NAFEM Data Protocol Standard

Version 3.00

1.0 Scope

This document provides a framework for standardized data transmission between a host computer and various pieces of commercial food service equipment. It is not the intent of this document to specify a particular physical interface or network protocol, but rather to establish a set of definitions, which allow various hardware and software applications to easily interface to equipment that are compliant to the NAFEM Data Protocol Standard.

2.0 Protocol Overview

The protocol has two components:

1) The data packets, as implemented on the piece of compliant equipment
2) The documented lists of supported packets and parameters, as maintained by the equipment manufacturer

To be fully compliant to the standard, both aspects of the protocol must be implemented.

Equipment that is compliant to the NAFEM Data Protocol Standard shall implement the following mandatory features:

- Equipment Identification Packet
- Equipment Output Data Packet
- Equipment Packet List document
- Equipment Parameter List document

Equipment that is compliant to the NAFEM Data Protocol Standard may implement zero or more of the following optional features:

- Host Command Packet
- Equipment Configuration Packet[1]
- Response Packet[1]

3.0 Packet Definition

All character data sent using this NAFEM Data Protocol standard are 8-bit octets (bytes) encoded per the ISO/IEC 8859-15:1999[2] standard, with the addition of C0 control codes[3].

Nearly all of the fields in the packets listed below are of fixed length; the parameter values of the Equipment Output Data Packet and Equipment Configuration Packet being the notable exceptions. In all cases, the field is left justified and each field must

either be filled with appropriate data or be padded to the full length specified. If the valid data fills the entire length of the field, no termination or padding is required. However, if the value occupies fewer characters than the full number specified, then the remaining characters in the field must be padded with the Null character (code 0).

As noted below, some fields are explicitly filled with a special value, like the `0` character (code 48). In this case, the field is completely filled and no additional padding is required. Fields that may require padding are noted below in their respective sections.

Listed below are the definitions for the five packets that comprise the first component of the NAFEM Data Protocol.

3.1 Equipment Identification Packet – Mandatory (95 characters)

This information is provided at the time the equipment is powered up and upon request from the host computer. The Equipment Identification Packet shall conform to the following structure:

- 8 character string: `EQUIP_ID`
- 32 character category of equipment identifier (per NAFEM Data Protocol User Manual Version 2.00)[4]
- 10 character manufacturer identifier (as registered with NAFEM)[4]
- 30 character manufacturer serial number[4]
- 15 character software version identifier[4,5]

3.2 Equipment Output Data Packet – Mandatory (15-269 characters)

The equipment shall provide an output data packet (as described in the Equipment Parameter List) that provides data about the equipment to a requestor. The Equipment Output Data Packet shall conform to the following structure:

- 8 character string: `DATA_PKT`
- 3 character parameter number that must match its reference in section 4.2 below (each character must be a digit character from 0-9; range: 001-999)
- 3 character size of payload that describes how many characters of data there are in the parameter value (each character must be a digit character from 0-9; range: 001-255)
- 1-255 character parameter value (per data formatting description in section 4.2 below)

The packet shall be sent in response to a command to send data (command ID `02` or `03` as described in section 3.3 below). This packet shall also be used to send autonomous BROADCAST data or ALARM data as specified in section 4.0 below.

3.3 Host Command Packet – Optional (20 characters)

The host command packet allows the equipment to respond to a request for data from an external device. The Host Command Packet shall conform to the following structure:

- 7 character string: `CMD_PKT`
- 8 character password[4]
- 2 character command ID (each character must be a digit character from 0-9; range: 01-99)
    - `01`: Send Equipment Identification Packet
    - `02`: Send a specific data packet (specified by the following command qualifier) as an Equipment Output Data Packet
    - `03`: Send all read and read/write data packets as Equipment Output Data Packets
    - `04-20`: Reserved for future use
    - `21-99`: User-defined
- 3 character command qualifier (unused for command ID `01` and must be set to `000`; corresponds to the parameter number for command IDs `02-03`; optional and user-defined for command IDs `21-99`; each character must be a digit character from 0-9; range: 000-999)

3.4 Equipment Configuration Packet[1] – Optional (25-279 characters)

An external host device can configure writable parameters in the equipment based upon the configuration list described in section 4.2 below. The Equipment Configuration Packet shall conform to the following structure:

- 10 character string: `CONFIG_PKT`
- 8 character password[4]
- 3 character configuration ID that must match its reference in section 4.2 below (each character must be a digit character from 0-9, except 000 is invalid; range: 001-999)
- 3 character size of payload that describes how many characters of data there are in the configuration value (each character must be a digit character from 0-9; range: 001-255)
- 1-255 character configuration value

3.5 Response Packet – Optional[1] (14 characters)

A response must be sent after the successful reception of an Equipment Configuration Packet. The response may include positive acknowledgement (i.e. the packet was received and processed properly) or negative acknowledgement (i.e. the packet was received properly but could not be processed.) In the case of negative

acknowledgement, either general or specific error codes may be returned. The Response Packet shall conform to the following structure:

- 12 character string: `RESPONSE_PKT`
- 2 character response code. Values `00` and `01` are required; other values are optional. Any value greater than 00 defines that the packet was received, but unable to be properly processed (each character must be a digit character from 0-9; range: 00-99)
    - `00`: Packet successfully received and processed (i.e. no error)
    - `01`: Undefined processing error (i.e. a generic code given when no specific error is defined or implemented by the equipment)
    - `02`: Read data error
    - `03`: Write data error
    - `04`: Unimplemented parameter number/ID
    - `05`: Unimplemented packet type
    - `06-20`: Reserved
    - `21-99`: User-defined

4.0 Feature List Documentation Definition

The NAFEM Data Protocol requires, as mandatory, the equipment manufacturer to maintain an up-to-date listing of every parameter and packet implemented for each compliant piece of equipment that an end-user may access. The list or lists must be made available to the public, but their format is determined by the manufacturer. For example, one manufacturer may provide the list on their website, while another provides a printed document with each piece of equipment.

The list or lists must be revised with each new version of the equipment's firmware. In the case of multiple software applications with differing revisions within one piece of equipment, the list or lists must be updated when the code that implements this protocol is modified.

The documents below must include information about which equipment software version(s) apply. This serves to identify what features are available for a given piece of equipment's firmware implementation. The documents may show a list or range of software version identifiers when the differences between implementations of the protocol between software versions is negligible. The manufacturer should be specific with the version identifiers and should avoid using vague qualifiers like "above" or "below" (e.g. avoid "Version 1.1b or above"; use "Version 1.1b – 1.3a" or "Version 1.1a and 1.2d", instead).

Listed below are the definitions for the documentation that the second component of the NAFEM Data Protocol requires.

4.1 Equipment Packet List – Mandatory

This list documents each of the packets, as described above, that is implemented in the piece of equipment. The Equipment Packet List shall provide the following information for each implemented packet type:

- Manufacturer identifier (this must match the value given in the Equipment Identification Packet, section 3.1 above; it only needs to be shown in the document once)
- Equipment software version identifier (this must match the value given in the Equipment Identification Packet, section 3.1 above; it may be shown in the document once if all packets apply to the version, or each packet may show which version(s) are supported)
- Packet name (as shown in the section headers in this document)

4.2 Equipment Parameter List – Mandatory

This list documents all of the parameters that are available to be provided by the equipment. The Equipment Parameter List shall provide the following information for each implemented parameter:

- Manufacturer identifier (this must match the value given in the Equipment Identification Packet, section 3.1 above; it only needs to be shown in the document once)
- Equipment software version identifier (this must match the value given in the Equipment Identification Packet; may be shown in the document once if all parameters apply to the version, or each parameter may show which version(s) are supported)
- Parameter number (each character must be a digit character from 0-9; range: 001-999)
- Parameter name (i.e. FREEZER TEMPERATURE)
- Units of measure (each character must be a digit character from 0-9; range: 001-036 & 600-999 per NAFEM Data Protocol User Manual Version 2.00)
- Description of parameter value formatting
- Protection qualifier:
    - `RO`: indicates a read-only value that may not be written
    - `RW`: indicates a read/write value that maybe read from or written to
    - `WO`: indicates a write-only that may not be read from
- Type of data:
    - `NORMAL`
    - `BROADCAST`
    - `ALARM`

The “description of parameter value formatting” is a textual description of what format a parameter’s value will be when transmitted. This description may include information

about the value's data type, like string, integer, or floating-point; value scaling, like a scalar multiplier or offset; or any other information that will help decipher the meaning of the transmitted data.

The "protection qualifier" describes how the listing equipment handles each parameter it provides. Some parameters may be values (or outputs) of the piece of equipment. Others may be configuration parameters (or inputs). Some may be both.

