INTERNATIONAL STANDARD

ISO 15143-1

First edition
2010-08-01

Earth-moving machinery and mobile road construction machinery — Worksite data exchange

Part 1: System architecture

Engins de terrassement et machines mobiles de construction de routes — Échange de données sur le chantier

Partie 1: Architecture du système

Reference number
ISO 15143-1:2010(E)

ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.org
Web www.iso.org

Published in Switzerland

Contents

Page

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 15143-1 was prepared by Technical Committee ISO/TC 127, *Earth-moving machinery*, Subcommittee SC 3, *Machine characteristics, electrical and electronic systems, operation and maintenance*.

ISO 15143 consists of the following parts, under the general title *Earth-moving machinery and mobile road construction machinery — Worksite data exchange*:

— *Part 1: System architecture*

— *Part 2: Data dictionary*

Introduction

Rapidly advancing information technology and measuring technology are being used to develop worksite information systems to support control of the finished form of work performed by machinery used in the construction industry. The introduction of such systems into construction projects, including earth-work and road construction work, has begun.

To use these worksite information systems, it must be possible for data to be easily and reliably exchanged between the machinery, measuring equipment and site information systems. When a construction project supported by a worksite information system begins, the system is introduced with specifications suited to the machine and the measuring equipment used at the project, and after this system has been used during the limited duration of the project, it is moved to another project. Therefore, an essential condition for the use of such a worksite information system is that it be possible for the system to exchange electronic data with the construction machine and measuring equipment.

In addition, the many concerned parties, which include not only site managers and machine operators, but also companies contracted to execute the work, machine owners, and project owners, must all have the measurement data, completed work data, machine control data, and so on, used and created during a project. Different information systems are also expected to be able to exchange electronic data.

Achieving data exchange using such electronic data is hampered by the fact that the names and definitions of data and data formats normally differ between worksite information systems, construction machines, and measuring equipment in use: a problem that severely obstructs the development and use of worksite information systems.

ISO 15143 is intended to resolve the above problems and guarantee the interoperability of data.

NOTE It includes the definition of data describing the real-time status of a machine in operation. These data are not intended for real time control of the machine (but such use is not prohibited).

The benefits of its use include greater freedom for product developers and users. Manufacturers of construction machinery, measuring equipment and information systems will benefit from the ability to expand the range of their customers and reduce their product development risk by designing products in compliance with ISO 15143, and to lower their costs by shortening product development periods and establishing more efficient development and maintenance systems. Without this standard it is difficult to connect equipment made by different makers for use in such information systems and system development is an extremely risky undertaking, thus making it difficult for manufacturers to begin to sell their products to users of systems made by other manufacturers. Another cause of high costs is the need to continuously employ many technicians to develop and maintain products after delivery, including the introduction of new versions.

However, application of ISO 15143 can be counted on to expand the range of customers of all makers by allowing them to develop and sell products that can be linked with systems from other companies. And the development of products that comply with ISO 15143 will achieve great cost savings by allowing each maker to sell products to many users, at the same time as it increases the efficiency of maintenance work.

It will benefit contractors by expanding the range of products that they can select and use from a single supplier to many suppliers, lowering costs and improving product quality. Systems development in the past was characterized by a general absence of competitiveness, because each user could introduce only products that satisfied the specifications of its existing system and had to continue to rely on its developer for maintenance. The application of ISO 15143 will enhance competition between makers, lowering costs and raising the level of the systems developed.

Expanding the use of information systems on worksites will permit the use of new more advanced products equipped with information technology. For manufacturers of construction machinery and measuring equipment, this will expand the market by developing new business opportunities. One example is stakeless earthwork,

the replacement of finishing stakes that indicate the targets of construction machines with support systems that use electronic data to indicate target positions to operators. Another is the development of construction machinery with automated blade control.

Owners of construction projects, including the national government, regional administrations and private sector users will enjoy the benefits of lower construction costs and higher quality. These benefits will result from greater competition, improved geometrical tolerances, increased data transfer and the precise control of finished products.

Earth-moving machinery and mobile road construction machinery — Worksite data exchange

Part 1: System architecture

1 Scope

This part of ISO 15143 specifies system architecture for the exchange of data related to the use of earth-moving machinery, as defined in ISO 6165, and mobile road construction machinery, as defined in ISO 22242 when used for work similar to earth-moving, in worksite data-controlled construction operations. It also applies to worksite data exchange for the purpose of services related to machine use (see Clause 4) and gives definitions of terms related to worksite data exchange.

It covers only the application layer of the OSI reference model according to ISO/IEC 7498-1, and does not cover the presentation, session, transport, network, data link or physical layers of the model. Specific agreement (selection of applicable specifications, standards, etc.) relating to those layers will therefore be needed if data exchange is to be facilitated.

This part of ISO 15143 is applicable to the following construction worksite data exchanges:

a) information exchanged between contractor and site information system (execution phase):

   1) information from contractor to site information system, such as basic project data, design data, operational conditions;

   2) information from site information system to contractor, such as achieved work data, machine working record;

b) information exchanged between site information system and construction machine:

   1) information from site information system to construction machine, such as mission data including target data;

   2) information from construction machine to site information system, such as machine working records (productivity) and machine running records (health).

c) information exchanged between site information system and measuring equipment:

   1) information from site information system to measuring equipment such as trigger data;

   2) information from measuring equipment to site information system such as measurement records including measurement data.

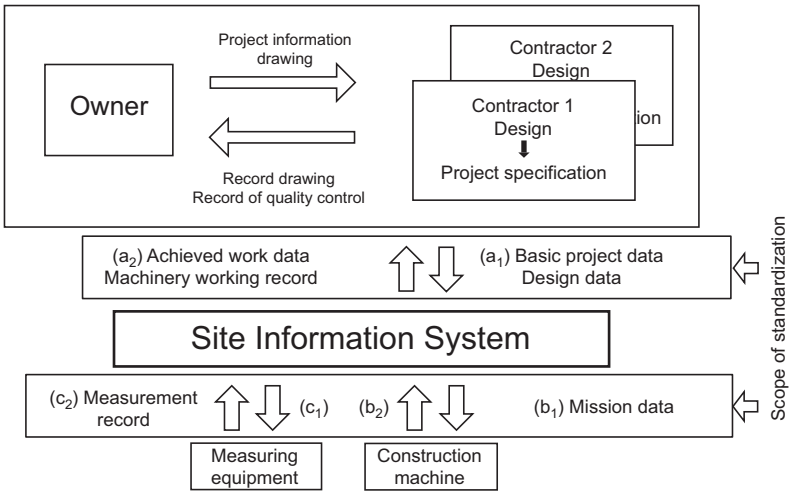
It is not applicable to information exchanged between project owner and contractor:

— information from project owner to contractor such as project information, drawing designed topographic data and survey data;

— information from contractor to project owner such as record drawing and record of quality control.

However, the possibility of its application to this area is not excluded.

See Figure 1.



The term *construction machine* is used here as a concept. The actual machine may contain measuring equipment and/or a data operation system. Construction machines are intended to be in the state in which they are delivered by the manufacturer.

ISO 15143 applies to open system data exchange and may be applicable to closed systems.

See Clause 4 for ISO 15143-applicable services.

Figure 1 — Information exchange relating to worksite data exchange

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 6165, *Earth-moving machinery — Basic types — Identification and terms and definitions*

ISO/IEC 7498-1, *Information technology — Open Systems Interconnection — Basic Reference Model: The Basic Model*

ISO/IEC 11179 (all parts), *Information technology — Metadata registries (MDR)*

ISO/IEC 19501-1, *Information technology — Open Distributed Processing — Unified Modeling Language (UML) Version 1.4.2*

ISO 22242, *Road construction and road maintenance machinery and equipment — Basic types — Identification and description*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 6165 and ISO 22242, and the following apply.

3.1 General terms relating to information processing

3.1.1
block transfer
process of transferring one or more blocks of data in one operation

NOTE A block transfer can be done with or without erasing data from the original location.

[ISO/IEC 2382-6]

3.1.2
collating sequence
specified arrangement resulting from collating

[ISO/IEC 2382-6]

3.1.3
configuration
manner in which the hardware and software of an information processing system are organized and interconnected

[ISO/IEC 2382-1]

3.1.4
data acquisition
process of collecting and entering data

[ISO/IEC 2382-6]

3.1.5
data collection
process of bringing data together from one or more points for use in a computer

EXAMPLE Collection of transactions generated at branch offices by a data network for use at a computer centre.

3.1.6
data communication
transfer of data among functional units according to sets of rules governing data transmission and the coordination of the exchange

[ISO/IEC 2382-9]

3.1.7
data entry
process of putting data onto a machine-readable medium

EXAMPLE Entering data to a payroll file on a flexible disk from a terminal.

[ISO/IEC 2382-6]

3.1.8
data processing
systematic performance of operations upon data

[ISO/IEC 2382-1]

3.1.9
data processing system
one or more computers, peripheral equipment, and software that perform data processing

[ISO/IEC 2382-1]

3.1.10
functional unit
entity of hardware or software, or both, capable of accomplishing a specified purpose

[ISO/IEC 2382-1]

3.1.11
index
list of the contents of a file or of a document together with keys or references for locating the contents

[ISO/IEC 2382-6]

3.1.12
information processing
systematic performance of operations upon information that includes data processing and may include operations such as data communication and office automation

[ISO/IEC 2382-1]

3.1.13
information processing system
one or more data processing systems and devices, such as office and communication equipment, that perform information processing

[ISO/IEC 2382-1]

3.1.14
information system
information processing system, together with associated organizational resources such as human, technical, and financial resources, that provides and distributes information

[ISO/IEC 2382-1]

3.1.15
input, adj.
pertaining to a device, process, or channel involved in an input process, or to the associated data or states

NOTE The term “input” may be used in place of “input data”, “input signal” or “input process” when such a usage is clear in a given context.

[ISO/IEC 2382-6]

3.1.16
input data
data being received or to be received by any component part of a computer

[ISO/IEC 2382-6]

3.1.17
input process
process that consists of the reception of data by any component part of a computer

[ISO/IEC 2382-6]

3.1.18
input-output, adj.
I/O
pertaining to a device, process, or channel involved in an input process and in an output process, concurrently or not, or to their associated data or states

NOTE The term “input-output” may be used in place of “input-output data”, “input-output signals” or “input-output process” when such a usage is clear in a given context.

[ISO/IEC 2382-6]

3.1.19
interface
shared boundary between two functional units, defined by various characteristics pertaining to the functions, physical interconnections, signal exchanges, and other characteristics of the units, as appropriate

[ISO/IEC 2382-9]

3.1.20
interoperability
capability to communicate, execute programs, or transfer data among various functional units in a manner that requires the user to have little or no knowledge of the unique characteristics of those units

[ISO/IEC 2382-1]

3.1.21
mask
pattern of characters that is used to control the retention or elimination of portions of another pattern of characters

[ISO/IEC 2382-6]

3.1.22
output, adj.
pertaining to a device, process, or channel involved in an output process, or to the associated data or states

NOTE The term “output” may be used in place of “output data”, “output signal”, “output process” when such a usage is clear in a given context.

[ISO/IEC 2382-6]

3.1.23
output data
data being produced or to be produced by any component part of a computer

[ISO/IEC 2382-6]

3.1.24
output process
process that consists of the production of data from any component part of a computer

[ISO/IEC 2382-6]

3.1.25
packing
operation performed when data are packed

[ISO/IEC 2382-6]

3.1.26
process
predetermined course of events defined by its purpose or by its effect, achieved under given conditions

[ISO/IEC 2382-1]

3.1.27
protocol
set of rules that determines the behaviour of functional units in achieving communication

[ISO/IEC 2382-9]

3.1.28
clear, vb.
to cause one or more storage locations to be set in a prescribed state, usually that corresponding to zero or that corresponding to the space character

[ISO/IEC 2382-6]

3.1.29
collate, vb.
to arrange two or more sets of data into a single one according to a predetermined order

[ISO/IEC 2382-6]

3.1.30
convert, vb.
to change the representation of data from one form to another, without changing the information conveyed

[ISO/IEC 2382-6]

EXAMPLE Code conversion, radix conversion, analogue-to-digital conversion, media conversion.

3.1.31
copy, vb.
to read data from a source data medium, leaving the source data unchanged, and to write the same data on a destination data medium that may differ from that of the source

EXAMPLE Copying a file from a magnetic tape onto a magnetic disk.

[ISO/IEC 2382-6]

3.1.32
decode, vb.
to convert data by reversing the effect of some previous encoding

[ISO/IEC 2382-6]

3.1.33
duplicate, vb.
to copy from a source data medium to a destination data medium that has the same physical form

EXAMPLE Copying a file from a magnetic tape to another magnetic tape.

[ISO/IEC 2382-6]

3.1.34
encode, vb.
code, vb.
to convert data by the use of a code in such a manner that re-conversion to the original form is possible

[ISO/IEC 2382-6]

3.1.35
edit, vb.
to prepare data for a later operation

NOTE Editing can include rearrangement, the addition or modification of data, the deletion of unwanted data, format control, code conversion and the application of standard processes such as zero suppression.

[ISO/IEC 2382-6]

3.1.36
extract, vb.
to select and remove from a group of items those which meet specific criteria

[ISO/IEC 2382-6]

3.1.37
load, vb.
to transfer data into storage device or working registers

[ISO/IEC 2382-6]

3.1.38
merge, vb.
to combine the items of two or more sets of data that are in the same given order into one set in that order

[ISO/IEC 2382-6]

3.1.39
move, vb.
transfer
to send data from one storage location to another

[ISO/IEC 2382-6]

3.1.40
pack, vb.
to convert data to a compact form in a storage medium by taking advantage of known characteristics of the data and of the storage medium, in such a way that the original form of the data can be recovered

EXAMPLE Making use of bit or byte locations that would otherwise remain unused.

[ISO/IEC 2382-6]

3.1.41
read, vb.
to obtain data from a storage device, from a data medium, or from another source

[ISO/IEC 2382-6]

3.1.42
sort, vb.
to segregate items into groups according to specified criteria without necessarily ordering the items within each group

[ISO/IEC 2382-6]

3.1.43
transcribe, vb.
to copy data from one data medium to another, converting them as necessary for acceptance by the receiving medium

[ISO/IEC 2382-6]

3.1.44
transform, vb.
to change the form of data according to specified rules, without fundamentally changing the meaning of the data

[ISO/IEC 2382-6]

3.1.45
translate, vb.
to change a portion of a program expressed in one programming language into another programming language or into some other representation suitable for execution

[ISO/IEC 2382-6]

3.1.46
transliterate, vb.
to convert data character by character

[ISO/IEC 2382-6]

3.1.47
write, vb.
to make a permanent or transient recording of data in a storage device or on a data medium

NOTE The phases “to read to” and “to read from” are often distinguished from the phrases “to write to” and “to write from” only by the viewpoint of the description. For example, the transfer of a block of data from internal storage to external storage may be called “writing to the external storage” or “reading from the internal storage”, or both.

[ISO/IEC 2382-6]

3.2 Terms specific to worksite data exchange

3.2.1
agreement
mutual acknowledgement of terms and conditions under which a working relationship is conducted

[ISO/IEC 12207]

3.2.2
clerk of works
person appointed to verify on behalf of a client that construction work is executed in accordance with drawings, specification of works and other contract documents

[ISO 6707-2]

3.2.3
client
customer
owner
person or organization that provides the plan of work, commissions the work and pays for it

[ISO 6707-2]

NOTE The term can be further qualified by the type of work undertaken, e.g. “building contractor client”, “roofing contractor customer”.

3.2.4
closed system
isolated system having no interaction with an environment

3.2.5
completion
state of readiness for occupation of the whole works although some minor work may be outstanding

NOTE In certain contracts, the term “practical completion” is used.

[ISO 6707-2]

3.2.6
conditions of contract 1
terms that collectively describe the rights and obligations of contracting parties and the agreed procedures for the administration of their contract

[ISO 6707-2]

3.2.7
conditions of contract 2
document containing **conditions of contract** (3.2.6)

[ISO 6707-2]

3.2.8
construction plan
construction plan concretely showing the basic policy for the construction work

NOTE Construction methods, construction sequences, ways of procurement, etc. are written to it.

3.2.9
contract
legally enforceable agreement to supply goods, execute work or provide services

[ISO 6707-2]

3.2.10
contract document
document forming part of a contract

[ISO 6707-2]

3.2.11
contractor
person or organization that undertakes construction work in accordance with a contract

[ISO 6707-2]

3.2.12
data set
prioritized data element sets structured in accordance with the utilization purpose

3.2.13
drawing
information presented in a graphical manner that may include annotations

NOTE The French term “*dessin*” is also used.

