A Recommended Standard of the Joint Committee on the NTCIP

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National Transportation Communications for ITS Protocol (NTCIP) Object Definitions for Environmental Sensor Stations (ESS)

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Contents

FOREWORD

The purpose of this document is to define the environmental sensor station (ESS) objects that are supported by the NTCIP.

The effort to develop NTCIP objects began with the 3-TS Transportation Management Systems and Associated Control Devices Section of the National Electrical Manufacturer's Association (NEMA). Their original desire was to address a user need for extending the TS-2 Standards for traffic control hardware into a systems communication network that would support defined functionality, regardless of the manufacturer of the field device or the type of central software.

In September 1996, a formal agreement was reached among NEMA, the Institute of Transportation Engineers (ITE) and the American Association of State Highway and Transportation Officials (AASHTO) to jointly develop, approve and maintain the NTCIP standards. Under the guidance of a Joint AASHTO/ITE/NEMA Committee on the NTCIP, a Working Group was created in order to develop the object definitions Environmental Sensor Stations. The first official meeting of this working group was in November 1996.

In preparation of this Standards Publication, input of users and other interested parties was sought and evaluated. Inquiries, comments and proposed or recommended revisions should be submitted to:

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1SECTION
INTRODUCTION

1.1INTRODUCTION

Environmental sensors include a wide array of sensors, including those which monitor weather, roadway surface, and air/water quality conditions. These sensors are typically connected to a nearby field device/ microprocessor termed a Remote Processor Unit (RPU). An Environmental Sensor Station (ESS) consists of the RPU plus its suite of sensors. In the transportation community, these devices are frequently used in order to improve roadway maintenance and traffic operations.

Unfortunately, there have not been standards defining how these devices communicate with other related equipment. As a result, each manufacturer has developed its own protocol to meet its particular needs. To integrate systems manufactured by different companies, considerable extra work must be performed resulting in increased costs. This shortcoming limits interchangeability of components between different vendors' and restricts information sharing within and between user organizations.

These problems have not been limited to weather and environmental monitoring. Many other devices also need to exchange information. In surface transportation, examples include traffic signal controllers, dynamic message signs, bus priority sensors, etc. To address these problems, the NTCIP is developing a family of open standards for communications among field devices and between field devices and central management stations, known as Information Management Subsystems (IMS).

1.2WEATHER IMPACTS

Weather has a profound effect on driving condition. More generally, all modes of transportation can be severely affected by adverse weather events. Timely and reliable information on developing weather situations can help support highway maintenance, transit operations, trip planning and route selection. Transportation and meteorological agencies have common interests in improved coordination of surface transportation and weather information systems.

1.2.1Transportation Facilities Maintenance

Several state transportation agencies already have a network of ESS in operation for road maintenance purposes; these systems have traditionally been called Road/Weather Information Systems (RWIS). At present, however, these systems often include proprietary elements which limit opportunities for effective information exchange.

The data from RWIS can be used to more accurately predict the start times, end times, and strength of storms. This information can then be used by maintenance agencies to better manage their staff and materials.

A study for the Strategic Highway Research Program (SHRP) showed that about two billion dollars are spent each year in North America on snow and ice control [1]. An estimated 10-12% of this total could be saved with better road and weather condition information. RWIS installed to date have proven highly cost effective.

The development of the NTCIP will allow a more open-systems approach, not only among RWIS equipment, but also with a wide variety of other field devices. It is expected that this open-systems approach will result in lower deployment and equipment costs similar to the PC industry. This in turn will allow for more devices to be deployed resulting in better decision-support to decrease maintenance costs.

1.2.2Transportation Management

Intelligent Transportation Systems (ITS) are currently applying the benefits of information technology more broadly within surface transportation. One of the key goals of ITS is to improve the management of the existing surface transportation infrastructure. Weather is a key component which should be considered when making such management decisions. For example, start-up green times at traffic signals may need to be lengthened under icy conditions, and traffic flows can be redirected to avoid areas which are experiencing air quality or other problems. These benefits cut across all modes of surface transportation, e.g. highways, rail, and transit.

1.2.3Commercial Vehicle Operator / Traveler Information

Another important area of ITS applications reside in the area of traveler information. By providing travelers with various environmental information, they can make more informed choices on their mode, route, and time of travel; this in turn will result in improved safety and increased convenience for travelers.

1.2.4Meteorological Analysis and Forecasting

In meteorology, advancements in analysis and forecasting have been equally rapid. Besides conventional data sources, geostationary satellite observations give frequent worldwide updates on global weather patterns. Sophisticated Doppler radar can track the movement of severe storms. Improved Automated Surface Observing Systems (ASOS) are currently being installed at more than 850 locations throughout the United States. Also, many ships and aircraft now serve as mobile data collection platforms, extending weather observations beyond the reach of surface sites. These new weather data sources can greatly add to the output from ESS (RWIS) locations.

More accurate and precise weather forecasts are also of interest to travelers and highway maintenance managers. New, supercomputer 'meso-scale' weather forecasting models will soon become widely available under the multi-billion dollar National Weather Service (NWS) modernization program. Collectively, these systems and models will support much more detailed weather predictions than has previously been possible.

1.2.5Integration of Systems

To make best use of these advancements, RWIS should be seen as a part of broader ITS and meteorological information systems. In Europe, integration has cut costs through accident reductions, lowered insurance premiums, improved snow removal efforts, and reduced traffic congestion. Information sharing across traditional system boundaries offers a win-win situation. RWIS data contribute to better weather forecasts which in turn support more efficient highway maintenance and more accurate traveler information. The key to these benefits is open standards, allowing agencies to share data and avoid getting locked into proprietary systems.

1.2.6Informational References

1) SHRP project H-207, “Road Weather Information Systems, Volume 1”, Research Report, SHRP-H-350, 1993.

1.3BENEFITS OF STANDARDIZATION

As transportation systems become more sophisticated, planners, users, and equipment manufacturers recognize the need for system interoperability and integration. Currently, there is no common protocol with which different types of equipment can communicate. If RWIS are to be integrated with ITS and the wider field of meteorology, common communications standards must be established.

Before the NTCIP development started, each vendor of electronic devices used in transportation adopted a different protocol for data communications. This made it very difficult to mix equipment from different vendors in the same system, and to communicate between systems operated by adjacent agencies. The NTCIP is now providing a common standard that can be used by all vendors.

The NTCIP offers increased flexibility and choice for agencies operating transportation information systems such as RWIS (ESS). It removes barriers to interjurisdictional coordination and allows equipment of different types and manufacturers to be mixed on the same communications line. For these reasons, operating agencies will benefit from specifying that the NTCIP is included in all future purchases and upgrades.

Benefits of adopting open standards based on the NTCIP include:

- *Avoiding Early Obsolescence*: Though it may not be practical to retrofit NTCIP support in some old equipment, most ESS (RWIS) vendors will offer NTCIP support in current and future products. An operating agency can ensure that its equipment remains useful and compatible long into the future by requiring NTCIP support for all future purchases and upgrades. This will include central computers and field stations for Environmental Sensor Station, traffic control, or traveler information devices.
- *Providing Choice of Vendor*: Once an agency has a weather information system that includes support for NTCIP it can buy field stations from any manufacturer offering NTCIP-compatible products, and they will communicate with the agency's "Information Management Subsystem" ('IMS', typically termed CPU).
- *Allowing Interjurisdictional Coordination*: In the future, an agency may want to communicate with ESS devices owned by other users and/or procured from different vendors. Under NTCIP, these various devices can be added onto an existing communications channel and mixed with different types of devices on the same line.
- *Using one Communications Network for All Devices*: NTCIP also allows a central computer to communicate with a range of field devices on the same communications channel. For example, if a dynamic message sign is installed near anESS, the central computer could communicate with the sign controller using the communications channel already in place for the ESS. The communications network is usually the most expensive component of a transportation management system and use of the NTCIP maximizes that investment.

1.4EXISTING STANDARDS

There are great benefits of adopting existing standards where possible. These include:
- reuse of software modules during development
- faster implementations
- reducing risks
- ability to integrate components from different manufacturers
- unambiguous meanings of terminology
- building on proven technologies

1.4.1BUFR

The World Meteorological Organization (WMO) is the international organization which establishes and maintains standards, guidelines and procedures for meteorology, oceanography and hydrology. These documents have been developed over the last 100 years and they continue to evolve as technology advances and needs arise. BUFR and GRIB are the WMO standard binary codes which have been developed to take advantage of automated systems in meteorology, oceanography and hydrology. GRIB (Gridded Binary) is used for encoding gridded fields of data whereas BUFR is used for all other types of data. BUFR is the most applicable WMO standard on which to base the definition of ESS data elements.

1.4.2Internet Standards

The Internet Engineering Task Force (IETF) is responsible for developing and maintaining the standards, guidelines and procedures for communications over the Internet. This group has become increasingly important over the last few years as the Internet has gained popularity. A wide range of Internet standards exist, including:

?1 Point-to-Point Protocol (PPP) - which may be used for NTCIP dial-up links

?2 Internet Protocol (IP) - which may be used for NTCIP communications over networks

?3 Transport Control Protocol (TCP) - which may be used to provide connection-oriented services over NTCIP networks

?4 User Datagram Protocol (UDP) - which may be used to provide connectionless transport services over NTCIP networks

?5 Simple Network Management Protocol (SNMP) - which may be used to exchange NTCIP data elements such as those defined within this document.

1.4.3International Standards Organization Standards

The International Standards Organization (ISO) also develops various communication standards among a wide variety of other standards. The Open Systems Interconnect Reference Model (OSI) is a widely-referenced ISO standard which defines the standard seven-layered communications model. While most implementations do not strictly conform to this standard, virtually all modern communications schemes, including the NTCIP, use many of the concepts defined within the standard. In addition, NTCIP communications may use the High Level Data Link Control Protocol (HDLC), another ISO standard, in specifying how to send a message over a single communications link.

1.4.4NTCIP

To support ITS developments, US DOT funded the design of a National ITS Architecture. This architecture defines major ITS subsystems and the needs for information exchange among them. The National Transportation Communications for ITS Protocol (NTCIP) group is now developing standards for these information exchanges. NTCIP – a joint initiative of AASHTO, ITE, and NEMA – recognizes that weather and road condition information are vital for efficient highway maintenance and safer traffic operations. The family of NTCIP standards will support ESS (that is, RWIS) procurement and support information sharing between the various data users. The development of the NTCIP, including this ESS standard, makes use of existing standards as appropriate.

1.5NTCIP SYSTEM DESIGN

NTCIP was initially designed to support traffic signal controllers because that was seen by the FHWA as an area of most pressing need. However, the development process planned that the protocol would be extended to other transportation environments (e.g., ITS) and, where appropriate, to other environments such as meteorology.

The NTCIP family of protocols is continually expanding to address additional needs. Work is in progress on additional protocols for computer-to-computer or center-to-center data exchange, transit communications, and communications with or between moving vehicles. The NTCIP along with other US DOT standards efforts will eventually provide a comprehensive family of communications protocols covering all appropriate ITS applications.

There may also be a future demand to use the system for communications to field devices that are not transportation related; for example air quality monitors for the Environmental Protection Agency (EPA), weather stations for the National Weather Service, or reservoir monitoring systems for the Corps of Engineers. The ultimate scope of NTCIP cannot be rigidly determined. The key is to determine how those changes might affect the system design and to provide flexible standards to accommodate these changes.

Where possible, NTCIP uses existing telecommunications and computer industry standards. That part of NTCIP addressing Environmental Sensor Stations (ESS) has also sought to follow worldwide standards used in meteorological data exchanges, such as BUFR (Binary Universal Format for the Representation of meteorological data). Sometimes, BUFR and NTCIP adopt different solutions, however, the aim has

been to maintain compatibility with BUFR and NTCIP, so that data can be easily converted from one format to the other.