If the parameter is listed as read-only, then the parameter must not be written to, as that behavior is undefined. An example of a read-only parameter might be a reading from a temperature sensor.

If the parameter is listed as read/write, then the parameter allows its current value to be read and allows the value to be changed. An example of this might be a temperature set point that can be read for its current value, but also written to in order to change the set point.

Finally, if a parameter is defined as write-only, then the parameter must not be read from, as that behavior is undefined. An example might be a password field that can be set with proper authorization, but subsequently cannot be read to see what the password value is.

The "type of data" information describes the intent of the Equipment Parameter when reading. This value has no expressed or implied meaning when writing. NORMAL data is only sent upon request from an external device. BROADCAST data is sent based upon a predetermined time or an internal equipment event occurring. ALARM data is sent based upon the specified alarm conditions being met.

NAFEM Data Protocol

Disclaimer

NAFEM (North American Association of Food Equipment Manufacturers) is an Illinois Not-For-Profit Corporation. The NAFEM Data Protocol seeks to provide a voluntary standard for food service and food equipment manufacturers, suppliers and customers who wish to employ hardware and software communication capability solutions in their equipment and make the same interoperable with other online equipment and systems. By resorting to well-accepted Internet communication standards, the NAFEM Data Protocol offers an industry standard for data exchange among equipment control devices whereby devices designed with communication capability compliant with the Protocol may offer automation of numerous functions, monitoring, calibration and control parameters in numerous environments of cooperative equipment control devices and online or networked systems. The rapidly changing and evolving diverse technical arts involved in data collection and exchange, equipment control devices, device networking and operative online systems may involve proprietary rights of others, particularly intellectual property protective right under applicable patent, trademark, copyright and trade secrete laws. Although the NAFEM Data Protocol Steering Committee has provided a statement appended hereto of applicable law relative to the issues involved in U.S. patent infringement determinations, the same is provided for background informational purpose only, there being no representation or assurance of exhaustive or relative prior art research, no representation of assurance of applicable intellectual property identification, and no representation or assurance of equipment control device of system or data or network clearance from implicating or infringing the property rights of others. All persons and legal entities employing the NAFEM Data Protocol must conduct their own comprehensive and competent due diligence relatively their particular application and usage thereof to the appropriate goal of respecting any copyright, trademark, patent, trade secret, license, or other intellectual or other property of others and to avoid infringing upon or otherwise acting adversely thereto.

NAFEM Internet Protocol Policy

Copyright, Trademark and Patents

1.0 Copyright

All NAFEM standards are copyrighted by NAFEM under the provisions of the United States Copyright Act.

1.1 Project Authorization Request (PAR): The committee or working group shall appoint a chair (or official reported) who shall sign a Copyright Agreement acknowledging that the proposed standard constitutes a “work made for hire” as defined by the Copyright Act, and as to any work not so defined, any rights or interest in the copyright to the standards publication is transferred to NAFEM. Except as noted below, NAFEM is the sole copyright owner of all material included in the standard.

At the time of PAR completion, any previously copyrighted material intended for inclusion shall be identified. The working group is responsible for receiving written permission to use all copyrighted material prior to final approval and publication.

1.2 Drafts of proposed IEEE standards: All drafts of proposed NAFEM standards shall contain the copyright statement.

2.0 Trademark

2.1 General: References to commercial equipment in a standard shall be generic and shall not include trademarks or other proprietary designations. Where a sole source exists for essential equipment or materials, it is permissible to supply the name and address of the source in a footnote, so long as the words “or the equivalent” are added to the reference.

2.2 PAR form: The working group shall identify any possible trademark use for the forthcoming standard.

3.0 Patents

3.1 The NAFEM standard may include the known use of patent(s), including patent applications, if there is technical justification in the opinion of the standards-developing committee and provided NAFEM receives assurance from the patent holder that it will license applicants under reasonable terms and conditions for the purpose of implementing the standard.

This assurance shall be provided without coercion and prior to approval of the standard (or reaffirmation when a patent becomes known after initial approval of the standard). This shall be a letter that is in the form of either:

3.1.1 A general disclaimer to the effect that the patentee will not enforce any of its present or future patent(s) whose use would be required to implement the proposed NAFEM standard against any person or entity using the patent(s) to comply with the standard; or

3.1.2 A statement that a license will be made available to all applicants without compensation or under reasonable rates, with reasonable terms and conditions that are demonstrably free of any unfair discrimination.