[ISO 6707-2]

3.2.14
engineer
person who designs and/or superintends the execution of civil engineering works, building structures and services, and their maintenance

[ISO 6707-2]

3.2.15
file format
data storage method used for loading data into file systems

NOTE Normally, this refers to a storage method capable of being used in special application software. This includes formats such as DXF and TEXT.

3.2.16
foreman
person employed by a contractor to be in charge of site labour

[ISO 6707-2]

3.2.17
general contractor
contractor responsible for the preparation, coordination and completion of the whole of the work on a project

[ISO 6707-2]

3.2.18
general information
information of an overall nature, prepared for a wider audience than that involved in a particular project

[ISO 6707-2]

3.2.19
joint venture
grouping of two or more contractors acting as one legal entity, where each is liable for the actions of the other

[ISO 6707-2]

3.2.20
labour
workers
all persons involved in physical construction work

[ISO 6707-2]

3.2.21
machine manufacturer
person or enterprise that makes or sells a machine

3.2.22
main contractor
contractor who sub-contracts part of his contract

[ISO 6707-2]

3.2.23
management contractor
organization, engaged on a fee basis, responsible to a client for the coordination of all parties involved in the whole of the work on a construction project

[ISO 6707-2]

3.2.24
management information
information utilized by management or produced to serve a management function

[ISO 6707-2]

3.2.25
measuring equipment
apparatus installed on a construction machine or placed on a worksite in order to acquire information on site conditions and situation

3.2.26
open system
system that transmits data to other systems from the apparatus that treats the data first

3.2.27
phase
section of work that arises from splitting up a project or a contract in accordance with a definite agreement

[ISO 6707-2]

3.2.28
plan of work
document that details principal stages in design, construction and maintenance of building and civil engineering projects that identifies main tasks and persons

[ISO 6707-2]

3.2.29
project information
information produced for, or utilized in, a particular project

[ISO 6707-2]

3.2.30
project manager
person appointed by the client to manage design and construction of building and civil engineering projects

NOTE In the context of public engineering or architectural contracts, a “project manager” is an internal technical service appointed by the developer to assist in defining the works, i.e. drawing up the programme, and to act as his representative during their execution (e.g. project approval, site supervision, preparing for handover).

[ISO 6707-2]

3.2.31
project specification
specification of work written for a specific project that describes the construction, the method of construction and the materials to be used

[ISO 6707-2]

3.2.32
real-time data
data generated one by one, and processed and used immediately

NOTE That which is processed collectively on data generated one by one is not included in real-time data.

3.2.33
record drawing
drawing that records construction works as completed

[ISO 6707-2]

3.2.34
resident engineer
engineer employed onsite to supervise work during construction

[ISO 6707-2]

3.2.35
service
beneficial performance conferred by the system in order to achieve the project goals

3.2.36
site information system
system that processes information at the site so that it can be used for implementation of a construction project

3.2.37
site manager
person employed by a contractor to organize and supervise works onsite

[ISO 6707-2]

3.2.38
specification of work
written document stating the requirements for construction work to be carried out

[ISO 6707-2]

3.2.39
subcontracting
procedure that enables a contractor to contract part of the work, usually of a specialist nature, to another contractor

[ISO 6707-2]

3.2.40
subcontractor
contractor to whom a main contractor has contracted part of his work

[ISO 6707-2]

3.2.41
sub-service
performance resulting from the subdivision of the service on an individual sub- system basis

NOTE It is a service provided by one subsystem to another or to the main system itself.

3.2.42
subsystem
entity resulting from the subdivision of a system in accordance with the system architecture in order to achieve the project goals more efficiently

NOTE In practice, a subsystem is composed of a subset of the system's functions oriented to the same sub-purpose. A subsystem does not necessarily include computer systems. The system decomposed into subsystems is a fractal figure, as each subsystem can itself be decomposed into different “sub-subsystems” and so on.

3.2.43
supplier
person or organization that provides materials or products for a building or civil engineering works

[ISO 6707-2]

3.2.44
system
group of functions oriented to the same global purpose, in a given environment

NOTE A system delivers a service in answer to a client's demand (the purpose may be subdivided into several goals).

3.2.45
technical specification
document that prescribes technical requirements to be fulfilled by a product, process or service

[ISO 6707-2]

3.2.46
topographic data
data in three-dimensional form representing the surface of the ground or any layer of the road and comprised of as-of-present (or as-built) and as-designed data

3.3 Terms relating to specification and standardization of data elements

3.3.1
administered component
component for which administrative attributes are collected

3.3.2
attribute
characteristic of an object or entity

3.3.3
attribute value
representation of an instance of an attribute

3.3.4
certified data element
recorded data element that has met the quality requirements specified in ISO/IEC 11179

3.3.5
classification scheme
arrangement or division of objects into groups based on characteristics that the objects have in common, e.g. origin, composition, structure, application, function, etc.

3.3.6
classification scheme item
CSI
component of content in a classification scheme

NOTE This may be a node in a taxonomy or ontology, a term in a thesaurus, etc.

3.3.7
classification component
any component of a data element that may be classified in one or more classification schemes

NOTE These components include the object class, property, representation class, data element concept, value domain, and data element.

3.3.8
comments
remarks on the data element

3.3.9
concept
unit of thought constituted through abstraction on the basis of characteristics common to a set of objects

3.3.10
context
designation or description of the application environment or discipline in which a name is applied or from which it originates

3.3.11
data
representation of facts, concepts, or instructions in a formalized manner, suitable for communication, interpretation, or processing by humans or by automatic means

3.3.12
data dictionary
database used for data that refers to the use and structure of other data; that is, a database for the storage of metadata

3.3.13
data element
unit of data for which the definition, identification, representation, and permissible values are specified by means of a set of attributes

3.3.14
data element dictionary
information resource that lists and defines all relevant data elements

NOTE See also **register** (3.3.52)

3.3.15
data element facet
any aspect of a data element that is subject to classification

NOTE This includes object class, property, representation, and data element concept

3.3.16
data element name
single or multi-word designation assigned to a data element

3.3.17
data element registry
information resource kept by a maintenance agency or registration authority that describes the meaning and representational form of data elements, including registration identifiers, definitions, names, value domains, metadata and administrative attributes, etc.

NOTE See also **register** (3.3.52)

3.3.18
data element value
value out of a set of permissible values pertaining to a data element

NOTE See also **data value** (3.3.24).

3.3.19
data item
one occurrence of a data element

3.3.20
data model
description of the organization of data in a manner that reflects an information structure

3.3.21
data steward
person or organization delegated the responsibility for managing a specific set of data resources

3.3.22
datatype
format used for the collection of letters, digits, and/or symbols, to depict values of a data element, determined by the operations that may be performed on the data element

3.3.23
datatype of data element values
set of distinct values for representing the data element value

3.3.24
data value
element of a value domain

3.3.25
definition
word phrase expressing the essential nature of a person or thing or class of persons or things; an answer to the question “what is x?” or “what is an x?”; a statement of the meaning of a word group

NOTE As a statement, it expresses the essential nature of a data element and permits its differentiation from all other data elements.

3.3.26
domain
set of possible data values of an attribute

3.3.27
entity
any concrete or abstract thing of interest, including associations among things

NOTE Also see **object class** (3.3.42).

3.3.28
enumerated domain
value domain that is specified by a list of all permissible values

3.3.29
form of representation
name or description of the form of representation for the data element

EXAMPLE “Quantitative value”, “code”, “text”, “icon”.

NOTE See also **representation term** (3.3.61).

3.3.30
identifier
unambiguous name for an object within a given context

NOTE 1 It is also a language-independent unique identifier of a data element within a maintenance agency or registration authority.

NOTE 2 See also international registration data identifier.

3.3.31
information
⟨information processing⟩ knowledge concerning objects, such as facts, events, things, processes, or ideas, including concepts, that within a certain context has a particular meaning

3.3.32
information interchange
process of sending and receiving data in such a manner that the information content or meaning assigned to the data is not altered during the transmission

3.3.33
international registration data identifier
IRDI
internationally unique identifier for a data element

3.3.34
keyword
one or more significant words used for retrieval of data elements

3.3.35
layout of representation
layout of characters in data element values expressed by a character string representation

3.3.36
lexical, adj.
pertaining to words or the vocabulary of a language as distinguished from its grammar and construction

3.3.37
logical model
information model expressing sub-service exchanged between a system and various subsystems

NOTE This does not include the notation of time or physical position.

3.3.38
maintenance agency
MA
organization authorized to register data elements or other objects

3.3.39
maintenance agency identifier
MAI
identifier assigned to a maintenance agency

3.3.40
maximum size of data element values
maximum number of storage units (of the corresponding datatype) to represent the data element value

3.3.41
minimum size of data element values
minimum number of storage units (of the corresponding datatype) to represent the data element value

3.3.42
name
primary means of identification of objects and concepts for humans

3.3.43
object
any part of the conceivable or perceivable world

3.3.44
object class
set of objects
set of ideas, abstractions, or things in the real world that can be identified with explicit boundaries and meaning and whose properties and behaviour follow the same rules

3.3.45
object class term
component of the name of a data element which represents the object class to which it belongs

EXAMPLE Employee.

3.3.46
permissible data element values
set of representations of permissible instances of the data element, according to the representation form, layout, datatype and maximum size specified in the corresponding attributes

NOTE The set can be specified by name, by reference to a resource, by enumeration of the representation of the instances, or by rules for generating instances.

3.3.47
physical model
information model expressing the data flow exchanged between various physical equipment

NOTE This includes the notation position of the time and the elements of data exchange.

3.3.48
process model
thing expressing how to deal with a means and data required for relation, the composition, and the purpose of the work and the process included in a project

NOTE If a process model is created, the data model contained in it can be developed. A process model can be described by a standardized technique such as SADT or IDEF0.

3.3.49
property
peculiarity common to all members of an object class

3.3.50
property term
component of the data element name which expresses a property of an object class (a component of the name of a data element which expresses the category to which the data element belongs)

3.3.51
qualifier
term that helps define and render a concept unique

3.3.52
qualifier term
word or words which help define and differentiate a name within the database

3.3.53
recorded data element
submitted data element that contains all mandatory attributes and which has been recorded but whose contents may not meet the quality requirements specified in the relevant part or parts of ISO/IEC 11179

3.3.54
register
set of files (papers, electronic, or a combination) containing the assigned data elements and the associated information

NOTE See also **data element registry** (3.3.17).

3.3.55
registration
assignment of an unambiguous identifier to a data element in a way that makes the metadata about those data elements available to interested parties

3.3.56
registration applicant
organization, individual, etc., which requests the assignment of an identifier from a maintenance agency

3.3.57
registration status
designation of the position in the registration life-cycle of a data element

3.3.58
related data reference
reference between a data element and any related data

3.3.59
representation
combination of a value domain, datatype, and, if necessary, a unit of measure or a character set

3.3.60
representation category
type of symbol, character, or other designation used to represent a data element

3.3.61
representation term
component of a data element name which describes the form of representation of the data element

3.3.62
requirements
that which defines the contents of the service asked of a system

3.3.63
responsible organization
organization or unit within an organization that is responsible for the contents of the mandatory attributes by which the data element is specified

3.3.64
semantics
branch of linguistic science which deals with the meaning of words

3.3.65
separator
symbol or space (delimiter) enclosing or separating components within a name

3.3.66
standardized data element
certified data element within the data element registry that is preferred for use

3.3.67
structure set
method of placing objects in context, revealing relationships to other objects

EXAMPLE Entity-relationship models, taxonomies, and ontologies.

3.3.68
submitting organization
SO
organization or unit within an organization that has submitted the data element for addition, change, cancellation, or withdrawal in the data element registry

3.3.69
synonymous name
single or multi-word designation that differs from the given name, but represents the same data element concept

3.3.70
syntax
structure of expressions in a language, and the rules governing the structure of a language relationship among characters or groups of characters, independent of their meanings or the manner of their interpretation and use

3.3.71
taxonomy
classification according to presumed natural relationships among types and their subtypes

3.3.72
term
designation of a defined concept in a special language by a linguistics expression

3.3.73
thesaurus
controlled vocabulary arranged in a given order in which relationships among terms are displayed and identified

3.3.74
type of relationship
expression that characterizes the relationship between the data element and related data

3.3.75
version identifier
VI
identifier assigned to a version under which a data element registration is submitted or updated

3.4 Terms relating to generalized schema for worksite data exchange

3.4.1
achieved work data
data in which a measurement record/work result of the subject of the work record and construction of a machine or circumference environment is shown for every unit of work

3.4.2
as-built data
data in which the shape and quality of the target work subject attained by the machine and its operator or other workers are shown for every unit work

3.4.3
basic machine data
data in which the specifications and the characteristics of the machine are shown

3.4.4
basic project data
data in which the basic conditions of the construction concerned are shown

3.4.5
construction checking data
data in which the quality of resulting work is shown by comparing *target data* with *as-built data* for every unit of work

3.4.6
construction planning data
data prepared in the construction phase presenting shape, structures and quality of the object of the construction concerned

3.4.7
design data
data prepared in the pre-construction phase presenting shape, structures and quality of the object of the construction concerned

3.4.8
machine control data
real-time data in which the variation from the work standard and machine work from the work target of the work state and construction subject of a machine are shown for machine control or operation support

3.4.9
machine management data
data in which the degree of health, the actual operating state, and the actual maintenance condition of the machine at the site aiming at using a machine smoothly is shown

3.4.10
machine running record
data in which the operating record of the machine is shown

NOTE This is the accumulated data of the **machine running state** (3.4.11).

3.4.11
machine running state
real-time data in which the operational state of the machine is shown

3.4.12
machine working record
data in which work progress and the amount of work are shown for every unit of work

NOTE This is accumulated data for the **machine working state** (3.4.13).

3.4.13
machine working state
real-time data in which the state of the working machine is shown

3.4.14
measurement data
real-time data in which the state of the shape, quality and circumference environment of the subject of construction is shown

3.4.15
measurement record
data in which changes in progress of states such as form, quality and circumference environment of the subject of construction are shown for every unit of work

NOTE This is the accumulated **measurement data** (3.4.14).

3.4.16
mission data
data in which the work method, work procedure, resources (machine, operator, other workers, materials), and work target are shown for every unit of work

3.4.17
target data
value for the shape of a work subject or quality aimed to be attained by the machine or by manual labour, shown for every unit of work

3.4.18
worksite management data
all data used by the site information system at the site for machine construction

4 Target services

ISO 15143 is applicable to the following:

— construction management;

— supervisor inspection;

— estimation, contract and decision;

— machine construction;

— equipment and supply;

— safety of construction and environmental preservation.

The application of ISO 15143 to these services is expected to lead to an improvement in quality and efficiency in civil engineering work.

The complete list of applicable services and sub-services is presented in Table 1.

NOTE The list of sub-services could be extended using the procedure given in Annex A.

Table 1 — List of sub-services

Service	Sub-service	Example of sub-service item(s)
Construction management	Progress control	Schedule updating
	Quality control	Comparison of design and construction quality
	Shape management	Comparison of shape and size between design and form
	Subsistence and stable management	On-site measurement and prediction of amount of sub-distance
Supervisor inspection	Reports of management	Arrangement of documents, drawings and photographs
	Quality control	Comparison of design and construction quality
	Shape management	Comparison of shape and size between design and form
Estimation, contract and decision	Cost management	Construction management which secures proper profits
	Progress control	Management of materials, equipment, staff and costs
Machine construction	Machine management	Management and maintenance of construction machines
	Machine operation support	Machine operation support for operator with machine control data
	Safety control	Safety measures in machine construction
Equipment and supply	Logistics	Supply and budget management of materials and equipment
	Cost management	Comparison of estimate and actual price
	Progress control	Rational arrangement of materials and equipment set by the process
Safety of construction and environmental preservation	Environmental management	Environmental consideration to residents in the area around the construction site
	Safety control	Management for safety of construction

5 Method of data exchange in worksite using this part of ISO 15143

5.1 Principle

Independent information systems can have unique data structures and definitions. Between different information systems, data of the first system (of the data supplier) are converted once into a standardized dataset according to this part of ISO 15143, then converted into data for the other system.

5.2 Data exchange procedure

5.2.1 General

Figure 2 shows the data transfer model for data suppliers and data users (between different systems). The structure and content of the data provided by the supplier and received by the user are described in application schemas for worksite data exchange. The conditions specified 5.2.2 to 5.2.5 shall be fulfilled so that it is possible to transfer the data.

