SmartGrid/AEIC AMI Interoperability Standard Guidelines
for
ANSI C12.19 End Device Communications and Supporting Enterprise Devices, Networks and Related Accessories

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Abstract

This SmartGrid/AEIC AMI Interoperability Standard identifies the components of Enterprise semantics and object models defined by IEEE-P1377-2009 / ANSI C12.19-2008 / MC1219-2009 and the required communication Application Services protocols provided by Standards such as IEEE P1703-2009 / ANSI C12.22-2008 / MC1222-2009, IEEE P1701-2009 / ANSI C12.18-2006 / MC1218-2009 and IEEE 1702-2009 / ANSI C12.21-2006 / MC12.21-2009. This document should be used by all compliant Utility enterprise head-in systems, billing systems, interfaces to the metering network, all the way down to the meters and End Devices. The guidelines build on the original work from AEIC Guidelines v1.0-09-21-98, Proposed AEIC Guidelines for Implementation of ANSI C12.19-1997 "Utility Industry End Device Data Tables", to define minimum requirements for ANSI C12.19-AMI interoperable End Devices, software and firmware produced by AMI technology solutions providers that meet the needs of NIST, AEIC and the SmartGrid interoperability.

It is an objective of these Standard Guidelines to recommend migration paths toward supporting enterprise infrastructure with consideration for existing deployments, capital investments and transition requirements from legacy technology. It also is the objective of this Standard to require that the ANSI C12.19 interoperability mechanisms identified within become a recommended purchasing requirement for all systems that implement IEEE-1377-2009 / ANSI C12.19-2008 / MC1219-2009 and their required communication Application Services protocols provided by IEEE 1703-2009 / ANSI C12.22-2008 / MC1222-2009, IEEE 1701-2009 / ANSI C12.18-2006 / MC1218-2009 or IEEE 1702-2009 / ANSI C12.21-2006 / MC12.21-2009) or other communication Application Service protocol Standard(s) compliant to ANSI C12.19-2008 requirements for the SmartGrid and recognized in the NIST Framework and Roadmap for Smart Grid Interoperability Standards.

It is an objective to contribute this document to NIST, IEEE, ANSI and Measurement Canada so that similar approaches may be taken throughout North America for increased interoperability of AMI on the SmartGrid.

It is an objective of these Standard Guidelines to support the NIST Priority Action Plan (PAP05) Standard Meter Data Profiles (6.2.5), which is to utilize ANSI C12.19 2008 data models to represent one or more meter profiles with distinct information locations and formats to simplify client access to commonly shared information.

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Table of Contents

1.0 Introduction

IEEE, ANSI and Measurement Canada developed the “Utility Industry End Device Data Tables” Standard for electronic metering products (water, gas, electric and generic appliances). The Standard’s objective is to achieve interoperability among systems that implement hardware and software from multiple vendors. The Standard organizes metering device data and defines operating requirements for communications. ANSI C12.19 defines a semantic data model that is based on Tables, thus providing significant flexibility. Indirect addressing (TABLES) for AMI End Devices was chosen deliberately over object-oriented methodology to allow simple “One way” and “Two way” devices entry into the ANSI C12.19 suite of Standards venue for AMI compliance and interoperability.

This significant flexibility is expressed in many ways. A number of transmission and encoding formats are provided for time, values, data order and text formats. Communications methods, data access methods and procedures are prescribed for dealing with the multitude of choices and the functionality offered. ANSI C12.19 contains up to 2040 “Standard Tables” that are fully defined by the Standard. These are organized into functional groups known as decades (up to 10 tables per decade). In addition, provision is made for an additional 2040 “Manufacturers’ Tables” so that future innovations can be implemented utilizing the framework and mechanisms specified by the semantic model of the Standard. These mechanisms facilitate the possibility of future inclusion of Manufacturer Defined Tables into future publications of the Standard. Another set of 2040 (Extended) User Defined Tables are available for “One way” and “Two way” communicating devices and enterprise systems that have a demand for extremely low communications overhead. Finally, the Standard defines “Pending” attributes for Standard and Manufacturer Tables and Procedures for use in applications such as End Device deferred programming, and End Device firmware-upgrades with roll-back capabilities. The Pending Tables also enable event driven and synchronized actionable-communication.

The Standard’s flexibility presents a challenge to system developers, to equipment manufacturers, and to utilities. System developers must continue to consider the real need to

provide the capability of processing multiple data formats from the End Devices. The obvious advantage of ANSI C12.19 is that the rules and semantic model are published, the Tables provided are machine readable (TDL/EDL XML Form), human readable (Standard Document Form) and are accessible through certified registries through the Internet.

Implementing all the mechanisms identified in ANSI C12.19 represents a significant challenge. For that reason, it is expected that data acquisition products should be capable of processing data from any End Device that follows the access rules defined by ANSI C12.19 and required communication services. The End Device's table of contents is provisioned by ANSI C12.19 Table 0 – General Configuration Table. Access to Standard Table 0, function limiting tables, and information found in device control tables can be combined with ANSI C12.19 registrar-supplied Device Class information about "End Devices" for improved efficiency and interoperability.

Equipment manufacturers will continue to be faced with the cost versus function questions in designing devices and will continue to look for innovations to increase their competitive position and efficiencies in their design options ANSI C12.19 recognizes this need and has provided for both Standard and Manufacturer defined tables to permit the introduction of new products. While ANSI C12.19 may appear to impose some overhead in the system design, ultimately, compliance to the Standard would seem to increase market exposure because the processing of the data is facilitated through the mechanisms within the Standard. Access to Table 0 provides the information that allows the data to be processed. Manufacturers shall provide this information with the syntax of ANSI C12.19 to facilitate data exchange. The Utility may require the manufacturer(s) to register the metering product utilizing ANSI C12.19 to ensure compliance and interoperability with the Utility's meter population.

Utilities face the most interesting challenges of all the participants in this discussion. The industry is in a state of change with an unclear future. Future roles for metering in the energy market place may not yet be defined. Despite this uncertainty, it would seem intuitive that metering will play an important part in future transactions with multiple parties desiring access to the meter or at least the metering data. The flexibility provided by ANSI C12.19 facilitates access to the necessary data and potentially reduces overall cost to the industry and ultimately the customers. It is up to the utility industry, now and in the future, to specify that systems and devices be in compliance with ANSI C12.19 and required companion communication protocols.

The guidelines described within this document were created in order to assist utilities in specifying implementations of ANSI C12.19 typical metering and AMI devices. Utilities using these guidelines will be able to purchase devices for AMI system interoperability and be able to enjoy an economy of scale with participating Utilities. Manufacturers will be able to reduce their extra product design work due to speciality requests from each Utility. Participating Utilities and Manufacturers will advance the Smart Grid another step towards interoperability of metering devices and enterprise metering systems.

These guidelines are the result of the work of an ad hoc team from interested members of the utility industry to identify common data requirements (within the ANSI C12.19 Standard) and to develop a set of voluntary implementation guidelines for Utilities' purchasing and operating requirements. The resultant guidelines reflect the collective opinions of the members of the working group. Where recommendations for values are stated, these recommendations should not be misunderstood by system developers as reducing the need for flexibility in the host system.

These guidelines have been made to facilitate the real challenges of operation and maintenance of End Devices. The recommendations reflect the existing needs for revenue data as perceived by the members of the working group. The working group has attempted to define these needs using the standard tables found within ANSI C12.19 exclusively. The user must compare his individual needs to the recommendations.

This version (v2.0) of the guidelines has been created to clarify sections of the AEIC v1.0 Guidelines document and to further define the different classifications of metering that are expected in the near future. Data requirements may shift as newer rate schedules in the utility

industry are developed, or as the application of new communication technologies evolve. In addition, revisions to ANSI C12.19 and introduction of new device data models may necessitate further revision to this document.

It is extremely important to note that this document is a voluntary guideline for use by any Utility or other interested party for purchase order specifications of electronic metering devices and associated enterprise apparatus. This document is not intended in any respect to preclude other designs, manufacture, purchase, or use of any products not conforming to this document.

Familiarity of the user with ANSI C12.19-2008 is assumed in this document. For definitions and for the range of values possible, please reference C12.19-2008, ANSI C12.22-2008, ANSI C12.21-2006 and ANSI C12.18-2006 as appropriate. Some of the required Standard Tables are scattered among all of the above Standards. The above Standards are co-published as IEEE 1377-2009, IEEE 1703-2009, IEEE 1701-2009 and IEEE 1702-2009 respectively and MC1219, MC1222, MC1218, and MC1221 respectively. The IEEE (and Measurement Canada) publications contain Errata to the ANSI Standards and provide additional elaborations, therefore they are required reading.

