines the direct relation between the "Thing" entity and the "Location" and

"Datastream" entities.

Requirement 2	/req/datamodel/thing/relations The “Thing” entity SHALL have the direct relation between the "Thing" entity and the entities listed in Table 3.

Table 3. Direct relation between a reporting facility "Thing" entity and other entity types

Entity type	**Relation**	**Description**
Location	One mandatory	A *reporting facility* "Thing" SHALL have one Location. Multiple *reporting facilities* "Thing" MAY be located at the same "Location".
Datastream	Three-to-many mandatory	A *reporting facility* "Thing" SHALL have three related Datastream entities, describing the *number-of-fugitive-emissions*, the *fugitive-emissions-volume*, and the *fugitive-emissions-mass* respectively. A *reporting facility* "Thing" MAY have additional "Datastreams".

7.2. Requirement Class: Location

Requirements Class	
http://www.opengis.net/spec/imsw-fm-aer60/1.0/req/datamodel/location	
Target type	JSON Object Instance
Dependency	http://www.opengis.net/spec/iot_sensing/1.1/req/datamodel/location
Requirement 3	http://www.opengis.net/spec/imsw-fm-aer60/1.0/req/datamodel/location/properties This requirement defines the mandatory properties of the "Location" entity of a *reporting facility*.

Requirement 4	http://www.opengis.net/spec/imsw-fm-aer60/1.0/req/datamodel/location/relations This requirement defines the direct relation between the "Location" entity and the "Thing" entity.

7.2.1. Requirement 3

This requirement defines the mandatory properties and relations of the "Location" of the *reporting facility*.

Requirement 3	/req/datamodel/location/properties The SensorThings SHALL have a "Location" entity that has the properties with the corresponding value and multiplicity listed in Table 4.

Table 4. Properties of a reporting facility Location entity

Name	Definition	Data types and values	Multiplicity and use
name	The *reporting facility's* legal description of the Legal Subdivision (LSD) according to the Alberta Township Survey (ATS) system	Character string type, and the value shall be a valid legal description of the LSD based on the ATS system	One
description	The description about the Location	Character string type	One
encodingType	The IANA media type for GeoJSON	Character string type, and the value shall be "application/geo+json"	One
location	The GeoJSON polygon [RFC7946] represents the area of the legal description LSD	A GeoJSON Polygon object, and the value of the GeoJSON Polygon coordinates shall be the boundary of the legal description LSD	One

7.2.2. Requirement 4

This requirement defines the direct relation between the "Location" entity and the "Thing" entity.

Requirement 4	/req/datamodel/location/relations The "Location" entity SHALL have the direct relation between the "Location" entity and the entities listed in Table 5.

Table 5. Direct relation between a reporting facility Location entity and the Thing entity

Entity type	Relation	Description
Thing	Many optional	Multiple *reporting facilities* "Thing" MAY be located at the same "Location". A Location MAY not have a *reporting facility* "Thing".

7.3. Requirement Class: Datastream

Requirements Class	
http://www.opengis.net/spec/imsw-fm-aer60/1.0/req/datamodel/datastream	
Target type	JSON Object Instance
Dependency	http://www.opengis.net/spec/iot_sensing/1.1/req/datamodel/datastream
Requirement 5	http://www.opengis.net/spec/imsw-fm-aer60/1.0/req/datamodel/datastream/number-of-fugitive-emissions-properties This requirement defines the mandatory properties of the *number-of-fugitive-emissions* "Datastream" entity of a *reporting facility* "Thing".
Requirement 6	http://www.opengis.net/spec/imsw-fm-aer60/1.0/req/datamodel/datastream/number-of-fugitive-emissions-relations This requirement defines the direct relation between the *number-of-fugitive-emissions* "Datastream" entity and the "Thing", "Sensor", "ObservedProperty", and "Observation" entity.
Requirement 7	http://www.opengis.net/spec/imsw-fm-aer60/1.0/req/datamodel/datastream/fugitive-emissions-volume-properties This requirement defines the mandatory properties of the *fugitive-emissions-volume* "Datastream" entity of a *reporting facility* "Thing".