5.2.2 Preconditions

The user and the supplier involved in the data exchange have independent site information systems and each has a data dictionary for worksite information systems. This makes direct data exchange impractical. The user and supplier shall prepare a system for data exchange that fulfils the following conditions.

5.2.3 Preparation of application schema for data exchange in accordance with ISO 15143-1

The user and the supplier shall agree on creating an application schema for data exchange in accordance with this part of ISO 15143-1. In order to facilitate the exchange of data, application schema for data exchange shall be developed using the application schemas from the user and the supplier referencing generalized schema as specified in Clause 6. The user and supplier shall also prepare a data dictionary for data exchange.

5.2.4 Data conversion by supplier

The supplier converts the application data defined with the supplier application schema into a transfer dataset defined with the application schema for the exchanged data.

5.2.5 Data conversion by user

The user transfers the dataset defined with the application schema for the data exchange into the application data defined with the user's application schema.

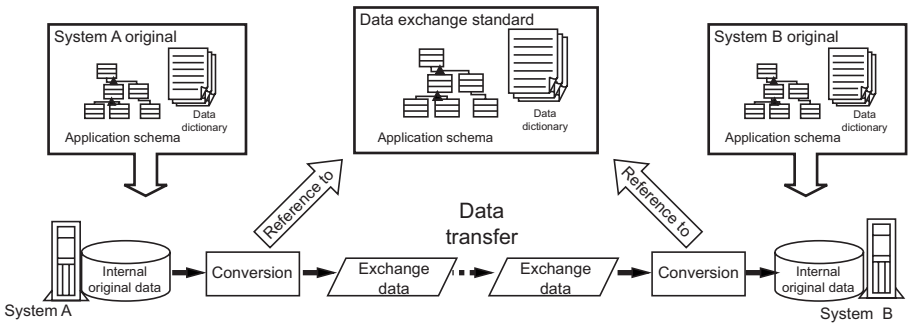


Figure 2 — Data transfer model

5.3 Application

5.3.1 Generalized schema for worksite data exchange

Generalized schema for worksite data exchange is constructed using the selected data for data exchange purposes from those extracted through modelling construction earthwork. See Clause 6 and also Annex A.

5.3.2 Data dictionary

5.3.2.1 General

The data dictionary defines the meanings and attributes of each data element that, as a whole, form the application schema. ISO 15143-2 specifies details of the data dictionary.

5.3.2.2 Concept of data dictionary

A data dictionary specifies the name, definition and other necessary attributes of each data element subjected to standardized data exchange.

For selection of the attributes to be specified in the data dictionary, refer to ISO 11179-3.

5.3.2.3 Function of data dictionary in data exchange

When data exchange between different systems is required, all data for exchange within both systems are converted into interchangeable ones with standardized terms, definitions and format of data attributes based on the data dictionary. Thus, the data dictionary provides a standardization tool for data exchange.

5.3.3 Terminology

Clause 3 defines the terms used for describing the data elements forming the data dictionary. These terms, definitions and data elements require common understanding. This part of ISO 15143 gives those terms and definitions needed to describe data elements specifically. ISO 15143-2 gives additional terms to be used for data exchange purposes.

6 Generalized schema for worksite data exchange

6.1 Concept of generalized schema for worksite data exchange

Generalized schema described for worksite data exchange defines data structure. Refer to it when developing the data dictionary. It defines the relation between data exchanged, data hierarchy and the relation between data and the specifically executed service.

NOTE For the purposes of data exchange between different systems, standardization in generalized schema (data construction through which service is executed) is necessary; it is also necessary to have a data dictionary which defines attributes of data elements including the meanings themselves.

6.2 Function of generalized schema for worksite data exchange

When data exchange between different systems is required, all data for exchange within both systems are converted into exchangeable ones with a standardized structure based on the generalized schema for worksite data exchange. Thus, generalized schema for worksite data exchange provides a standardization tool for data exchange.

Generalized schema for worksite data exchange provides a classification of general semantics for exchanged information. The classification is based on process analysis. The schema also provides semantic classification for the data dictionary specified in ISO 15143-2.

NOTE 1 The process analysis of construction work is presented in Annex F.

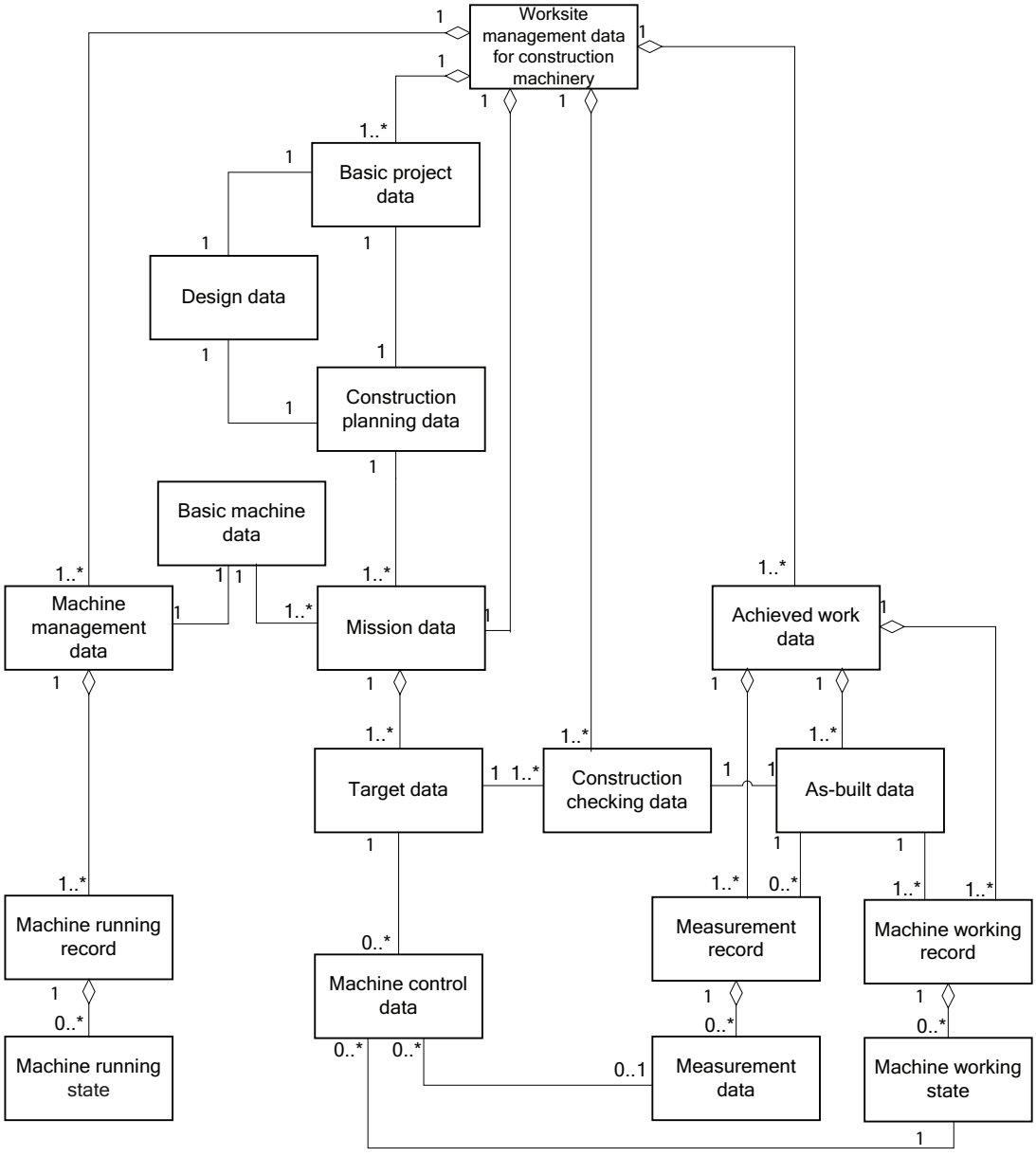
NOTE 2 The composition of the data dictionary and the basic dictionary are defined in ISO 15143-2.

6.3 Description of generalized schema for worksite data exchange

The main definition of ISO 15143 is given in the data dictionary. The data dictionary should be supported by a data schema as a description of the data frame. This part of ISO 15143 gives a generalized schema for worksite data exchange as a general framework.

The use of a formal language provides unambiguous and consistent representation of models, which facilitates implementations of applications. This part of ISO 15143 uses UML (unified modelling language, see ISO/IEC 19501-1) as the formal language for the description of the generalized schema for worksite data exchange. The rules given in Clause 5 are dependent on the UML formalism.

Generalized schema for worksite data exchange is described in Figure 3, together with Table 2, as a UML class diagram.



Key

0..1	no instances, or one instance	1	exactly one instance
0..*	zero or more instances	1..*	one or more instances

Figure 3 — Generalized schema for worksite data exchange

Table 2 — Descriptions of generalized schema described for worksite data exchange

Class	Description
Worksite management data for construction machine	This class represents all data used in SIS. This class consists of “basic project data”, “mission data”, “achieved work data”, “construction checking data” and “machine management data”.
Basic project data	This class is of the basic data of the construction project. It contains construction name, period of construction, execution place and so on.
Design data	This class shows the design information of the construction project which was prepared at the pre-construction stage, for example, technical specifications, drawings and necessary design documents.
Construction planning data	This class represents construction plan data prepared at the construction stage, for example, shape control data, quality control data, progress control data, material information data, arrangement plan data for materials and construction machine. This class contains accumulated “mission data”.
Machine management data	This class represents the data for planning machine use, maintenance and monitoring machine condition. It contains “basic machine data” and “machine running record (health)”.
Machine running record	This class includes the accumulated data for the maintenance of the machine.
Machine running state	This class includes real time data for the operation of a machine at the worksite. Additionally, it provides for the transfer of the data group to “machine running record”.
Basic machine data	This class includes the fundamental attribute information describing a particular machine at the worksite. For example, it contains ability, distinction number, classification, and so on.
Mission data	This class includes short-term planning data establishing an incremental goal for a machine to use. This data is used for a unit of work, which means a sequence work for a construction machine, for example, work area, type of construction machine, operator information, working process and type of work. This class is the content of “construction planning data”. It contains accumulated “target data”.
Target data	This class represents data describing the shape and the quality of a given object shown by the directions.
As-built data	This class represents data describing the shape and the quality resulting from carrying out the work in accordance with the directions for the work. The “as-built data” format is to be compared directly with the “target data”.
Construction checking data	This class includes the difference between the “as-built data” and the “mission data”.
Achieved work data	This class represents all data showing the results and progress of the work which has been executed in response to “mission data”. It is composed of “as-built data”, “machine working record” and “measurement record”.
Machine working record	This class represents the data which shows the process of machine working; it also gives the work quantity of a machine. This class includes the working state of the construction machines.
Machine working state	This class is the data group that shows the real-time working state of each construction machine at the worksite. It also comprises the content of “machine working record”.
Measurement record	This class represents the data which shows the transition of the state of the execution object and environment acquired from the measuring equipment at the worksite. It contains “measurement data” in part. This data is used for quality control and shape management.
Measurement data	This class is the data group which includes the real-time state of the execution object and environment acquired from the measuring equipment at the worksite. It comprises the content of “measurement record".
Machine control data	This class includes the data used to supervise the machine or to support machine operation during the work. It includes the service reporting when a machine deviates from the prescribed execution route. The machine may detect the deviation automatically and signal the operator with an alarm. It is created by comparing “machine working state", “measurement data" with “target data”.
If it is necessary to make an extension to ISO 15143, focusing on Figure 3, Table 2 and ISO 15143-2, this shall be done as specified in Annex A.	

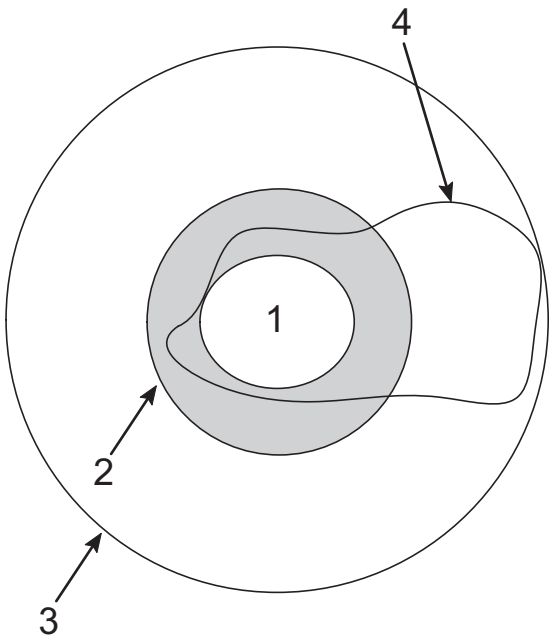
Annex A
(normative)

Extensions to the ISO 15143 application schema and data dictionary

A.1 Selection methodology of data items for ISO 15143

ISO 15143 enables data exchange between different systems or machines on mechanized construction worksites. Exchanged data are used for six specific service areas: construction management; supervision inspection; estimation, contract and decision; machine construction; equipment and supply management; and safety of construction and environmental preservation (see Clause 4). This list covers data exchanged between worksite information systems, construction machinery and measuring equipment, but many kinds of data are necessary according to the kinds of machinery and services, and the conditions and requirements, unique to each worksite.

The first editions of ISO 15143-1 and ISO 15143-2 do not directly apply to all data currently used for the entire range of worksite data exchange. Therefore, for the life of the first editions, application is limited to the basic data items. While Figure A.1 illustrates this, it also shows the possibility of including additional data items commonly used at many worksites.



Key

1 basic data items (ISO 15143)
2 data commonly used at many worksites
3 data items used for the entire range
4 data of a particular worksite

Figure A.1 — Classification of data items for ISO 15143

Some data items used for the entire range could be too specific and might not be appropriate for standardization. As a result, at certain worksites, necessary data exchange could be confined to the basic data items standardized in the first edition, while at other worksites, data exchange might be related not only to said basic items but also to some other commonly used data. In the latter case, stakeholders may widen the range of ISO 15143 to cover these additional commonly used data items. There could be some worksites where specific data items, not appropriate for treatment using ISO 15143, are additionally needed and/or where a certain closed system might use ISO 15143. In such cases, the related data items will remain outside the scope of ISO 15143, but the International Standard may still be used as a part of those systems as well as being applied conceptually.

A.2 Extension procedure

The following procedure is used for submission to, and processing by, the maintenance agency (MA) of proposed extensions.

a) Log on to the website http://www.jcmanet.or.jp/english/ISO/15143.

b) Open one or both of the empty Excel tables provided: one table for data elements; the other for value domains.

c) Using ISO 15143-2:2010, Tables A.1 and A.2, for guidance, enter the data attributes of the proposed extension(s) into the respective table. Schema-related data are presented in the “classification scheme item value” column of the tables.

d) Save the table(s) to local disk.

e) Send an e-mail with the completed table(s) attached to the Secretary of the MA (iso15143maintenance@jcmanet.or.jp).

f) The MA checks the extension submission for suitability, completeness and duplication with existing entries:

   — terms and definitions shall not conflict with those already specified within ISO 15143;

   — terms and definitions should not be in conflict with those already specified within related areas, such as ISO/TC 59, TC 71, TC 127, TC 182, TC 190, TC 195, TC 204, TC 211 and ISO/IEC/JTC 1;

   — the same wording shall be used for the same meanings as far as possible;

   — different wordings shall be used for different meanings as far as possible.

   If necessary, the MA Secretary consults with the members of the MA group (ISO/TC 127/SC 3/WG 5) as to the suitability of the proposed extension.

g) If the submission is determined to be appropriate, the MA Secretary uploads the extension(s) to the data dictionary extension URL on the MA website, where they can be consulted by the users of ISO 15143.

Annex B
(informative)

Creation of a worksite data dictionary using ISO 15143

B.1 General

This annex describes a method for creating a worksite data dictionary focusing on the specification mechanism and correlation of provided means by ISO 15143. It also provides the functions of those means and how to use the standards. It provides explanations of the generalized schema according to this part of ISO 15143 and the data dictionary specified in ISO 15143-2, together with the method for creating a worksite dictionary.

Figure B.1 illustrates the specification mechanisms and the correlation of means provided by ISO 15143.

B.2 Provided means and correlation

B.2.1 Overview

It shows the pattern diagram and correlation between the generalized schema for worksite data exchange (hereinafter called the generalized schema), the data dictionary according to ISO 15143-2, and the ISO 15143 worksite data dictionary, which are the provided means of ISO 15143. This correlation and provided means are explained in B.2.2 and B.2.3.