Patent holders shall submit letters of assurance to NAFEM Headquarters before the time of final approval and publication of the standard. Unless the letter of assurance is received from an individual within the issuing organization who has clear authority for intellectual property and/or legal matters, NAFEM shall send a certificate letter, return receipt requested, to the General Counsel of the issuing organization to confirm receipt of the letter of assurance to ensure that the letter of assurance is factually correct and was submitted by an appropriate individual within the issuing organization. No response to this letter, other than the return receipt, is required. NAFEM will provide contact information about the patent holder upon request.

3.2 Public Notice: The following notice shall appear when NAFEM receives assurance from a known patent holder prior to the time of publication that a license will be made available to all applicants either without compensation or under reasonable rates, terms and conditions that are demonstrably free of any unfair discrimination.

Attention is called to the possibility that implementation of this standard may require use of subject matter covered by patent rights. By publication of this standard, no position is taken with respect to the existence or validity of any other patent rights in connection therewith. NAFEM shall not be responsible for identifying patents for which a license may be required by the NAFEM standard or for conducting inquiries into the legal validity or scope of those patents that are brought to its attention. A patent holder has filed a statement of assurance that it will grant licenses under these rights without compensation or under reasonable rates and nondiscriminatory, reasonable terms and conditions to all applicants desiring to obtain such licenses. NAFEM makes no representation as to the reasonableness of rates and/or terms and conditions of the license agreements offered by patent holders.

If NAFEM has not received letters of assurance prior to the time of publication, the following notice shall appear:

Attention is called to the possibility that implementation of this standard may require use of subject matter covered by patent rights. By publication of this standard, no position is taken with respect to the existence or validity of any patent rights in connection therewith. NAFEM shall not be responsible for

identifying patents for which a license may be required by the NAFEM standard or for conducting inquiries into the legal validity or scope of those patents that are brought to its attention.

3.3 Submittal: Through the working group, the Sponsor chair shall request that known patent holders submit a statement either that the patent does not apply to the standard or that licenses will be made without compensation or under reasonable rates, terms and conditions. This assurance shall be submitted to NAFEM at the earliest practical time prior to the approval of the NAFEM standard. NAFEM encourages early disclosure to the working group of patent information that might be relevant to the standard.

While the standard may include the known use of patents if there is technical justification, the working group should not attempt to determine whether or not a patent applies. The working group shall accept the view of the patent holder patents that are brought to its attention.

3.4 Disclaimer: NAFEM shall not be responsible for identifying all patents for which a license may be required by the NAFEM standard or for conducting inquires into the legal validity or scope of those

Appendix A – Standards and References for Optional Ethernet Interface

The protocol stack, developed, published, and supported by NAFEM, represented below is formatted to illustrate compliance with the OSI model of the International Standards Organization. This standard was derived from open and community available standards and references the detailed documentation required to implement the protocol.

2.1 Physical Layer
- 2.1.1 IEEE 802.3 Section 14 – 10 BASE T
- 2.1.2 IEEE 802.11b Wireless Ethernet

2.2 Data Link Layer
- 2.2.1 IEEE 802.2 Ethernet
- 2.2.2 RFC 826 Ethernet Address Resolution Protocol [ARP]
- 2.2.3 IEEE 802.11b Wireless Ethernet

2.3 Networking Layer
- 2.3.1 RFC 791 Internet Protocol version 4.0 [IPv4]
- 2.3.2 RFC 792 Internet Control Message Protocol [ICMP]

2.4 Transport Layer
- 2.4.1 RFC 768 User Datagram Protocol [UDP]

2.5 Session Layer
- 2.5.1 Due to the selection of UDP in Transport Layer, no Session Layer protocol is required.

2.6 Presentation and Application Layer
- 2.6.1 RFC 951 Bootstrap Protocol [BOOTP]
- 2.6.2 RFC 1350 Trivial File Transfer Protocol [TFTP]
- 2.6.3 RFC 1157 Simple Network Management Protocol version 1 [SNMPv1]
- 2.6.4 RFC 1156 Structure and Identification of Management Information [SMI]
- 2.6.5 RFC 1213 Management Information Base for Networks Management of TCP/IP Based Internets [MIB0II]

Appendix B – Management Information Bases (MIBs) For Optional SNMP Interface

3.1 Administration [v2.00]
3.2 Asset Management [v2.00]
3.3 Bulk Transfer [2.00]
3.4 Clock/Calendar [v2.00]
3.5 Inventory Management [v2.00]
3.6 Maintenance [v2.00]
3.7 Monitor [v2.00]
3.8 NAFEM Registration [v2.00]
3.9 NAFEM Textual Convention [v2.00]
3.10 Notify [v2.00]
3.11 Security [v2.00]
3.12 Traps [v2.00]

Appendix C – Data Packet Summary

The following tables summarize the different data packets available in the NAFEM Data Protocol Standard. Refer to section 3.0 above, for more detail.