Requirement 8	http://www.opengis.net/spec/imsw-fm-aer60/1.0/req/datamodel/datastream/fugitive-emissions-volume-relations This requirement defines the direct relation between the *fugitive-emissions-volume* "Datastream" entity and the "Thing", "Sensor", "ObservedProperty", and "Observation" entity.
Requirement 9	http://www.opengis.net/spec/imsw-fm-aer60/1.0/req/datamodel/datastream/fugitive-emissions-mass-properties This requirement defines the mandatory properties of the *fugitive-emissions-mass* "Datastream" entity of a *reporting facility* "Thing".
Requirement 10	http://www.opengis.net/spec/imsw-fm-aer60/1.0/req/datamodel/datastream/fugitive-emissions-mass-relations This requirement defines the direct relation between the *fugitive-emissions-mass* "Datastream" entity and the "Thing", "Sensor", "ObservedProperty", and "Observation" entity.

7.3.1. Requirement 5

This requirement defines the mandatory properties of the *number-of-fugitive-emissions* "Datastream" of the *reporting facility*.

Requirement 5	/req/datamodel/datastream/number-of-fugitive-emissions-properties The *reporting facility* "Thing" SHALL have a *number-of-fugitive-emissions* "Datastream" entity that has the properties with the corresponding value and multiplicity listed in Table 6.

Table 6. Properties of a number-of-fugitive-emissions Datastream entity

Name	**Definition**	**Data types and values**	**Multiplicity and use**
name	Number of identified sources of fugitive emissions	Character string type, and the value shall be "Number of identified sources of fugitive emissions"	One
description	A short description of the Datastream	Character string type	One

Name	Definition	Data types and values	Multiplicity and use
observationType	The observation type of the *number-of-fugitive-emissions* "Observation" is a ISO/OGC 19156 count observation	The value shall be compliant with OM_CountObservation	One
phenomenonTime	This "Datastream" SHOULD have a phenomenonTime, describes the temporal interval of the phenomenon times of all observations belonging to this Datastream	TM_Period (ISO 8601 Time Interval)	One

7.3.2. Requirement 6

This requirement defines the direct relation between the "Datastream" entity and other entity types.

Requirement 6	/req/datamodel/datastream/number-of-fugitive-emissions-relations The *number-of-fugitive-emissions* "Datastream" entities SHALL have the direct relation between the "Datastream" entity and the entities listed in Table 7.

Table 7. Direct relation between a number-of-fugitive-emissions Datastream entity and other entity types

Entity type	Relation	Description
Thing	One mandatory	Each *number-of-fugitive-emissions* "Datastream" SHALL have one and only one *reporting facility* "Thing". A *reporting facility* "Thing" SHALL have one and only one *number-of-fugitive-emissions* "Datastream".

Entity type	Relation	Description
Sensor	One mandatory	The "Observations" in a *number-of-fugitive-emissions* "Datastream" are performed by one "Sensor". One "Sensor" MAY be used by different Datastreams. **Note:** A "Sensor" in this best practice is an observation process describing the Fugitive Emissions Management Program (FEMP) that generates the observation result.
ObservedProperty	One mandatory	The "Observations" of a *number-of-fugitive-emissions* "Datastream" SHALL observe the methane fugitive emissions "ObservedProperty" as defined in Requirement 11.
Observation	Many optional	A *number-of-fugitive-emissions* "Datastream" has zero-to-many "Observations". One Observation SHALL occur in one-and-only-one "Datastream".

7.3.3. Requirement 7

This requirement defines the mandatory properties the *fugitive-emissions_volume* "Datastream" of the *reporting facility*.

Requirement 7	/req/datamodel/datastream/fugitive-emissions-volume-properties A *reporting facility* "Thing" SHALL have a *fugitive-emissions-volume* "Datastream" entity that has the properties with the corresponding value and multiplicity listed in Table 8.