B.2.2 Correlation

The specification mechanism illustrated in Figure B.1 is largely divided into two parts along the horizontal line. The upper part is an accurate view of the classification specifications for the data management area, focusing on the durability and extension of the data standard exchange. The lower part is the view of the tools used to share perspectives between users.

a) **Generalized schema (ISO 15143-1)**

The generalized schema shows visualized correlations of data class which are configured on the basis of the construction process and the data generating place. The schema provides a structuralized data package to the data dictionary and the worksite data dictionary.

b) **Data dictionary (ISO 15143-2)**

The data dictionary is composed of two tables: the first precisely categorizes the data elements of the data categories by definition; the second, the value domain table, precisely categorizes the selection and range, providing the category of expression and range of the permissible values. The data dictionary provides constituent data elements of the data items that are used on the worksite data dictionary.

c) **Worksite data dictionary**

The worksite data dictionary is created to share the perspectives of the data items between users who exchange data. The worksite data dictionary confirms the categorization of the data items with the generalized schema and is created by combining the data elements of the data dictionary and the necessary value domain.

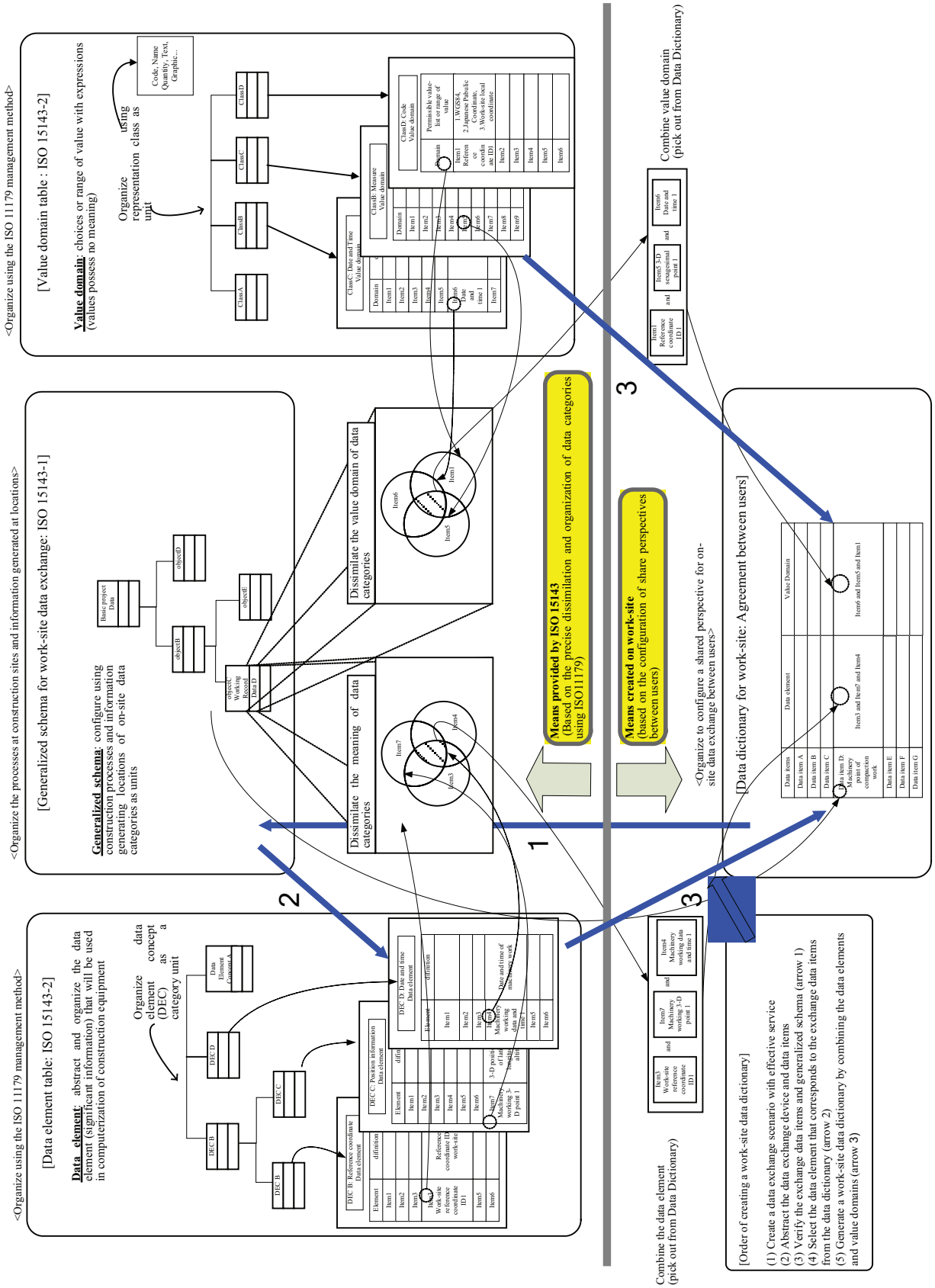


Figure B.1 — Means provided by ISO 15143 and specification mechanism

B.2.3 Provided means

B.2.3.1 Generalized schema for on-site data exchange

The scope of the generalized schema is the on-site data exchange between the earth-moving machinery/mobile road construction machinery, the measuring equipment and the information systems on the construction site.

The generalized schema is composed with the concept class constructed by the construction process as seen from the point of view of the owner, the contractor and the machine administrator.

The generalized schema functions as a classification schema that categorizes the data elements of the worksite data dictionary, simplifying the shared perspectives between the users by visualizing the construction of the data as classes. The data elements stored as attributes in the schema class are further divided into definitions and expressions in the data dictionary.

Target services, as specified in this part of ISO 15143, can be achieved by combining the data categorized in the generalized schema. The unified modelling language (UML) is used as the method of expression in the generalized schema.

When creating a schema using the worksite mounted data system, specialized classes can be created under the generalized schema class.

B.2.3.2 Data dictionary

The ISO 15143 data dictionary precisely clarifies the data items, structuralized by the generalized schema, by their multiple attributes.

As ISO 15143 is based on the idea of gradually extending the items lacking in the data dictionary, it is necessary to secure easy extension and long-term readability for the items in this data dictionary. Their clear categorization will aid the data dictionary, through use of the ISO/IEC 11179 data management scheme, to secure extensions.

To organize the divided data item clearly, the data dictionary is managed by separation of the data into two tables, the data element table and the value domain table (see ISO 15143-2), using data management meta-data in accordance with ISO/IEC 11179-3.

B.2.3.3 Worksite data dictionary

The worksite data dictionary is a data dictionary created at the worksite by the agreement of several users, who exchange data in order to enhance worksite efficiency, and who possess sufficient data categories and attributes necessary for on-site usage.

The worksite data dictionary is comprised of a combination of data elements and value domains as described in the ISO 15143-2 data dictionary. The worksite data dictionary stores the data attributes to a table that contains all the metadata of the data element and value domain tables.

To secure reuse and durability of the data dictionary, the user should not decrease the metadata of ISO 15143-2.

ISO 15143 does not exclude additional new metadata or data items in the internal data dictionary of the on-site information system that does not exchange data.

Users will decide through agreement the data communication protocol and method of transferring the data set under the shared perspective of data items defined by the worksite data dictionary.

In the case where a data item of the worksite cannot be configured under the combination of data elements and value domains of the data dictionary according to ISO 15143, the data dictionary can be extended. See Annex A.

B.3 How to create a worksite data dictionary using ISO 15143

B.3.1 Procedure

The procedure for creating a worksite data dictionary from the generalized schema and data dictionary provided by ISO 15143 is as follows, in the sequence given:

a) create a data exchange scenario with effective service;

b) abstract the data exchange device and data items;

c) verify the exchange data items and generalized schema;

d) select the data element that corresponds to the exchange data items from the data dictionary;

e) generate a worksite data dictionary by combining the data elements and value domains.

B.3.2 presents examples of the order used to create a worksite data dictionary using the generalized schema and data dictionary provided by ISO 15143.

B.3.2 Examples of creating a worksite data dictionary

B.3.2.1 Creation of a data exchange scenario with effective service

The user generates a text scenario on the data exchange necessary to achieve the agreed effective service of data exchange. The scenario should include the instrument and data items used for exchange, the work situations, and the objectives of exchanging data usage. See Table B.1.

Table B.1 — Example of a data exchange scenario

Scenario
Among the roller working data used for compaction on fillings, transfer the GPS data of roller and filling materials information with location data to the site information system. The roller location is used to calculate the roller moving path and the number of compactions used for quality control in the site information system.

B.3.2.2 Abstracting the data exchange device and data items

Abstract the instrument to exchange data and the data items that will be exchanged from the scenario. To explain the task, the scenario includes internal data items of the instrument and instruments that will not exchange data. See Tables B.2 and B.3.

Table B.2 — Examples of data exchange instruments

Data exchange instruments
Rollers
Site information systems

Table B.3 — Examples of exchange data items

Exchange data items
Location data accumulated in the roller
Filling materials information with location data

B.3.2.3 Verification of the exchange data items and generalized schema

Users match exchange data items to class of the generalized schema indicated in this part of ISO 15143. Matching will help users visualize the concept of data items by the generalized schema. See Table B.4.

Table B.4 — Examples of verification of data items and generalized schema

Exchange data items	Class name of generalized schema
Location information accumulated in the roller	Machine working state
Information for identifying the location site for filling materials	Construction planning data

B.3.2.4 Selection of the data element corresponding to exchange data items from data dictionary

Users select the data element that corresponds to the exchange data items from the data element table of the data dictionary. The data element table has a layered system. The class of generalized schema and the data element concept are the upper layers of data element. The user selects class name, data element concept and the data element in the order given in the data element table. The selected data element has a unique relation to a value domain. The value domain contains the permissible values and a data format. The data element table has a system to define the derivation rule for the new data element by combining the multiple data elements. (Where a necessary data element is not available, the proposal can be carried out using the method presented in Annex A). See Table B.5.

Table B.5 — Examples of verification of data categories and generalized schema

Exchange data items	Class name for generalized schema	Data element for data dictionary	Value domain for data dictionary
Location information accumulated in the roller	Machine working state	date_and_time_machine_working_state_1	datetime_1
		machine_position_working_state_1	point_2
Information for identifying the location site for earth-filling materials	Construction planning data	fill_material_id_1	material_id_1
		fill_material_name_1	character_string_4

B.3.2.5 Generating a worksite data dictionary by combining the data elements and value domains

Users generate a worksite data dictionary by listing all the metadata (e.g. definitions and data format) described in the ISO 15143-2 data dictionary, including the selected data elements and the value domain. See Table B.6.

Table B.6 — Examples of a worksite data dictionary

Data element				Value domain		
Classification schema name	**Data element concept name**	**Name**	**~**	**Conceptual domain name**	**Value domain name**	**~**
Machine working state	date_and_time_ machine_ working_state	date_and_time_ machine_working_ state_1	Omit	date_and_time	datetime_1	Omit
	machine_position _working_state	machine_position_ working_state_1		point	point_2	
Construction planning data	fill_material_id	fill_material_id_1		material_id	material_id_1	
	fill_material_name	fill_material_name_1		character_string	character_string_4	

Under the premise that the data items of the worksite data dictionary have shared perspectives among users, the necessary agreement for data exchange (communication protocol and data expression format) will be decided by agreement between the users.

Annex C
(informative)

Relevant diagrams of generalized schema for worksite data exchange

C.1 Use-case diagram of generalized schema for worksite data exchange

The actors at a construction worksite are generalized for the purposes of ISO 15143-1 as the owner of the construction project, the contractor, the manager of a construction machine, its operator, the site information system, the construction machine itself and the measuring equipment.

The use-case diagram shown in Figure C.1 clarifies the relationship between the actors and use-cases, which describe the actor's behaviour in worksite data exchange.

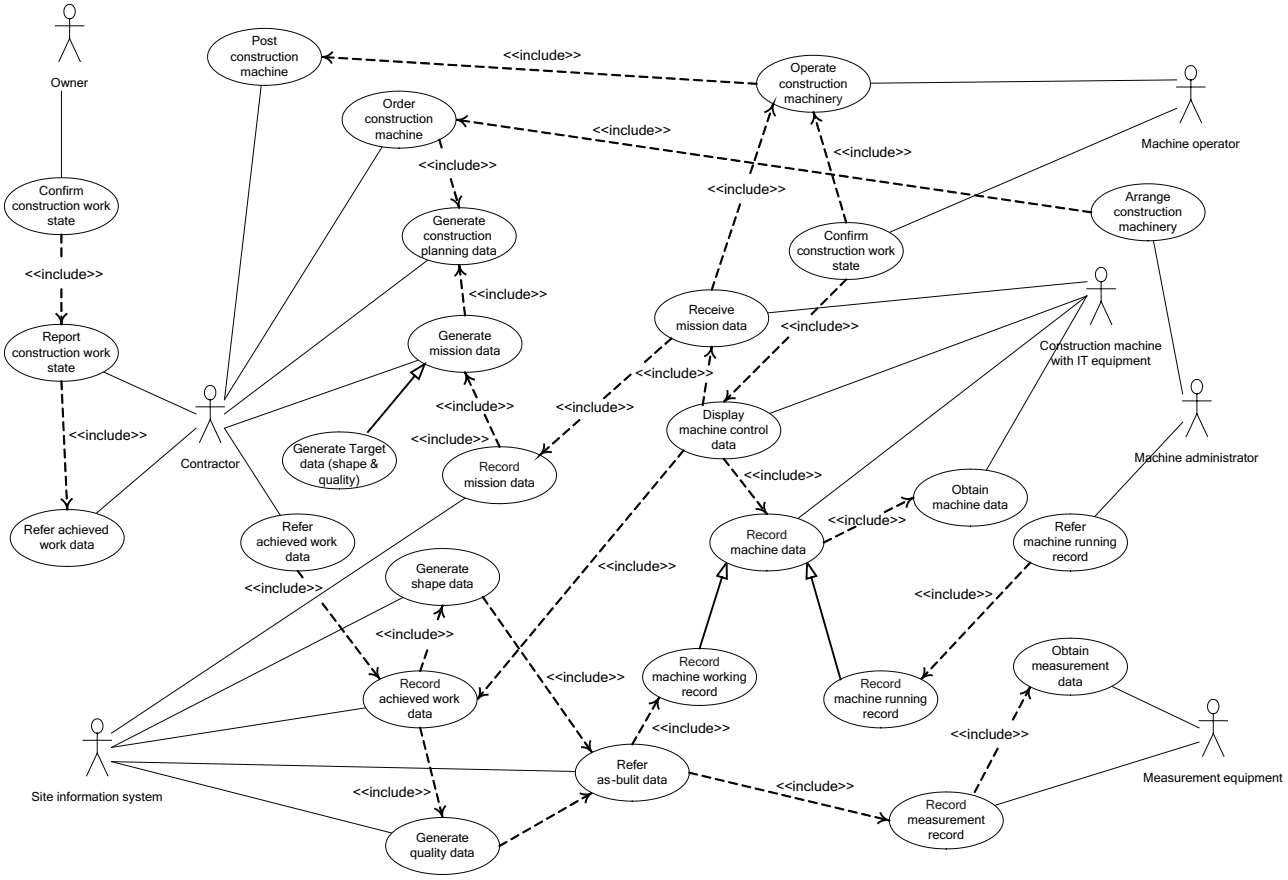


Figure C.1 — Use-case diagram of generalized schema for worksite data exchange

C.2 Sequence diagram of generalized schema for worksite data exchange

The sequence diagram shown in Figure C.2 describes the actors collaborating in some behaviour over time and captures the behaviour of a single use-case for worksite data exchange.