2SECTION
GENERAL

2.1SCOPE

The communications between an ITS Management Center or portable computer and an Environmental Sensor Station (ESS) is accomplished by using the NTCIP Application Layer services to convey requests to access or modify values of ESS objects resident in the device via an NTCIP network. An NTCIP message consists of a specific Application Layer service and a set of data objects. An NTCIP message may be conveyed using any NTCIP defined class of service which has been specified to be compatible with the Simple Transportation Management Framework (STMF).

The scope of this document is limited to the functionality related to ESS within a transportation environment. This publication defines objects which are specific to ESS and also defines standardized object Groups which can be used for conformance statements.

2.2REFERENCES

For approved revisions, contact:

NTCIP Coordinator
National Electrical Manufacturers Association
1300 North 17th Street, Suite 1847
Rosslyn, VA 22209-3801

For proposed revisions, which are under discussion by the relevant NTCIP Working Group, and revisions recommended by the NTCIP Joint Committee are available on the World Wide Web at http://www.ntcip.org.

The following standards (normative references) contain provisions which, through reference in this text, constitute provisions of this Standard. Other documents and standards (other references) are referenced in these documents, which might provide a complete understanding of the entire protocol and the relations between all parts of the protocol. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this Standard are encouraged to investigate the possibility of applying the most recent editions of the standard listed below.

2.2.1Normative References

ISO/IEC 8824-1:1995, Information Technology - Abstract Syntax Notation One (ASN.1): Specification of Basic Notation.

ISO/IEC 8824-2:1995, Information Technology -- Abstract Syntax Notation One (ASN.1): Information Object Specification..

RFC1155, Structure and Identification of Management Information for TCP/IP-based Internets. K. McCloghrie; M. Rose; 05/10/1990

RFC1212, Concise MIB Definitions. K. McCloghrie; M. Rose; 03/26/1991

WMO No. 306: 1995 Technical Regulations; Manual on Codes, International Codes, Volume 1.2, Annex II, FM 94-X Ext. BUFR - Binary Universal Form for the Representation of Meteorological Data.

2.2.2Other References

NEMA Standards

TS 3.2-1996, National Transportation Communications and ITS Protocol - STMF

TS 3.3-1996, National Transportation Communications and ITS Protocol - Class B Profile

World Meteorology Organization and American Meteorological Society

Glossary of Meteorology (fifth printing), American Meteorological Society. 1989

Office of the Federal Coordinator for Meteorology

A Guide to WMO Code Form FM-94 BUFR, Office of the Federal Coordinator for Meteorology (OFCM). March 1995.

2.2.3Contact Information

ISO/IEC Standards

Members of the ISO maintain registers of currently valid ISO/IEC International Standards. For the USA, the member of ISO is the American National Standards Institute (ANSI), which may be contacted as follows:

ANSI
11 West 42nd Street, 13th Floor
New York, New York 10036
(212) 642-4900

RFC Documents

Electronic copies of RFC documents may be obtained using “anonymous” FTP to the host nic.ddn.mil or ds.internic.net. Printed copies are available from:

DDN Network Information Center
14200 Park Meadow Drive
Suite 200
Chantilly, VA 22021
(800) 365-3642
(703) 802-4535

American Meteorological Society and World Meteorological Organization Documents

Prepayment is required prior to shipment of these documents. Printed copies are available from:

American Meteorological Society
45 Beacon Street
Boston, MA 02108
(617) 227-2425

OFCM Documents

Office of the Federal Coordinator for Meteorology
8455 Colesville Rd., Suite 1500
Silver Spring, MD 20910
(301) 427-2002

2.3GENERAL STATEMENTS

For all bitmapped objects, if a bit is zero (0), then the referenced function is disabled or not supported, and if a bit is one (1), then the referenced function is enabled or supported.

The format of this document is unlike other NTCIP Standards. The format for this standard groups the objects by device and purpose irrespective of the tree structure within the environmental sensor station node. Therefore the object definition identifiers indicate either the NTCIP node or the BUFR node. The groupings of these objects are indicated by title. The tree structure is shown beginning from the devices node within the NEMA node and maps this to the section structure.

This document is managed by the Joint AASHTO/ITE/NEMA Committee on the NTCIP and proprietary features should be defined through vendor-specific nodes or vendor-specific extensions to this Management Information Base (MIB).

2.4ENVIRONMENTAL SENSOR STATION TERMS

For a better understanding of this standard, here are some terms and definitions.

BITMAP	A subset of the SYNTAX type OCTET STRING where every bit is a representation of a part or function (e.g. lamp 1 = bit 1, lamp 2 = bit 2).
BITMAP8	BITMAP with 8 bits
BITMAP16	BITMAP with 16 bits
BITMAP32	BITMAP with 32 bits
Binary Universal Form for the Representation of meteorological data (BUFR)	BUFR is the name of the WMO standard binary code for the exchange and storage of non-gridded meteorological data.
Checksum	Result of an algorithm used to detect errors.
Communication Failure	When a computer (central/master/portable/maintenance) cannot communicate with a specific station for any reason.
Communication Interface	The serial communication port on the controller used to communicate with another device.
Controller Address	See Physical Address
Cyclical Redundancy Check (CRC)	A data error-detection scheme. A polynomial algorithm is performed on a block of data. There are different algorithms involving a different number of bits and bytes in the calculation such as CRC-16 and CRC-32.
Download	To transfer information into the referenced device.
Environmental Analysis Package	The component within a management subsystem which performs advanced processing of the collected environmental data. This would include the analysis, forecasting and packaging of weather and road condition information for resource management.
Surface Transportation Environmental Market Package	A set of components which perform all operations related to sensing, collecting, processing, and exchanging environmental related information, including the exchange of data among the dispersely located equipment.
Environmental Sensor Station (ESS)	A location that includes a remote processor unit (RPU) connected to one or more sensors for the collection of environmental or meteorological data.
Information Management Subsystem (IMS)	A generic reference to any one of the management subsystems identified in the National Architecture; these include Traffic Management Subsystems, Transit Management Subsystems, Emergency Management Subsystems, etc. These management subsystems are responsible for collecting and processing information from remote devices, controlling remote devices, and/or disseminating this information to other subsystems or devices. These devices may include, but are not limited to, ESS.
Intelligent Transportation Systems (ITS)	The application of advanced information processing and communications, sensing, and control technologies to surface transportation with the objective of promoting more efficient use of the existing highway and

	transportation network, increasing safety and mobility, and decreasing the environmental cost of travel.
ITS Management Center	The physical location of an Information Management Subsystem(s).
Management Information Base (MIB)	Management information of object definitions so that devices on a network can be remotely monitored, configured and controlled. The information is provided in a format called Abstract Syntax Notation.1 (ASN.1), which is an international standard for defining objects.
National Transportation Communications for ITS Protocol (NTCIP)	The NTCIP is a family of protocols that provide common control and data collection services as well as accommodating various system topologies and data routing duties. The NTCIP will support not only currently deployed systems, but new systems and technologies as they become available.
Physical Address	The Data Link identifier which differentiates a field device in a multidrop- or point-to-point communication circuit, to allow the central computer to communicate with a specific field device.
Point-To-Point	A form of communications where data is transmitted between two devices without any other devices existing on the communication circuit.
Protocol	A specific set of rules, procedures and conventions defining the format and timing of data transmissions between devices that must be accepted and used to understand each other.
Remote Processor Unit (RPU)	A field processor which collects data from sensors and can communicate the collected data to other computers; the processor may also process the collected data and/or control equipment.
Road/Weather Information System (RWIS)	The collection of RPUs and sensors connected to a central system for analysis and use by maintenance personnel.
Sensor	A device which is capable of detecting a condition and reporting the result to an RPU.
Simple Network Management Protocol (SNMP)	A communications protocol developed by the IETF, used for configuration and monitoring of network devices.
Simple Transportation Management Framework (STMF)	Describes the organization of the information within devices and the methods of retrieving or modifying any information within the device. STMF also explains how to generate and utilize computer readable information organization descriptions.
Simple Transportation Management Protocol (STMP)	A variation of SNMP developed by NEMA to address low bandwidth communication links and real time device monitoring.
Upload	To transfer information from the referenced device to the central computer or an attached portable computer.

For a definition of meteorological terms, see the *Glossary of Meteorology*.

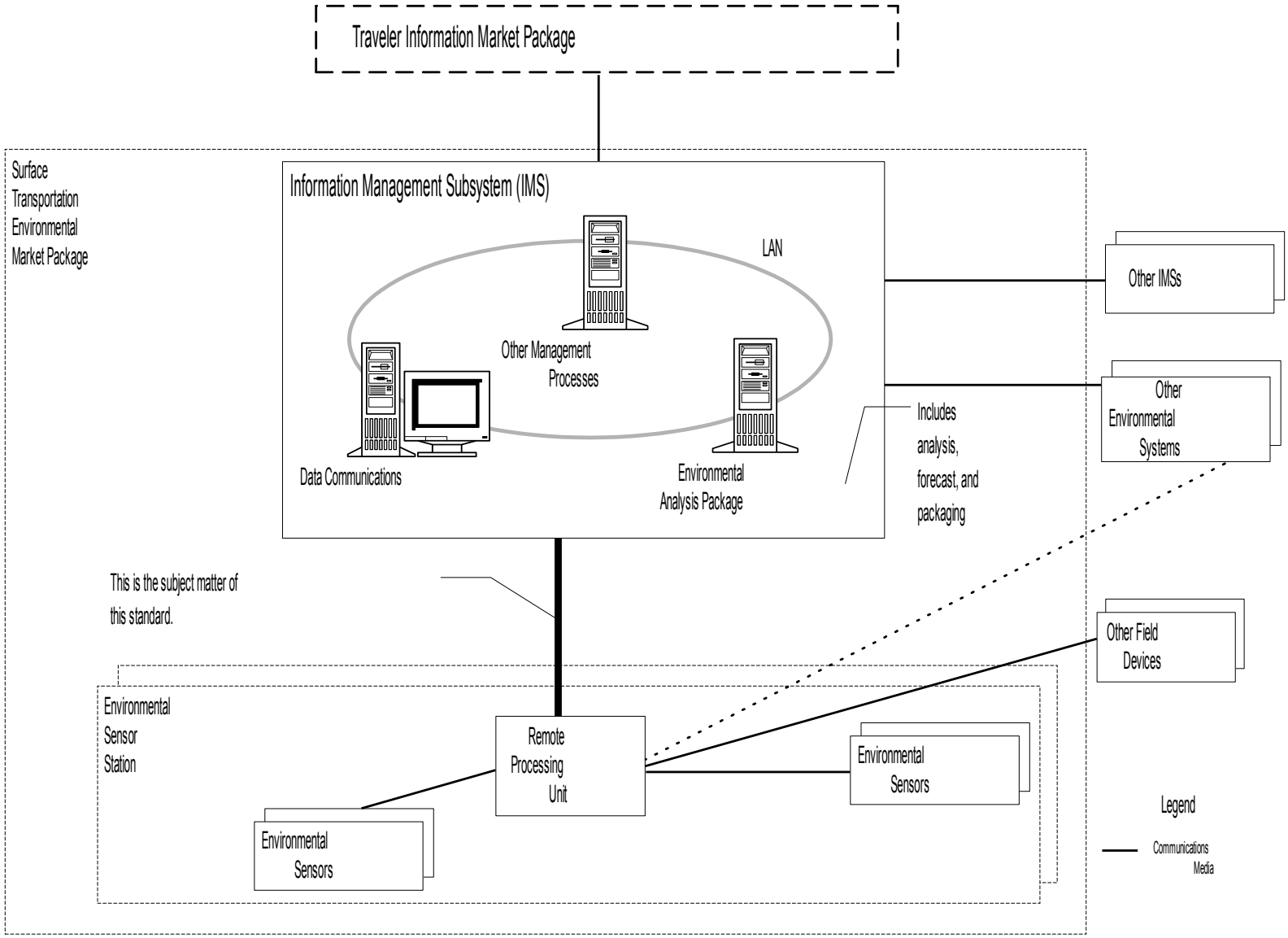
2.5ACRONYMS

BUFR	Binary Universal Form for the Representation of meteorological data
CRC	Cyclical Redundancy Check
ESS	Environmental Sensor Station