2.0 Overview

2.1 Purpose

This document is to be utilized when specifying an implementation of ANSI C12.19, "Utility Industry End Device Data Tables" and required associated control service elements that are provided by Standard communication protocols that implement (E)PSEM. Users of these guidelines need to evaluate their individual needs against those stated herein and decide on their applicability.

These guidelines are designed to forward the following definitions of interoperability:

1. It shall be possible to determine the contents of ANSI C12.19 meters and End Devices through the analysis of only the ANSI C12.19 Standard and the Tables that are internal to the meter or externally provided by the manufacturer via the North American Utility End Device Registry Authority which is overseen by the IEEE/ANSI/MC Object ID Oversight Committee. Additional features may be present as defined in manufacturer-specific tables and the manufacturers are encouraged to create extended features. However, information modeled in standard tables must be completely represented through standard tables and this includes utilizing space in Standard tables designated for manufacturer-specific data, e.g., the display tables, data source tables etc.
2. It shall be possible to obtain an unambiguous measurement of kWh, kVARh, accumulated values, and related demands from reading and analyzing the tables. This includes the units of measure and the other attributes of information needed for billing.
3. Certain desirable capabilities shall be configurable within any instance of a meter claiming to be represented by this specification. These capabilities are those arising from modification via writing to tables identified as writeable. When these writeable tables are so modified, the resulting observable behaviour of the meter through communications shall be consistent with the ANSI C12.19 Standard.
4. All Standard, Manufacturer and Extended User-Defined Tables shall be written (expressed) utilizing the C12.19 Standard Syntax and communicated using the Standard's data transmission formats.
5. All Manufacturer Tables shall be written (expressed) to co-exist within Decade structure and Decade functionality of the ANSI C12.19 Standard as follows:
    a. Manufacturer Tables X0/X1 shall be reserved for FLC Tables of Manufacturer defined Decades.
    b. Manufacturer defined Decades shall not utilize Decade numbers that are used by the C12.19 Standard that the End Device references semantically.

c. Manufacturer Tables may be associated with a Standard Decade using the TDL Table's "associate" attribute.
d. Manufacturer Tables that are associated with a Standard Decade may (it is recommended) assume Table Decade number of the Standard Decade. E.g. <table name="MFG_DISPLAY_CONTROL_TBL" number="33" associate="LOCAL_DISPLAY_DEC"> is a Manufacturer defined Table that exists in the context of Standard Decade 3.
e. Subject to the constraints (a) and (b) above, Manufacturer Tables do not need to be associated with any Decade.

6. Programming, reading and or writing data to ANSI C12.19 meters or other AMI End Devices shall utilize ANSI C12.19 table read/write operations on table structures via supported Standard communication protocols.

2.2 Objectives

This document is the framework and accreditation criteria to be used for ANSI C12.19/IEEE 1377/MC1219 meters and other AMI devices by users and testers of this technology. It is noted here that these three Standards are identical because of mutual memorandums of understanding that exist among the three organizations, ANSI, IEEE and Measurement Canada (Legal Metrology Branch). The three Standards will be referenced throughout this document as ANSI C12.19. The ANSI C12.19 Standard relies on complementary ancillary suite of Standards to handle communication methodologies using interfaces such as optical port, telephone and any-area network.

The three Standards bodies have jointly produced the following communication and application protocol-services for ANSI C12.19:

- ANSI C12.18/IEEE 1701/MC12.18 – Protocol Specification for ANSI Type 2 Optical Port
- ANSI C12.21/IEEE 1702/MC12.21 – Protocol Specification for Telephone Modem Communication
- ANSI C12.22/IEEE 1703/MC12.22 – Protocol Specification for Interfacing to Data Communication Networks

Similarly, ANSI C12.19 is referenced by [10], ISO/IEC 62056-62, 2006: Electricity metering – Data exchange for meter reading, tariff and load control – Part 62: Interface classes (ANSI C12.19 Utility Tables class_id: 26). Therefore, any Data Model that is defined by this document will be applicable for any implementation that is based on ISO/IEC 62056-62.

This set of guidelines aims to:

1. Reduce the complexity of meter reading through the reduction of variations in the implementation and interpretation of the ANSI C12.19 and the required communication suite of Standards.
2. Establish a user's expectation for "best practices" for implementers of the ANSI C12.19 suite of Standards.
3. Provide definite interpretation, from a Utility user's perspective, for terms and items that are vaguely defined, undefined or optionally supported by the C12 suite of Standards.
4. Provide implementation guidelines for the uniform definition, display, transportation and interpretation of metering logical units of measures.
5. Provide performance guidelines and metrics for the efficient definition, display, transportation and interpretation of metering legal units of measures.
6. Establish pass/fail acceptance criteria for ANSI C12.19 metering and required communication technologies.

7. Provide easy tabular reference to typical meters and other AMI devices for Utility purchase order description. This is for Utilities desiring system interoperability without intimate knowledge of these Standards.

It is expected that reduced variation, decreased complexity and uniform implementation of these Standards will help the users of these Standards to attain the objectives of reducing the overall complexity and cost of AMI for the SmartGrid. Specifically, the Utilities' economy of scale and Manufacturers' reduction of extra design work due to Utility specialty requirements are clear opportunities for the Utilities and Manufacturers while providing interoperability for Smart Grid.

2.3 Scope

This document provides implementation guidelines in the following areas:

1. Usage requirements and rules for implementers of ANSI C12.19-2008 in regard to
    a. The transmission of Table Data,
    b. The security of Table Data
    c. The encoding of Table Data
    d. The interpretation of Table Data
    e. Enterprise use of the Table Structure and Table Data semantic model
    f. Use of Event Loggers
    g. Use of Manufacturer-defined Tables
    h. Use of Extended User-Defined Tables
2. Communication Protocol Standards and Application services required to communicate ANSI C12.19 Elements
    a. Use of local optical port communication protocols covering all 7-layers of the OSI stack
    b. Use of telephone MODEM communication protocols covering top 6-layers of the OSI model down to the Datalink later only
    c. Use of Network communication protocols covering top 3-layers of the OSI model (Application, Presentation and Session)
    d. Use of Network communication protocols covering the Transport layers of the OSI model for Internet Enterprise use (e.g. TCP/IP, UDP/IP and IGMP/IP)
    e. Use of other Network communication protocols covering the Network layers of the OSI model for Internet Enterprise use
3. Define and develop a number of utility metering models using the semantic model of ANSI C12.19 including:
    a. Data models for residential single phase meters
    b. Data models for commercial polyphase meters
    ~~a.~~c. Data models for industrial polyphase meters
    ~~b.~~d. Data models for AMI load control devices
4. Provide guiding principles for achieving end-to-end and Enterprise AMI interoperability when communicating C12.19 and Standard protocols and services over any medium.

3.0 References

1. ANSI C12.18-2006: Protocol Specification for ANSI Type 2 Optical Port.

2. ANSI C12.19-2008: Utility Industry End Device Data Tables.
3. ANSI C12.21-2006: Protocol Specification For Telephone Modem Communication.
4. ANSI C12.22-2008: Protocol Specification for Interfacing to Data Communication Networks.
5. Handbook for Electricity Metering, 10th Edition, Washington, District of Columbia, Edison Electric Institute, 2002, ISBN 0-931032-52-0.
6. IEEE P1377-2009: Draft Standard for Utility Industry Metering Communication Protocol Application Layer (End Device Data Tables). *Contains Errata for C12.19-2008*.
7. IEEE P1701-2009: Draft Standard for Optical Port Communication Protocol to Complement the Utility Industry End Device Data Tables. *Same as C12.18-2006*
8. IEEE P1702-2009: Draft Standard for Telephone Modem Communication Protocol to Complement the Utility Industry End Device Data Tables, *Same as C12.21-2006*.
9. IEEE P1703-2009: Draft Standard for Local Area Network/Wide Area Network (LAN/WAN) Node Communication Protocol to Complement the Utility Industry End Device Data Tables. *Contains Errata for C12.22-2008*.
10. IETF RFC 768-1980: User Datagram Protocol, J. Postel.
11. IETF RFC 791-1981: Internet Protocol, Information Sciences Institute University of Southern California.
12. IETF RFC 793-1981: Transmission Control Protocol, J. Postel.
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14. IETF RFC C1222 Transport Over IP - 2009: Draft ANSI C12.22, IEEE 1703 and MC1222 Transport Over IP, A. Moise et. al.
15. ISO/IEC 7498-1, 1994: Information Technology - Open Systems Interconnection - Basic Reference Model: The Basic Model.
16. ISO/IEC 10035-1, 1995: Information Technology - Open Systems Interconnection - Connectionless Protocol for the Association Control Service Element - Protocol Specification.
17. ISO/IEC 8825-1, 2002: Information Technology - ASN.1 Encoding Rules: Specification of Basic Encoding Rules (BER), Canonical Encoding Rules (CER) and Distinguished Encoding Rules (DER).
18. ISO/IEC 62056-62, 2006: Electricity metering – Data exchange for meter reading, tariff and load control – Part 62: Interface classes (ANSI C12.19 Utility Tables class_id: 26).
19. LUM-0610-01-V17: Recommendations for Establishing Electricity LUM Outside an Approved Meter – Final Report, 2009.
20. NEMA SG-AMI 1-2009: Requirements for Smart Meter Upgradeability, 2009,
21. Principles for Sealing Meters and Trade Devices, Measurement Canada, 1999-07-26.
22. Specifications Relating to Event Loggers for Electricity Metering Devices and Systems (Measurement Canada, IS-E-01-E, 2003)
23. XHTML 1.0 The Extensible HyperText Markup Language (Second Edition). W3C Recommendation 26 January 2000, revised 1 August 2002.
24. XML Schema Part 1: Structures Second Edition, W3C Recommendation 28 October 2004.