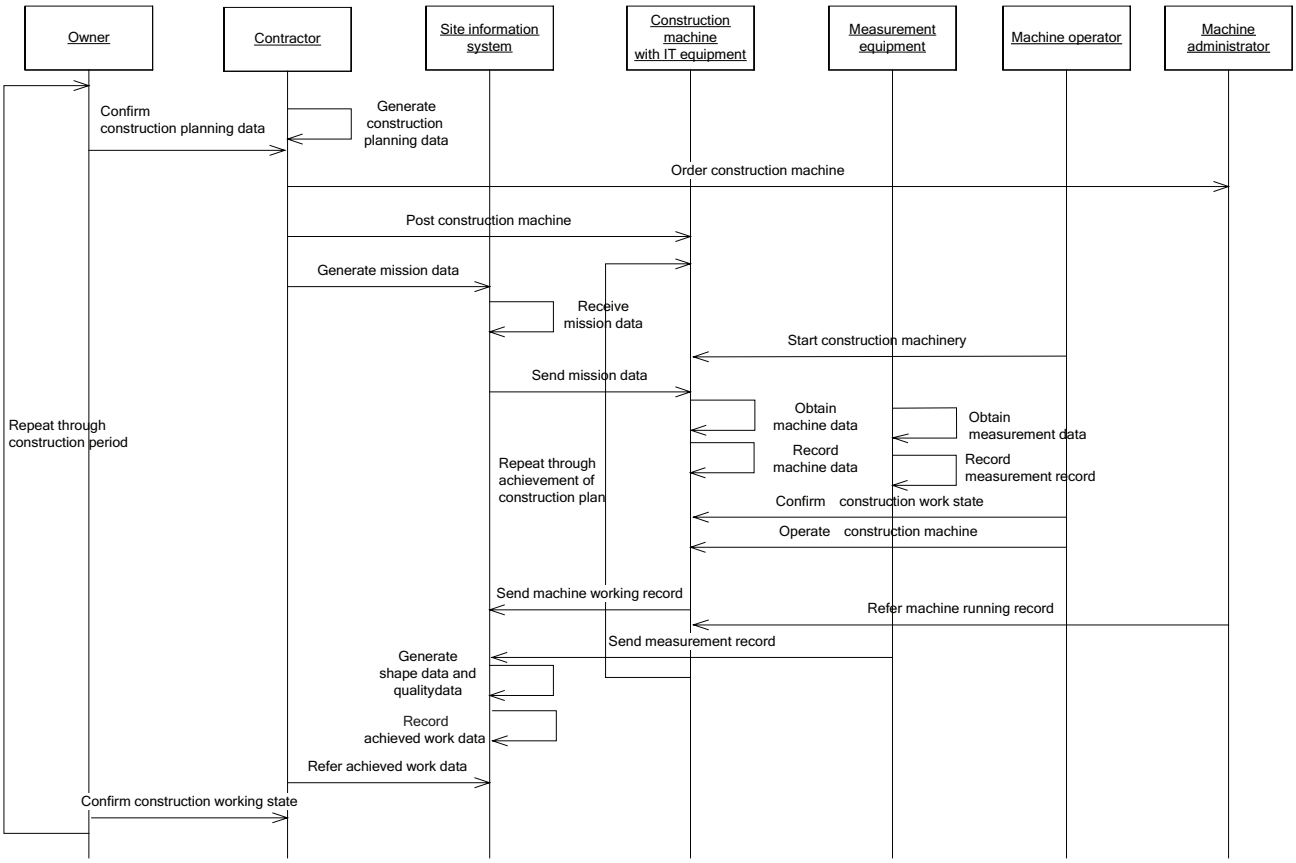


Figure C.2 — Sequence diagram of generalized schema for worksite data exchange

C.3 Generalized schema for worksite data exchange

Objects in the generalized schema for the worksite data exchange of ISO 15143 are extracted based on the use-case diagram (Figure C.1) and the sequence diagram (Figure C.2).

The generalized schema for the worksite data exchange is defined as a class diagram. The diagram describes the conceptual information structure and conceptual information arrangement as classes which are generalized from objects on the use-case diagram and the sequence diagram.

Annex D
(informative)

ISO 15143 application example — Machine construction

D.1 General

This annex presents an ISO 15143 application example based on experience in a fill construction project. The target work type is spreading by dozers and compaction by rollers.

D.2 Agreement for worksite data exchange

D.2.1 Objective

The objective of the worksite data exchange is to promote the efficiency and progress acceleration of "construction management" and "machine construction".

D.2.2 Worksite data exchange system function

To achieve the objective, machine construction is executed without finishing stakes. The target worksite data exchange system enables functions as follows.

a) The site information system (SIS) controls the work area, spreading thickness, compaction count, and related data.

NOTE 1 Work area is based on three dimensional (3-D) CAD data.

NOTE 2 At this site, fill construction quality (ground stiffness) is controlled by compaction count. A target compaction count is determined on test construction for each soil material.

b) The SIS sends the necessary execution direction to "construction machinery" using wireless LAN.

c) The construction machines provide operation support according to SIS direction. Dozer operators execute spreading according to a 3-D target shape without finishing stake. Roller operators execute compaction according to the target compaction count. "Construction machinery" indicates completion of work to the operator.

d) "Construction machinery" sends the execution results to the SIS using wireless LAN.

NOTE The results include finishing shape, compaction count, relating ground stiffness, and related data.

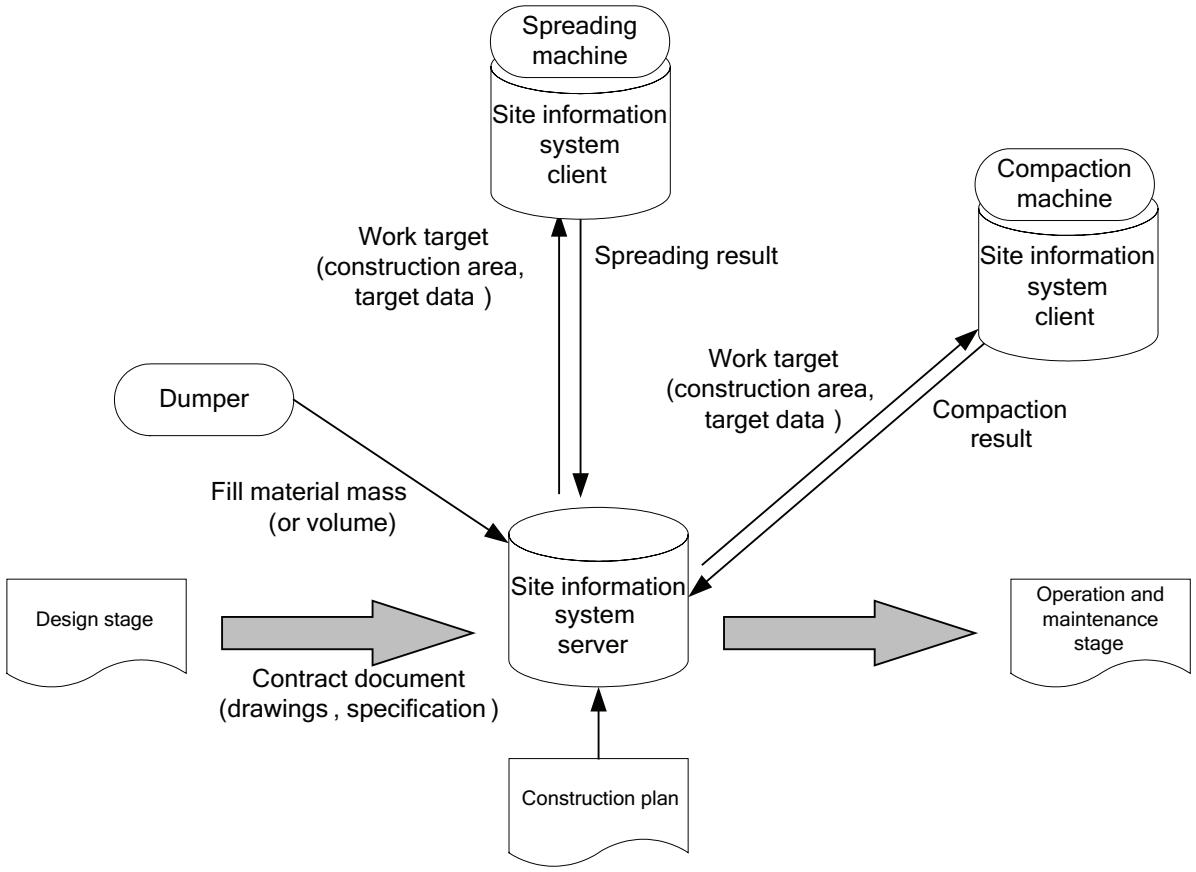


Figure D.1 — Target worksite data exchange system functions of the application example (conceptual presentation)

D.2.3 Target service

Applied services provided for the application example corresponding to the services and sub-services listed in Table 2 are presented in Table D.1.

Table D.1 — Applied services corresponding to services and sub-services

Applied service of the application example	Corresponding ISO 15143-1 sub-service	Corresponding ISO 15143-1 service
Mission and target supplying service	Machine operation support	Machine construction
Machine operation supporting service	Machine operation support	Machine construction
As-build judging service	Quality control, shape management	Construction management
Achieved work supplying service	Quality control, shape management	Construction management

D.3 Construction work process and data flow

D.3.1 Scenarios and use-case for worksite data exchange

Figure D.2 shows the construction work process and data flow conceptually.

In the following, a scenario is provided for each target service of data exchange composed of the main scenario text and the list of associated actors, together with the related exchanged class and data. A corresponding use-case diagram is presented for each service (see Figures D.3 to D.6).

NOTE The application example “site information system” is composed of the “server” at the site office and “client” installed on the construction machine.

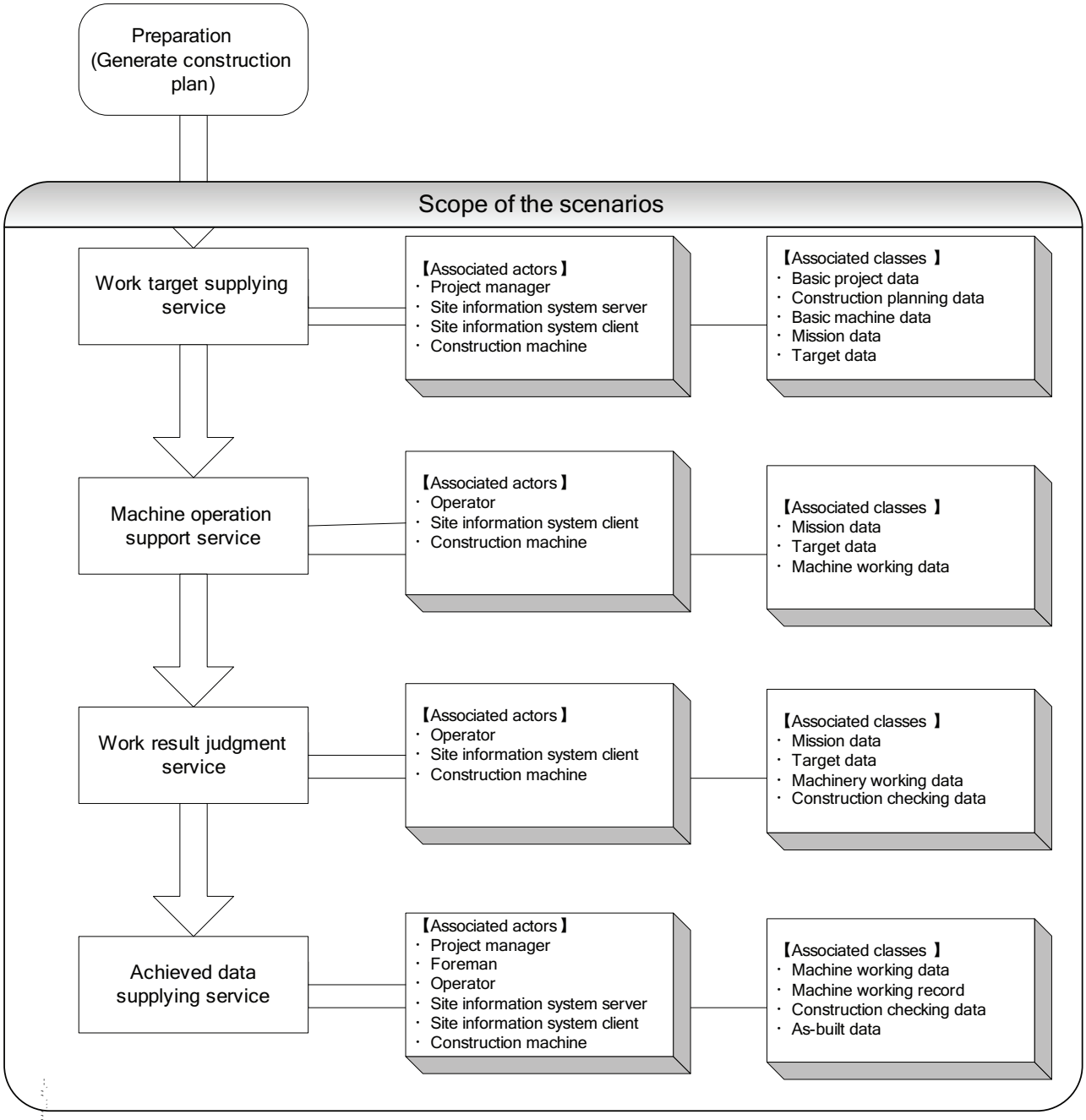


Figure D.2 — Work process and related actors and classes — Conceptual flow chart

D.3.2 Preparatory work

The site manager and the foreman generate work site data, such as work order, to be registered to the site information system based on the (design) drawings and technical specifications (documents), as well as (construction) and plan of work (documents).

D.3.3 Mission and target supplying service

Mission and target supplying service
Scenario
1) The site manager registers (records) “basic project data”, “construction planning data” and “basic machine data” on the site information system server. 2) From the data recorded within the site information system, the site manager extracts “mission data” being referenced for a certain machine operation, then, based on them, extracts “target data” (work area and compaction thickness target) and then registers (records) them on the site information system server. 3) The operator starts the construction machine, then its equipping “client” from the site information system receives mission data and target data from the site information system server and then registers (records) them to the client system.
Actors
The site manager, the site information system (the server and the client), and the construction machine
Related class and data
Basic project data: construction_project_name_1, contractor_name_1, construction_period_beginning_1, construction_period_complete_1, station_beginning_1, station_end_1 **Basic machine data:** local_machine_id_1, machine_family_1, machine_name_1, cutting_edge_width_1, work_area_capacity_1, work_volume_capacity_1, ground_contact_pressure_1, rolling_width_1, dynamic_liner_load_1, Laden weight **Construction planning data:** landfill_material_id_1, landfill_material_name_1, landfill_material_characteristic_1 **Mission data:** ID, Type, Name, work_time_start_1, work_time_end_1, foreman_name_1, machine_operator_name_1, work_area_id_1, work_area_name_1, Work_area_type_1, work_area_boundary_1, Surface ID, Triangle ID, Point ID, work_point_1,WorkDate, UseMaterial **Target data:** TargetMachineName, MachineID, spreading_elevation_target_1, compaction_quality_target_1

NOTE Data underlined are those newly defined at the site.