IMS	Information Management Subsystem
ITS	Intelligent Transportation Systems
MIB	Management Information Base
NTCIP	National Transportation Communications for ITS Protocol
RPU	Remote Processor Unit
RWIS	Road/Weather Information System
SNMP	Simple Network Management Protocol
STMF	Simple Transportation Management Framework
STMP	Simple Transportation Management Protocol

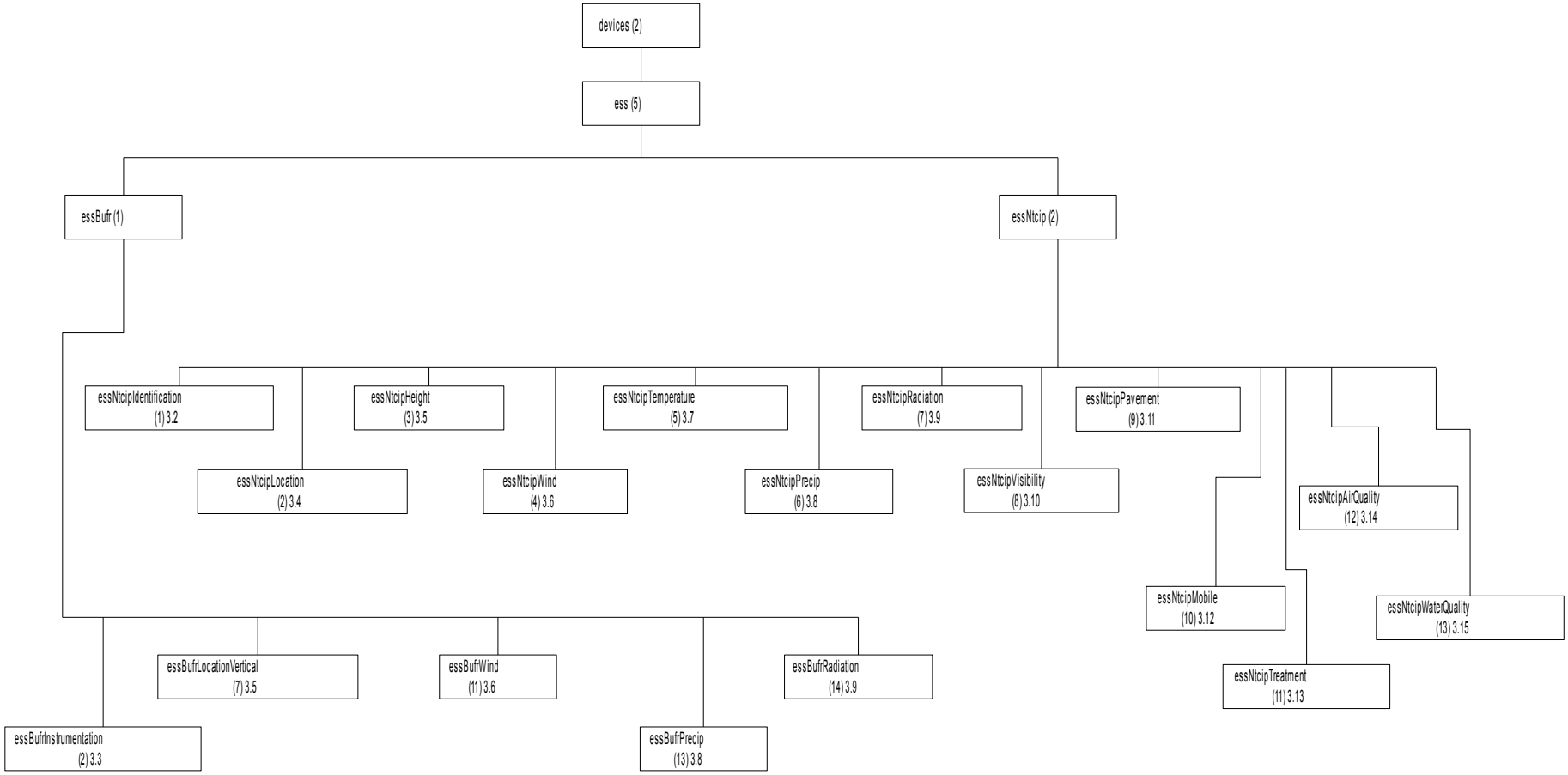
2.6SUPPLEMENTAL FIGURES

The following two figures provide a pictorial representation of the ESS architecture and the Environmental Sensor Station Tree Structure. This is an architecture that is a proposed component for the National Architecture. The architecture diagram identifies some of the terms and acronyms described above and identifies the focus of this standard. The tree structure identifies how the object definitions are combined under specific nodes.



Architectural Terminology Diagram

Environmental Sensor Station Tree Branch of the Devices Tree



3SECTION
OBJECT DEFINITIONS

This section defines those objects which are specifically used by Environmental Sensor Stations (ESS). The objects are defined using the OBJECT-TYPE macro as specified in RFC 1212. The text provided from Clause 3.1 through the end of the section (except the clause headings) constitutes the standard ESSMIB1.

The clauses below present the objects in lexicographical order of their OBJECT IDENTIFIERS which correspond to their physical location within the global naming tree. All of the objects defined in this document reside under the “ess” node of the global naming tree. To aid in object management, the “ess” node has been subdivided into logical categories, each defined by a node under the “ess” node. The individual objects are then located under the appropriate node.

Nodes should not be confused with Conformance Groups, which are defined in Section 4. A Conformance Group is a logical grouping of objects which is used for conformance statements. While Conformance Groups will frequently correspond to the nodal structure, a Conformance Group may contain objects which are not lexicographically ordered.

3.1ENVIRONMENTAL SENSOR STATION (ESS) MIB HEADER INFORMATION

```
ESS-MIB DEFINITIONS ::= BEGIN
IMPORTS
  IpAddress, Counter
FROM RFC1155-SMI
  DisplayString
FROM RFC1158-SMI
  OBJECT-TYPE
FROM RFC-1212
  experimental
FROM NEMA_SMI
  devices
FROM TMIB;
-- For the purpose of this section, the following OBJECT IDENTIFIERS are used:
ess OBJECT IDENTIFIER ::={devices 5}

essBufr OBJECT IDENTIFIER ::= {ess 1}
-- This node contains objects that describe BUFR information based on the BUFR Standards.

essNtcip OBJECT IDENTIFIER ::= {ess 2}
-- This node contains objects that describe surface transportation environmental information
-- which deviate from the BUFR Standards.
```

3.2IDENTIFICATION OBJECTS

```
-- These are objects used to describe the identification of the environmental sensor station.
essNtcipIdentification  OBJECT IDENTIFIER ::= {essNtcip 1 }
```

3.2.1Station Category

```
essNtcipCategory OBJECT-TYPE
SYNTAX          INTEGER { other (1),
                          permanent (2),
```

transportable (3),
mobile (4)}
ACCESS read-only
STATUS mandatory
DESCRIPTION “Indicates the type of station.
value description
other of a design not listed in this standard.
permanent not designed to be relocated.
transportable able to be relocated, but does not take readings while moving.
mobile capable of taking readings while moving.”
::= {essNtcipIdentification 1}

3.2.2Station Site Description

essNtcipSiteDescription OBJECT-TYPE
SYNTAX DisplayString (SIZE (255))
ACCESS read-write
STATUS mandatory
DESCRIPTION “A textual description of the station’s location.”
::= {essNtcipIdentification 2}

-- it is also recognized that there would be a great value of an object to indicate the quality of data;
-- however, this is a very complex topic and thus we have not determined an appropriate mechanism.

3.3DATA INSTRUMENTATION OBJECTS

-- Contains objects used to describe the type of data and the type of instrumentation used to
-- collect the data being received from the ess.
essBufrInstrumentation OBJECT IDENTIFIER ::= {essBufr 2 }

3.3.1Type of Station

essTypeofStation OBJECT-TYPE
SYNTAX INTEGER (0..3)
ACCESS read-only
STATUS mandatory
DESCRIPTION “Integer value that indicates the type of station. If the station is a hybrid station, it shall be defined as two stations, one staffed and one automatic.
value description
0 - automatic the data is collected electronically/mechanically
1 - staffed the data is collected by humans
3 - missingValue the type of station is unknown.”
REFERENCE “WMO Code Form FM 94 BUFR Table B item 0 02 001.”
::= {essBufrInstrumentation 1}

-- The definition of the type, make, model, and version of the various sensors connected to the ESS shall
-- be defined in the Global Module Table.

3.4LOCATION OBJECTS

-- Contains objects used to describe the location of the ess that is transmitting the collected data.

essNtcipLocation OBJECT IDENTIFIER ::= {essNtcip 2 }

3.4.1Latitude

essLatitude OBJECT-TYPE
SYNTAX INTEGER (-90000000..90000001)
ACCESS read-only
STATUS mandatory
DESCRIPTION “The latitude in 10^-6 degrees of the ESS station. The *essLatitude* at the North Pole is 90,000,000. The *essLatitude* at the South Pole is -90,000,000. The value 90,000,001 shall indicate a missing value.”
REFERENCE “Resolution based on on-going location referencing activities; the WMO Code Form FM 94 BUFR Table B item 0 05 001 can be obtained by dividing this value by 10.”
::= {essNtcipLocation 1}

3.4.2Longitude

essLongitude OBJECT-TYPE
SYNTAX INTEGER (-180000000..180000001)
ACCESS read-only
STATUS mandatory
DESCRIPTION “The east longitude in 10^-6 degrees from the Prime Meridian of the ESS location. The *essLongitude* of 180 degrees West shall be -180,000,000. The *essLongitude* of 180 degrees East shall be 180,000,000. The value 180,000,001 shall indicate a missing value.”
REFERENCE “Resolution based on on-going location referencing activities; the WMO Code Form FM 94 BUFR Table B item 0 06 001 can be obtained by dividing this value by 10.”
::= {essNtcipLocation 2}

3.4.3Vehicle Speed

essVehicleSpeed OBJECT-TYPE
SYNTAX INTEGER (0..255)
ACCESS read-only
STATUS mandatory
DESCRIPTION “Indicates the current speed being reported by the vehicle in kilometers per hour. The value 255 shall indicate an error condition or missing value.”
::= { essNtcipLocation 3}

3.4.4Vehicle Bearing

essVehicleBearing OBJECT-TYPE
SYNTAX INTEGER (0..361)
ACCESS read-only
STATUS mandatory
DESCRIPTION “Indicates the current bearing of the vehicle in degrees, measured clockwise from True North. The value 361 shall indicate an error condition or missing value.”
::= { essNtcipLocation 4 }

3.4.5Odometer

essOdometer OBJECT-TYPE
SYNTAX Counter
ACCESS read-only
STATUS mandatory
DESCRIPTION “Indicates the current odometer reading of the vehicle in meters.”
::= { essNtcipLocation 5 }

3.5STATION ELEVATION OBJECTS

-- Contains objects used to describe the elevation and atmospheric pressure at the ess that is
-- transmitting the collected data.

essNtcipHeight OBJECT IDENTIFIER ::= {essNtcip 3 }
essBufrLocationVertical OBJECT IDENTIFIER ::= {essBufr 7 }

3.5.1Reference Height

essReferenceHeight OBJECT-TYPE
SYNTAX INTEGER (-400..8001)
ACCESS read-only
STATUS mandatory
DESCRIPTION "The reference elevation of the ESS in meters above mean sea level. For a permanent station, this height shall be measured to the base of the structure; for transportable stations, this height shall be measured to the ground surface upon which the station resides; and for mobile, this height shall be measured to the surface under the vehicle. The value 8001 shall indicate an missing value."
REFERENCE "Resolution based on WMO Code Form FM 94 BUFR Table B item 0 07 001."
::= {essNtcipHeight 1}

3.5.2Pressure Height

essPressureHeight OBJECT-TYPE
SYNTAX INTEGER (-1000..1001)
ACCESS read-only
STATUS mandatory
DESCRIPTION "The height of the pressure sensor with respect to the essReferenceHeight in meters. The value 1001 shall indicate a missing value."
REFERENCE "essRefernceHeight plus this value equals the WMO Code Form FM 94 BUFR Table B item 0 07 001."
::= {essNtcipHeight 2}