4.0 Definitions

For additional definitions, please reference C12.19-2008, ANSI C12.22-2008, ANSI C12.21-2006 and ANSI C12.18-2006 as appropriate.

4.1 AEIC

The Association of Edison Illuminating Companies. Founded by Thomas Edison and his associates, AEIC is one of the oldest associations to be affiliated with the electric energy industry.

4.2 ANSI C12.19 Device

Any device that contains ANSI C12.19 data tables and uses ANSI C12.18, ANSI C12.21 or ANSI C12.22 protocols for communication in any combination.

4.3 AMI (Advanced Metering Infrastructure)

AMI is defined as the communications hardware and software and associated system and data management software that creates a network between advanced meters and utility business systems and which allows collection and distribution of information to customers and other parties such as competitive retail providers, in addition to providing it to the Utility itself.

Also, according to FERC, advanced metering is a metering system that records customer consumption [and possibly other parameters] hourly or more frequently and that provides for daily or more frequent transmittal of measurements over a communication network to a central collection point.

4.4 AMI Communication Module

A physical hardware device that enables two-way and end-to-end communications capabilities between an End Device (such as a meter) and the Utility Enterprise. AMI Communication Modules service layers 4-1 of the OSI 7-layers protocol stack

4.5 AMI Integrated Meter

A C12.19 Device that implements both the metrology registers (C12.19 Tables) and all 7-layers of the OSI communication protocol and hardware using an integrated solution. An Integrated AMI Meter does not have an Interchangeable AMI Communication Module.

4.6 AMI Modular Meter

A C12.19 Device that implements both the metrology registers (C12.19 Tables) and can be physically attached to one or more Interchangeable AMI Communication Modules. As seen from the network, it is not possible to distinguish between an Integrated AMI Meter and a AMI Modular Meter.

4.7 AMI Interchangeable Communication Module

An AMI Communication Module that attaches to an End Device (e.g., a Modular AMI Meter) using the End Device's internal or an external physical interface. The Interchangeable AMI Communication Module enables communication to at least one LAN/WAN that can reach the Utility Enterprise.

4.8 ANSI C12.19 Meter (a.k.a. End Device)

A Meter that contains ANSI C12.19 data tables and uses ANSI C12.18, ANSI C12.21 or ANSI C12.22 protocols for communication in any combination. This device and its accessories are Constituted by this set of guidelines.

4.9 AMR (Automated Meter Reading)

The automated meter reading application is software built which enables users to read and program ANSI C12.19 Standard-based meters. It communicates using any of the ANSI C12.18, ANSI C12.21 or ANSI C12.22 Standard communication protocols. It may also accept and use Table Definition Language (ANSI C12.19 XML/TDL Form) and Exchange Data Language (ANSI C12.19 XML/EDL Form) files. These are XML files which describe the meter's specific table architecture, default sets used and constant values associated with the ANSI C12.19 meter registered with a C12.19 Device Class. The C12.19 Device Class may be obtained from NAEDRA, the "North American End Device Registrar Authority" which is overseen by the IEEE/ANSI/MC Object ID Oversight Committee.

4.10 Catastrophic Failure a.k.a. Fatal Failure

A failure that results in temporary or permanent disruption of communication, corruption of protocol, corruption of data, unexpected manipulation of data, delivery of wrong data, unexpected data format or incorrect placement of data within transported record. The assessment shall be performed by a reference implementation (a Test that is based upon the registered End Device Table data model).

4.11 Decade

A decade is a functional grouping of tables into groups of ten (10). The tables are numbered X0 through X9, with X representing the decade number.

4.12 EDL (Exchange Data Language)

The EDL file form is used to express C12.19 Device data values that make up the device tables (this is in contrast to TDL which describe the device's table structures). The EDL file is associated with one specific C12.19 Device model, thus it is uniquely associated with a registered C12.19 Device Class.

This property implies that the EDL file content is derived from the data model of all the Tables used (Standard and Manufacturer) and all of the procedures used (Standard and Manufacturer) that are defined for the C12.19 Device Class referenced.

EDL files shall be used to express imported and exported values and parameters to (and from) the reference AMR application or reference Test Application and among utilities.

4.13 Enterprise Systems (ES)

Enterprise systems are large-scale, integrated application-software packages that use the computational, data storage, and data transmission power of modern information technology (IT) to support processes, information flows, reporting, and data analytics within and between complex organizations.

4.14 EPSEM (Extended PSEM)

Extended PSEM defines the application layer services of ANSI C12.22/IEEE 1703/MC1222. For a complete description of EPSEM see the referenced Standards ANSI C12.12/IEEE 1703/MC1222. See also PSEM.

4.15 FERC (U.S. Federal Energy Regulatory Commission)

The U.S. Federal Energy Regulatory Commission is an independent agency that regulates the interstate transmission of electricity, natural gas, and oil

4.16 FLC (Function Limiting Control)

ANSI C12.19 Function Limiting Control tables (X0/X1, where X is the decade number 0-204).

4.17 HAN (Home Area Network)

A HAN is a Communication Network within a customer's residence which may be a capable of communicating with an AMI meter, Energy Management System, other Gateways or devices inside a home.

4.18 Head-End

Head-end: An application associated with both one way and two way metering and end point systems that provides some of the following features:

- Manages the communication network for meters & end points
- Manages the collection of data
- Allows operators of the system to extract data and send commands to meters and end points
- Supplies metering and associated data to Enterprise systems, such as a MDM.

4.19 Load Profile

A load profile is the recording, storage and analysis of consumption, demand and other sensory data over a period of time, using ANSI C12.19 Load Profile Tables from Decade 6 (Standard Tables 60-69)

4.20 Manufacturer (Supplied) Tables

Tables defined by the manufacturer of the C12.19 Meter. Manufacturer table descriptions shall use table description syntax. These tables shall be available and readable by the Enterprise and/or head-end system and used for configuration, set-up and data storage of component-data and only for processes not already fully or partially covered by ANSI C12.19.

4.21 Meter

A meter is a device that measures the amount of electrical, gas or water utility commodities supplied, generated or consumed. Some or all values measured by these meters may be used for the purpose of billing.

4.22 MDMS (Meter Data Management System)

An MDM system performs long term data storage and management for the vast quantities of data that are now being delivered by advanced metering systems. This data consists primarily of usage data and events that are imported from the head end applications that manage the data collection in Advanced Metering Infrastructure (AMI) or Automated Meter Reading (AMR) systems. An MDM system will typically import the data, then validate, cleanse and process it before making it available for billing and analysis.

4.23 Metrological Element (parameter)

A metrological element is any constant, factor or algorithm that is used by a C12.19 Meter to produce results for the purpose of billing.

4.24 PSEM (Protocol Specifications for Electric Metering)

PSEM defines the application layer services of ANSI C12.18 / IEEE 1701 / MC1218 or ANSI C12.21 / IEEE 1702 / MC1221. In implementations that are not restricted just to electricity metering (e.g., gas and water), the acronym PSEM may also equivalently represent the Protocol Specifications for Electronic Metering. For a complete description of PSEM see the referenced Standards ANSI C12.18 / IEEE 1701 / MC1218 and ANSI C12.21 / IEEE 1702 / MC1221.