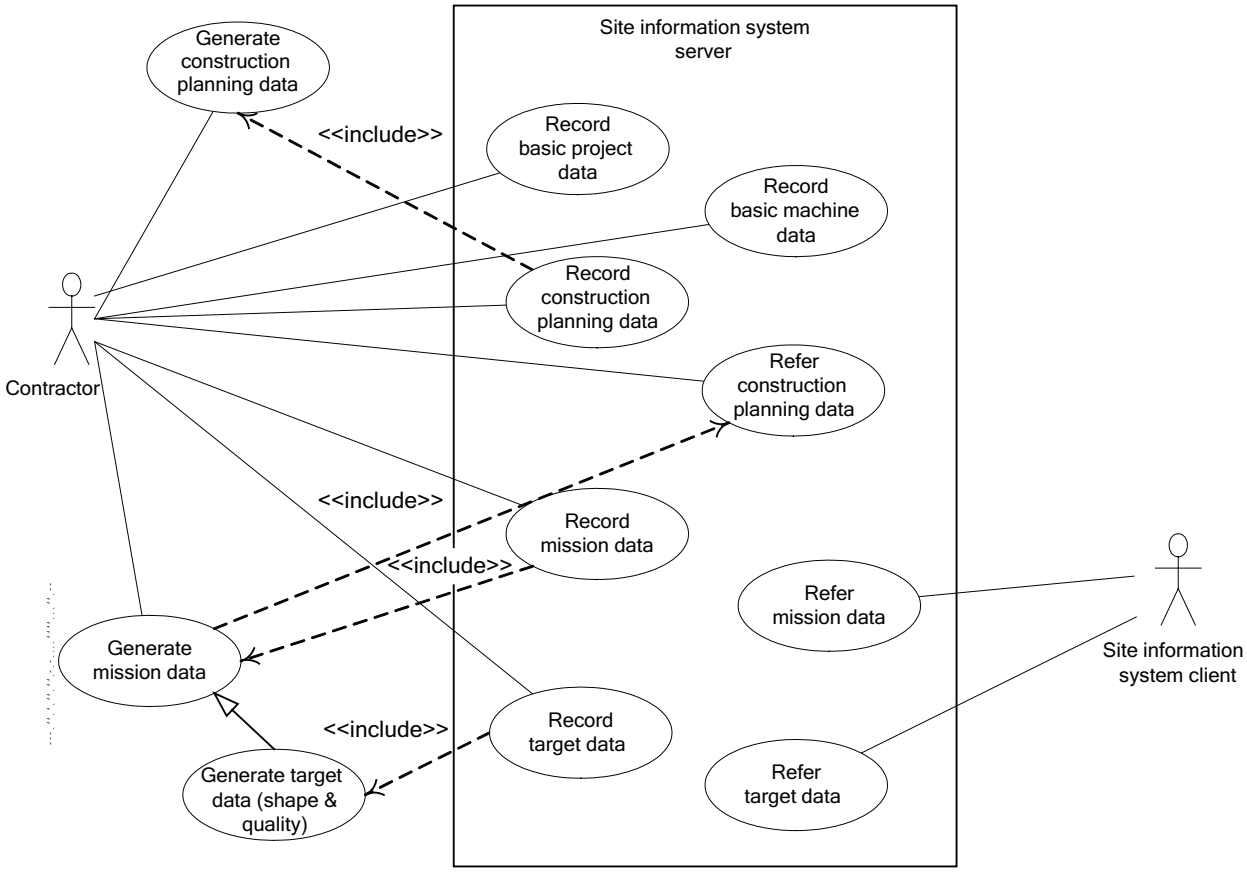


Figure D.3 — Use-case diagram — Mission and target supplying service

D.3.4 Machine operation supporting service

Machine operation supporting service
Scenario
1) The machine operator confirms mission of the work checking the “mission data” and “target data” already registered and recorded within the site information system client. 2) The machine operator operates the machine receiving “mission data” and “target data”, on occasion also referencing “machine working data” generated and submitted from the machine sensor and confirming the differences (within the tolerances) between the former and the latter.
Actors
The site information system client, the construction machine, the machine operator and the measuring equipment (sensor)
Related class and data
Basic machine data: machine_family_1, machine_name_1, cutting_edge_width_1, work_area_capacity_1, work_volume_capacity_1, ground_contact_pressure_1, rolling_width_1, dynamic_linear_load_1, Laden weight **Construction planning data:** landfill_material_id_1, landfill_material_name_1, landfill_material_characteristic_1 **Mission data:** ID, Type, Name, work_time_start_1, work_time_end_1, foreman_name_1, machine_operator_name_1, work_area_id_1, work_area_name_1, Work area type 1, work_area_boundary_1, Surface ID, Triangle, Point ID, work_point_1, WorkDate, UseMaterial **Target data:** TargetMachineName, MachineID, spreading_elevation_target_1, compaction_quality_target_1 **Machine working record:** Refmission, Time, S (number of spread layers), Point (X, Y, Z), N (pass number of compaction), D (Density), D =(gradient in degrees), E(coefficient of elasticity), A (acceleration)

NOTE Data underlined are those newly defined at the site.

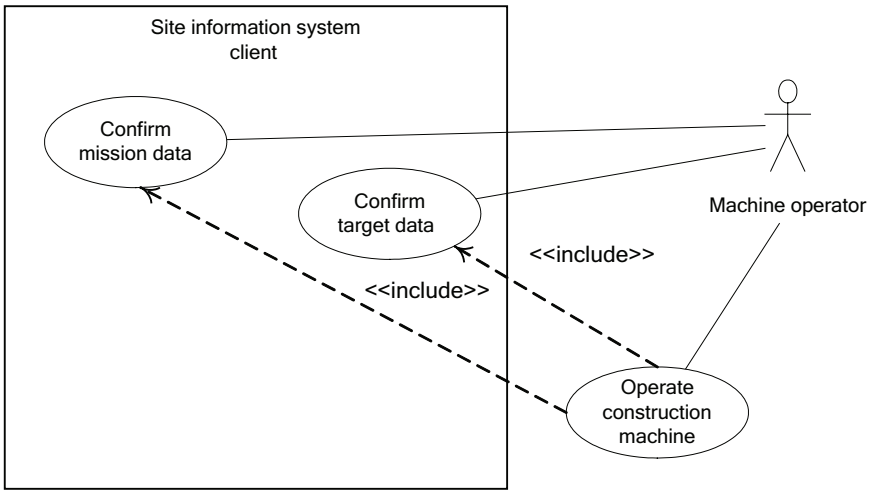


Figure D.4 — Use-case diagram — Machine operation supporting service

D.3.5 As-build judging service

As-build judging service
Scenario
1) The site information system client provides differences between measuring equipment providing “machine working data” and “target data” as “construction checking data” to the machine operator. 2) The machine operator completes the operation checking if “construction checking data” satisfy the target within related tolerances.
Actors
The site information system client, the construction machine and the machine operator
Related class and data
Basic machine data: machine_family_1, machine_name_1 **Construction planning data:** landfill_material_id_1, landfill_material_name_1, landfill_material_characteristic_1 **Mission data:** ID, Type, Name, work_time_start_1, work_time_end_1, foreman_name_1, _operator_name_1, work_area_id_1, work_area_name_1, Work_area_type_1, work_area_boundary_1, Surface ID, Triangle, Point ID, work_point_1, WorkDate, UseMaterial **Target data:** TargetMachineName, MachineID, spreading_elevation_target_1, compaction_quality_target_1

NOTE Data underlined are those newly defined at the site.

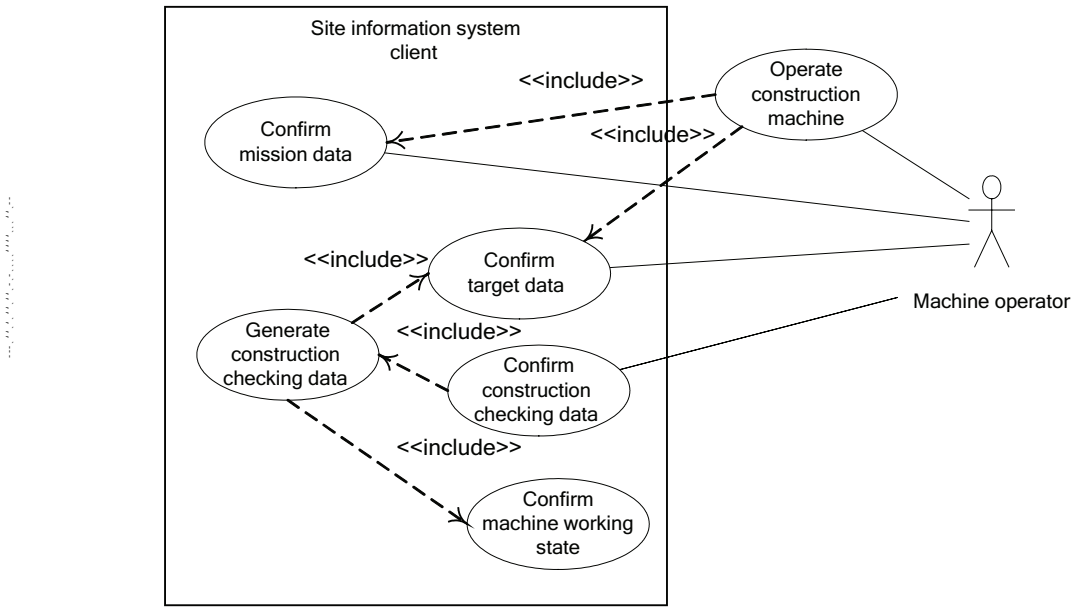


Figure D.5 — Use-case diagram — As-build judging service

D.3.6 Achieved work supplying service

As-build judging service
Scenario
1) The site information system client cumulatively records “machine working state” received and submitted from the measuring equipment as “machine working record”. 2) The site information system client submits the “machine working record” at the time of the end of the operation as “as-built data” to the site information system server with “construction checking data” 3) The site manager and the foreman control the shape and quality of the work by checking records in the information system server.
Actors
The site manager, the foreman, the machine operator, the site information system server, the site information system client and the construction machine
Related class and data
Basic machine data: machine_family_1, machine_name_1 **Construction planning data:** landfill_material_id_1, landfill_material_name_1, landfill_material_characteristic_1 **Mission data:** ID, Type, Name, work_time_start_1, work_time_end_1, foreman_name_1, machine_operator_name_1, work_area_id_1, Surface ID, Triangle ID, Point ID, work_point_1 **Target data:** spreading_elevation_target_1, compaction_quality_target_1 **Mission data:** ID, Type, Name, work_time_start_1, work_time_end_1, foreman_name_1, machine_operator_name_1, work_area_id_1, work_area_name_1, Work_area_type_1, work_area_boundary_1, Surface ID, Triangle, Point ID, work_point_1, WorkDate, UseMaterial **Target data:** TargetMachineName, MachineID, spreading_elevation_target_1, compaction_quality_target_1 **Machine working record:** Refmission, Time, S (number of spread layers), Point (X, Y, Z), N (pass number of compaction), D (Density), D =(gradient in degrees), E(coefficient of elasticity), A (acceleration)

NOTE Data underlined are those newly defined at the site.

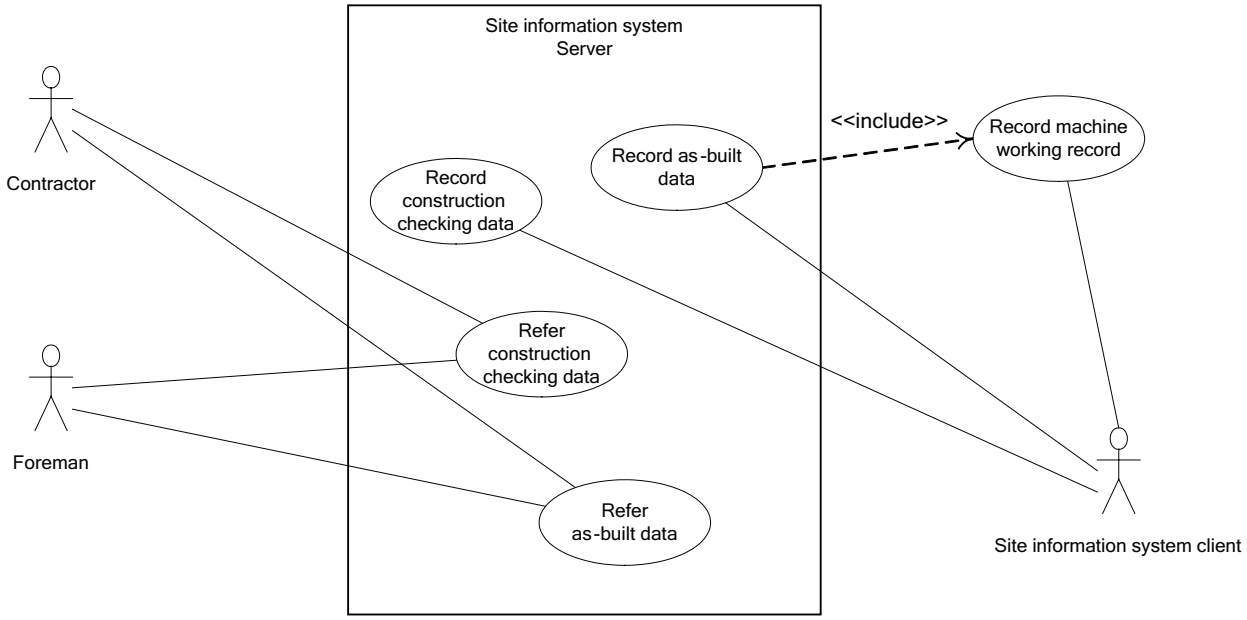


Figure D.6 — Use-case diagram — Achieved work supplying service

D.4 Generation of application schema for worksite data exchange

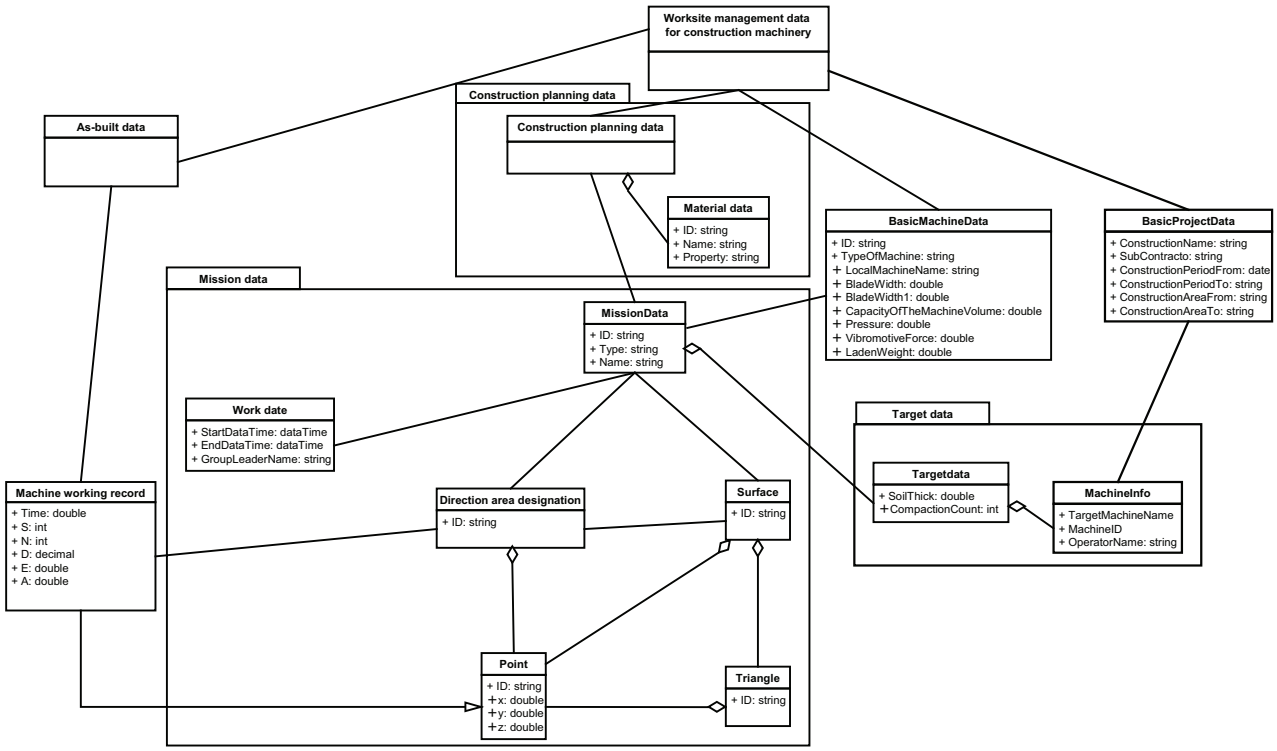
Firstly, native application schema and generalized schema are compared for worksite data exchange in accordance with ISO 15143. The semantic of class and relation of class are confirmed.

Secondly, the data element name is harmonized between the native data dictionary and the data dictionary according to ISO 15143-2.

Thirdly, an application schema for this site is generated which is composed of the necessary classes on generalized schema for worksite data exchange.

NOTE In this case, all the data semantics for worksite data exchange on this site are harmonized with ISO 15143.

See Figure D.7.



NOTE 1 Some classes are shown structuralized sub-class for visibility of data structure.

NOTE 2 Classes attributes show major exchanged data.

Figure D.7 — Application schema for construction management on fill construction site

D.5 Agreement of data format and system mount

D.5.1 Agreement of data format

XML is used as the data format for this site. XML schema for worksite data exchange is generated from application schema for worksite data exchange. A sample XML instance follows.

NOTE 1 The use of XML is not a requirement of this part of ISO 15143. While the application layer of the OSI reference model does not include XML, the scope of this part of ISO 15143 covers only the application layer.

