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Monitoring and Control Interface for Infrastructure Equipment (Power, Cooling and Building Environment Systems used in Telecommunication Networks);
Part 6: Air Conditioning System control and monitoring information model

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ETSI

650 Route des Lucioles
F-06921 Sophia Antipolis Cedex - FRANCE

Tel.: +33 4 92 94 42 00 Fax: +33 4 93 65 47 16

Siret N° 348 623 562 00017 - NAF 742 C
Association à but non lucratif enregistrée à la
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Contents

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Foreword

This ETSI Standard (ES) has been produced by ETSI Technical Committee Environmental Engineering (EE).

The present document is part 6 of a multi-part deliverable. Full details of the entire series can be found in part 1 [1].

1 Scope

The present document applies to monitoring and control of air conditioning Systems for telecommunication equipment.

This multi-part deliverable defines:

- The monitored and controlled air conditioning system architectures.
- The minimum set of exchanged information required at the interface, described in "natural language" in text tables.
- XML structure specific to the present document.

2 References

References are either specific (identified by date of publication and/or edition number or version number) or non-specific. For specific references, only the cited version applies. For non-specific references, the latest version of the referenced document (including any amendments) applies.

Referenced documents which are not found to be publicly available in the expected location might be found at http://docbox.etsi.org/Reference.

NOTE: While any hyperlinks included in this clause were valid at the time of publication, ETSI cannot guarantee their long term validity.

2.1 Normative references

The following referenced documents are necessary for the application of the present document.

[1] ETSI ES 202 336-1: "Environmental Engineering (EE); Monitoring and Control Interface for Infrastructure Equipment (Power, Cooling and Building Environment Systems used in Telecommunication Networks) Part 1: Generic Interface".

[2] ETSI EN 300 019 (all parts): "Environmental Engineering (EE); Environmental conditions and environmental tests for telecommunications equipment".

2.2 Informative references

The following referenced documents are not necessary for the application of the present document but they assist the user with regard to a particular subject area.

[i.1] IEEE 802.1 to 802.11: "IEEE Standard for Local & Metropolitan Area Network".

[i.2] ISO/IEC 8879: "Information processing - Text and office systems - Standard Generalized Markup Language (SGML)".

[i.3] ETSI TR 102 336: "Environmental Engineering (EE); Power and cooling system control and monitoring guidance".

3 Definitions and abbreviations

3.1 Definitions

For the purposes of the present document, the following terms and definitions apply:

air conditioner: encased assembly or assemblies designed as an appliance to provide delivery of conditioned air to an enclosed space, room or zone

NOTE: It includes an electrically operated refrigeration system for cooling and possibly dehumidifying the air. It may have means for heating, circulating, cleaning and humidifying the air.

alarm: any information signalling abnormal state, i.e. different to specified normal state of hardware, software, environment condition (temperature, humidity, etc.)

NOTE: The alarm signal should be understood by itself by an operator and should always have at least one severity qualification or codification (colour, level, etc.). Example: fan failure, temperature low, …).

alarm loop: electrical loop which open or closed state correspond to alarm start (set) or end (clear) state

alarm message: text parts of the alarm structure

alarm structure: organized set of information fields in an alarm data frame (time stamp, set/clear, text, etc.)

Control form Style Sheet (CSS): simple mechanism for adding style (e.g. fonts, colours, spacing) to Web documents

EXAMPLE: Tutorials, books, mailing lists for users, etc.

Control Unit (CU): integrated unit in an equipment to monitor and control this equipment through sensors and actuators

Data Gathering Unit (DGU): functional unit used for several functions:

- collect serial, digital, and analogue data from several equipment;
- option to send (output) serial or digital commands;
- forward/receive information to/from the Local/Remote Management Application via agreed protocols;
- mediation between interfaces and protocols.

NOTE: This function may be integrated as part of specific equipment.