Table 8. Properties of a fugitive-emissions-volume Datastream entity

Name	Definition	Data types and values	Multiplicity and use
name	The volume of fugitive emissions (`m3`)	Character string type, and the value shall be "Fugitive Emissions Volume (`m3`)"	One
description	A short description of the Datastream	Character string type	One
observationType	The observation type of the *fugitive-emissions-volume* "Observation" is a ISO/OGC 19156 measurement	The value shall be compliant with OM_Measurement	One
phenomenonTime	This "Datastream" SHOULD have a phenomenonTime, describes the temporal interval of the phenomenon times of all observations belonging to this Datastream	TM_Period (ISO 8601 Time Interval)	One
unitOfMeasurement	The unit of measurement of this Datastream is cubic meter	A SensorThings "unitOfMeasurement" JSON Object, with the following key-value pairs: `{"uom":"m3","symbol":"Cubic Meter","definition":"http://qudt.org/vocab/unit/M3"}`	One

7.3.4. Requirement 8

This requirement defines the direct relation between the *fugitive-emissions-volume* "Datastream" entity and other entity types.

Requirement 8	/req/datamodel/datastream/fugitive-emissions-volume-relations The *fugitive-emissions-volume* "Datastream" entity SHALL have the direct relation between the "Datastream" entity and the entities listed in Table 9.

Table 9. Direct relation between a fugitive-emissions-volume Datastream entity and other entity types

Entity type	**Relation**	**Description**
Thing	One mandatory	Each *fugitive-emissions-volume* "Datastream" SHALL have one and only one *reporting facility* "Thing". A *reporting facility* "Thing" SHALL have one and only one *fugitive-emissions-volume* "Datastream".
Sensor	One mandatory	The "Observations" in a *fugitive-emissions-volume* "Datastream" are performed by one "Sensor". One "Sensor" MAY be used by different Datastreams. **Note:** A "Sensor" in this best practice is an observation process describing the Fugitive Emissions Management Program (FEMP) that generates the observation result.
ObservedProperty	One mandatory	The "Observations" of a *fugitive-emissions-volume* "Datastream" SHALL observe the methane *fugitive-emissions*"ObservedProperty" as defined in Requirement 11.

Entity type	Relation	Description
Observation	Many optional	A *fugitive-emissions-volume* "Datastream" has zero-to-many "Observations". One Observation SHALL occur in one-and-only-one "Datastream".

7.3.5. Requirement 9

This requirement defines the mandatory properties of the *fugitive-emissions-mass* "Datastream" of the *reporting facility*.

Requirement 9	/req/datamodel/datastream/fugitive-emissions-mass-properties A *reporting facility* "Thing" SHALL have a *fugitive-emissions-mass* "Datastream" entity that has the properties with the corresponding value and multiplicity listed in Table 10.

Table 10. Properties of a fugitive-emissions-mass "Datastream" entity

Name	Definition	Data types and values	Multiplicity and use
name	The mass of fugitive emissions (`kg`)	Character string type, and the value shall be "Fugitive Emissions Mass Methane (`kg`)"	One
description	A short description of the Datastream	Character string type	One
observationType	The observation type of the *fugitive-emissions-mass* "Observation" is a ISO/OGC 19156 measurement	The value shall be compliant with OM_Measurement	One

Name	Definition	Data types and values	Multiplicity and use
phenomenonTime	This "Datastream" SHOULD have a phenomenonTime, describes the temporal interval of the phenomenon times of all observations belonging to this Datastream	TM_Period (ISO 8601 Time Interval)	One
unitOfMeasurement	The unit of measurement of this Datastream is kilogram	A SensorThings "unitOfMeasurement " JSON Object, with the following key-value pairs: `{"uom":"kg","symbol":"Kilogram","definition":"http://qudt.org/vocab/unit/KiloGM"}`	One

7.3.6. Requirement 10

This requirement defines the direct relation between the *fugitive-emissions-mass* "Datastream" entity and other entity types.