NOTE 2 XML as shown below is the actual presentation of major data.

```
<?xml version="1.0" encoding="UTF-8"?>
<WMDCM xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" xsi:noNamespaceSchemaLocation="WMDCM02.xsd">
    <basic_project_data>
        <construction_project_name_1>String</construction_project_name_1>
        <contractor_name_1>String</contractor_name_1>
        <construction_period_beginning_1>String</construction_period_beginning_1>
        <construction_period_complete_1>String</construction_period_complete_1>
        <station_beginning_1>sta###+##.###</station_beginning_1>
        <station_end_1> sta###+##.###</station_end_1>
    </basic_project_data>>
    <basic_machine_data>
        <machine>
```

```
<local_machine_ID_1>3</local_machine_ID_1>
                    <machine_family_1>String</machine_family_1>
                    <machine_name_1>String</machine_name_1>
                    <cutting_edge_width_1>####.###</cutting_edge_width_1>
                    <work_area_capacity_1>####.###</work_area_capacity_1>
                    <work_volume_capacity_1>####.###</work_volume_capacity_1>
                    <ground_contact_pressure_1>####.###</ground_contact_pressure_1>
                    <rolling_width_1>####.###</rolling_width_1>
                    <dynamic_liner_load_1>####.###</dynamic_liner_load_1>
                    <LadenWeight>####.###</LadenWeight>
               </machine>
               <machine>
<local_machine_ID_1>4</local_machine_ID_1>
                    <machine_family_1>String</ machine_family_1>
                    <machine_name_1>String</machine_name_1>
                    <cutting_edge_width_1>####.###</cutting_edge_width_1>
                    <work_area_capacity_1>####.###</ work_area_capacity_1>
                    <work_volume_capacity_1>####.###</work_volume_capacity_1>
                    <ground_contact_pressure_1>####.###</ground_contact_pressure_1>
                    <rolling_width_1>####.###</rolling_width_1>
                    <dynamic_liner_load_1>####.###</dynamic_liner_load_1>
                    <LadenWeight>####.###</LadenWeight>
               </machine>
          </basic_machine_data>
          <construction_planning_data>
               <material>
                    <landfill_material_id_1>1</landfill_material_id_1>
                    <landfill_material_name_1>String</landfill_material_name_1>
                    <landfill_material_characteristic_1>String</landfill_material_characteristic_1>
               </material>
               <material>
                    <landfill_material_id_1>2</landfill_material_id_1>
                    <landfill_material_name_1>String</landfill_material_name_1>
                    <landfill_material_characteristic_1>String</landfill_material_characteristic_1>
               </material>
          </construction_planning_data>
<mission_data>
<mission ID="1" type="String" name="String">
                    <work_area work_area_id_1="1" stratum="0" work_area_name_1="String" work_area_type_1="D" status="String">
                         <work_point_1="1">2 2 2</work_point_1>
                         <work_point_1="2">1 1 1</work_point_1>
                    </work_area>
                    <WorkingSurface refAreaID="1">
                         <Area ID="1">
                              <Surface>
```

```
                <Triangle>
                    <Point ID="1">1 1 1</Point>
                    <Point ID="2">1 1 1</Point>
                    <Point ID="3">1 1 1</Point>
                </Triangle>
                <Triangle>
                    <Point ID="4">1 1 1</Point>
                    <Point ID="5">1 1 1</Point>
                    <Point ID="6">1 1 1</Point>
                </Triangle>
            </Surface>
            <Surface>
                <Triangle>
                    <Point ID="7">1 1 1</Point>
                    <Point ID="8">1 1 1</Point>
                    <Point ID="9">1 1 1</Point>
                </Triangle>
                <Triangle>
                    <Point ID="10">1 1 1</Point>
                    <Point ID="11">1 1 1</Point>
                    <Point ID="12">1 1 1</Point>
                </Triangle>
            </Surface>
        </Area>
        <Area ID="2">
            <Surface>
                <Triangle>
                    <Point ID="13">1 1 1</Point>
                    <Point ID="14">1 1 1</Point>
                    <Point ID="15">1 1 1</Point>
                </Triangle>
                <Triangle>
                    <Point ID="16">1 1 1</Point>
                    <Point ID="17">1 1 1</Point>
                    <Point ID="18">1 1 1</Point>
                </Triangle>
            </Surface>
            <Surface>
                <Triangle>
                    <Point ID="19">1 1 1</Point>
                    <Point ID="20">1 1 1</Point>
                    <Point ID="21">1 1 1</Point>
                </Triangle>
                <Triangle>
                    <Point ID="22">1 1 1</Point>
```

```
                                <Point ID="23">1 1 1</Point>
                                <Point ID="24">1 1 1</Point>
                            </Triangle>
                        </Surface>
                    </Area>
                    <Point ID="25">1 1 1</Point>
                    <Point ID="26">1 1 1</Point>
                </WorkingSurface>
                <target_data>
                    <TargetMachineName MachineID="3">
                        <MachineName1>String</MachineName1>
                    </TargetMachineName>
                    <TargetMachineName MachineID="4">
                        <MachineName1>String</MachineName1>
                    </TargetMachineName>
                    <spreading_elevation_target_1>####.###</ spreading_elevation_target_1>
                    <compaction_quality_target_1>0</compaction_quality_target_1>
                    <machine_operator_name_1>String</machine_operator_name_1>
                </target_data>
                <WorkDate>
                    <StartDateTime>2001-12-17T09:30:47-05:00</StartDateTime>
                    <EndDateTime>2001-12-17T09:30:47-05:00</EndDateTime>
                    <GroupLeaderName>String</GroupLeaderName>
                </WorkDate>
                <UseMaterial>
                    <Material ID="1" Name="String"/>
                    <Material ID="2" Name="String"/>
                </UseMaterial>
            </mission>
        </mission_data>
        <machine_working_record>
            <Refmission ID="1">
                <RD  Time="2001-12-17T09:30:47-05:00"  S="0"  X="####.###"  Y="####.###"  Z="####.###"  N="0"  D="####.###"
E="####.###" A="####.###"/>
                <RD  Time="2001-12-17T09:30:47-05:00"  S="0"  X="####.###"  Y="####.###"  Z="####.###"  N="0"  D="####.###"
E="####.###" A="####.###"/>
            </Refmission>
        </machine_working_record>
</WMDCM>
```

D.5.2 System mount

See Figure D.8.

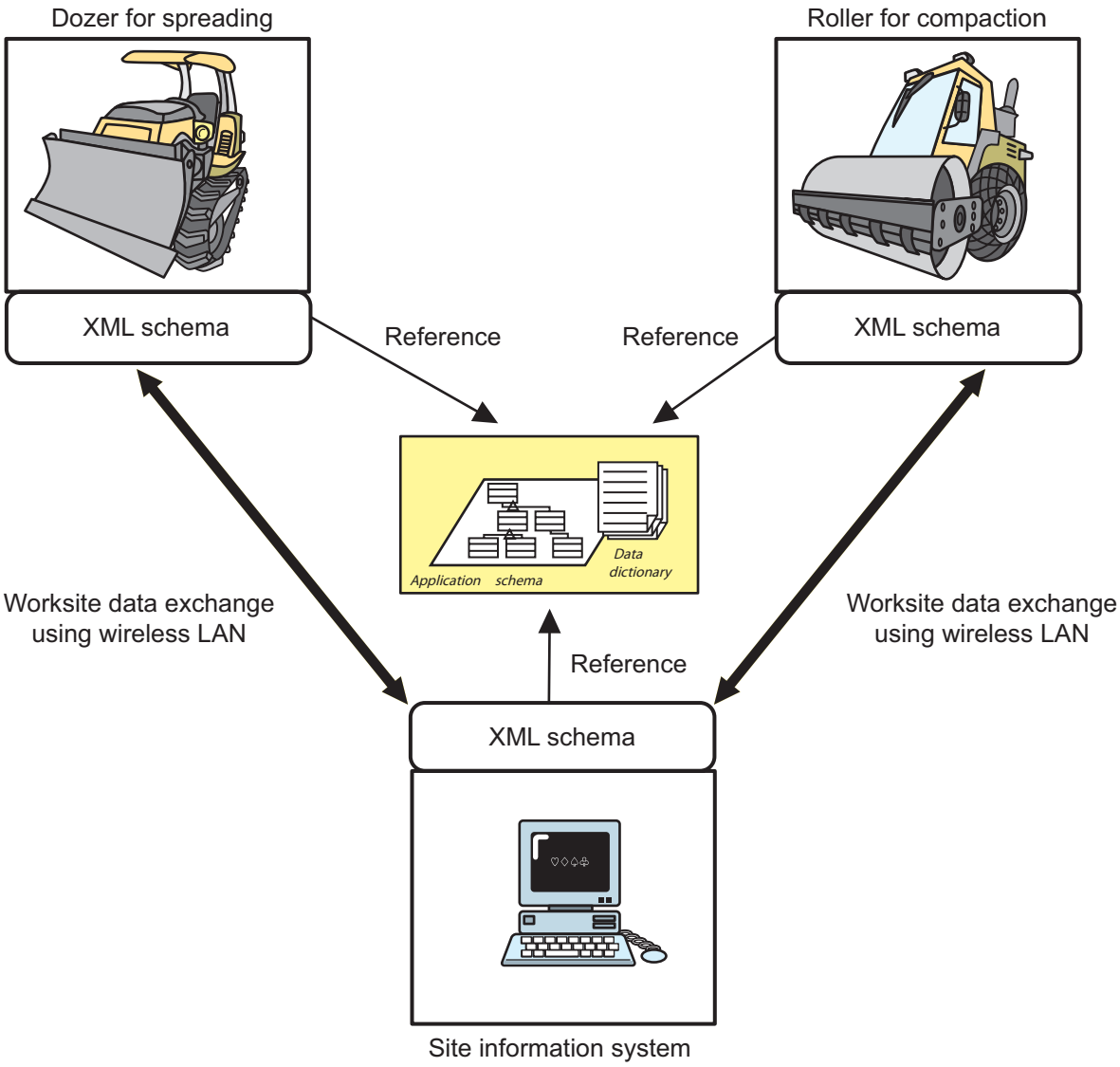


Figure D.8 — Physical model for construction management on fill construction site

Annex E
(informative)

Process modelling (conceptual)

E.1 General

For the purposes of data exchange, the process of construction work is modelled as presented in this annex.

NOTE The work process is modelled for common understanding between those who handle data for exchange, while data exchange can only be realized through this common understanding.

E.2 Construction project life cycle

E.2.1 Overview

A construction project is generally made as a life cycle, as shown in Figure E.1. This part of ISO 15143 is applicable to the construction phase and is expected to be reused during the maintenance phase.

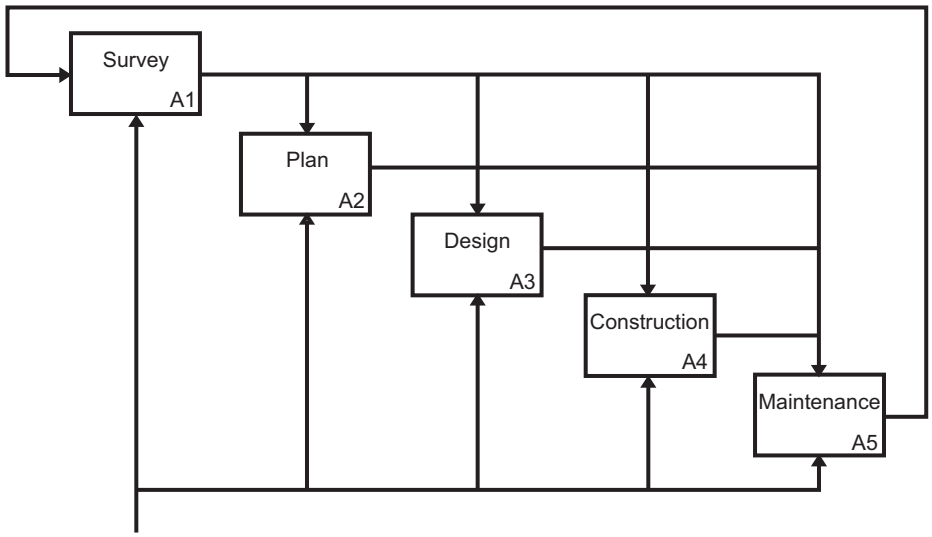


Figure E.1 — Construction project life cycle (IDEF0)

See E.3 for an explanation of the IDEF0 model.

E.2.2 Construction phase work process

The construction phase operation is generally as shown in Figure E.2.

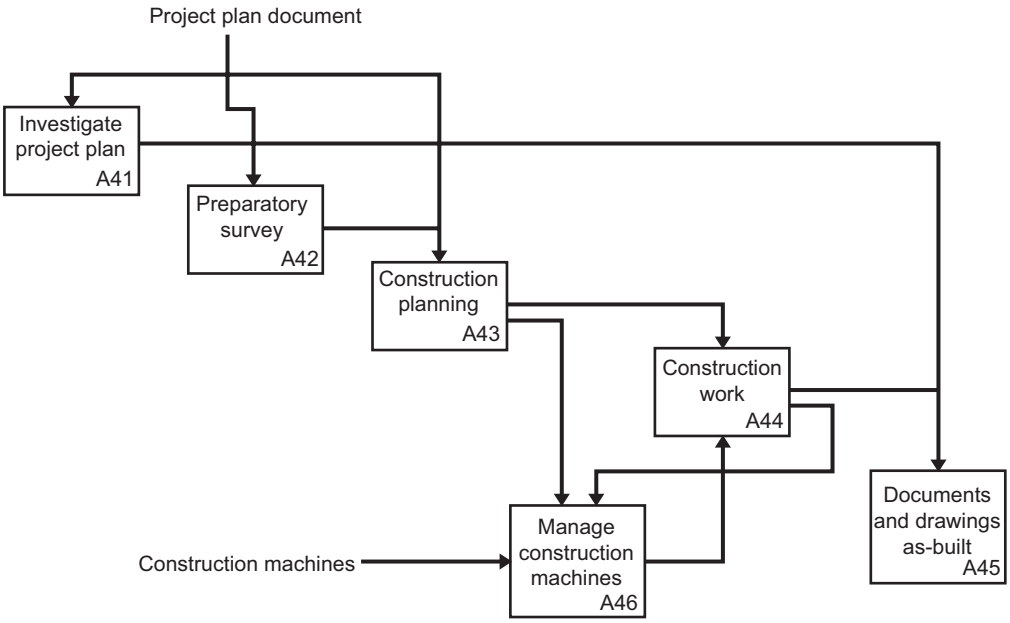


Figure E.2 — Construction phase work process (IDEF0)

E.2.3 Site operation process

Site operation is generally as shown in Figure E.3.

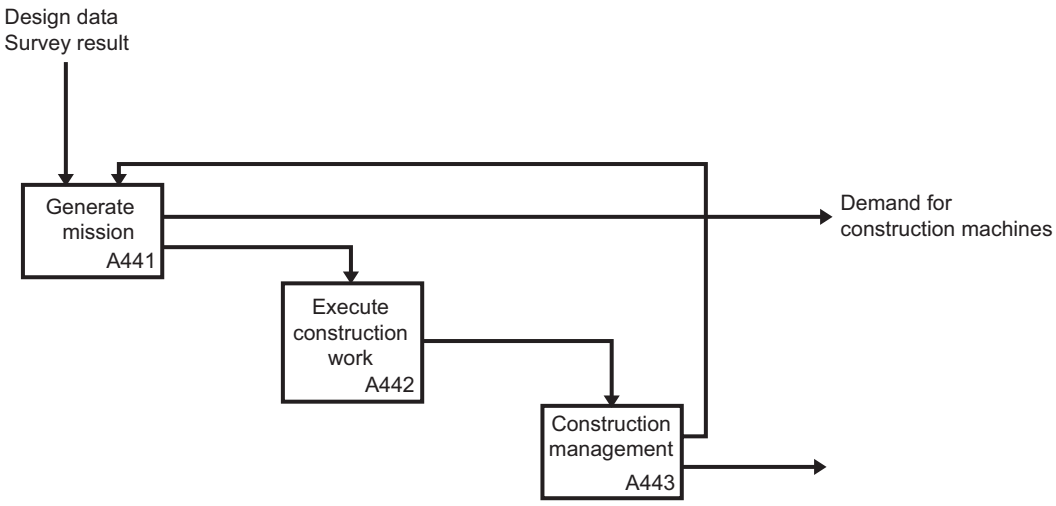


Figure E.3 — Site operation process (IDEF0)

E.2.4 Machine management process

Machine management is generally as shown in Figure E.4.