Ethernet: LAN protocol

NOTE: Equivalent to IEEE 802.1 to 11 [i.1].

event: any information signalling a change of state which is not an alarm: e.g. battery test, change of state of battery charge

NOTE: The event signal should be understood by itself by an operator and should always have at least one severity qualification or codification (colour, level, etc.). It should be transmitted in a formatted structure with text message and other fields like for alarm, e.g. an event can be coded as an alarm with severity "0".

eXtensible Mark-up Language (XML): application profile or restricted form of SGML

NOTE: By construction, XML documents are conforming SGML the Standard Generalized Markup Language (ISO/IEC 8879 [i.2]). XML is designed to describe data and focus on what data is. XML is discerned from the well known Hypertext Transfer Mark-up Language (HTML) which was designed to display data and to focus on how data looks.

eXtensible Style sheet Language (XSL): language for expressing style sheets

NOTE: It consists of two parts, a language for transforming XML documents, and an XML vocabulary for specifying formatting semantics. An XSL style sheet specifies the presentation of a class of XML documents by describing how an instance of the class is transformed into an XML document that uses the formatting vocabulary.

infrastructure equipment: power, cooling and building environment systems used in telecommunications centres and Access Networks locations

NOTE: Examples of the infrastructure equipment are cabinets, shelters, underground locations, etc.

intranet: internal company network generally using Ethernet protocol and extended IP addresses

menu: list of possible input command choices that may be presented in different ways on a display

NOTE: Selection is normally made by a keyboard, a pointing device, a mouse or directly by finger on a sensitive screen.

object: class description of items that accept a set of properties or functions

NOTE: Generic objects can include more specific items and inherit from their properties. If correctly structured, object programming can allow the system to evolve, i.e. be more future-proof. The code should intrinsically be open and structured.

Simple Object Access Protocol (SOAP): way to communicate between applications running on different operating systems, with different technologies and programming languages

NOTE: SOAP communicates over HTTP, because HTTP is supported by all Internet browsers and servers, SOAP traffic is not blocked by firewalls and proxy servers (see W3C).

warning: low severity alarm

web: common name for the Internet or Intranet

World Wide Web Consortium (W3C): consortium founded in October 1994 to develop common interoperable protocols and promote World Wide Web

NOTE: See http://www.w3c.org.

XCU: CU enabled to communicate using XML interface as defined in the present document

XML Schema Definition (XSD): new more detailed XML description compared to the previous one, the DTD

3.2 Abbreviations

For the purposes of the present document, the following abbreviations apply:

CSS	Control form Style Sheet
CU	Control Unit of an equipment
DGU	Data Gathering Unit
DTD	Document Type Definition
HTML	Hypertex Transfer Make-up Language
HTTP	Hypertex Transfer Protocol
IP	Internet Protocol
LAN	Local Area Network
MCB	Miniature Circuit Breaker
RMA	Remote Management Application
SOAP	Simple Object Access Protocol
TEC	ThermoElectric Cooler
TCP	Transmission Control Protocol for IP
W3C	World Wide Web Consortium
XCU	XML enabled CU
XML	eXtensible Mark-up Language

XSD	XML Schema Definition
XSL	eXtensible Style sheet Language

4 Air conditioning systems

The Air conditioning system subset is described in ES 202 336-1 [1] and TR 102 336 [i.3].

The Air conditioning systems addressed by the present document are depicted in figures 1 and 2. One single control unit XCU can monitor and control several air conditioning systems through field bus. Field bus is outside the scope of this multi-part deliverable.