Requirement 10	/req/datamodel/datastream/fugitive-emissions-mass-relations The *fugitive-emissions-mass* "Datastream" entity SHALL have the direct relation between the "Datastream" entity and the entities listed in Table 11.

Table 11. Direct relation between a fugitive-emissions-mass "Datastream" entity and other entity types

Entity type	Relation	Description
Thing	One mandatory	Each *fugitive-emissions-mass* "Datastream" SHALL have one and only one *reporting facility* "Thing". A *reporting facility* "Thing" SHALL have one and only one *fugitive-emissions-mass* "Datastream".

Entity type	Relation	Description
Sensor	One mandatory	The "Observations" in a *fugitive-emissions-mass* "Datastream" are performed by one "Sensor". One "Sensor" MAY be used by different Datastreams. **Note:** A "Sensor" in this best practice is an observation process describing the Fugitive Emissions Management Program (FEMP) that generates the observation result.
ObservedProperty	One mandatory	The "Observations" of a *fugitive-emissions-mass* "Datastream" SHALL observe the methane *fugitive-emissions* "ObservedProperty" as defined in Requirement 11.
Observation	Many optional	A *fugitive-emissions-mass* "Datastream" has zero-to-many "Observations". One Observation SHALL occur in one-and-only-one "Datastream".

7.4. Requirement Class: ObservedProperty

Requirements Class	
http://www.opengis.net/spec/imsw-fm-aer60/1.0/req/datamodel/observed-property	
Target type	JSON Object Instance
Dependency	http://www.opengis.net/spec/iot_sensing/1.1/req/datamodel/observed-property
Requirement 11	http://www.opengis.net/spec/imsw-fm-aer60/1.0/req/datamodel/observed-property/properties

7.4.1. Requirement 11

This requirement defines the mandatory properties of the fugitive emissions "ObservedProperty".

Requirement 11	/req/datamodel/observed-property/properties The three mandatory "Datastream" entities (*i.e.*, *number-of-fugitive-emissions*, *fugitive-emissions-volume*, and *fugitive-emissions-mass*) SHALL have a related *fugitive-emissions* "ObservedProperty" entity that has properties with the corresponding value and multiplicity listed in Table 12.

Table 12. Properties of a fugitive emissions "ObservedProperty" entity

Name	Definition	Data types and values	Multiplicity and use
name	The term used in AER Directive 60 to describe fugitive emissions	Character string type, and the value shall be "Fugitive Methane Emissions"	One
description	A description about the ObservedProperty	The value shall be "Fugitive methane emissions are the unintentional releases of methane to the atmosphere."	One
definition	This property is the URI of the ObservedProperty definition. Dereferencing this URI SHOULD result in a representation of the definition of the ObservedProperty.	The value shall be "http://www.opengis.net/def/integrated-methane-sensor-web/observed-properties/fugitive-methane-emissions"	One

7.5. Requirement Class: Observation

Requirements Class	
http://www.opengis.net/spec/imsw-fm-aer60/1.0/req/datamodel/observation	
Target type	JSON Object Instance
Dependency	http://www.opengis.net/spec/iot_sensing/1.1/req/datamodel/observation
Requirement 12	http://www.opengis.net/spec/imsw-fm-aer60/1.0/req/datamodel/observation/properties

7.5.1. Requirement 12

This requirement defines the mandatory properties of the fugitive emissions "Observations".

Requirement 12	/req/datamodel/observation/properties The "Observations" of the three mandatory "Datastream" entity SHALL have properties with the corresponding value and multiplicity listed in Table 13.