3.5.3Wind Sensor Height

essWindSensorHeight OBJECT-TYPE
SYNTAX INTEGER (-1000..1001)
ACCESS read-only
STATUS mandatory
DESCRIPTION "The height of the wind sensor with respect to the essReferenceHeight in meters. The value 1001 shall indicate a missing value."
::= {essNtcipHeight 3}

3.5.4Atmospheric Pressure Parameter

essAtmosphericPressure OBJECT-TYPE
SYNTAX INTEGER (0..65535)
ACCESS read-only
STATUS mandatory
DESCRIPTION "The force per unit area exerted by the atmosphere in 1/10ths of millibars, a.k.a. tenths of hectoPascals. A value of 65535 shall indicate an error condition or missing value."
REFERENCE "WMO Code Form FM 94 BUFR Table B item 0 07 004."
::= { essBufrLocationVertical 4}

3.6WIND DATA SECTION

-- Contains objects used to describe the wind data that is collected at the ess.
essNtcipWind OBJECT IDENTIFIER ::= {essNtcip 4 }
essBufrWind OBJECT IDENTIFIER ::= {essBufr 11 }

3.6.1Average Wind Direction

essAvgWindDirection OBJECT-TYPE

SYNTAX INTEGER (0..361)
ACCESS read-only
STATUS mandatory
DESCRIPTION “A two minute average of the direction from which the wind is blowing measured clockwise in degrees from true North and measured at a height as indicated by essWindSensorHeight. A value of 361 shall indicate an error condition or missing value.”
REFERENCE “WMO Code Form FM 94 BUFR Table B item 0 11 001.”
::= {essBufrWind 1}

3.6.2Average Wind Speed

essAvgWindSpeed OBJECT-TYPE
SYNTAX INTEGER (0..65535)
ACCESS read-only
STATUS mandatory
DESCRIPTION “A two minute average of the wind speed in tenths of meters per second measured at a height as indicated by essWindSensorHeight. A value of 65535 shall indicate an error condition or missing value.”
REFERENCE “WMO Code Form FM 94 BUFR Table B item 0 11 002.”
::= {essBufrWind 2}

3.6.3Spot Wind Direction

essSpotWindDirection OBJECT-TYPE
SYNTAX INTEGER (0..361)
ACCESS read-only
STATUS mandatory
DESCRIPTION “The direction from which the wind is blowing measured in degrees clockwise from true North and measured at a height as indicated by essWindSensorHeight. A value of 361 shall indicate an error condition or missing value. For mobile platforms, the wind direction shall be corrected for vehicle movement.”
::= { essNtcipWind 1}

3.6.4Spot Wind Speed

essSpotWindSpeed OBJECT-TYPE
SYNTAX INTEGER (0..65535)
ACCESS read-only
STATUS mandatory
DESCRIPTION “The wind speed in tenths of meters per second measured at a height as indicated by essWindSensorHeight. A value of 65535 shall indicate an error condition or missing value. For mobile platforms, the wind speed shall be corrected for vehicle movement.”
::= {essNtcipWind 2}

3.6.5Wind Situation

essWindSituation OBJECT-TYPE
SYNTAX INTEGER { other (1),
unknown (2),
calm (3),
lightBreeze (4),
moderateBreeze (5),
strongBreeze (6),
gale (7),
moderateGale (8),
strongGale (9),
stormWinds (10),

hurricaneForceWinds (11),
gustyWinds (12)}
ACCESS read-only
STATUS mandatory
DESCRIPTION “Describes the weather and travel situation in terms of wind from staffed stations only. Specific ranges for these values are defined in the Glossary of Meteorology. Defined values are:

Range	Meaning
other	not defined within this standard, consult manufacturers documentation
unknown	Unknown conditions
calm	Calm
lightBreeze	Light breeze
moderateBreeze	Moderate breeze
strongBreeze	Strong breeze
gale	Gale
moderateGale	Moderate gale
strongGale	Strong gale
stormWinds	Storm winds
hurricaneForceWinds	Hurricane force winds
gustyWinds	Gusty winds – defined by a peak and a lull of greater than 46.3 tenths of meters per second within a 2 minute period.”

::= {essNtcipWind 3}

3.6.6Maximum Wind Gust Speed

essMaxWindGustSpeed OBJECT-TYPE
SYNTAX INTEGER (0..65535)
ACCESS read-only
STATUS mandatory
DESCRIPTION “The maximum wind gust recorded during the 10 minutes preceding the observation at a height as indicated by essWindSensorHeight and measured in tenths of meters per second. The value 65535 shall indicate an error condition or missing value.”
REFERENCE “WMO Code Form FM 94 BUFR Table B item 0 11 041.”
::= {essBufrWind 41}

3.6.7Maximum Wind Gust Direction

essMaxWindGustDir OBJECT-TYPE
SYNTAX INTEGER (0..361)
ACCESS read-only
STATUS mandatory
DESCRIPTION “The direction of the maximum wind gust recorded during the 10 minutes preceding the observation at a height as indicated by essWindSensorHeight; measured in degrees clockwise from true North. The value 361 shall indicate an error condition or missing value.”
REFERENCE “WMO Code Form FM 94 BUFR Table B item 0 11 043.”
::= {essBufrWind 43}

3.7TEMPERATURE DATA OBJECTS

-- Contains objects used to describe the temperature data that is collected at the ess.
essNtcipTemperature OBJECT IDENTIFIER ::= {essNtcip 5 }

3.7.1Number of Temperature Sensors

essNumTemperatureSensors OBJECT-TYPE
SYNTAX INTEGER (0..255)
ACCESS read-only
STATUS mandatory

DESCRIPTION “Indicates the number of entries in the temperature sensor table.”
::= {essNtcipTemperature 1}

3.7.2Temperature Sensor Table

essTemperatureSensorTable OBJECT-TYPE
SYNTAX SEQUENCE OF EssTemperatureSensorEntry
ACCESS not-accessible
STATUS mandatory
DESCRIPTION “Table containing the temperature sensor data fields.”
::= {essNtcipTemperature 2}

essTemperatureSensorEntry OBJECT-TYPE
SYNTAX EssTemperatureSensorEntry
ACCESS not-accessible
STATUS mandatory
DESCRIPTION “Parameters for specific temperature sensor data fields.”
INDEX {essTemperatureSensorIndex}
::= {essTemperatureSensorTable 1}

*Ess*Temperature*SensorEntry* ::= SEQUENCE {
essTemperatureSensorIndex INTEGER,
essTemperatureSensorHeight INTEGER,
essAirTemperature INTEGER }

Temperature Sensor Index

essTemperatureSensorIndex OBJECT-TYPE
SYNTAX INTEGER (1..255)
ACCESS read-only
STATUS mandatory
DESCRIPTION “Enumerated list of row entries that will provide temperature sensor data.”
::= {essTemperatureSensorEntry 1}

Temperature Sensor Height

essTemperatureSensorHeight OBJECT-TYPE
SYNTAX INTEGER (-1000..1001)
ACCESS read-only
STATUS mandatory
DESCRIPTION “The height of the temperature sensor as measured in meters above essReferenceHeight.”
::= { essTemperatureSensorEntry 2}

Air Temperature

essAirTemperature OBJECT-TYPE
SYNTAX INTEGER (-1000..1001)
ACCESS read-only
STATUS mandatory
DESCRIPTION “The dry-bulb temperature in tenths of degrees Celsius. The temperature is an instantaneous reading at the height specified by *essTemperatureSensorHeight*. The value 1001 shall indicate an error condition or missing value.”
REFERENCE “Resolution is based on WMO Code Form FM 94 BUFR Table B item 0 12 001; temperature in kelvin is determined by adding 273.15 to this value.”
::= { essTemperatureSensorEntry 3}

3.7.3Wet-Bulb Temperature

essWetbulbTemp OBJECT-TYPE
SYNTAX INTEGER (-1000..1001)
ACCESS read-only
STATUS mandatory
DESCRIPTION “The wet-bulb temperature in tenths of degrees Celsius. The temperature is an instantaneous reading at the height specified by the *essTemperatureSensorHeight* as specified in the first row of the essTemperatureTable. The value 1001 shall indicate an error condition or missing value.”
REFERENCE “Resolution is based on WMO Code Form FM 94 BUFR Table B item 0 12 002; temperature in kelvin is determined by adding 273.15 to this value.”
::= {essNtcipTemperature 3}

3.7.4Dew-Point Temperature

essDewpointTemp OBJECT-TYPE
SYNTAX INTEGER (-1000..1001)
ACCESS read-only
STATUS mandatory
DESCRIPTION “The dewpoint temperature in tenths of degrees Celsius. The temperature is an instantaneous reading at the height specified by the *essTemperatureSensorHeight* as specified in the first row of the essTemperatureTable. The value 1001 shall indicate an error condition or missing value.”
REFERENCE “Resolution is based on WMO Code Form FM 94 BUFR Table B item 0 12 003; temperature in kelvin is determined by adding 273.15 to this value.”
::= {essNtcipTemperature 4}

3.7.5Maximum Temperature

essMaxTemp OBJECT-TYPE
SYNTAX INTEGER (-1000..1001)
ACCESS read-only
STATUS mandatory
DESCRIPTION “The maximum temperature in tenths of degrees Celsius recorded during the 24 hours preceding the observation at the height specified by the *essTemperatureSensorHeight* as specified in the first row of the essTemperatureTable. The value 1001 shall indicate an error condition or missing value.”
REFERENCE “Resolution is based on WMO Code Form FM 94 BUFR Table B item 0 12 011; temperature in kelvin is determined by adding 273.15 to this value.”
::= {essNtcipTemperature 5}

3.7.6Minimum Temperature

essMinTemp OBJECT-TYPE
SYNTAX INTEGER (-1000..1001)
ACCESS read-only
STATUS mandatory
DESCRIPTION “The minimum temperature in tenths of degrees Celsius recorded during the 24 hours preceding the observation at the height specified by the *essTemperatureSensorHeight* as specified in the first row of the essTemperatureTable. The value 1001 shall indicate an error condition or missing value.”
REFERENCE “Resolution is based on WMO Code Form FM 94 BUFR Table B item 0 12 012; temperature in kelvin is determined by adding 273.15 to this value.”
::= {essNtcipTemperature 6}

3.8HUMIDITY AND PRECIPITATION DATA OBJECTS

-- Contains objects used to describe the humidity and precipitation data that is collected by the
-- ess.
essBufrPrecip OBJECT IDENTIFIER ::= {essBufr 13 }
essNtcipPrecip OBJECT IDENTIFIER ::= {essNtcip 6 }

3.8.1Relative Humidity

essRelativeHumidity OBJECT-TYPE
SYNTAX INTEGER (0..101)
ACCESS read-only
STATUS mandatory
DESCRIPTION “The relative humidity in percent. The value of 101 shall indicate an error condition or missing value.”
REFERENCE “WMO Code Form FM 94 BUFR Table B item 0 13 003.”
::= {essBufrPrecip 3}

3.8.2Water Depth

essWaterDepth OBJECT-TYPE
SYNTAX INTEGER (0..65535)
ACCESS read-only
STATUS optional
DESCRIPTION “Indicates the depth of the water from a user defined point in centimeters. The value of 65535 shall indicate an error condition or missing value. This may be used for stream depth, depth of water over a roadway, reservoir depth, or other such uses.”
::= {essNtcipPrecip 1}

3.8.3Adjacent Snow Depth

essAdjacentSnowDepth OBJECT-TYPE
SYNTAX INTEGER (0..3001)
ACCESS read-only
STATUS mandatory
DESCRIPTION “The depth of snow in centimeters on representative areas other than the highway pavement, avoiding drifts and plowed areas. The value 3001 shall indicate an error condition or missing value.”
::={ essNtcipPrecip 2}