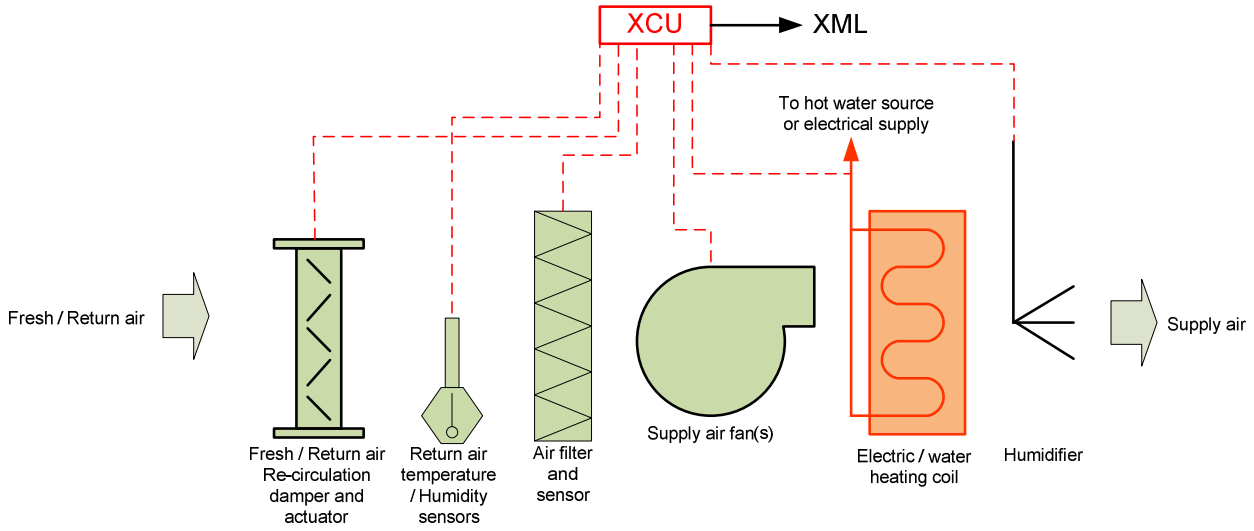

Figure 1: Air conditioning system (without chillers)

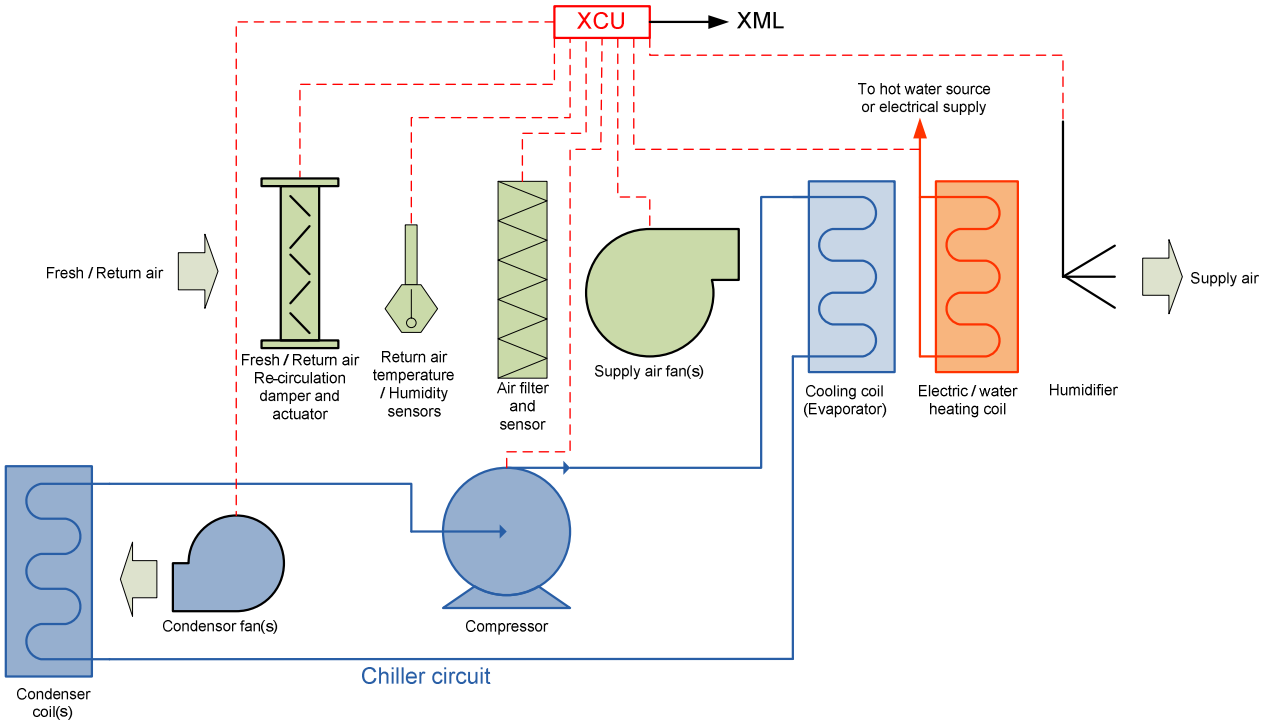

Figure 2: Air conditioning system (with chillers)