4.25 Read Meter (Meter Reading)

The transmission from the meter to the Enterprise and/or head-end system of an entire or partial C12.19 Table is a meter reading operation. The act of data retrieval may require the invocation of

some or all the following (E)PSEM services: Identification, Negotiate, Timing-setup, Logon, Wait, Security, Authenticate, Read, Write, Logoff, Terminate and Disconnect as per the relevant communication protocol implemented by the meter.

4.26 Reliable Transportation

In the context of billing and trade, this is a requirement that metered data shall be accurately and safely transported across any communication media. The method of transportation of the metered data shall ensure that the metered data remains intact on arrival at its destination (e.g. billing system) regardless of the medium the metered data are transported.

4.27 TDL (Table Definition Language)

ANSI C12.19 defines the Tables' syntax using the Published Document Form (the printed Standard). The document form can be derived from a corresponding syntax using XML notation. The XML annotated file is also an input to an AMR application that communicates with any C12.19 Device.

4.28 TOU Metering

TOU is an acronym for "Time of Use" metering. TOU metering equipment records metered or measured quantities according to a time schedule into separate registers (collection bins or tiers) using ANSI C12.19 Standard Decade 2 (Time and TOU, Standard Tables 20-29) and Standard Decade 5 (Clock Standard Tables 50-59).

4.29 UOM (Unit of Measure)

~~2.~~1. UOM is an acronym for "Unit of Measure". The unit of measure provides a method for describing a billing/trade quantity or selecting data source attributes. Some of the attributes include the physical quantity measured, the time base used for averaging, the scaling constants, direction of flow, method of measurement and harmonic component indication.

4.30 Upgrade/Upgrade Process

The series of communication steps required to replace or modify the existing operating Firmware of a meter and/or its associated communication and metrology components. The upgrade process does not require the removal of the meter and/or its associated communication and metrology components out of service.

4.31 Write/Program Meter

Writing and programming an ANSI C12.19 meter will affect the entire or partial ANSI C12.19 Table set. The act of data writing may, in addition to the aforementioned, require the invocation of some meter reading functions and any of the following (E)PSEM services: Identification, Negotiate, Timing-Setup, Logon, Wait, Security, Authenticate, Read, Write, Logoff, Terminate and Disconnect, as per the relevant communication protocol implemented by the meter. The C12.19 Meter may require the invocation of Standard Procedure 2, "Save Configuration", prior to Logoff to ensure retention of the changes. No other procedure shall be used for this purpose.

5.0 General Requirements

5.1 Interoperability

The AEIC guidelines document strives to describe, illustrate and create the environment for interoperability of the ANSI C12.19 – 2008 Communications Standard End Devices, metering head-end systems and MDM systems. One of the goals of this set of guidelines is to provide a more efficient use of the C12.19 Standard and to provide interoperability for the "smart grid". Where the ANSI C12.19 – 2008 Standard is ambiguous or unclear or opaque, this set of guidelines shall augment those areas to insure clear and unambiguous description for utilities' purchasing and vendors' manufacturing of interoperable End Devices.

5.1.1 Disclosure of Data Model

Full disclosure shall be provided. This disclosure shall minimally include the configuration, state-management of the meter based on the Device Class, TDL, EDL and reference C12.19 Standard used, Manufacturer tables and any manufacturer-specific procedures. These shall be provided for the user to independently read, write, program and interpret the metering data using the C12.19 Semantics.

5.1.2 Non Disclosure Agreement

The ANSI C12.19 meter shall be programmed, read and written strictly using the interpretation of ANSI C12.19 Standard Tables and Procedures according to these guidelines without the necessity to engage the users or manufacturers of these meters in a non-disclosure agreement.

5.1.3 Access to Semantic Data Model

The registered ANSI Standard C12.19 Device Class, TDL and EDL shall be directly available from the registrar using the Internet as a delivery mechanism. The C12.19 Meter device class shall be registered with a certified North American End Device Registrar who is responsible to the IEEE/ANSI/MC Object ID Oversight Committee.

5.1.4 Valuation and Assessment

The relevant ANSI Standard normative text is used as a reference for making these guidelines. However, when a Standard is clear about its intent, but does not provide implementation details or the Standard is vague or there is room for interpretation, then these guidelines shall be used as the definitive guide for the interpretation of the Standards.

5.1.5 Functions Considered and Ranking

It is the intention of these guidelines to establish whether the meters and End Devices expose and provide the interface, state, timing, data values, data representation, data placement, protocol, implementation-parameters or performance in accordance with these guidelines. A “Conforming”, “Non-Conforming” and “Not-Applicable” assignment shall be used for each identified component when ranking the meter or End Device for conformance.

5.1.6 Use of ANSI C12.19 Tables and Syntax

The primary objective of this document is to establish an interoperable data format for gas, water and electricity meters for the purpose of control and transport of data records between the Enterprise and/or head-end system and End Device. This document aims to maximize the degree of interoperability, recognizing that it is not possible to define a universal data format that is suitable for all devices. It defines mechanisms for the promotion and establishment of interoperability with End Devices through the introduction of pre-defined data structures and syntax, also known as Tables.

5.1.6.1 *Type of Tables*

The Tables shall be transferred to and from the head-end system and End Device. These shall be grouped according to content into three major types: “Standard Tables”, “Manufacturer Tables” and “(Extended) User-Defined Tables”. Each type is capable of having up to 2040 tables. The “Standard Tables” and “Manufacturer Tables” shall be organized by function into groups of 10 Tables, known as Decades [Ref. ANSI C12.19-2008 Sections 4.1.1 Standard Tables Grouping and 4.2.1 Manufacturer Tables Grouping]. The Standard Decades are:

~~1.~~0 General Configuration Tables

~~2.~~1 Data Source Tables

~~3.~~2 Register Tables

~~4.~~3 Local Display Tables

~~5.~~4 Security Tables

~~6.~~5 Time-of-Use Tables

~~7.~~6 Load Profile Tables

~~8.~~7 History & Event Logs Tables

~~9.~~8 User- Defined Tables

~~10.~~9 Telephone Control Tables

~~11.~~10 Unassigned

~~12.~~11 Load Control and Pricing Tables

~~13.~~12 Node Network Control Tables

~~14.~~13 Network Relay Control Tables

~~15.~~14 Extended User- Defined Tables

~~16.~~15 Quality of Service Tables

~~17.~~16 One-way Devices Tables

In contrast, the (extended) user-defined tables are not organized into decade structures. They are collections of contiguous data sub-elements related to the formal data elements of the ANSI C12.19/IEEE 1377/MC12.19 Standard. The (Extended) User-defined tables allow data streams of repetitive billing data for communication efficiency for “one-way” devices or “two-way” devices.

5.1.6.2 *Manufacturer Tables*

Manufacturer Tables shall not have a predefined or overlapping Standard function. These Tables shall only be provided by the manufacturers in those instances where it is not possible to provide the desired functionality using Standard Tables or when the manufacturer desires to introduce new innovation. Manufacturer tables shall be defined using the Standard Table syntax.

5.1.6.3 *User-Defined Tables and Extended Use- Defined Tables*

User-defined tables refer to the tables defined by Decade 8, “User-Defined Tables”, Extended User-Defined tables represent tables defined by Decade 14, “Extended User- Defined Tables” of ANSI C12.19 – 2008. The Extended User-Defined Tables may provide data collation from more than one End Device instance that are registered for a device class.

User0Defined Tables and Extended User-Defined Tables shall only make references to Standard or Manufacturer-defined Table elements that are available physically (can be transported by a communication protocol) or logically in the C12.19 Device (a logically defined table is also referred to as a “virtual table”). Collectively these elements are referred to as “Formal Table Elements”

A User-Defined Table syntax or element shall not make a reference to another User-Defined Table Element. An Extended User-Defined Table syntax or Element shall not make a reference to another Extended-User Defined data Element (selected in Decade 14) or User-Defined data Element (defined in Decade 8).

When encoded as EDL elements for the purpose of enterprise data exchange; User-Defined Table Element data and Extended-User Defined Table Element data shall be encoded in the EDL as the ANSI C12.19 registered Formal Table Elements.

5.1.6.4 *Standard Table Syntax*

All Table structures shall be described in terms of C12.19 syntax. The user and Enterprise and/or head-end system recognize this syntax (XML/TDL Form) and use it to describe the manufacturer, Standard and extended user-defined tables’ structure of the meter. The manufacturers’ meter manual shall also utilize the C12.19 syntax to describe its tables.