3.8.4Roadway Snow Depth

essRoadwaySnowDepth OBJECT-TYPE
SYNTAX INTEGER (0..3001)
ACCESS read-only
STATUS mandatory
DESCRIPTION “The current depth of unpacked snow in centimeters on the driving surface. The value 3001 shall indicate an error condition or missing value.”
::={essNtcipPrecip 3}

3.8.5Roadway Snow Pack Depth

essRoadwaySnowPackDepth OBJECT-TYPE
SYNTAX INTEGER (0..3001)
ACCESS read-only
STATUS mandatory
DESCRIPTION “The current depth of packed snow in centimeters on the roadway surface. The value 3001 shall indicate an error condition or missing value.”
::={ essNtcipPrecip 4}

3.8.6Precipitation Indicator

essPrecipYesNo OBJECT-TYPE
SYNTAX INTEGER { precip (1),
noPrecip (2),

error (3)}
ACCESS read-only
STATUS mandatory
DESCRIPTION “Indicates whether or not moisture is detected by the sensor.”
::={ essNtcipPrecip 5}

3.8.7Rainfall or Water Equivalent of Snow

essPrecipRate OBJECT-TYPE
SYNTAX INTEGER (0..65535)
ACCESS read-only
STATUS mandatory
DESCRIPTION “The rainfall, or water equivalent of snow, rate in tenths of grams per square meter per second (for rain, this is approximately to 0.36 mm/hr). A value of 65535 shall indicate an error condition or missing value.”
REFERENCE “WMO Code Form FM 94 BUFR Table B item 0 13 014.”
::= { essBufrPrecip 14}

3.8.8Snowfall Accumulation Rate

essSnowfallAccumRate OBJECT-TYPE
SYNTAX INTEGER (0..65535)
ACCESS read-only
STATUS mandatory
DESCRIPTION “The snowfall accumulation rate in 10^-7 meters per second (this is equivalent to 0.36 mm/hr). The value 65535 shall indicate an error condition or missing value.”
REFERENCE “WMO Code Form FM 94 BUFR Table B item 0 13 015.”
::= { essBufrPrecip 15}

3.8.9Precipitation Situation

essPrecipSituation OBJECT-TYPE
SYNTAX INTEGER { other (1),
unknown (2),
noPrecipitation (3),
unidentifiedSlight (4),
unidentifiedModerate (5),
unidentifiedHeavy (6),
snowSlight (7),
snowModerate (8),
snowHeavy (9),
rainSlight (10),
rainModerate (11),
rainHeavy (12),
frozenPrecipitationSlight (13),
frozenPrecipitationModerate (14),
frozenPrecipitationHeavy (15)}
ACCESS read-only
STATUS mandatory

DESCRIPTION “Describes the weather situation in terms of precipitation. Defined values of intensity are:

Intensity	Meaning
slight	< 2mm/h water equivalent
moderate	>= 2 and < 8 mm/h water equivalent
heavy	>= 8 mm/h water equivalent

If one exists, the corresponding BUFR value is indicated for staffed (BUFRs) and automated (BUFRa) stations. The indicated value can be found in the BUFR Table referenced below. Defined values are:

Range	BUFRa	BUFRs	Meaning
1			other
2			unknown
3			no precipitation
4			unidentified slight
5			unidentified moderate
6			unidentified heavy
7	171	85	snow slight
8	172	86	snow moderate
9	173	86	snow heavy
10		61	rain slight
11	165	63	rain moderate
12	163	65	rain heavy
13			frozen precipitation slight
14			frozen precipitation moderate
15			frozen precipitation heavy”

REFERENCE “The values identified in the above table for BUFRa and BUFRs can be found in WMO Code Form FM 94 BUFR Table B item 0 20 003.”
::= { essNtcipPrecip 6}

3.8.10Ice Deposit (Thickness)

essIceThickness OBJECT-TYPE
SYNTAX INTEGER (0..65535)
ACCESS read-only
STATUS optional
DESCRIPTION “Indicates the thickness of the ice in millimeters. The value 65535 shall indicate an error condition or missing value.”
::= {essNtcipPrecip 7}

3.8.11Precipitation Start Time

essPrecipitationStartTime OBJECT-TYPE
SYNTAX INTEGER (0..4294967295)
ACCESS read-only
STATUS mandatory
DESCRIPTION “The time at which the most recent precipitation event began, measured in seconds since 00:00:00 January 1, 1970 UTC.”
::= { essNtcipPrecip 8}

3.8.12Precipitation End Time

essPrecipitationEndTime OBJECT-TYPE
SYNTAX INTEGER (0..4294967295)
ACCESS read-only
STATUS mandatory
DESCRIPTION “The time at which the most recently completed precipitation event ended, measured in seconds since 00:00:00 January 1, 1970 UTC.”
::= { essNtcipPrecip 9}

3.8.13Total Precipitation Past One Hour

essPrecipitationOneHour OBJECT-TYPE
SYNTAX INTEGER (0..65535)
ACCESS read-only
STATUS mandatory
DESCRIPTION “The total water equivalent precipitation over the hour preceding the observation in tenths of kilograms per square meter (for rain, this is approximately tenths of millimeters). A value of 65535 shall indicate an error condition or missing value.”
REFERENCE “WMO Code Form FM 94 BUFR Table B item 0 13 019.”
::= { essBufrPrecip 19}

3.8.14Total Precipitation Past Three Hours

essPrecipitationThreeHours OBJECT-TYPE
SYNTAX INTEGER (0..65535)
ACCESS read-only
STATUS mandatory
DESCRIPTION “The total water equivalent precipitation over the three hours preceding the observation in tenths of kilograms per square meter (for rain, this is approximately tenths of millimeters). A value of 65535 shall indicate an error condition or missing value.”
REFERENCE “WMO Code Form FM 94 BUFR Table B item 0 13 020.”
::= { essBufrPrecip 20}

3.8.15Total Precipitation Past Six Hours

essPrecipitationSixHours OBJECT-TYPE
SYNTAX INTEGER (0..65535)
ACCESS read-only
STATUS mandatory
DESCRIPTION “The total water equivalent precipitation over the six hours preceding the observation in tenths of kilograms per square meter (for rain, this is approximately tenths of millimeters). A value of 65535 shall indicate an error condition or missing value.”
REFERENCE “WMO Code Form FM 94 BUFR Table B item 0 13 021.”
::= { essBufrPrecip 21}

3.8.16Total Precipitation Past Twelve Hours

essPrecipitationTwelveHours OBJECT-TYPE
SYNTAX INTEGER (0..65535)
ACCESS read-only
STATUS mandatory
DESCRIPTION “The total water equivalent precipitation over the twelve hours preceding the observation in tenths of kilograms per square meter (for rain, this is approximately to tenths of millimeters). A value of 65535 shall indicate an error condition or missing value.”
REFERENCE “WMO Code Form FM 94 BUFR Table B item 0 13 022.”
::= { essBufrPrecip 22}

3.8.17Total Precipitation Past Twenty-Four Hours

essPrecipitation24Hours OBJECT-TYPE
SYNTAX INTEGER (0..65535)
ACCESS read-only
STATUS mandatory
DESCRIPTION “The total water equivalent precipitation over the twenty-four hours preceding the observation in tenths of kilograms per square meter (for rain, this is equivalent to tenths of millimeters). A value of 65535 shall indicate an error condition or missing value.”

REFERENCE “WMO Code Form FM 94 BUFR Table B item 0 13 023.”
::= { essBufrPrecip 23}

3.9RADIATION OBJECTS

-- Contains objects used to describe the data that is collected by the pavement surface sensor.
essBufrRadiation OBJECT IDENTIFIER ::= {essBufr 14 }
essNtcipRadiation OBJECT IDENTIFIER ::= {essNtcip 7}

Solar Radiation

essSolarRadiation OBJECT-TYPE
SYNTAX INTEGER (0..65535)
ACCESS read-only
STATUS mandatory
DESCRIPTION “The direct solar radiation integrated over the 24 hours preceding the observation in Joules per square meter. A value of 65535 shall indicate a missing value.”
REFERENCE “WMO Code Form FM 94 BUFR Table B item 0 14 024.”
::= {essBufrRadiation 24}

Total Sun

essTotalSun OBJECT-TYPE
SYNTAX INTEGER (0..1441)
ACCESS read-only
STATUS mandatory
DESCRIPTION “The total amount of sunshine in minutes over the 24 hour period preceding the observation. A value of 1441 shall indicate a missing value.”
REFERENCE “WMO Code Form FM 94 BUFR Table B item 0 14 031.”
::= {essBufrRadiation 31}

3.9.1Cloud Cover Situation

essCloudSituation OBJECT-TYPE
SYNTAX INTEGER { overcast (1),
cloudy (2),
partlyCloudy (3),
mostlyClear (4),
clear (5)}
ACCESS read-only
STATUS mandatory
DESCRIPTION “Describes the amount of cloud cover. The associated percentages of cloud cover are indicated to identify the differences between the defined values. Defined values are:

Value	Meaning	Percent Cloud Cover
1	Overcast	100 %
2	Mostly cloudy	62.5 % - 99 %
3	Partly cloudy	37.5 % - 62.4 %
4	Mostly sunny	1 % - 37.4 %
5	Clear skies	0 %”

::= {essNtcipRadiation 1}

3.10VISIBILITY DATA OBJECTS

-- Contains objects used to describe the visibility data that is collected by the ess.
essNtcipVisibility OBJECT IDENTIFIER ::= {essNtcip 8 }

3.10.1Visibility Parameter

essVisibility OBJECT-TYPE
SYNTAX INTEGER (0..1000001)
ACCESS read-only
STATUS mandatory
DESCRIPTION “Surface visibility measured in one tenth of a meter. The value 1000001 shall indicate an error condition or missing value.”
REFERENCE “The value for WMO Code Form FM 94 BUFR Table B item 0 20 001 is given by this value divided by 100.”
::= { essNtcipVisibility 1}

3.10.2Visibility Situation

essVisibilitySituation OBJECT-TYPE
SYNTAX INTEGER { other (1),
unknown (2),
clear (3),
fogNotPatchy (4),
patchyFog (5),
blowingSnow (6),
smoke (7),
seaSpray (8),
vehicleSpray (9),
blowingDustOrSand (10),
sunGlare (11),
swarmsOfInsects (12)}
ACCESS read-only
STATUS mandatory
DESCRIPTION “Describes the travel environment in terms of visibility. If one exists, the corresponding BUFR value is indicated for staffed (BUFRs) and automated (BUFRa) stations. The indicated value can be found in the BUFR Table referenced below. Defined values are:

Range	BUFRs	BUFRa	Meaning
1			other visibility anomaly
2			unknown
3	0	100	clear
4	44	130	Fog - not patchy
5	41	131	Patchy fog
6	36	127	Blowing snow
7	04	104	Smoke
8	07	207	Sea Spray
9			Vehicle Spray
10	31	127	Blowing dust or sand
11			sun glare
12			Swarms of insects”

REFERENCE “The values identified in the above table for BUFRa and BUFRs can be found in WMO Code Form FM 94 BUFR Table B item 0 20 003.”
::= {essNtcipVisibility 3}

3.11PAVEMENT SENSOR OBJECTS

-- Contains objects used to describe the data that is collected by the pavement surface sensor.
essNtcipPavement OBJECT IDENTIFIER ::= {essNtcip 9}

3.11.1Number of Pavement Sensors

numEssPavementSensors OBJECT-TYPE
SYNTAX INTEGER (0..255)

ACCESS read-only
STATUS mandatory
DESCRIPTION “Indicates the number of entries in the pavement sensor table.”
::= {essNtcipPavement 1}

3.11.2Pavement Sensor Table

essPavementSensorTable OBJECT-TYPE
SYNTAX SEQUENCE OF EssPavementSensorEntry
ACCESS not-accessible
STATUS mandatory
DESCRIPTION “Table containing the pavement sensor data fields.”
::= {essNtcipPavement 2}

essPavementSensorEntry OBJECT-TYPE
SYNTAX EssPavementSensorEntry
ACCESS not-accessible
STATUS mandatory
DESCRIPTION “Parameters for specific pavement sensor data fields.”
INDEX {essPavementSensorIndex}
::= {essPavementSensorTable 1}

EssPavementSensorEntry ::= SEQUENCE {

essPavementSensorIndex	INTEGER,
essPavementSensorLocation	DisplayString,
essPavementType	INTEGER,
essPavementElevation	INTEGER,
essPavementExposure	INTEGER,
essPavementSensorType	INTEGER,
essSurfaceStatus	INTEGER,
essSurfaceTemperature	INTEGER,
essPavementTemperature	INTEGER,
essSurfaceWaterDepth	INTEGER,
essSurfaceSalinity	INTEGER,
essSurfaceConductivity	INTEGER,
essSurfaceFreezePoint	INTEGER,
essSurfaceBlackIceSignal	INTEGER,
essPavementSensorError	INTEGER}

Pavement Sensor Index

essPavementSensorIndex OBJECT-TYPE
SYNTAX INTEGER (1..255)
ACCESS read-only
STATUS mandatory
DESCRIPTION “Enumerated list of row entries that will provide surface sensor data.”
::= {essPavementSensorEntry 1}

Pavement Sensor Location

essPavementSensorLocation OBJECT-TYPE
SYNTAX DisplayString (SIZE (0..255))
ACCESS read-write
STATUS mandatory
DESCRIPTION “A textual string indicating the location of the pavement sensor.”
::= { essPavementSensorEntry 2}

-- We have contacted the LRMS group to express a need for a better mechanism for
-- defining this location down to the lane level.