NOTE: The Cooling coil shown in figure 2 may be part of a Direct Expansion chiller circuit (as shown) or could be supplied with chilled water from a remotely sited centralized cooling plant.

The main function of air conditioning systems is to use the temperature control system (such as fans, compressor chillers or water-cooling device) to control the telecom system environment (including the equipment room and equipment cabinets) at the appropriate humidity and temperature.

Air conditioning systems without chillers as depicted in figure 1 usually include the following main components:

- System controller unit e.g. XCU
- Cooling fan(s)
- Fan monitoring unit
- Thermoelectric cooler
- Sensors
- Fresh/return air recirculation damper or actuator

Thermoelectric cooler, heat exchanger, direct Cooling and membrane cooling are four different types of air conditioning system without chillers. All systems have a controller, cooling fan(s) and temperature/humidity sensors. Air filters, fresh/return air recirculation damper or actuator and electric or water heat transmission medium are also normally included. The elements of each key component are detailed below.

A fan monitoring unit includes the following elements:

- Temperature sensors
- Filters
- Control unit

A heat exchanger includes the following elements:

- Fans
- Temperature sensors
- Heat exchange core
- Control unit
- Heater

A membrane cooling system includes the following elements:

- Fans
- Temperature & humidity sensors
- Air pressure sensors
- Membrane
- Control Unit
- Heater

A direct cooling unit includes the following elements:

- Fans
- Temperature & humidity sensors
- Control unit
- Heater

A Thermoelectric cooler includes the following elements:

- Fans
- Temperature sensors
- Thermoelectric unit
- Control unit

Air Conditioning systems with chillers as depicted in figure 2 usually comprise the following elements in addition to those of cooling systems without chillers (figure 1):

- Compressor
- Condenser
- Cooling coil (evaporator)
- Chilled and hot water circuit

Tables A.1 and A.2 correspond to mandatory data that shall be provided for air conditioning systems.

Tables B.1 and B.2 correspond to non mandatory data that should be provided.

Annex C standardizes XML coding structures for these data.

Annex A (normative): Summary of mandatory monitoring / supervision information and functions

This annex gathers the information needed on the remote monitoring application for different types of Air conditioning systems. It specifies the mandatory requirements that shall be provided in all cases.

NOTE 1: These tables do not specify the power equipment by itself. These tables refer to subsets or devices that are not necessarily present in each equipment configuration. As a matter of fact, one alarm and its class apply only in case of the presence of this subset or device.

When an optional alarm that requires a parameter set is present, the corresponding parameter set is mandatory in the control section in order to allow remote adjustment under appropriate login procedure.

According to their types (Description, Alarm, Data, etc.), as defined in ES 202 336-1 [1] the information shall be provided by the Control Unit (XCU).

NOTE 2: If there is no XCU this data should be provided by the Data Gathering Unit (DGU).

When a CU has a field data bus connected to the DGU, at least, the DGU shall store data (record measurements, log files). The XCU which has the XML interface over Ethernet TCP/IP shall store these data.

NOTE 3: The "Explanation" column provided in the following data tables has been used where necessary to further explain the statements in the "Monitored information" column. The "Type" column gives the assigned name used in XML coding and the "Monitored information" column provides details of the condition or state being monitored. The identifiers used in the "Type" column of the following tables are described in ES 202 336-1 [1].

NOTE 4: Partial communication network failures e.g. XCU link fault should be detected by an upper element of the network e.g. the RMA (refer to figure 1 of ES 202 336-1) [1].