5.1.6.5 *Operations on Tables*

The Tables are structured such that only Table Read and Table Write services are required to perform AMI. These guidelines require that the Enterprise and/or head-end system utilize exclusively the full or partial Table read/write services (following link, session and security establishment using the appropriate communication protocol) to set-up, program, manage and read the meter.

5.1.6.6 *Table 0, General Configuration Table*

The Standard organizes the tables by functional groups beginning with Table 0, General Configuration Table. These guidelines require that the meter provides table 0 with valid contents; whereby the Enterprise and/or head-end system may confirm the presence of all tables and their write access modes. Only Standard and Manufacturer Tables implemented by the meter shall be listed in table 0. Access to Table zero shall not be limited by Table role security.

5.1.6.7 *Function Limiting Control Tables*

In addition to Table 0, the Standard defines rules for the implementation of function limiting tables. When Standard or Manufacturer tables supported by the meter are numbered X0/X1 they shall be interpreted as FLC/FLC+1 Tables according to ANSI C12.19.

5.1.6.8 *Special Function, Placement and Management*

The Standard defines certain meter procedures for process management, interpretation mechanisms and placeholders for meter specific functions. These guidelines require that:

~~18.~~1. Manufacturer functions and control parameters shall be placed in the Standard designated areas, if supported by the meter and if the Standard provides Standard Table Elements as a placeholder for those functions (e.g. Display Tables, Data Source Control Tables).

~~19.~~2. List management facilities shall be implemented using Standard Procedures for correct operation. This includes self-read tables, history tables, event-logger tables, profile tables, power-quality (2008) tables and the like.

~~20.~~3. Calendar and clock programming shall be implemented using Standard Clock tables and Standard Clock management Procedures.

~~21.~~4. Standard Security and Key Tables shall be used if a security policy is implemented (as per communication protocol implementation requirements). Also, access control is consistent with the ANSI C12.19 Standard security model.

~~22.~~5. Register Data Tables shall reflect correct and linear readings as described in Data Sources Tables (Decade 1) multipliers, constants, timing and related UOMs.

~~23.~~6. Data types, source identification, scaling and application shall be readable and correctly implemented.

~~24.~~7. Control and presentation of pending tables shall be correctly implemented as per the C12.19 Standard.

~~25.~~8. Procedure invocation and procedure status reporting shall work correctly in a manner that the last procedure invoked via Standard Table 7 shall have its completion status available from Standard Table 8.

5.1.6.9 *UOM Usage*

UOM shall be available through Standard Decade 1's Standard Table 12. Billing and trade quantities shall be transmitted by the C12.19 Meter in the proper units of measure and scale (i.e. ask for kWh - get kWh). The order of placement of UOMs shall be determined by the user of the C12.19 Meter, not the manufacturer. For example, the Utility may group UOMs as follows:

~~a.~~1. UOMs are first prioritized by function as follows (from high priority to low priority):

a. Energy
b. Demand
c. Instantaneous
d. Event
e. Time
f. Count

~~b.~~2. Within each function above the UOMs could be prioritized as follows (from high to low priority):

~~c.~~a. Active (Real) Power (e.g. Watt)

~~d.~~b. Reactive (VAR) Power (e.g. Var)

~~e.~~c. Apparent Power (e.g. VA)

~~f.~~d. Quantity (Q) Power (e.g. 45 or 60 degrees Q-Power)

~~g.~~e. Voltage (e.g. Demand average RMS volts)

~~h.~~f. Current (e.g. Demand average RMS Ampere)

~~i.~~g. Power quality (e.g. Power factor or T.H.D.)

~~j.~~h. Time, counters, sense input etc.

~~k.~~i. Gas measurements

~~l.~~j. Water measurements

~~1.~~3. All data shall be delivered with all calculations and enabled (by the user) multipliers applied within the metering device (again, i.e. ask for kWh - get kWh).

5.1.6.10 *Miscellaneous*

1. Reserved Table fields shall be set to zero or space values, in accord with their data type.
2. Protected fields shall read as blanks (e.g. passwords).
3. Default sets shall be assumed when FLC tables are not present and a default set used is indicated in Table 0.
4. Limited Table variables shall operate within FLC limits stated.
5. Hidden Tables or Procedures shall not exist.
6. All data type implementation in all Tables present in the meter including manufacturer tables shall be consistent and implemented with the types defined in Table 0.

5.1.7 Communication Services for ANSI C12.19 data structures

The data structures and functions of ANSI C12.19 require read, write and other services specified in the ANSI C12.19 Standard. The ANSI C12 body has produced the ANSI C12.18 (Optical Port) Standard, the ANSI C12.21 (Telephone modem) Standard and the ANSI C12.22 (LAN/WAN) Standard to accommodate the necessary services for the ANSI C12.19 data functions. If other Standards become known and certified to satisfy the ANSI C12.19 data structure services requirements, they will be included in these following sections. When using ANSI C12.19 in conjunction with ANSI C12.18, ANSI C12.21 or ANSI C12.22 then the following is applicable.

5.1.7.1 *(E)PSEM Services*

These guidelines require the ANSI C12.18, C12.21 PSEM and C12.22 EPSEM services identified in this document to be implemented.

5.1.7.2 *State Machine*

These guidelines require the ANSI C12.18, C12.21 and C12.22 state machine described in the Standards' informative annexes to be implemented.

5.1.7.3 *ANSI C12.21 Modem Tables*

C12.19 meters implementing ANSI C12.21 protocol shall have Modem Tables and default sets.

5.1.7.4 *ANSI C12.21 Inbound Base State Timeouts*

ANSI C12.21 meters shall wait for an Identification Service request for a minimum of default channel-traffic-timeout (30 seconds) before telephone line hang-up.

5.1.7.5 *ANSI C12.21 Timing Setup Service*

C12.19 meters implementing ANSI C12.21 protocol shall support the optional Timing Setup Service.

5.1.7.6 *ANSI C12.21 Outbound Base State Timeouts*

C12.19 meters implementing ANSI C12.21 protocol shall wait for an Identification Service request for a minimum of default channel-traffic-timeout (30 seconds) before telephone line hang-up.

5.1.7.7 *ANSI C12.18 and ANSI C12.21 Data Link Identity Byte*

Value 0 shall always access the meter and not its modem or communication interface. (Add note to users and vendors regarding warning about present and future behaviour)

5.1.7.8 *ANSI C12.22 Network Tables*

C12.19 meters implementing ANSI C12.22 protocol shall have Network Tables.

C12.19 Devices implementing ANSI C12.22 Relays and Master Relays protocol shall have Relay Tables.

Enterprise ANSI C12.22 (Internet) Hosts shall implement the IETF C12.22 over IP protocol specifications

5.1.7.9 *ANSI C12.22 Transport Layer requirements*

ANSI C12.22 does not specific the Transport layer for integrated devices. When the network layer is IP (the internet) then the Transport Layer shall be implemented according to the IETF C12.22 over IP protocol specifications. Other transport layers may be utilized on non-internet networks.

5.1.7.10 *ANSI C12.22 Physical Layer requirements*

ANSI C12.22 does not specify the Physical layer for integrated devices. Any Physical layer may be utilized as applicable.

5.1.7.11 *ANSI C12.22 Communication Module requirements*

When implementing an external, or optionally an internal, communication module, the physical interface and transport layer interfaces of the C12.22 Communication Module shall be implemented as specified by ANSI C12.22 for a C12.22 Communication Module. Also, the physical interface and transport layer interfaces of the mating C12.22 Device (meter) shall be implemented as specified by ANSI C12.22 for a C12.22 Device.

5.1.7.12 *ANSI C12.22 Local Optical Port*

An ANSI C12.22 Optical port shall be present on ANSI C12.19 metering Devices and implemented as a minimum to be compliant with ANSI C12.18 Optical Port Communication.

5.1.8 C12.19 Algorithms

(These guidelines may specify and expect the meter to utilize standard Algorithms such as those listed below. The final list of Algorithms and details of Algorithms will be finalized in 2010.)

These guidelines will specify and expect the meter to utilize Standard algorithms for:

1. Local time to GMT conversion
2. GMT to local time conversion
3. Setting the clock and time-zone management
4. Meter state management (metering mode vs. meter-shop mode)
5. Conversion of register (sensor) values to physical units (billing data retrieval)
6. Conversion of load profile readings to physical units (profile data retrieval)
7. Meter status flag operation
8. Meter security programming
9. Display configuration
10. History log management and retrieval
11. Event logger / audit trail processing
12. Time of use and calendar scheduling
13. Power quality monitoring and acquisition
14. Extended user defined table setup
15. Standard procedures operations
16. Modem tables and procedures operations
17. Network tables and procedures operations
18. Relay tables and procedures operations
19. Pending tables operation and activations.