Pavement Type

essPavementType OBJECT-TYPE
SYNTAX INTEGER { other (1),
unknown (2),
asphalt (3),
openGradedAsphalt (4),
concrete (5),
steelBridge (6),
concreteBridge (7),
asphaltOverlayBridge (8),
timberBridge (9) }
ACCESS read-write
STATUS mandatory
DESCRIPTION “Indicates the type of pavement on the roadway.
other a different type of bridge deck
unknown the data was never recorded in the system
asphalt asphalt pavement on ground
concrete concrete pavement on ground
steelBridgeconcrete a concrete driving surface on a steel girder bridge
steelBridgeAsphalt an asphalt driving surface on a steel girder bridge
steelBridge a steel lattice driving surface on the bridge
concreteBridge a concrete driving surface on a concrete bridge
concreteBridgeAsphalt an asphalt overlay driving surface on a concrete bridge
timberBridge a wooden deck driving surface on the bridge”
::= { essPavementSensorEntry 3}

Pavement Elevation

essPavementElevation OBJECT-TYPE
SYNTAX INTEGER (-1000..1001)
ACCESS read-only
STATUS mandatory
DESCRIPTION “The elevation of the street surface in meters with respect to the essReferenceHeight.
The value 1001 shall indicate a missing value.”
::= { essPavementSensorEntry 4}

Pavement Exposure

essPavementExposure OBJECT-TYPE
SYNTAX INTEGER (0..101)
ACCESS read-write
STATUS mandatory
DESCRIPTION “Indicates a very rough percentage of the solar energy which will directly hit the sensor.
A value of 100 indicates a fully visible sky. A value of 101 shall indicate a missing value.”
::= { essPavementSensorEntry 5}

Pavement Sensor Type

essPavementSensorType OBJECT-TYPE
SYNTAX INTEGER {other (1),
contactPassive (2),
contactActive (3),
infrared (4),

```
                        radar (5),
                        vibrating (6),
                        microwave (7)}
ACCESS      read-only
STATUS      mandatory
DESCRIPTION "A value indicating the type of pavement sensor."
::= { essPavementSensorEntry 6}
```

Surface Status

```
essSurfaceStatus OBJECT-TYPE
SYNTAX      INTEGER { other (1),
                      error (2),
                      dry (3),
                      traceMoisture (4),
                      wet (5),
                      chemicallyWet (6),
                      iceWarning (7),
                      iceWatch (8),
                      snowWarning (9),
                      snowWatch (10),
                      absorption (11),
                      dew (12),
                      frost (13),
                      absorptionAtDewpoint (14) }
ACCESS      read-only
STATUS      mandatory
DESCRIPTION "A value indicating the pavement surface status."
::= { essPavementSensorEntry 7}
```

Surface Temperature

```
essSurfaceTemperature OBJECT-TYPE
SYNTAX      INTEGER (-1000..1001)
ACCESS      read-only
STATUS      mandatory
DESCRIPTION "The current pavement surface temperature in tenths of degrees Celsius.  The value
1001 shall indicate an error condition or missing value."
::= { essPavementSensorEntry 8}
```

Pavement Temperature

```
essPavementTemperature OBJECT-TYPE
SYNTAX      INTEGER (-1000..1001)
ACCESS      read-only
STATUS      optional
DESCRIPTION "The current pavement temperature 2-10 cm below the pavement surface in tenths of
degrees Celsius.  The value 1001 shall indicate an error condition or missing value."
::= { essPavementSensorEntry 9}
```

Surface Water Depth

```
essSurfaceWaterDepth OBJECT-TYPE
SYNTAX      INTEGER (0..255)
ACCESS      read-only
STATUS      optional
DESCRIPTION "The current depth of water on the surface of the roadway measured in millimeters."
```

::= { essPavementSensorEntry 10}

-- A comment was received indicating that we need to add an error condition to this object. This issue will
-- be addressed along with any other comments received during the balloting process.

Surface Salinity

essSurfaceSalinity OBJECT-TYPE
SYNTAX INTEGER (0..65535)
ACCESS read-only
STATUS mandatory
DESCRIPTION "The pavement salinity in parts per one hundred thousand. The value 65535 shall indicate an error condition or missing value."
::= { essPavementSensorEntry 11}

-- A comment has been received to make both the surface salinity and surface conductivity optional
-- objects. This issue will be discussed by the WG with any other comments received during balloting.

Surface Conductivity

essSurfaceConductivity OBJECT-TYPE
SYNTAX INTEGER (0..65535)
ACCESS read-only
STATUS mandatory
DESCRIPTION "Indicates the conductance of the ice/liquid mixture on the pavement as detected by the sensor, in mhos, which is the inverse of ohms. The value 65535 shall indicate an error condition or missing value."
::= { essPavementSensorEntry 12}

Pavement Freezing Point

essSurfaceFreezePoint OBJECT-TYPE
SYNTAX INTEGER (-1000..1001)
ACCESS read-only
STATUS optional
DESCRIPTION "The temperature in tenths of degrees Celsius at which the existing solution on the roadway will freeze. The value 1001 shall indicate an error condition or missing value."
::= { essPavementSensorEntry 13}

Surface Black Ice Signal

essSurfaceBlackIceSignal OBJECT-TYPE
SYNTAX INTEGER {other (1),
noIce (2),
blackIce (3),
detectorError (4) }
ACCESS read-only
STATUS optional
DESCRIPTION "A value indicating if Black Ice is detected by the sensor."
::= { essPavementSensorEntry 14}

Surface Sensor Error

essPavementSensorError OBJECT-TYPE
SYNTAX INTEGER {other (1),
none (2),
noResponse (3),
cutCable (4),

shortCircuit (5),
dirtyLens (6) }
ACCESS read-only
STATUS mandatory
DESCRIPTION “A value indicating the type of pavement sensor error.”
::= { essPavementSensorEntry 15}

3.11.3Number of Sub-Surface Sensors

numEssSubSurfaceSensors OBJECT-TYPE
SYNTAX INTEGER (0..255)
ACCESS read-only
STATUS mandatory
DESCRIPTION “Indicates the number of entries in the Sub-Surface Sensor Table.”
::= {essNtcipPavement 3}

3.11.4Sub-Surface Sensor Table

essSubSurfaceSensorTable OBJECT-TYPE
SYNTAX SEQUENCE OF EssSubSurfaceSensorEntry
ACCESS not-accessible
STATUS mandatory
DESCRIPTION “Table containing the surface sensor data fields.”
::= {essNtcipPavement 4}

essSubSurfaceSensorEntry OBJECT-TYPE
SYNTAX EssSubSurfaceSensorEntry
ACCESS not-accessible
STATUS mandatory
DESCRIPTION “Parameters for specific sub-surface sensor data fields.”
INDEX {essSubSurfaceSensorIndex}
::= {essSubSurfaceSensorTable 1}

EssSubSurfaceSensorEntry ::= SEQUENCE {
essSubSurfaceSensorIndex INTEGER,
essSubSurfaceSensorLocation DisplayString,
essSubSurfaceType INTEGER,
essSubSurfaceSensorDepth INTEGER,
essSubSurfaceTemperature INTEGER,
essSubSurfaceMoisture INTEGER,
essSubSurfaceSensorError INTEGER}

Sub-Surface Sensor Index

essSubSurfaceSensorIndex OBJECT-TYPE
SYNTAX INTEGER (1..255)
ACCESS read-only
STATUS mandatory
DESCRIPTION “Enumerated list of row entries that will provide surface sensor data.”
::= { essSubSurfaceSensorEntry 1}

Sub-Surface Sensor Location

essSubSurfaceSensorLocation OBJECT-TYPE
SYNTAX DisplayString (SIZE (0..255))
ACCESS read-write
STATUS mandatory
DESCRIPTION “A textual string indicating the location of the subsurface sensor.”

::= { essSubSurfaceSensorEntry 2}

Sub-Surface Type

essSubSurfaceType OBJECT-TYPE
SYNTAX INTEGER {other (1),
unknown (2),
concrete (3),
asphalt (4),
openGradedAsphalt (5),
gravel (6),
clay (7),
loam (8),
sand (9),
permafrost (10),
variousAggregates (11),
air (12)}
ACCESS read-only
STATUS mandatory
DESCRIPTION “Indicates the type of sub-surface. A value of air would indicate a bridge.”
::= { essSubSurfaceSensorEntry 3}

Sub-Surface Sensor Depth

essSubSurfaceSensorDepth OBJECT-TYPE
SYNTAX INTEGER (0..1001)
ACCESS read-only
STATUS mandatory
DESCRIPTION “Depth of sub-surface sensor in centimeters below the pavement surface. The value 1001 shall indicate an error condition or missing value.”
::= { essSubSurfaceSensorEntry 4}

Sub-Surface Temperature

essSubSurfaceTemperature OBJECT-TYPE
SYNTAX INTEGER (-1000..1001)
ACCESS read-only
STATUS mandatory
DESCRIPTION “The current sub-surface temperature in tenths of degrees Celsius. The value 1001 shall indicate an error condition or missing value.”
::= { essSubSurfaceSensorEntry 5}

Sub-Surface Moisture

essSubSurfaceMoisture OBJECT-TYPE
SYNTAX INTEGER (0..101)
ACCESS read-only
STATUS optional
DESCRIPTION “The sub-surface moisture expressed as a percentage (eg. 0 indicates dry, 100 indicates saturated). The value 101 indicates an error condition or missing value”
::= { essSubSurfaceSensorEntry 7}

Sub-Surface Sensor Error

essSubSurfaceSensorError OBJECT-TYPE
SYNTAX INTEGER {other (1),
none (2),
noResponse (3),

cutCable (4),
shortCircuit (5)}
ACCESS read-only
STATUS mandatory
DESCRIPTION “A value indicating the type of sensor error.”
::= { essSubSurfaceSensorEntry 8}

3.12MOBILE PLATFORM OBJECTS

-- This node contains objects which have been developed to facilitate experiments with data that collected
-- by mobile platforms (e.g., specially-equipped maintenance vehicles).
-- There has been limited use of mobile ESS platforms within the surface transportation industry and as
-- such these objects should be considered experimental.
-- It is expected that mobile platforms will use the objects defined above plus these objects.
essNtcipMobile OBJECT IDENTIFIER ::= {essNtcip 10}

3.12.1Mobile Friction

essMobileFriction OBJECT-TYPE
SYNTAX INTEGER (0..101)
ACCESS read-only
STATUS mandatory
DESCRIPTION “Indicates measured coefficient of friction in percent. The value 101 shall indicate an error condition or missing value.”
::= { essNtcipMobile 1}