NOTE 5: Clause 9.4.4 of ES 202 336-1 [1] details the parameters associated with XML elements e.g. time delay, severity of alarm element. The tables below do not include the application of these parameters.

A table is giving minimum set of information for each type of air conditioning system.

A.1 Table for air conditioning system without chillers

Table A.1

Type	Monitored information	Explanation
Description	Device description	
Alarm	Fan Failure	Can be detected by a fast temperature rise or an air flow detector
	Temperature sensor Failure	May be detected by an erratic value or a static value or too fast changes
	High Temperature	Temperature > maximum threshold (ETSI absolute maximum range is given EN 300 019 (all parts) [2]
	Fan speed control failure	
	Electrical circuit protective device failure	Fuse failure / MCB trip
Event	None	
Data	Outdoor temperature (±0,5 °C)	
	Room temperature (±0,5 °C - 1 sensor per room)	
	Relative humidity (±5 % - 1 sensor per room)	
	Runtime of the Fan	
	Runtime of the filter	
	Energy consumption (±2 % - kWh) - 1 hour period)	
Data Record	Record of energy consumption	Energy consumption recorded periodically e.g. every hour
Config	Parameters set (time counter) for fans, filters replacement	
	Parameters set : high level temperature threshold (for thermal calculation autonomy)	
	Parameters set : ΔP threshold	
	Parameters set : , Energy record period	
Control	All XCU alarm/event/test/command parameters (time-out, counter, thresholds, etc.) if any	
	Precise cooling system tuning (T, humidity, …) but with min/max safety	
	At least 2 sets of temperature/humidity levels for summer/winter	
	Scheduled remote heating or cooling command for intervention with timer limit	
	XCU program download with default to previous release	

A.2 Table for air conditioning system with chillers

NOTE: Partial network failure (high error rate, XCU-DGU link fault) is raised by the DGU, not the air conditioning system.

Any network communication failure on the air conditioning XCU interface shall be detected by the air conditioning supervision unit.

Table A.2

Type	Monitored information	Explanation
Description	device description (hardware and software)	
Alarm	Fan(s) Failure	Can be detected by a fast temperature rise or an air flow detector
	Pump(s) failure	
	High Temperature	Temperature > maximum threshold (ETSI absolute maximum range is given EN 300 019 [2] (all parts)
	Compressor Failure	May be detected by an erratic fluid flow or pressure value or a static value or too fast changes
	Temperature sensor Failure	May be detected by an erratic value or a static value or too fast changes
	Condenser Failure	
	Electrical circuit protective device	Fuse failure / MCB tripped
Event	None	
Data	Outdoor temperature (±0,5 °C)	
	Cooling fluid temperature (±0,5 °C)	
	Operation time counters for filter, fans, fluid, pump, compressors	
	Energy consumption (±2 % - 1 hour period)	
Data Record	None	
Config	Parameters set : fans, pumps, filters replacement time counter	
	Parameters set (time counter) for fans, filters replacement	
	Parameters set: high level temperature threshold for thermal calculation autonomy	
	Parameters set: tests duration (fans, pumps, etc.)	
	Parameters set: ΔP threshold	
	Parameters set: energy counter	
	Precise cooling system tuning (T, humidity, …) but with min/max safety	
Control	All XCU alarm/event/test/command parameters (time-out, counter, thresholds, …) if any	
	Scheduled remote heating or cooling command for intervention with timer limit	
	At least 2 sets of temperature/humidity levels for summer/winter	
	XCU program download with default to previous release	

Annex B (informative): Summary of non-mandatory monitoring / supervision information and functions

According to their types (Description, Alarm, Data, etc.), as defined in ES 202 336-1 [1], the information should be provided by the Control Unit (XCU) or by the Data Gathering Unit (DGU).

The non mandatory information of tables of annex B are provided in addition to the mandatory information defined in tables of annex A.

NOTE: The "Explanation" column provided in the following data tables has been used where necessary to further explain the statements in the "Monitored information" column. The "Type" column gives the assigned name used in XML coding and the "Monitored information" column provides details of the condition or state being monitored. The identifiers used in the "Type" column of the following tables are described in ES 202 336-1 [1].