All references to [ANSI C12.19-2008] are assumed to include all of the corrections to errors and omissions published in [IEEE P1377-2009 (still in draft at the time of this writing)]

5.2 Economy of Scale

The AEIC guidelines document shall provide clear and unambiguous instructions for the Utility to purchase ANSI C12.19 end devices. The instructions shall be provided allowing Utilities without intimate knowledge of the ANSI suite of Standards to attain populations of interoperable end devices. These guidelines apply to smart grid metering and all data being communicated whether the data comes from the meter or communication module or data concentrator, etc. shall comply with the AEIC Guidelines for C12.19.

5.3 Typical Utility end devices

These guidelines shall identify typical end devices such as simple register, demand register, TOU registers, etc. and provide tabular or other organizational grouping to assist the Utility with quick and concise ordering information. Utilities will benefit with other participating Utilities in an economy of scale of the common and typical end devices and the manufacturers will benefit with less specialty design for each Utility.

5.4 Path to Interoperability without loss of legacy device population remaining value

These guidelines shall indicate where possible suggestions or possible mechanisms to guide Utilities toward the goal of System devices interoperability and interchangeability without the loss of existing legacy systems' and devices' remaining life value.

6.0 Communications Requirements

NOTE: *Section 6 continues under discussion as of the distribution date of this Working Draft Document 12/11/09, and is subject to change, both in format and in content.*

Compliant communication protocols shall be implemented in accordance with [ANSI C12.19-2008, Sections 3, 4, 7, 8, and 9.1]. A compliant End Device firmware shall not be changed by an End Device vendor, while retaining the existing device class designation, without ensuring that the change in the End Device registered Data Model will not create interoperability problems with existing implementations that use the existing Device Class. *To ensure interoperability it is strongly recommended that users also require compliance with Annex L.* All references to [ANSI C12.19-2008] are assumed to include all of the corrections to errors and omissions published in [IEEE P1377-2009 (still in draft at the time of this writing)]

6.1 General Principles for Interoperable Communications

All compliant protocol implementations shall be based on Standards.

The Application Layers of a compliant communication protocol shall be defined by a published Standard. When the lower layers (such as Transport, Network, Data-link and Physical) are not defined by a Standard protocol the protocol may be based on draft Standards or industry de-facto implementations as specified by these guidelines.

OSI 7 Layer Stack

Application (Layer 7)

Presentation (Layer 6)

Session (Layer 5)

Transport (Layer 4)

Network (Layer 3)

Data Link (Layer 2)

Physical (Layer 1)

In addition all compliant communication protocols shall meet the requirements listed in the following subsections.

6.1.1 Types of Tables Transported

The compliant communication protocol shall be able to transport Standard Tables, Manufacturer Tables, Pending Tables and Extended User Defined Tables, in accordance with [ANSI C12.19-2008]. This is not meant to imply that all four types of tables (Standard Tables, Manufacturer Tables, Pending Tables and Extended User Defined Tables) must be present in any particular Device Class.

6.1.2 Types of Procedures Transported

The compliant communication protocol shall be able to transport Standard Procedures, Manufacturer Procedures and Pending Procedures, in accordance with [ANSI C12.19-2008]. This is not meant to imply that all three types of procedures (Standard Procedures, Manufacturer Procedures, and Pending Procedures) must be present in any particular Device Class.

6.1.3 Extent of Tables Transported

1. The compliant communication protocol shall be able to transport full Tables and partial Tables, in accordance with [ANSI C12.19-2008]. For specific details on Table access methods see [ANSI C12.19-2008, Sections 4, 7, 8 and 9.1.1].
2. The transport protocol shall also comply (when requesting Table elements and when transmitting Table elements) with the default accessibility properties defined in [ANSI C12.19-2008, Section 4], as modified the data model of the registered Device Class of the End Device.
3. The compliant communication protocol shall be able to transmit the End Device Class in accordance with [ANSI C12.19-2008, Section 9.1.1].
4. The compliant communication protocol shall be able to transmit the End Device IDENTIFICATION element in accordance with [ANSI C12.19-2008, Section 9.1.6 / IDENTIFICATION at index 2 and Section 9.1.1 ID_FORM 0 and CHAR_FORMAT 1, 2 or 3].
5. The compliant communication protocol shall be able to transmit the entire Table 00, General Configuration Table and all atomic Tables, when requested to do so, as a result of a full Table read request.
6. The compliant communication protocol shall not transmit partial atomic tables, unless it can guarantee that none of the elements of an atomic Table can change during the transmission of a subset of the atomic Table, as part of a single transaction.

   e.g. When a Table is atomic, and it contains 100 bytes, then it should be transmitted as a single 100 bytes element. It may also be transmitted as 40+40+20 bytes (assuming a maximum payload size of 40 bytes) only if none of the elements can change during the transmission of the three payloads that make up the atomic Table.
7. All compliant meters and sensors shall implement the full Table and partial Table read/write capabilities (read/write requests are initiated by the enterprise application).
8. All compliant meters and sensors shall implement the partial Table offset/octet-count Table read/write capability (read/write requests are initiated by the enterprise application).
9. Non-meters and non-sensors-based compliant communication protocols of End Devices shall implement the full Table and partial Table read and write capabilities.
10. Non meters and sensors compliant communication protocols of End Devices shall implement the partial Table offset/octet-count read and write capabilities.
11. All compliant communication protocols may implement the partial Table index/element-count read and write capabilities.
12. It is recommended that the compliant Enterprise application implement the full Table read/write, partial Table read/write using offset/octet-count method and partial Table read/write using index/element-count methods.

6.1.4 Element-format of Tables Transported

1. Transmission of active (non-pending Standard or Manufacturer) Tables shall not include a pending header [C12.19-2008, Section 8.2].

2. Transmission of pending (Standard or Manufacturer) Tables shall include a pending header [C12.19-2008, Section 8.2] in addition to the read or written Table Elements.
3. Transmission of Table Element Data shall be ordered per Table Element definition order and per selections made [C12.19-2008, Sections 8.1.3, 8.1.4 and 8.1.5]

6.1.5 Table Element Security and Reliability

1. The compliant communication protocol shall be secure.
2. Compliant communication protocols that connect, bridge or interface Enterprise systems to field Meters and End Devices shall not re-write transmitted encapsulated Table elements in a manner that results in the loss of data integrity and authentication of the source and destination and data. See [C12.19-2008, Section 3.25-3.39, 9.1.8 procedures 30/31, 9.8, B].
3. Compliant communication protocols shall implement and not permit violation of Table-role based security per [C12.19-2008, Sections 9.1.1 STD_TBLS_WRITE and MFG_TBLS_WRITE, 9.5.1, 9.5.2, 9.5.3, 9.5.4 and 9.5.5], whether Table element or Procedure were requested directly or indirectly through User Defined Tables or Extended User Defined Tables.
4. Compliant communication protocols shall use the security passwords and keys as defined in [C12.19-2008, Sections, 9.5.3, 9.5.6, 9.5.7, 9.5.8 or 9.5.8 and ANSI C12.22, Sections C5, C6 and C1.4] as appropriate for the type of communication protocol type, in order to maintain Enterprise to field End Device interoperability.
5. Additional Transport or Network layer security protocols may be provided transparently by network integrators. However, any added network security features shall act only to enhance and preserve (i.e., not be a substitution for, or an alteration of) the ANSI C12.19-2008 interoperable security provisions found in [C12.19-2008, Sections 9.1.1 STD_TBLS_WRITE and MFG_TBLS_WRITE, 9.5.1, 9.5.2, 9.5.3, 9.5.4 and 9.5.5], and service and mechanisms as defined by ANSI C12.22-2008.

6.1.6 Meter and End Device Firmware Upgradability

1. The compliant communication protocol shall be capable of performing End Device firmware upgrade strictly through the communication of [C12.19-2008] Tables and the execution of [C12.19-2008] Procedures, in accordance with the registered device class.
2. Although it is possible to use any manufacturer table to make any manufacturer upgrade, it is strongly recommended that the following protocol be applied:

   The compliant communication protocol should use partial Pending Table writes or full Pending Table writes, Pending Table management procedures and state-storage management procedures to transmit the firmware upgrades [C12.19-2008, Sections 6.3.1, 6.4, 7, 8.2, 9.1.1, 9.1.9 and 9.1.10 procedures 0, 1, 2, 11, 12, 13, 14 and 15].
3. Compliant implementations shall use the same pending table activation header for all Pending Table write requests of the same Pending Table that is associated with a single firmware image upgrade.
4. An End Device shall not fail as a result of Rule 3 above being violated and it shall reject (NOK response) to the infringing Pending Table or discard the previous contents of Pending Table, at the discretion of the vendor.