3.12.2Mobile Observation for the State of the Ground

essMobileObservationGroundState OBJECT-TYPE
SYNTAX INTEGER {other (1),
dry (2),
moist (3),
wet (4),
flooded (5),
frozen (6),
glaze (7),
dustySandy (8),
veryDry (9),
icy (10),
patchyWetSnow (11),
moderateWetSnowCover (12),
fullWetSnowCover (13),
patchyDrySnow (14),
moderateDrySnowCover (15),
fullDrySnowCover (16),
driftingSnow (17),
unknown (18)}
ACCESS read-only
STATUS mandatory
DESCRIPTION “The prevailing observed ground state of the surrounding environment as determined by the observer. This is an indicator of past weather conditions.”
::= { essNtcipMobile 2}

3.12.3Mobile State of the Pavement

essMobileObservationPavement OBJECT-TYPE

SYNTAX INTEGER {other (1),
dry (2),
wet (3),
puddles (4),
shallowStandingWater (5),
shallowFlowingWater (6),
deepStandingWater (7),
deepFlowingWater (8),
dustingFreshSnow (9),
moderateFreshSnow (10),
deepFreshSnow (11),
plowedSnow (12),
slush (13),
packedSnowPatches (14),
packedSnow (15),
lightSnowDrifts (16),
moderateSnowDrifts (17),
heavySnowDrifts (18),
frost (19),
icePatches (20),
moderatelyIcy (21),
heavyIcing (22),
blackIce (23),
sheetIce (24),
frozenSlush (25) }
ACCESS read-only
STATUS mandatory
DESCRIPTION “The prevailing observed conditions on the driving surface as determined by the observer.”
::= { essNtcipMobile 3}

3.13PAVEMENT TREATMENT OBJECTS

-- This node contains objects which have been developed to monitor the various types and amounts of
-- treatments that are spread on the pavement surface.
essNtcipTreatment OBJECT IDENTIFIER ::= { essNtcip 11 }

3.13.1Number of Treatments

numEssTreatments OBJECT-TYPE
SYNTAX INTEGER (0..255)
ACCESS read-only
STATUS mandatory
DESCRIPTION “Indicates the number of entries in the Pavement Treatment Table.”
::= {essNtcipTreatment 1}

3.13.2Pavement Treatment Table

essPavementTreatmentTable OBJECT-TYPE
SYNTAX SEQUENCE OF EssPavementTreatmentEntry
ACCESS not-accessible
STATUS mandatory
DESCRIPTION “Table containing the pavement treatment data fields.”
::= {essNtcipTreatment 2}

essPavementTreatmentEntry OBJECT-TYPE
SYNTAX EssPavementTreatmentEntry

```
ACCESS        not-accessible
STATUS        mandatory
DESCRIPTION "Parameters for specific pavement treatment data fields."
INDEX  {essPavementTreatmentIndex}
::= {essPavementTreatmentTable 1}

EssPavementTreatmentEntry ::= SEQUENCE {
essPavementTreatmentIndex                INTEGER,
essPaveTreatProductType                  INTEGER,
essPaveTreatProductForm                  INTEGER,
essPercentProductMix                     INTEGER}
```

Pavement Treatment Index

```
essPavementTreatmentIndex OBJECT-TYPE
SYNTAX        INTEGER (1..255)
ACCESS        read-only
STATUS        mandatory
DESCRIPTION "Enumerated list of row entries that will provide pavement treatment data."
::= { essPavementTreatmentEntry 1}
```

Pavement Treatment Product Type

```
essPaveTreatProductType OBJECT-TYPE
SYNTAX        INTEGER {other (1),
                       sand (2),
                       dirt (3),
                       gravel (4),
                       cinders (5),
                       water (6),
                       enhancedSalts (7),
                       naCl (8),
                       caCl (9),
                       mgCl (10),
                       cMA (11),
                       kAC (12),
                       naFormate (13),
                       naA (14) }
ACCESS        read-only
STATUS        mandatory
DESCRIPTION "Indicates the type of treatment being applied to the road.  An enhanced definition of
some of the values are as follows:
other - any other type of treatment
water - used as a diluting agent
cMA - Calcium-Magnesium Acetate
kAC - Potassium-Magnesium Acetate
naFormate - Sodium Formate
naA - Sodium Acetate"
::= { essPavementTreatmentEntry 2}
```

Treatment Product Form

```
essPaveTreatProductForm OBJECT-TYPE
SYNTAX        INTEGER { other (1),
                        dry (2),
                        prewet (3),
                        liquid (4)}
```

ACCESS read-only
STATUS mandatory
DESCRIPTION “Indicates the condition of the treatment being applied to the road.”
::= { essPavementTreatmentEntry 3}

Percentage of Treatment Type in Mix

essPercentProductMix OBJECT-TYPE
SYNTAX INTEGER (0..100)
ACCESS read-only
STATUS mandatory
DESCRIPTION “Indicates the percentage of the total application mix by weight that is of the type specified in *essPaveTreatProductType*. The sum of these percentages within the total mixture shall equal 100.”
::= { essPavementTreatmentEntry 4}

3.13.3Treatment Amount

essPaveTreatmentAmount OBJECT-TYPE
SYNTAX INTEGER (0..255)
ACCESS read-only
STATUS mandatory
DESCRIPTION “Indicates quantity of the treatment being applied in kilograms per lane kilometer.”
::= { essNtcipTreatment 3}

3.13.4Treatment Width

essPaveTreatmentWidth OBJECT-TYPE
SYNTAX INTEGER (0..255)
ACCESS read-only
STATUS mandatory
DESCRIPTION “Indicates the width of the spread of treatment in meters.”
::= { essNtcipTreatment 4}

3.14AIR QUALITY PARAMETERS

essNtcipAirQuality OBJECT IDENTIFIER ::= { essNtcip 12 }
-- This node contains objects used for monitoring air quality conditions.

-- A comment has been received to add error conditions to these objects as per previous objects. This
-- was the original intent and this modification will be discussed by the WG along with any other comments
-- received during balloting.

3.14.1Carbon Monoxide Parameter

essCO OBJECT-TYPE
SYNTAX INTEGER (0..255)
ACCESS read-only
STATUS mandatory
DESCRIPTION “The concentration of carbon monoxide in the air, measured in parts per million. Add error values”
::= {essNtcipAirQuality 1}

3.14.2Carbon Dioxide Parameter

essCO2 OBJECT-TYPE
SYNTAX INTEGER (0..65535)

ACCESS read-only
STATUS mandatory
DESCRIPTION “The concentration of carbon dioxide in the air, measured in parts per billion. Add error values”
::= {essNtcipAirQuality 2}

3.14.3Nitrous Oxide Parameter

essNO OBJECT-TYPE
SYNTAX INTEGER (0..255)
ACCESS read-only
STATUS mandatory
DESCRIPTION “The concentration of nitrous oxide in the air, measured in parts per million”
::= {essNtcipAirQuality 3}

3.14.4Nitrogen Dioxide Parameter

essNO2 OBJECT-TYPE
SYNTAX INTEGER (0..255)
ACCESS read-only
STATUS mandatory
DESCRIPTION “The concentration of nitrogen dioxide in the air, measured in parts per billion”
::= {essNtcipAirQuality 4}

3.14.5Sulfur Dioxide Parameter

essSO2 OBJECT-TYPE
SYNTAX INTEGER (0..65535)
ACCESS read-only
STATUS mandatory
DESCRIPTION “The concentration of sulfur dioxide in the air, measured in parts per billion”
::= {essNtcipAirQuality 5}

3.14.6Ozone Parameter

essO3 OBJECT-TYPE
SYNTAX INTEGER (0..255)
ACCESS read-only
STATUS mandatory
DESCRIPTION “The concentration of ozone in the air, measured in parts per one hundred billion”
::= {essNtcipAirQuality 6}

3.14.7Particulate Matter Parameter

essPM10 OBJECT-TYPE
SYNTAX INTEGER (0..65535)
ACCESS read-only
STATUS mandatory
DESCRIPTION “The concentration of small particulate matter of 10 micrograms per cubic meter or less in diameter in the air, measured in parts per million. The value 65535 shall indicate an error condition or missing value.”
::= {essNtcipAirQuality 7}

3.15WATER QUALITY PARAMETERS

essNtcipWaterQuality OBJECT IDENTIFIER ::= { essNtcip 13 }
-- This node contains objects used for monitoring water quality conditions. Appropriate agencies have
-- been contacted to assist in the development of these objects for future versions.

```
END         -- ESS-MIB
```

4SECTION
CONFORMANCE

The conformance groups have been developed to be used as minimum requirements to claim compliance to the standard. There may be varying levels of compliance to the standard as there are numerous devices that have varying levels of performance. Therefore, hierarchical levels of conformance for certain data have been developed. These levels of conformance have been defined as Basic, Standard, Enhanced, and Emerging. Basic Conformance identifies the object(s) that must be supported to claim the lowest level of compliance to the standard. Standard Conformance identifies the object(s) that are supported by current technology. These objects must be supported to claim compliance at the Standard Conformance level.

The Enhanced Conformance level identifies new technology that will become common in the near future but are currently used in some areas. To claim compliance at the Enhanced Conformance level, the object(s) listed at this level must be supported. The Emerging Conformance level identifies that object(s) that must be supported to claim the highest level of compliance to the standard. The Emerging Conformance level identifies the object(s) that are under development or are being tested, but not being used. These objects are considered to be enhancements that may not be available in the near future.

4.1CONFORMANCE STATEMENT

ESS devices shall adhere to the conformance requirements specified in Table 4.1 as a minimum to claim compliance to this standard. Additional objects or groups may be supported without being non-compliant with ESS objects or NTCIP.

Minimum and maximum ranges of objects that differ from the values of the object's SYNTAX field may be enforced by an application running on a device.

A device may enforce range limits within the bounds specified by the values of the object's SYNTAX field without being categorized as non-compliant with ESS objects or NTCIP; however, it may be categorized as non-compliant for other reasons. For example, a temperature sensor which only supports a range of -40°C to 100°C is compliant if all other requirements are met.

A device may support a subset of defined values for an enumerated object without being categorized as non-compliant with ESS objects or NTCIP; however, it may be categorized as non-compliant for other reasons. For example, a visibility sensor which can only distinguish between fog and other visual anomalies is compliant if all other requirements are met.

TABLE 4-1: CONFORMANCE TABLE

CONFORMANCE GROUP	REFERENCE	CONFORMANCE REQUIREMENT
Configuration	TS 3.4	mandatory
Database Management	TS 3.4	optional
Time Management	TS 3.4	mandatory
Timebase Event Schedule	TS 3.4	optional
Report	TS 3.4	optional
STMF	TS 3.4	optional
PMPP	TS 3.4	optional
ESS Configuration	TS 3.X	mandatory
ESS Location	TS 3.X	mandatory
Pressure	TS 3.X	optional
Wind Data	TS 3.X	optional
Mobile Wind Data	TS 3.X	optional
Basic Temperature Data	TS 3.X	optional
Enhanced Temperature Data	TS 3.X	optional
Basic Precipitation Data	TS 3.X	optional
Standard Precipitation Data	TS 3.X	optional
Enhanced Precipitation Data	TS 3.X	optional
Emerging Precipitation Data	TS 3.X	optional
Solar Radiation	TS 3.X	optional
Visibility Data	TS 3.X	optional
Standard Pavement Sensor Data	TS 3.X	optional
Enhanced Pavement Sensor Data	TS 3.X	optional
Standard Sub-Surface Sensor Data	TS 3.X	optional
Enhanced Sub-Surface Sensor Data	TS 3.X	optional
Emerging Mobile Platform	TS 3.X	optional
Pavement Treatment	TS 3.X	optional
Air Quality	TS 3.X	optional
Staffed Station	TS 3.X	optional

For additional information in producing procurement specifications, visit the NTCIP Home Page at http://www.ntcip.org.

4.2CONFORMANCE GROUPS

A Conformance Group is defined in TS 3.2 Simple Transportation Management Framework (STMF), clause 3.3.5, as a basic unit of conformance.