A table is giving list of useful non mandatory information for each type of air conditioning system.

B.1 Table for air conditioning system without chillers

Table B.1

Type	Monitored information	Explanation
Description	Additive information	
Alarm	Fan(s) lose control	
	Low Temperature	Temperature < maximum threshold (ETSI absolute maximum range is given EN 300 019 [2] (all parts)
	Low Humidity	Humidity < maximum threshold (ETSI absolute maximum range is given EN 300 019 [2] (all parts)
	High Humidity	Humidity > maximum threshold (ETSI absolute maximum range is given EN 300 019 [2] (all parts)
	Humidity sensor Failure	
	Out of normal ETSI standard ranges, for a longer duration than specified by EN 300 019 [2] (all parts)	
	Filter blocked	
	Filters, fans replacement needed	Based on time counters or other conditions
	Fan(s) speed controller failure	
	Rate of change of temperature when fans operate	
	Power failure	
	TEC failure	
	Control unit failure	
	Membrane jam	

Type	Monitored information	Explanation
Event	Details of any change of configuration	
	Efficiency (ratio) = telecom system power consumption	Measured cooling system power consumption/measured
	Fan test execution report (on/off, ΔP)	
	Change of operating mode	
	Operation of the heater	Contactor state
	Operation of the TEC	Contactor state
	Operation of the Fan	Contactor state
	Control Mode	
Data	Power of the system (±2 %)	
	Differential pressure (ΔP) for problem assessment on filters, fans or louvres	
	Fan speed	
	Estimated thermal autonomy after fan failure, considering outdoor temperature	
Data Record	Additive records	
Config	Heater switch-on temperature	
	Heater switch-off temperature	
	TEC start-up temperature	
	TEC shut-off temperature	
	Over-temperature threshold	
	Low-temperature threshold	
	Over- Humidity threshold	
	Low- Humidity threshold	
Control	Start-upTEC	
	Scheduled remote heating or cooling command for intervention with timer limit	
	Adjust fan Speed	
	Turn on heater	
	Turn off heater	

B.2 Table for air conditioning system with chillers

Table B.2

Type	Monitored information	Explanation
Description	Additive information	
Alarm	Out of normal ETSI standard ranges, for a longer duration than specified by EN 300 019 [2] (all parts)	
	Rate of change of temperature when fans operate	
	Fans speed variation default	Fan speed deviates from default setting
	Fan(s) lose control	
	Cooling fluid leakage detection	
	Filters, fans, pumps replacement needed	Detection based on time counters or other conditions
	Cooling fluid replacement needed	Detection based on time counters or other conditions
	Low Temperature	Temperature < maximum threshold (ETSI absolute maximum range is given EN 300 019 [2] (all parts)

Type	Monitored information	Explanation
	Low Humidity	Humidity < maximum threshold (ETSI absolute maximum range is given EN 300 019 [2] (all parts)
	High Humidity	Humidity > maximum threshold (ETSI absolute maximum range is given EN 300 019 [2] (all parts)
	Humidity sensor Failure	Detected by etc.
	Power failure	
	Heater failure	Detected by over or under consumption
	Filter blocked	Detected by differential pressure sensor
Event	Details of any change of configuration Change of operating mode	
	Test execution report (on/off, ΔP)	
	Fans test execution report	Detected by air flow
	Pumps test execution report	Detected by water flow
	Operation of the compressors	Contactor state
	Operation of the heater	Contactor state
	Operation of the fan	Contactor state
Data	Estimated autonomy in case of cooling system failure considering outside temperature	Based on calculation with temperature gradient and maximum value
	Differential pressure (ΔP) for problem assessment on filters, fans or louvres	
	Fan speed	
	Fan Control Signal	
	Control Mode	
	Runtime of the Fan	
	Temperature	Room / return air temperature
	Humidity	Room humidity
	Running times (since installation, since starting)	
	Efficiency (ratio) telecom equipment power consumption	= measured cooling system power consumption / measured
	Runtime of the filter	
	Electric power used by the system (±2 %)	
Data Record	All of the data	
Config	Heater switch-on temperature	
	Heater switch-off temperature	
	Compressor switch-on temperature	
	Compressor switch-off temperature	
	Over-temperature threshold	
	Low-temperature threshold	
	Over- Humidity threshold	
	Low- Humidity threshold	
Control	Turn on heater	
	Turn off heater	
	Turn on Compressors	
	Turn off Compressors	
	Adjust fan speed	