6.1.7 Directionality and Performance

1. All compliant communication protocols shall implement bi-directional (two-way) communication capability.
2. The compliant communication protocol shall be capable of encoding the entire ANSI C12.19 Table 00 in one Application Layer Unit Data.

6.2 Point-to-point Optical Port Communication Standards

6.2.1 Optical Port Communication Using ANSI C12.18-2006

The ANSI C12.18 protocol defines the roles (a) C12.18 Device and (b) C12.18 Client. Unless stated otherwise, devices that are C12.18 Devices shall assume the role of a C12.18 PSEM service requester, and devices that are C12.18 Clients shall assume the role of a C12.18 PSEM service responder. Terms enclosed within '<' and '>', e.g. <full-read>, represent PSEM service descriptors that are defined in ANSI C12.18. The service states described in ANSI C12.18, Annex C - Service Sequence State Control, shall be implemented.

6.2.1.1 *Identification Service (required)*

The code identifying reference Standard <std> shall be set to 00_H for ANSI C12.18.

6.2.1.2 *Read Service (required)*

The device shall support a full table read <full-read> and partial table read with offset <pread-offset>.

6.2.1.3 *Write Service (required: C12.18 Device, optional: C12.18 Client)*

C12.18 Devices shall support a full table write <full-write> and partial table write with offset <pwrite-offset>. C12.18 Clients, that implement procedures and writable tables shall support a full table write <full-write> and partial table write with offset <pwrite-offset>.

6.2.1.4 *Logon Service (required)*

6.2.1.5 *Security Service (optional)*

The security service is optional in those instances where the End Device does not implement the PSEM write service and all Tables are readable by any C12.18 client. Otherwise, the Security Service is required. When the Security Service is implemented by a C12.18 Device, the <password> element shall be compared with the PASSWORD elements of SECURITY_TBL (Table 42) of ANSI C12.19.

6.2.1.6 *Logoff Service (required)*

The <logoff> service shall be used to conclude a successful session, thus causing the orderly shutdown of the session established by the <logon> service.

6.2.1.7 *Negotiate Service (required)*

6.2.1.8 *Wait Service (required)*

C12.18 Devices shall support all <time> values whereby <time> = 0 shall not affect the channel settings; otherwise all the <time> idle values in the range of 1 to 255 seconds shall be supported.

6.2.1.9 *Terminate Service (required)*

The <terminate> service shall be used to abort any open session for reasons such as excessive errors, security issues and internal error conditions. It may also be used to establish a well known initial state of the C12.18 Device. Following terminate service any or all session-oriented transactions may be lost. Also utility Enterprise and/or head-end system shall assume the role of a C12.21 Client. Meters shall assume the role of a C12.18 Device.

6.2.2 Optical Port Communication Using ANSI C12.22-2008

All C12.22 Nodes shall implement a local port (in accordance with Local Port of ANSI C12.22) using the physical form and type defined in ANSI C12.18. Two implementations are possible:

1. A local port that supports only the ANSI C12.18 protocol (required). This mode is also referred to as ANSI C12.18 compatibility mode.
2. A local port that implements both the ANSI C12.22 protocol and the ANSI C12.18 protocol (optional).

C12.22 meters and C12.22 embedded field devices shall comply with ANSI C12.22 Section 7.2, C12.22 Local Port Communication using a C12.18 Optical Port. This section describes the means to establish a C12.22 compatibility-mode of the local port and a C12.18 compatibility-mode of the local port.

When operating in C12.22 local port compatibility mode, the C12.22 node shall implement the Application, Transport, Data link and Physical layers as specified in Section 7, Local Port Communication Protocol Details, of ANSI C12.22. In addition the C12.22 local port shall provide access to the C12.22 node's interfaces. The implementation of the ANSI C12.2 data link protocol is optional.

When operating in ANSI C12.18 compatibility mode, the C12.18 Device shall operate in accordance with Section 6.2.1, Optical Port Communication Using ANSI C12.18-2006.

When operating in ANSI C12.22 compatibility mode, the ANSI C12.22 Node application layer shall operate in accordance with Section 5.3, Layer 7—Application Layer, of ANSI C12.22. The C12.22 Node's transport layer shall operate in accordance with Section 6, Protocol Details: C12.22 Device to C12.22 Communication Module Interface.

6.3 Point-to-point Telephone MODEM Communications Standards

6.3.1 Telephone MODEM Communications Using ANSI C12.21-2006

ANSI C12.21 is a protocol that supports legacy POT (plain old telephone) and point-to-point communication between Enterprise and/or head-end systems and ANSI C12.19 meters. Looking forward, it is likely that ANSI C12.21 will be superseded by the ANSI C12.22 protocol, which can provide the same services as ANSI C12.21, without a compromise to security. Users of ANSI C12.21 are cautioned that the ANSI C12.21 security service (provides password) may be communicated in clear text (not encrypted). For this reason, users of the ANSI C12.21 protocol are advised not to use ANSI C12.21 on unsecured networks (networks that may compromise the security of the meter, metering system or the Smart Grid, through the weakness in password delivery). When transmission of passwords in the clear is not acceptable, then it is strongly recommended that a secured ANSI C12.22 protocol be used instead, optionally acting as a gateway to ANSI C12.21 legacy technology.

The ANSI C12.21 protocol defines the roles (a) C12.21 Device and (b) C12.21 Client. Unless stated otherwise, devices that are C12.21 Devices shall assume the role of a C12.21 PSEM service requester, and devices that are C12.21 Clients shall assume the role of a C12.21 PSEM service responder. Terms enclosed within '<' and '>', e.g. <full-read>, represent PSEM service descriptors that are defined in ANSI C12.18. Also the utility AMR/AMI system shall assume the role of a C12.21 Client. Meters shall assume the role of a C12.21 Device. The service states described in ANSI C12.21, Annex C - Service Sequence State Control, shall be implemented.

6.3.1.1 *Identification Service (required)*

The code identifying reference Standard <std> shall be set to 02_H for ANSI C12.21.

The <feature> list of the identification response shall provide the <auth-ser> and <auth-ser-ticket> elements in support of the <authenticate> service. The authentication algorithm used, <auth-alg-id>, shall be set to 00_H thus selecting the ANSI INCITS 92-1981 (R2003), Data Encryption Algorithm.

6.3.1.2 *Read Service (required)*

The device shall support a full table read <full-read> and partial table read with offset <pread-offset>.

6.3.1.3 *Write Service (required)*

C12.21 Devices shall support a full table write <full-write> and partial table write with offset <pwrite-offset>. C12.21 Clients, that implement procedures and writable tables shall support a full table write <full-write> and partial table write with offset <pwrite-offset>.

6.3.1.4 *Logon Service (required)*

6.3.1.5 *Security Service (optional)*

The <security> service may serve the same roles as the <security> service of ANSI C12.18. It establishes the tables and procedures access role of the C12.21 Client. The security service is optional in those instances where the End Device does not implement the PSEM write service

and all Tables are readable by any C12.21 client. Otherwise, the Security Service is required. When the Security Service is implemented by a C12.21 Device, the <password> element may be compared with the PASSWORD elements of SECURITY_TBL (Table 42) of ANSI C12.19.

6.3.1.6 *Authenticate Service (required)*

The <auth-request> element shall be compared with the KEY elements of KEY_TBL (Table 45) of ANSI C12.19

6.3.1.7 *Logoff Service (required)*

The <logoff> service shall be used to conclude a successful session, thus causing the orderly shutdown of the session established by the <logon> service.

6.3.1.8 *Negotiate Service (required)*

6.3.1.9 *Timing Setup Service (required)*

C12.21 Devices shall support all <traffic>, <inter-char>, <resp-to> and <nbr-retries> values in the range of 1 to 255. The value zero (00_H) should be avoided, however when supplied as a parameter, the corresponding state of the timing service shall not change (i.e. it shall remain in its present state).

6.3.1.10 *Wait Service (required)*

C12.21 Devices shall support all <time> values whereby <time> = 0 shall not affect the channel settings, otherwise the all <time> idle values in the range of 1 to 255 seconds shall be supported.

6.3.1.11 *Terminate Service (required)*

The <terminate> service shall be used to abort any open session for reasons such as excessive errors, security issues and internal error conditions. It may also be used to establish a well known initial state of the C12.18 Device. Following terminate service any or all session-oriented transactions may be lost.