A Conformance Statement refers to Conformance Groups and defines them as being either mandatory or optional. For a device to claim compliance to a Conformance Statement, it must be compliant with each of the mandatory Conformance Groups as defined within that Conformance Statement.

For a device to claim compliance to a Conformance Group, it must be compliant with each of the mandatory tables and mandatory objects as defined within that Conformance Group.

For a device to claim compliance with a table, it must be compliant with each of the mandatory objects included in the table.

For a device to claim compliance to an object, it must support at least one value of the object and all indicated functionality for the values it supports.

A device may support any optional feature.

TABLE 4-2: OBJECT SUPPORT REQUIREMENTS

OBJECT STATUS	TABLE STATUS	CONFORMANCE GROUP STATUS (IF ANY)	OBJECT SUPPORT
mandatory	Mandatory	mandatory	mandatory
mandatory	Mandatory	optional	mandatory, if conformance group is supported
mandatory	Optional	mandatory	mandatory, if table is supported
mandatory	Optional	optional	mandatory, if both the conformance group and table are supported
optional	Mandatory	mandatory	optional
optional	Mandatory	optional	optional
optional	Optional	mandatory	optional
optional	Optional	optional	optional

The Conformance Group definitions for Environmental Sensor Station (ESS) are defined in the following Clauses. An ESS may have multiple capabilities; thus, Conformance Groups are defined for each capability.

4.2.1ESS Configuration Conformance Group

The ESS Configuration Conformance Group consists of a variety of ESS objects related to general configuration information. The ESS Configuration Conformance Group shall consist of the following objects and tables:

Object or Table Name	Reference
EssNtcipNum	TS 3.X
EssNtcipCategory	TS 3.X
EssNtcipSiteDescription	TS 3.X
EssTypeofStation	TS 3.X

4.2.2ESS Location Conformance Group

The ESS Location Conformance Group consists of objects that specify the location of the ESS. The ESS Location Conformance Group shall consist of the following objects:

Object or Table Name	Reference
essLatitude	TS 3.X
essLongitude	TS 3.X
essReferenceHeight	TS 3.X

4.2.3Pressure Conformance Group

The Pressure Conformance Group consists of objects that specify the pressure sensor height and pressure measurement of the ESS. The Pressure Conformance Group shall consist of the following objects:

Object or Table Name	Reference
essPressureHeight	TS 3.X
essAtmosphericPressure	TS 3.X

4.2.4Wind Data Conformance Group

The Wind Data Conformance Group consists of objects that describe the wind sensor elevation and wind data collected by the ESS. The Wind Data Conformance Group shall consist of the following objects:

Object or Table Name	Reference
essWindSensorHeight	TS 3.X
essAvgWindDirection	TS 3.X
essAvgWindSpeed	TS 3.X
essMaxWindGustSpeed	TS 3.X
essMaxWindGustDir	TS 3.X

4.2.5Mobile Wind Data Conformance Group

The Mobile Wind Data Conformance Group consists of objects that describe the wind sensor elevation and wind data collected by a mobile ESS. The Mobile Wind Data Conformance Group shall consist of the following objects:

Object or Table Name	Reference
essWindSituation	TS 3.X
essSpotWindDirection	TS 3.X
essSpotWindSpeed	TS 3.X

4.2.6Basic Temperature Data Conformance Group

The Basic Temperature Data Conformance Group consists of objects that describe the basic temperature data collected by the ESS. The Basic Temperature Data Conformance Group shall consist of the following objects:

Object or Table Name	Reference
essNumTemperatureSensors	TS 3.X
Temperature Sensor Table	TS 3.X
essTemperatureSensorIndex	TS 3.X
essTemperatureSensorHeight	TS 3.X
essAirTemperature	TS 3.X
essMaxTemp	TS 3.X
essMinTemp	TS 3.X

4.2.7Enhanced Temperature Data Conformance Group

The Enhanced Temperature Data Conformance Group consists of objects that describe the enhanced temperature data collected by the ESS. The Enhanced Temperature Data Conformance Group shall consist of the following objects:

Object or Table Name	Reference
essNumTemperatureSensors	TS 3.X
Temperature Sensor Table	TS 3.X
essTemperatureSensorIndex	TS 3.X
essTemperatureSensorHeight	TS 3.X
essAirTemperature	TS 3.X
essMaxTemp	TS 3.X
essMinTemp	TS 3.X
essRelativeHumidity	TS 3.X
essWetBulbTemp	TS 3.X
essDewpointTemp	TS 3.X

4.2.8Basic Precipitation Data Conformance Group

The Basic Precipitation Data Conformance Group consists of objects that describe the precipitation data collected by the ESS. The Basic Precipitation Data Conformance Group shall consist of the following objects:

Object or Table Name	Reference
essPrecipYesNo	TS 3.X

4.2.9Standard Precipitation Data Conformance Group

The Standard Precipitation Data Conformance Group consists of objects that describe the precipitation data collected by the ESS. The Standard Precipitation Data Conformance Group shall consist of the following objects:

Object or Table Name	Reference
EssPrecipRate	TS 3.X
EssPrecipitationStartTime	TS 3.X
EssPrecipitationEndTime	TS 3.X

4.2.10Enhanced Precipitation Data Conformance Group

The Enhanced Precipitation Data Conformance Group consists of objects that describe the precipitation data collected by the ESS. The Enhanced Precipitation Data Conformance Group shall consist of the following objects:

Object or Table Name	Reference
EssPrecipRate	TS 3.X
EssPrecipitationStartTime	TS 3.X
EssPrecipitationEndTime	TS 3.X
EssPrecipitationOneHour	TS 3.X
EssPrecipitationThreeHour	TS 3.X
EssPrecipitationSixHour	TS 3.X
EssPrecipitationTwelveHour	TS 3.X
EssPrecipitation24Hours	TS 3.X
EssPrecipSituation	TS 3.X

4.2.11Emerging Precipitation Data Conformance Group

The Emerging Precipitation Data Conformance Group consists of objects that describe the precipitation data collected by the ESS. The Emerging Precipitation Data Conformance Group shall consist of the following objects:

Object or Table Name	Reference
essPrecipRate	TS 3.X
essPrecipitationStartTime	TS 3.X
essPrecipitationEndTime	TS 3.X
essPrecipitationOneHours	TS 3.X
essPrecipitationThreeHours	TS 3.X
essPrecipitationSixHours	TS 3.X
essPrecipitationTwelveHours	TS 3.X
essPrecipitation24Hours	TS 3.X
essWaterDepth	TS 3.X
essRoadwaySnowDepth	TS 3.X
essRoadwaySnowPackDepth	TS 3.X
essIceThickness	TS 3.X
essAdjacentSnowDepth	TS 3.X
essSnowfallRate	TS 3.X
essPrecipSituation	TS 3.X

4.2.12Solar Radiation Conformance Group

The Solar Radiation Conformance Group consists of objects that describe the solar radiation data collected by the ESS. The Solar Radiation Conformance Group shall consist of the following objects:

Object or Table Name	Reference
essSolarRadiation	TS 3.X
essSurfaceTotalSun	TS 3.X

4.2.13Visibility Data Conformance Group

The Visibility Data Conformance Group consists of objects that describe the wind data collected by the ESS. The Visibility Data Conformance Group shall consist of the following objects:

Object or Table Name	Reference
essVisibility	TS 3.X
essVisibilitySituation	TS 3.X

4.2.14Standard Pavement Sensor Data Conformance Group

The Standard Pavement Sensor Data Conformance Group consists of objects that describe the standard pavement surface data collected by the ESS. The Standard Pavement Sensor Data Conformance Group shall consist of the following objects:

Object or Table Name	Reference
numEssPavementSensors	TS 3.X
essPavementSensorTable	TS 3.X
essPavementSensorIndex	TS 3.X
essPavementSensorLocation	TS 3.X
essPavementType	TS 3.X
essPavementElevation	TS 3.X
essPavementExposure	TS 3.X
essPavementSensorType	TS 3.X
essSurfaceStatus	TS 3.X
essSurfaceTemperature	TS 3.X
essPavementSensorError	TS 3.X

4.2.15Enhanced Pavement Sensor Data Conformance Group

The Enhanced Pavement Sensor Data Conformance Group consists of objects that describe the standard and enhanced pavement surface data collected by the ESS. A device claiming conformance to the Enhanced Pavement Sensor Data Conformance Group shall support all of the following objects:

Object or Table Name	Reference
numEssPavementSensors	TS 3.X
essPavementSensorTable	TS 3.X
essPavementSensorIndex	TS 3.X
essPavementSensorLocation	TS 3.X
essPavementType	TS 3.X
essPavementElevation	TS 3.X
essPavementExposure	TS 3.X
essPavementSensorType	TS 3.X
essSurfaceStatus	TS 3.X
essSurfaceTemperature	TS 3.X
essPavementSensorError	TS 3.X
essPavementTemperature	TS 3.X
essSurfaceWaterDepth	TS 3.X
essSurfaceFreezePoint	TS 3.X
essSurfaceBlackIceSignal	TS 3.X

4.2.16Standard Sub-Surface Sensor Data Conformance Group

The Sub-Surface Sensor Data Conformance Group consists of objects that describe the pavement surface data collected by the ESS. The Sub-Surface Sensor Data Conformance Group shall consist of the following objects:

Object or Table Name	Reference
numEssSubSurfaceSensors	TS 3.X
essSubSurfaceSensorTable	TS 3.X

4.2.17Enhanced Sub-Surface Sensor Data Conformance Group

The Enhanced Sub-Surface Sensor Data Conformance Group consists of objects that describe the standard and enhanced sub-surface data collected by the ESS. A device claiming conformance to the Enhanced Sub-Surface Sensor Data Conformance Group shall support all of the Standard Sub-Surface Sensor Data Conformance Group and the following object:

Object or Table Name	Reference
essSubSurfaceMoisture	TS 3.X

4.2.18Emerging Mobile Platform Conformance Group

The Emerging Mobile Platform Conformance Group consists of objects that describe the data collected by a mobile ESS. The Mobile Platform Conformance Group shall consist of the following objects:

Object or Table Name	Reference
essVehicleSpeed	TS 3.X
essVehicleBearing	TS 3.X
essVehicleOdometer	TS 3.X
essMobileFriction	TS 3.X
essSpotWindSpeed	TS 3.X
essSpotWindDirection	TS 3.X

4.2.19Pavement Treatment Conformance Group

The Pavement Treatment Conformance Group consists of objects that describe the pavement treatment which is being applied by the maintenance vehicle. The Pavement Treatment Conformance Group shall consist of the following objects:

Object or Table Name	Reference
numEssTreatments	TS 3.X
essPavementTreatmentTable	TS 3.X
essPavementTreatmentIndex	TS 3.X
essPaveTreatProductType	TS 3.X
essPaveTreatProductForm	TS 3.X
essPercentProductMix	TS 3.X
essPaveTreatmentAmount	TS 3.X
essPaveTreatmentWidth	TS 3.X

4.2.20Air Quality Conformance Group

The Air Quality Conformance Group consists of objects that describe the air quality data collected by the ESS. The Air Quality Conformance Group shall consist of the following objects:

Object or Table Name	Reference
essCO	TS 3.X
essCO2	TS 3.X
essNO	TS 3.X
essNO2	TS 3.X
essSO2	TS 3.X
essO3	TS 3.X
essPM10	TS 3.X

4.2.21Staffed Station Conformance Group

The Staffed Station Conformance Group consists of objects that describe those data which can be provided from staffed ESS. The Staffed Station Conformance Group shall consist of the following objects:

Object or Table Name	Reference
essWindSituation	TS 3.X
essWaterDepth	TS 3.X
essRoadwaySnowDepth	TS 3.X
essRoadwaySnowPackDepth	TS 3.X
essIceThickness	TS 3.X
essAdjacentSnowDepth	TS 3.X
essPrecipSituation	TS 3.X
essCloudSituation	TS 3.X
essVisibilitySituation	TS 3.X
essMobileObservationGroundState	TS 3.X
essMobileObservationPavement	TS 3.X