Table 13. Properties of a number-of-fugitive-emissions Observation entity

Name	**Definition**	**data types and values**	**Multiplicity and use**
phenomenonTime	The time period of when the "Observation" happens.	TM_Period (ISO 8601 Time Interval)	One
result	The *number-of-fugitive-emissions*	Depending on Observation type	One
parameters	Key-value pairs describing an event-specifc parameter.	The value SHALL be a JSON object, with a key of "Survey or Screening Type", and the corresponding value SHALL be one of the following: "ALTFEMP", "SITESURVEY", "TANKSURVEY", "WELLSCREENING"	One

7.6. Requirement Class: FeatureOfInterest

Requirements Class	
http://www.opengis.net/spec/imsw-fm-aer60/1.0/req/datamodel/feature-of-interest	
Target type	JSON Object Instance
Dependency	http://www.opengis.net/spec/iot_sensing/1.1/req/datamodel/feature-of-interest
Requirement 13	http://www.opengis.net/spec/imsw-fm-aer60/1.0/req/datamodel/feature-of-interest/properties
Requirement 14	http://www.opengis.net/spec/imsw-fm-aer60/1.0/req/datamodel/feature-of-interest/relations

7.6.1. Requirement 13

This requirement defines the mandatory properties of the "FeatureOfInterest" entity related to the "Observations" of the three mandatory "Datastreams." In the context of fugitive emissions, the "FeatureOfInterest" of fugitive emissions "Observation" is where the leaks occur. In AER Directive 60, the "FeatureOfInterest" is modelled as a site. In some cases, a *reporting facility* called "Thing" can have more than one site, such as wells, controlled tanks, process units, or wellhead [AER Manual015 Figure 1] and [AER Manual015 Figure 3]. The following figure describes the relationship between a *reporting facility* "Thing" and "FeaturesOfInterest."

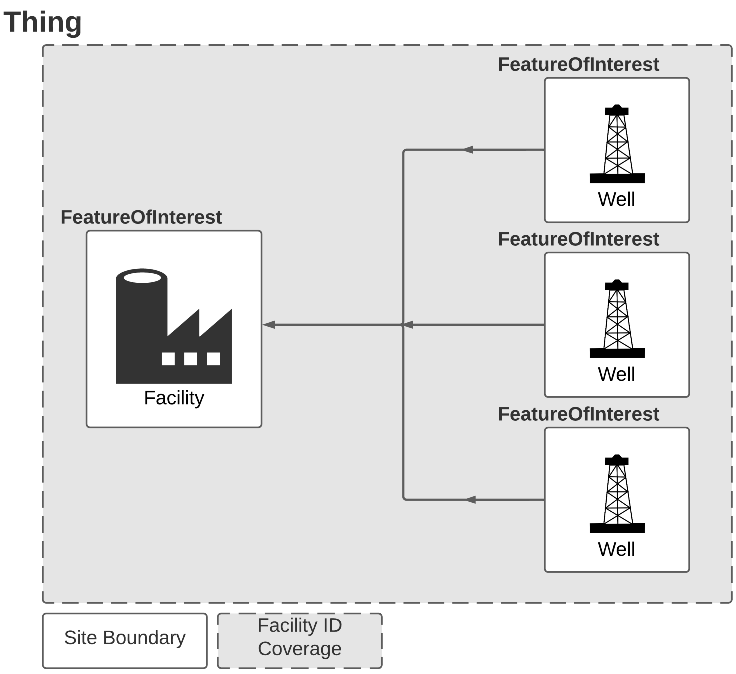

Figure 9. Thing and FeatureOfInterest Relationship

An Observation results in a value that is being assigned to a phenomenon. The phenomenon is a property of a feature, the latter being the FeatureOfInterest of the Observation [OGC and ISO 19156:2011]. In the context of this best practice, the FeatureOfInterest is the *site* and can be identified by the site's location. For example, the FeatureOfInterest of a wifi-connected thermostat can be the thermostat's location (*i.e.*, the living room where the thermostat is located). In the case of remote sensing, FeatureOfInterest can be the geographical area or volume that is being sensed.

Requirement 13	/req/datamodel/feature-of-interest/properties The "FeatureOfInterest" entity of the "Observations" of the three mandatory "Datastreams" SHALL have the properties with the corresponding value and multiplicity listed in Table 14.