Annex C (normative): Mandatory XML structure and elements

C.1 Structure of an XML document for an air conditioning system

In the site DGU XML data structure as described in ES 202 336-1 [1], an air conditioning system equipment is always a child of a site energy system.

The XML structure shall be as follows.

NOTE: It indicates precisely the generic mandatory XML structure and where to put the information if it exists (where it starts and stops). Every equipment and element, should be considered as a folder in the XML structure.

```
<site id="23" status ="normal">
        ....
   <energy_system id="1" status="normal">
      <description_table>
      …
      </description_table>
      …
      < air_conditioning_system id="1" status="normal">

      Here is the XCU file embedded (see next paragraph)….

      </air_conditioning_system >

      < air_conditioning_system id="2,3, ...n" status="normal">

      Here is the XCU file embedded (see next paragraph)….

      </air_conditioning_system >
```

```
</energy_system>
   …
</site>
```

An air conditioning system XCU will only generate the XML document "air_conditioning_ system.xml". This file can be downloaded by the DGU of the site and embedded in the "site.xml" document. In this case, the structure of the document is as follows:

```
< air_conditioning_system id="1" status="normal">
   <description_table>
   …
   </description_table>
   <alarm_table>
   …
   </alarm_table>
   <event_table>
   …
   </event_table>
   <data_table>
   …
   </data_table>
   <data_record_table>
   …
   </data_record_table>
   <config_table>
   …
   </config_table>
   <control_table>
   …
   </control_table>
   < general id="10" status="normal">
   …
   </ general >

   < TBA id="1" status="normal">
   …
   </ TBA >

   < TBA_id="2" status="normal">
   …
   </ TBA >

   < TBA_id="3" status="normal">
   …
   </ TBA >

   < TBA_id="4" status="normal">
   …
   </ TBA >

   < TBA_id="5" status="normal">
   …
   </ TBA >

   < TBA_id="6" status="normal">
   …
   </ TBA >

   < TBA="7" status="normal">
   …
   </ TBA >
   …
</ air_conditioning_system >
```

C.2 The specific elements of an air conditioning system

Child Element	Description	Datatype
<TBA> <TBA> <TBA> <TBA> <TBA> <TBA> <TBA>	For detailed information about each air conditioning component	xs:complexType

NOTE: In the following, xml example has been given in a flat description only using the parameter group = "xxx circuit", but it is possible to define circuit as child element in a more hierarchical description.

Annex D (informative): Bibliography

ETSI ETS 300 132-1: "Equipment Engineering (EE); Power supply interface at the input to telecommunications equipment; Part 1: Operated by alternating current (ac) derived from direct current (dc) sources".

ETSI EN 300 132-2: "Environmental Engineering (EE); Power supply interface at the input to telecommunications equipment; Part 2: Operated by direct current (dc)".

ETSI EN 300 132-3: "Environmental Engineering (EE); Power supply interface at the input to telecommunications equipment; Part 3: Operated by rectified current source, alternating current source or direct current source up to 400 V".

ETSI EN 300 019-1-3 "Environmental Engineering (EE); Environmental conditions and environmental tests for telecommunications equipment; Part 1-3: Classification of environmental conditions; Stationary use at weather protected locations".

ETSI EN 300 019-2-3: "Environmental Engineering (EE); Environmental conditions and environmental tests for telecommunications equipment; Part 2-3: Specification of environmental tests; Stationary use at weather protected locations".

ETSI ES 202 336-2: "Environmental Engineering (EE); Monitoring and control interface for infrastructure equipment (Power, Cooling and environment systems used in telecommunication networks); Part 2: DC power system control and monitoring information model".

History

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