Equipment Identification Packet – Mandatory (95 characters)

Description	Size (Characters)	Range of Values	Comments
Packet header	8	EQUIP_ID	
Equipment category[4]	32	N/A	Refer to NAFEM Data Protocol User Manual Version 2.00 for recommended values.
Manufacturer ID[4]	10	N/A	This value is registered with NAFEM.
Equipment serial number[4]	30	N/A	Each piece of equipment should have a unique value here. Along with the Manufacturer ID, this is used to address any particular piece of equipment.
Software version[4]	15	N/A	This should correspond to the software revision of the most important piece of software, as deemed by the manufacturer. Typically, this will be the software revision of the main application code.

Equipment Output Data Packet – Mandatory (15-269 characters)

Description	Size (Characters)	Range of Values	Comments
Packet header	8	DATA_PKT	
Parameter number	3	001 – 999	Uniquely identifies a piece of information in a given unit of equipment.
Size of data payload	3	001 – 255	This defines the number of characters (size) of the value data in the packet.
Parameter value	1-255	001 – 036 600 – 999	This is the actual value of the data being requested. It must fit in exactly the size specified in the "Size of data payload".

Host Command Packet – Optional (20 characters)

Description	Size (Characters)	Range of Values	Comments
Packet header	7	CMD_PKT	
Password[4]	8	N/A	A string of characters required to gain access to the host command section of the equipment. Care should be taken when selecting and transmitting this value. The protocol does not define encryption for this value. It will be sent as clear-text if other protocol layers do not encrypt or otherwise obfuscate the data transmission.

Description	Size (Characters)	Range of Values	Comments
Command ID	2	01 – 03 21 – 99	Defines what action the receiving piece of equipment should take. 01-20 are reserved and defined in section 3.3 above; 21-99 are available for user definition.
Command qualifier	3	000 – 999	Provides additional information for a particular command. It must be set to 000 for command IDs 00, 04-20, and any user-defined qualifier that does not require a value. For IDs 02-03, this must be the parameter value being requested.

Equipment Configuration Packet – Optional (25-279 characters)

Description	Size (Characters)	Range of Values	Comments
Packet header	10	CONFIG_PKT	
Password[4]	8	N/A	A string of characters required to gain access to the host command section of the equipment. Care should be taken when selecting and transmitting this value. The protocol does not define encryption for this value. It will be sent as clear-text if other protocol layers do not encrypt or otherwise obfuscate the data transmission.
Configuration ID	3	001 – 999	Uniquely identifies a configuration parameter in a given piece of equipment.
Size of data payload	3	001 – 255	This defines the number of characters (size) of the configuration data in the packet.
Parameter value	1-255	001 – 036 600 – 999	This is the actual value of the data being configured. It must fit in exactly the size specified in the "Size of data payload".

Response Packet – Optional[1] (14 characters)

Description	Size (Characters)	Range of Values	Comments
Packet header	12	RESPONSE_PKT	
Response code	2	00 – 01[6] 02 – 99[7]	00 is treated as "OK" or "SUCCESS". All other values are treated as error codes, as defined in section 3.5 above.

Endnotes

[1] If the Equipment Configuration Packet is implemented, then the Response Packet becomes mandatory and must be implemented.
[2] ISO/IEC 8859-15:1999 is also commonly called "Latin-9". It shares the printable codes 32-126 with the ASCII standard, but adds codes 160-255 for additional characters. These characters are primarily accented letters and common symbols, including the Euro (€), used for many Western European languages. The remaining codes are reserved for control codes defined elsewhere.
[3] The C0 control codes define codes 0-31 and map directly to the ISO/IEC 646:1991 (ASCII) codes of the same position and are commonly called the ASCII Control Codes.
[4] This value requires Null padding if the number of characters to be sent is less than the number of characters specified for this field.
[5] In the case of multiple applications within one piece of equipment, the software version identifier must match the version ID of the piece of software that contains the protocol's implementation.
[6] Required.
[7] Optional.