Table 14. Properties of a FeatureOfInterest entity

Name	Definition	Data types and values	Multiplicity and use
name	The well ID or site ID that is associated with the facility ID	CharacterString, the value SHALL be a valid well or site ID	One
description	Site description	CharacterString	One
encodingType	The IANA media type for GeoJSON	Character string type, and the value shall be "application/geo+json"	One
feature	The GeoJSON polygon [RFC7946] represents the site boundary	A GeoJSON Polygon object, and the value of the GeoJSON Polygon coordinates shall be the boundary of the site or well	One

7.7. Requirement Class: Sensor

Requirements Class	
http://www.opengis.net/spec/imsw-fm-aer60/1.0/req/datamodel/sensor	
Target type	JSON Object Instance
Dependency	http://www.opengis.net/spec/iot_sensing/1.1/req/datamodel/sensor
Requirement 15	http://www.opengis.net/spec/imsw-fm-aer60/1.0/req/datamodel/sensor/properties

7.7.1. Requirement 14

This requirement defines the mandatory properties of the "Sensor" entity.

NOTE	The "Sensor" entity in this best practice is not an instrument, but rather it SHALL be an observation process ISO/OGC 19156:2001 OM_Process described the Fugitive Emissions Management Program (FEMP) that generates the observation result.

Requirement 14	/req/datamodel/sensor/properties A "Sensor" in this best practice is an observation process describing the Fugitive Emissions Management Program (FEMP) that generates the observation result. The "Sensor" SHALL have the properties with the corresponding value and multiplicity listed in Table 15.

Table 15. Properties of a Sensor entity

Name	**Definition**	**Data types and values**	**Multiplicity and use**
name	Provides a label for the "Sensor" entity, and it should be the descriptive name of the FEMP that generates the fugitive emissions observation results	CharacterString	One
description	The description of the FEMP	CharacterString	One
encodingType	The encoding type of the metadata property.	Character string type, and the value shall be "application/pdf" or "text/html"	One
metadata	This value depends on the value of the encodingType. The value SHALL be a resolvable URI, linking to either a PDF document or an HTML page, describing the FEMP used to generate the fugitive emissions observation results.	The value SHALL be a resolvable URI.	One

Annex A: Conformance Class Abstract Test Suite (Normative)

This section contains the conformance classes for the OGC Integrated Methane Sensor Web for Emissions Management Best Practice - Part I - Fugitive Emissions Management based on AER Directive 60. An SensorThings API service, that is compliant to this BP, needs to pass all the conformance tests defined in this section as well as the OGC SensorThings API Part 1: Sensing Version 1.1 Conformance Class Abstract Test Suit.

A.1. Conformance Class: Thing

<table>
<tr><td>Conformance Class</td><td colspan="2">/conf/datamodel/thing</td></tr>
<tr><td>Requirements</td><td colspan="2">/req/datamodel/thing/properties

/req/datamodel/thing/relations</td></tr>
<tr><td>Dependency</td><td colspan="2">http://www.opengis.net/spec/iot_sensing/1.1/conf/datamodel/thing</td></tr>
<tr><td rowspan="5">Test 1</td><td colspan="2">/conf/datamodel/thing/properties</td></tr>
<tr><td>Requirement</td><td>/req/datamodel/thing/properties</td></tr>
<tr><td>Test purpose</td><td>Verify that the Thing entity has mandatory properties as defined in this BP Specification.</td></tr>
<tr><td>Test method</td><td>Inspect the entire JSON object of the Thing entity set to identify if each entity has the mandatory properties defined in the corresponding requirement. Pass if no errors are reported. Fail otherwise.</td></tr>
<tr><td>Test type</td><td>Conformance</td></tr>
</table>

Test 2	/conf/datamodel/thing/relations	
	Requirement	/req/datamodel/thing/relations
	Test purpose	Verify that the Thing entity has mandatory relations as defined in this BP Specification.
	Test method	Inspect the entire JSON object of each Thing entity set to identify if each entity has the mandatory relations defined in the corresponding requirement. Pass if no errors are reported. Fail otherwise.
	Test type	Conformance