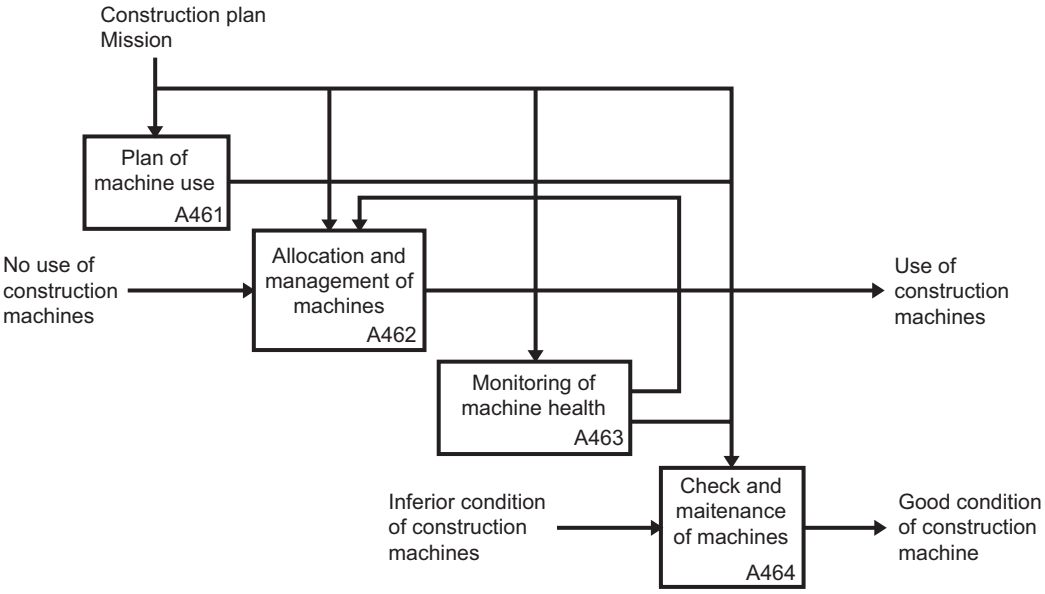


Figure E.4 — Machine management process (IDEF0)

E.3 Integration definition for function modelling (IDEF0)

IDEF0 is a method designed to model the decisions, actions and activities of an organization. The “box and arrow” graphics of an IDEF0 diagram show the function as a box and the interfaces to or from the function as arrows entering or leaving the box. To express functions, boxes operate simultaneously with other boxes, with the interface arrows “constraining” when and how operations are triggered and controlled. The basic syntax for an IDEF0 model is shown in Figure E.5.

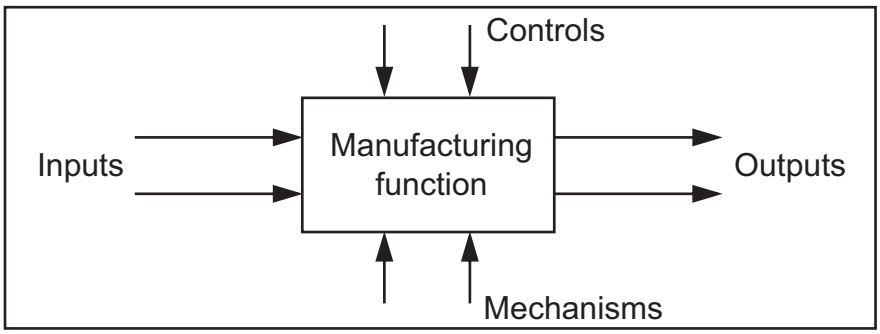


Figure E.5 — IDEF0 function box and interface arrows (http://www.idef.com/)

Annex F
(informative)

Process modelling (typical examples)

F.1 Work flow

Figure F.1 models a typical fill construction working process.

F.2 Physical model

Construction earth-work data flow and executed services, focusing on earth-moving operation are physically modelled in Figure F.2. This model presents machines (and related equipment) cooperating physically as well as the services targeted. It also describes the functions of each machine, with its methods for generating data targeting the required services. Generated data circulate through the processes and are available in services other than that specific for each process in Figure F.2.

NOTE Another model may be possible in each application.

F.3 Logical model

Example construction earth-work data flow and executed services focusing on earth-moving operation are logically modelled as shown in Figure F.3, based on the Figure F.1 work flow, logically developed and generalized based on Figure F.2.

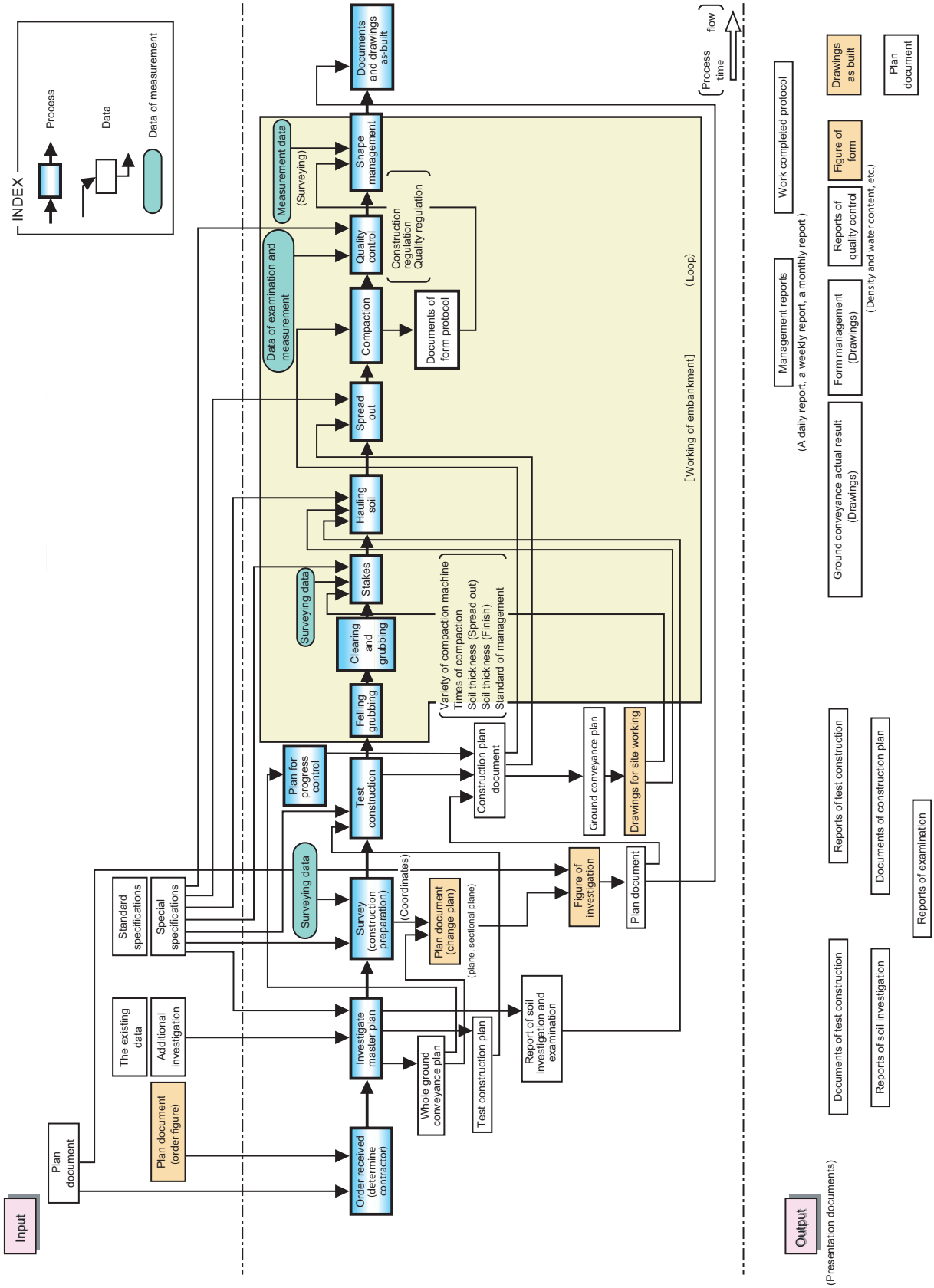


Figure F.1 — Working process of fill construction

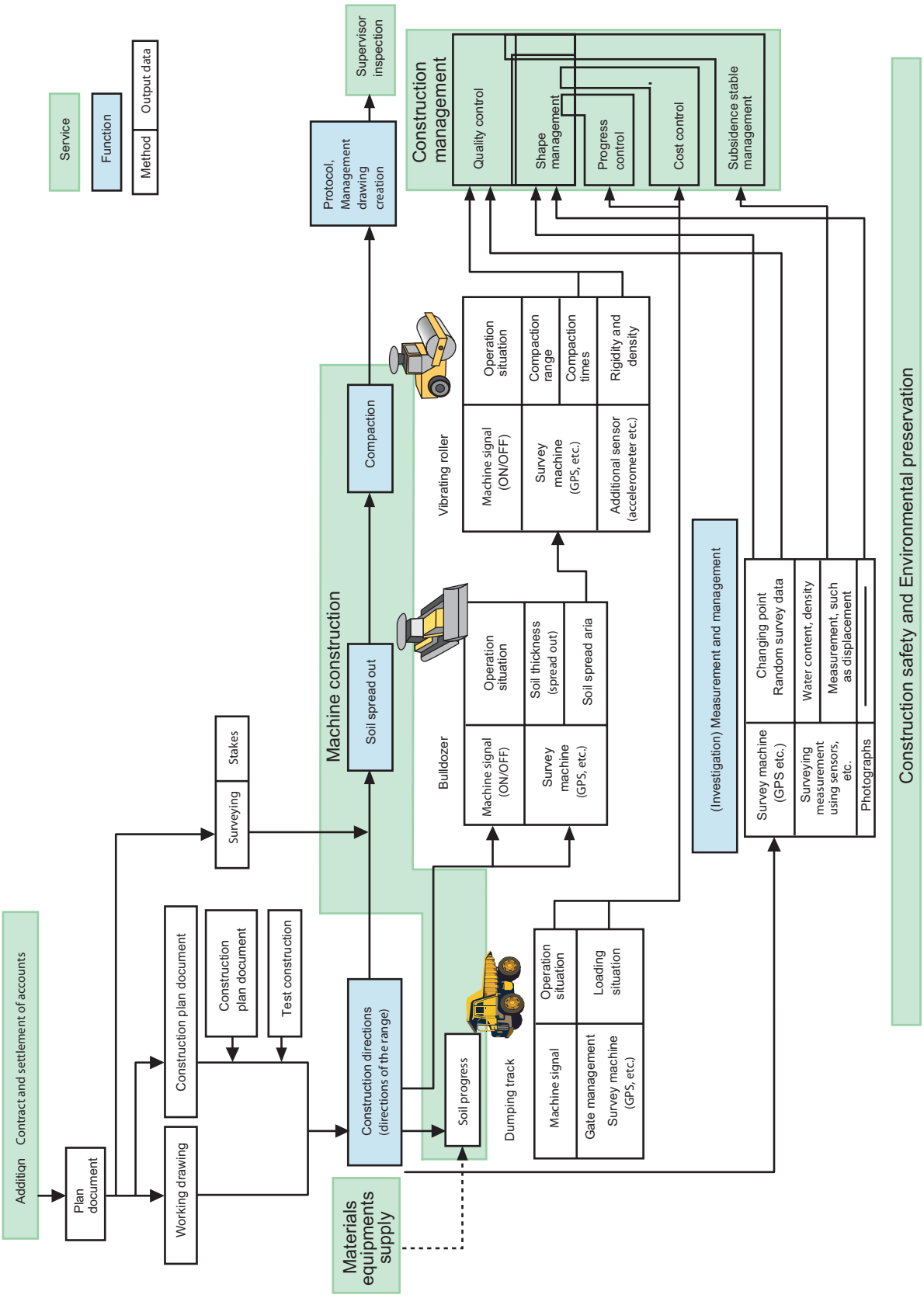


Figure F.2 — Information service of fill construction (physical model)

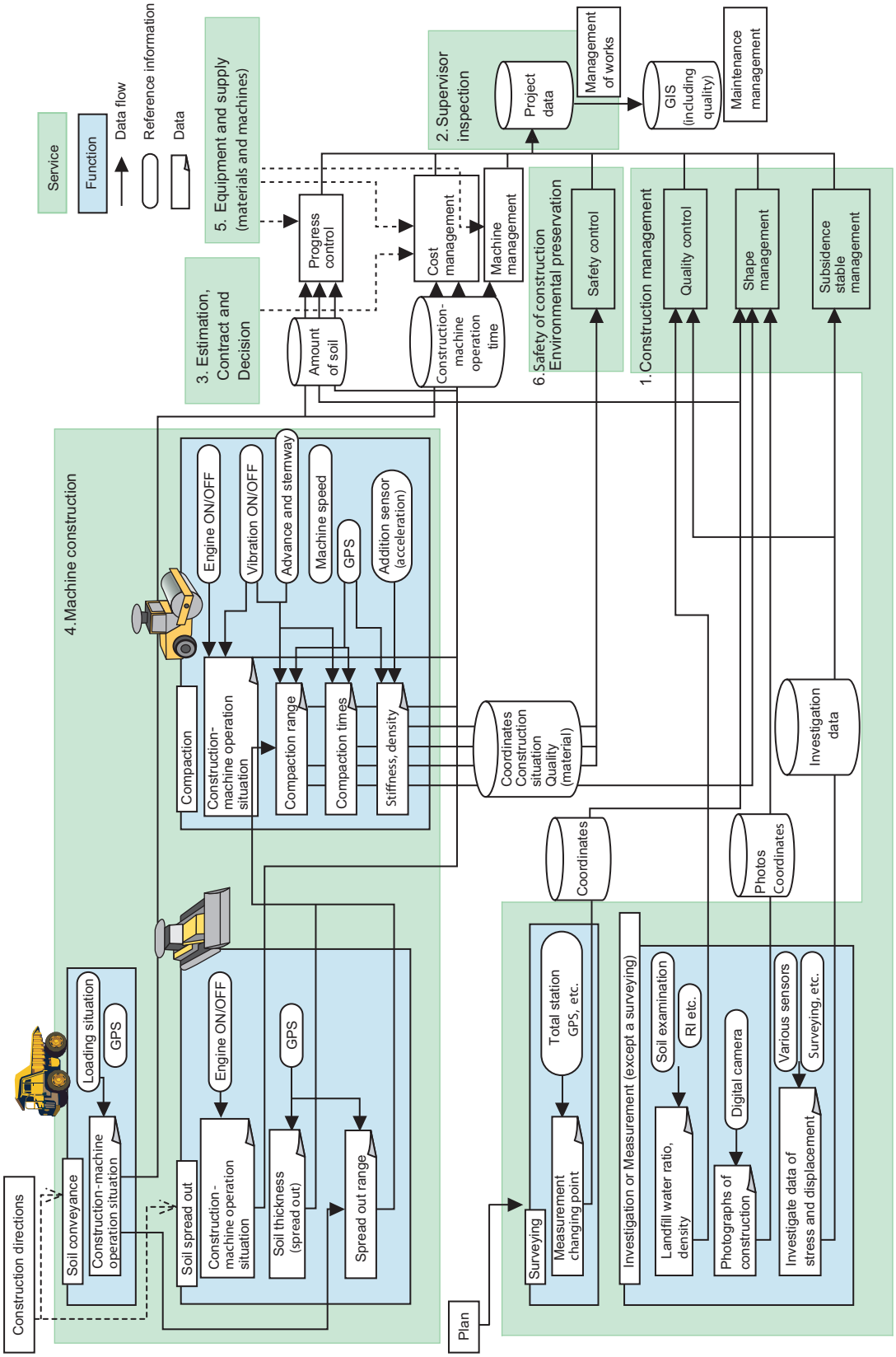


Figure F.3 — Information service of fill construction (logical model)

Bibliography

[1] ISO 1087-1:2000, *Terminology work — Vocabulary — Part 1: Theory and application*

[2] ISO 1087-2:2000, *Terminology work — Vocabulary — Part 2: Computer applications*

[3] ISO/IEC 2382-1:1993, *Information technology — Vocabulary — Part 1: Fundamental terms*

[4] ISO/IEC 2382-4:1999, *Information technology — Vocabulary — Part 4: Organization of data*

[5] ISO 2382-6:1987, *Information processing systems — Vocabulary — Part 6: Preparation and handling of data*

[6] ISO/IEC 2382-9:1995, *Information technology — Vocabulary — Part 9: Data communication*

[7] ISO 6707-2:1993, *Building and civil engineering — Vocabulary — Part 2: Contract terms*

[8] ISO/IEC 12207, *Systems and software engineering — Software life cycle processes*

[9] ISO 15645, *Road construction and maintenance equipment — Road milling machinery — Terminology and commercial specifications*

[10] ISO 15688, *Road construction and maintenance equipment — Soil stabilizers — Terminology and commercial specifications*

[11] ISO 15878, *Road construction and maintenance equipment — Asphalt pavers — Terminology and commercial specifications*

[12] ISO 16039, *Road construction and maintenance equipment — Slipform pavers — Definitions and commercial specifications*

[13] ISO/IEC Directives, Part 1:2008, *Procedures for the technical work*

[14] FIPS Publication 183, *Integration Definition for Function Modelling (IDEF0)* [1)]

1) Federal information processing standards (FIPS), published by the US National Institute of Standards and Technology (NIST).

ICS 35.240.99; 53.100

Price based on 57 pages