

*A Joint Standard of AASHTO, ITE, and NEMA*

# **NTCIP 1204:1998** v01.13

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

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November 23, 2001

*Includes Jointly Approved NTCIP 1204 Amendment 1 v02*

This Adobe® PDF copy of an NTCIP standard is available at no-cost for a limited time through support from the U.S. DOT / Federal Highway Administration, whose assistance is gratefully acknowledged.

*Published by*

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## ACKNOWLEDGEMENTS

This publication was prepared by the NTCIP Environmental Sensor Station Working Group, which is a subdivision of the Joint Committee on the NTCIP. The Joint Committee is organized under a Memorandum of Understanding among the American Association of State Highway and Transportation Officials (AASHTO), the Institute of Transportation Engineers (ITE), and the National Electrical Manufacturers Association (NEMA). The Joint Committee on the NTCIP consists of six representatives from each of the standards organizations, and provides guidance for NTCIP development.

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In addition to the many volunteer efforts, recognition is also given to those organizations who supported the efforts of the working groups by providing comments and funding for the standard, including:

- Aanderaa Instruments
- AURORA
- California Department of Transportation
- Castle Rock Consultants
- Coastal Environmental Systems
- Colorado Department of Transportation
- Federal Highway Administration
- Georgia Institute of Technology
- Idaho Department of Transportation
- Illinois Department of Transportation
- Iowa Department of Transportation
- JAYCOR
- Maine Department of Transportation
- Minnesota Department of Transportation
- New York Department of Transportation

- Odetics ITS
- Ontario Ministry of Transportation
- Office of the Federal Coordinator for Meteorology
- Parsons Transportation Group
- P B Farradyne, Inc.
- Peek Traffic - Transyt Corp.
- Surface Systems Inc.
- Texas Transportation Institute
- University of North Dakota
- Vaisala, Inc.
- Viggen Corporation
- Virginia Department of Transportation
- Weather Solutions Group
- WELS Research Corporation
- Wisconsin Department of Transportation

## FOREWORD

This document uses only metric units.

This publication defines the data elements and conformance requirements for environmental sensor stations. It defines requirements that are applicable to all NTCIP environmental sensor stations and it also contains optional and conditional clauses that are applicable to specific environments for which they are intended. There are no annexes to this document.

This document is an NTCIP Data Dictionary Standard. Data Dictionary Standards provide formal definitions of data elements for use within NTCIP systems; they are formally approved by AASHTO, ITE, and NEMA through a ballot process, after a formal recommendation by the NTCIP Joint Committee.

For more information about NTCIP standards, visit the NTCIP Web Site at <http://www.ntcip.org>. For a hardcopy summary of NTCIP information, contact the NTCIP coordinator at the above address.

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## Approvals

This document was separately balloted and approved by AASHTO, ITE, and NEMA after recommendation by the Joint Committee on the NTCIP. Each organization has approved this standard as the following standard type, as of the date:

AASHTO – Standard Specification; 1998  
ITE – Software Standard; June 1998  
NEMA – Standard; August 1998

## History

From 1996 to 1998, this document was referenced as NEMA TS 3.7. However, to provide an organized numbering scheme for the NTCIP documents, this document is now referenced as NTCIP 1204. The technical specifications of NTCIP 1204 are identical to the former references, except as noted in the development history below:

TS 3.7 version 97.01.11. November 1997 – Approved by AASHTO, ITE, and NEMA in 1998.

TS 3.7 Amendment 1, version 98.01.02. September 1998 – Approved by AASHTO and NEMA in 1999 and approved by ITE in 2001.

NTCIP 1204:1998 v01.12. September 1998 – Combined version 01.11 and Amendment 1 version 02, converted to revised standard numbering scheme, and made changes to the front matter. Added underline and strikethrough to indicate changes in Subclauses 3.2.2, 3.3.1, 3.8.11, 3.8.12, 3.11.2.10, 3.11.2.11, 3.11.2.12, 3.11.4.3, 3.11.4.4, 3.14.1 through 3.14.7, and 4.2.1.

NTCIP 1204:1998 v01.13. November 2001 – Reformatted for printing: incremented version number and updated date. Updated document to NTCIP 8002 v04 Template format, added approvals and history to Foreword, and converted references to TS 3 Standards to renumbered NTCIP Standards. The underline and strikethrough format used to indicate the amendment changes was removed. The normative reference to WMO BUFR was corrected and References were updated.

## INTRODUCTION

This publication provides definitions of data elements for use with environmental sensor stations (ESS). The data is defined using the Simple Network Management Protocol (SNMP) object-type format as defined in RFC 1212 and would typically be exchanged using one of the NTCIP recognized Application Layers (e.g., SNMP).

This standard defines requirements that are applicable to all NTCIP environments and the standard also contains optional and conditional clauses that are applicable to specific environments for which they are intended.

The following keywords apply to this document: AASHTO, ITE, NEMA, NTCIP, ESS, RWIS, data, data dictionary, object, road weather, air quality.

In 1992, the NEMA 3-TS Transportation Management Systems and Associated Control Devices Section began the effort to develop the NTCIP. The Transportation Section's purpose was to respond to user needs to include standardized systems communication in the NEMA TS 2 standard, Traffic Controller Assemblies. Under the guidance of the Federal Highway Administration's NTCIP Steering Group, the NEMA effort was expanded to include the development of communications standards for all transportation field devices that could be used in an Intelligent Transportation Systems (ITS) network.

In September 1996, an agreement was executed among AASHTO, ITE, and NEMA to jointly develop, approve, and maintain the NTCIP standards. One of the first tasks of the joint effort was to establish the Environmental Sensor Station Working Group to standardize ESS equipment communication. The first ESS WG meeting was held in November 1996 to begin the development of this document.

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NTCIP Management Information Base and Data Dictionary

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## **Section 1 INTRODUCTION**

### **1.1 INTRODUCTION**

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).

### **1.2 WEATHER 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.

#### **1.2.1 Transportation 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.

### **1.2.2 Transportation 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.

### **1.2.3 Commercial 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.

### **1.2.4 Meteorological 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.

### **1.2.5 Integration 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.

### **1.2.6 Informational References**

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

## **1.3 BENEFITS 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 an ESS, 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.

## 1.4 EXISTING 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

### 1.4.1 BUFR

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.

### 1.4.2 Internet 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:

- Point-to-Point Protocol (PPP) - which may be used for NTCIP dial-up links
- Internet Protocol (IP) - which may be used for NTCIP communications over networks
- Transport Control Protocol (TCP) - which may be used to provide connection-oriented services over NTCIP networks
- User Datagram Protocol (UDP) - which may be used to provide connectionless transport services over NTCIP networks
- Simple Network Management Protocol (SNMP) - which may be used to exchange NTCIP data elements such as those defined within this document.

### 1.4.3 International 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.

### 1.4.4 NTCIP

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.

## 1.5 NTCIP 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.