A.2. Conformance Class: Location

Conformance Class	**/conf/datamodel/location**	
Requirements	/req/datamodel/location/properties /req/datamodel/location/relations	
Dependency	http://www.opengis.net/spec/iot_sensing/1.1/conf/datamodel/location	
Test 3	/conf/datamodel/location/properties	
	Requirement	/req/datamodel/location/properties
	Test purpose	Verify that the Location entity has the mandatory properties as defined in this BP Specification.
	Test method	Inspect the full JSON object of the Location entity set to identify if each entity has the mandatory properties defined in the corresponding requirement. Pass if no errors are reported. Fail otherwise.
	Test type	Conformance

Test 4	/conf/datamodel/location/relations	
	Requirement	/req/datamodel/location/relations
	Test purpose	Verify that the Location entity has the mandatory relations as defined in this BP Specification.
	Test method	Inspect the full JSON object of each Location entity set to identify if each entity has the mandatory relations defined in the corresponding requirement. Pass if no errors are reported. Fail otherwise.
	Test type	Conformance

A.3. Conformance Class: Datastream

Conformance Class	**/conf/datamodel/datastream**
Requirements	/req/datamodel/datastream/number-of-fugitive-emissions-properties /req/datamodel/datastream/number-of-fugitive-emissions-relations /req/datamodel/datastream/fugitive-emissions-volume-properties /req/datamodel/datastream/fugitive-emissions-volume-relations /req/datamodel/datastream/fugitive-emissions-mass-properties /req/datamodel/datastream/fugitive-emissions-mass-relations
Dependency	http://www.opengis.net/spec/iot_sensing/1.1/conf/datamodel/datastream

Test 5	/conf/datamodel/datastream/number-of-fugitive-emissions-properties	
	Requirement	/req/datamodel/datastream/number-of-fugitive-emissions-properties
	Test purpose	Verify that each *number-of-fugitive-emissions* Datastream entity has the mandatory properties as defined in this BP Specification.
	Test method	Inspect the full JSON object of the *number-of-fugitive-emissions* Datastream entity set to identify if each entity has the mandatory properties defined in the corresponding requirement. Pass if no errors are reported. Fail otherwise.
	Test type	Conformance
Test 6	/conf/datamodel/datastream/number-of-fugitive-emissions-relations	
	Requirement	/req/datamodel/datastream/number-of-fugitive-emissions-relations
	Test purpose	Verify that each *number-of-fugitive-emissions* Datastream entity has the mandatory relations as defined in this BP Specification.
	Test method	Inspect the full JSON object of each *number-of-fugitive-emissions* Datastream entity set to identify if each entity has the mandatory relations defined in the corresponding requirement. Pass if no errors are reported. Fail otherwise.
	Test type	Conformance

Test 7	/conf/datamodel/datastream/fugitive-emissions-volume-properties	
	Requirement	/req/datamodel/datastream/fugitive-emissions-volume-properties
	Test purpose	Verify that each *fugitive-emissions-volume* Datastream entity has the mandatory properties as defined in this BP Specification.
	Test method	Inspect the full JSON object of the *fugitive-emissions-volume* Datastream entity set to identify if each entity has the mandatory properties defined in the corresponding requirement. Pass if no errors are reported. Fail otherwise.
	Test type	Conformance
Test 8	/conf/datamodel/datastream/fugitive-emissions-volume-relations	
	Requirement	/req/datamodel/datastream/fugitive-emissions-volume-relations
	Test purpose	Verify that each *fugitive-emissions-volume* Datastream entity has the mandatory relations as defined in this BP Specification.
	Test method	Inspect the full JSON object of each *fugitive-emissions-volume* Datastream entity set to identify if each entity has the mandatory relations defined in the corresponding requirement. Pass if no errors are reported. Fail otherwise.
	Test type	Conformance

Test 9	/conf/datamodel/datastream/fugitive-emissions-mass-properties	
	Requirement	/req/datamodel/datastream/fugitive-emissions-mass-properties
	Test purpose	Verify that each *fugitive-emissions-mass* Datastream entity has the mandatory properties as defined in this BP Specification.
	Test method	Inspect the full JSON object of the *fugitive-emissions-mass* Datastream entity set to identify if each entity has the mandatory properties defined in the corresponding requirement. Pass if no errors are reported. Fail otherwise.
	Test type	Conformance
Test 10	/conf/datamodel/datastream/fugitive-emissions-mass-relations	
	Requirement	/req/datamodel/datastream/fugitive-emissions-mass-relations
	Test purpose	Verify that each *fugitive-emissions-mass* Datastream entity has the mandatory relations as defined in this BP Specification.
	Test method	Inspect the full JSON object of each *fugitive-emissions-mass* Datastream entity set to identify if each entity has the mandatory relations defined in the corresponding requirement. Pass if no errors are reported. Fail otherwise.
	Test type	Conformance

A.4. Conformance Class: ObservedProperty

Conformance Class	**/conf/datamodel/observed-property**
Requirements	/req/datamodel/observed-property/properties
Dependency	http://www.opengis.net/spec/iot_sensing/1.1/conf/datamodel/observed-property

Test 11	/conf/datamodel/observed-property/properties	
	Requirement	/req/datamodel/observed-property/properties
	Test purpose	Verify that the ObservedProperty entity has the mandatory properties as defined in this BP Specification.
	Test method	Inspect the full JSON object of the ObservedProperty entity set to identify if each entity has the mandatory properties defined in the corresponding requirement. Pass if no errors are reported. Fail otherwise.
	Test type	Conformance

A.5. Conformance Class: Observation

Conformance Class	**/conf/datamodel/observation**	
Requirements	/req/datamodel/observation/properties	
Dependency	http://www.opengis.net/spec/iot_sensing/1.1/conf/datamodel/observation	
Test 12	/conf/datamodel/observation/properties	
	Requirement	/req/datamodel/observation/properties
	Test purpose	Verify that the Observation entity has the mandatory properties as defined in this BP Specification.
	Test method	Inspect the full JSON object of the Observation entity set to identify if each entity has the mandatory properties defined in the corresponding requirement. Pass if no errors are reported. Fail otherwise.
	Test type	Conformance

A.6. Conformance Class: FeatureOfInterest

Conformance Class	**/conf/datamodel/feature-of-interest**

Requirements	/req/datamodel/feature-of-interest/properties	
Dependency	http://www.opengis.net/spec/iot_sensing/1.1/conf/datamodel/feature-of-interest	
Test 13	/conf/datamodel/feature-of-interest/properties	
	Requirement	/req/datamodel/feature-of-interest/properties
	Test purpose	Verify that the FeatureOfInterest entity has the mandatory properties as defined in this BP Specification.
	Test method	Inspect the full JSON object of the FeatureOfInterest entity set to identify if each entity has the mandatory properties defined in the corresponding requirement. Pass if no errors are reported. Fail otherwise.
	Test type	Conformance

A.7. Conformance Class: Sensor

Conformance Class	**/conf/datamodel/sensor**	
Requirements	/req/datamodel/sensor/properties	
Dependency	http://www.opengis.net/spec/iot_sensing/1.1/conf/datamodel/sensor	
Test 14	/conf/datamodel/sensor/properties	
	Requirement	/req/datamodel/sensor/properties
	Test purpose	Verify that the Sensor entity has the mandatory properties as defined in this BP Specification.
	Test method	Inspect the full JSON object of the Sensor entity set to identify if each entity has the mandatory properties defined in the corresponding requirement. Pass if no errors are reported. Fail otherwise.
	Test type	Conformance

Annex B: Title ({Normative/Informative})

NOTE	Place other Annex material in sequential annexes beginning with "B" and leave final two annexes for the Revision History and Bibliography

Annex C: Revision History

Date	Release	Editor	Primary clauses modified	Description
2021-11-19	0.1	Steve Liang	all	initial version

Annex D: Bibliography

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