6.4 Network Communications Standards

6.4.1 Networks Communication Using ANSI C12.22-2008

6.4.1.1 *Common Requirements Networks Implementing ANSI C12.22*

Provide descriptions of common requirements for implementing a C12.22 Network and its Application Services. Provide context for the paragraphs and Tables that follow.

6.4.1.2 *Minimum Requirements for all ANSI C12.22 Communication*

6.4.1.2.1 ANSI C12.22 Application Message Envelop Structure (required)

ANSI C12.22 Applications relies on the use of Connectionless-mode ACSE to convey association and security parameters. This includes the identification of the application context, application process titles (names) of called and calling processes, authentication information if a authentication or privacy of transaction is required.

6.4.1.2.2 ACSE Un-segmented APDU Processing (required)

6.4.1.2.3 Un-segmented ACSE Constituents

Although many of the elements may be optional in constructing the ACSE-PDU, their interpretation, processing and devices' ability to generate in compliance with the Standard is not optional. The following members shall be understood by all implementations:

<aSO-context-element>

<called-AP-title-element>

<called-AP-invocation-id-element>

<calling-AP-title-element>

<calling-AE-qualifier-element>

<calling-AP-invocation-id-element>

<mechanism-name-element>

<calling-authentication-value-element>

<user-information-element>

6.4.1.2.4 Segmented APDU Processing (required)

6.4.1.2.4.1 APDU Segmentation and Segment Creation (optional)

C12.22 Nodes with large tables or C12.22 Relays that bridge across mixed message–size topologies should implement full segment assembly and disassembly. This is an interoperability requirement.

6.4.1.2.4.2 APDU Segments-assembly (required)

C12.22 Nodes that implement message processing need to be able to assemble incoming segments.

6.4.1.2.5 APDU C12.22 Security/Authentication/Privacy (required)

The following are Standard-registered authentication-mechanism names. Other mechanism names can be registered.

6.4.1.2.5.1 APDU C12.22 Security Mechanisms (RelOID=.2.1, required, MGMT)

Processing of ACSE-PDU (C12.22 application message) that is secured with RELATIVE-OID ".2.1" shall be supported.

6.4.1.2.5.2 APDU C12.22 Security Mechanisms (RelOID=.2.0, optional, C12.21 Tunnels)

Processing of ACSE-PDU (C12.22 application message) that are secured with RELATIVE-OID ".2.0" shall be supported in tunneling application to C12.21 Meters.

6.4.1.2.5.3 ANSI C12.19-tables Role-based Security (required)

Processing of ACSE-PDU (C12.22 application message) that implement the C12.22 Security Service shall be supported.

6.4.1.2.6 Use of Sub-branches of a Registered ApTitle (required)

6.4.1.2.6.1 Use of assigned sub-branch spaces (required)

Any sub-branch of the registered root ApTitle can be used to communicate with the C12.22 Node that registered that root under controlled conditions. All sub-branches are assumed to be registered and managed by the root ApTitle holder as long as the root ApTitle is registered.

This requires recognition and proper use of:

1. Assigned sub-branch
2. Reserved sub-branch
3. Dynamic sub-branch

6.4.1.2.6.2 Use of local-ports and Mailboxes (required)

Reserved sub-branches were assigned by the Standard to access the C12.22 Devices' Local Ports and C12.22 Communication Modules' interfaces. The assignments shall be respected and processed by C12.22 Nodes.

6.4.1.2.7 EPSEM Application Services (required)

6.4.1.2.7.1 EPSEM Envelope Structure (required)

All elements described are required.

6.4.1.2.7.2 Required EPSEM Services

C12.22 Master Stations (i.e. C12.22 Notification Hosts) must implement all of the following services as initiators of the service. They must implement the Write service as recipients of C12.22 Notification messages. They must also implement the registration/de-registration services as notification and authentication hosts. They must implement the resolve service as C12.22 Relays.

6.4.1.2.7.3 Identification Service (respondent all: required)

This service is used to obtain information about C12.19/C12.22 Device functionality.

Mode: Session-less mode or session-state mode.

6.4.1.2.7.4 Read Service (respondent meters+C12.22 Hosts: required)

~~6.4.1.2.7.4.1~~1.1.1.1.1.1.1 Full table read (required)

If all tables can be read using this mode then this is a minimal requirement.

If some tables cannot be read using this mode then in addition one of the partial table read forms (byte offset/count or element index/count) is required.

~~6.4.1.2.7.4.2~~1.1.1.1.1.1.2 Partial table read byte offset/count (optional)

If some tables cannot be read using the other modes then this form is required.

~~6.4.1.2.7.4.3~~1.1.1.1.1.1.3 Partial table read element offset/count (optional)

If some tables cannot be read using the other modes then this form is required.

~~6.4.1.2.7.4.4~~1.1.1.1.1.1.4 Default table read (optional)

When implemented it reads the preset default table.

6.4.1.2.7.5 Write Service (respondent meters+C12.22 Hosts all: optional)

Support for this service is required only when ANSI C12.19 End Devices are programmable or implement procedures.

~~6.4.1.2.7.5.1~~1.1.1.1.1.1.5 Full table write (required if write service implemented)

If all tables can be written using this mode then this is a minimal requirement.

If some tables cannot be written using this mode then in addition one of the partial table write forms (byte offset/count or element index/count) is required.

~~6.4.1.2.7.5.2~~1.1.1.1.1.1.6 Partial table write byte offset/count (optional)

This service is required when some tables cannot be written using the other modes.

~~6.4.1.2.7.5.3~~1.1.1.1.1.1.7 Partial table write element offset/count (optional)

This service is required when some tables cannot be written using the other modes.

~~6.4.1.2.7.5.4~~1.1.1.1.1.1.8 Default table write (not supported by the Standard)

This service is not available in ANSI C12.22.

6.4.1.2.7.6 Logon Service (respondent meters+C12.22 Hosts all: optional)

Logon Service establishes a session without establishing access permissions.

This service is required if there is no way to establish C12.22 peer-to-peer Node association in support of complex and lengthy transactions with the possibility of transaction rollback (cancellation).

Also supports audit requirements of ANSI C12.19.

Note: This is really a required service for SmartGrid especially across wide-area heterogeneous network implementations.

6.4.1.2.7.7 Security Service (respondent meters+C12.22 Hosts all: optional)

The Security Service is provided for setting access permissions to tables (not to be confused with APDU content security).

Note: When a read or write service is implemented then security should also be implemented if it is possible to modify the tables.

6.4.1.2.7.8 Logoff Service (respondent meters+C12.22 Hosts all: optional, all: required if Logon implemented)

The Logoff Service provides for an orderly termination of the session that was established by the Logon Service and leads to the completion of the processing of all transactions that were carried during that session.

6.4.1.2.7.9 Terminate Service (all: optional, all: required if Logon implemented)

The Terminate Service provides for an orderly abortion of the Session that was established by the Logon Service.

6.4.1.2.7.10 Disconnect Service (respondent meters+C12.22 Hosts all: optional, all: required MGMT)

The Disconnect Service is used to remove a C12.22 Node from the C12.22 Network Segment. The service is required for interoperability if the nodes can be instructed to get off the network.

All peer-to-peer associations across the interface of the C12.22 Node on the C12.22 Network segment that processed this request shall terminate. The C12.22 Node's settings shall reset to their default off-line state values for that C12.22 Network Segment.

Note: If not implemented it impedes interoperability.

6.4.1.2.7.11 Wait Service (respondent meters+C12.22 Hosts all: optional, all: required if Logon supported)

The Wait Service is used to maintain an established Session during idle periods, thus preventing automatic termination.

6.4.1.2.7.12 Registration Service (all: required, MGMT)

To be part of a C12.22 Network, a C12.22 Node shall send a Registration Service request to one of the C12.22 Master Relays. This service is also required for asset management and SmartGrid / AMI application service management.

6.4.1.2.7.13 De-registeration Service (all: required, MGMT)

This service provides ANSI C12.22 service discontinuation notification to all of the C12.22 Master Relay Authentication and Notification hosts.

6.4.1.2.7.14 Resolve Service (all: required, MGMT)

The Resolve Service is used to retrieve the native network address of a C12.22 Node. The native address is used to communicate directly with other C12.22 Nodes, such as C12.22 Relays, on the same native network (i.e. for network node discovery).

Mode: On network segments capable of broadcast (or multicast), this service should also be used to retrieve native addresses of C12.22 Relays.

6.4.1.2.7.15 Trace Service (all: optional, MGMT)

The Trace Service is used to retrieve the list of C12.22 Relays that have forwarded this C12.22 Message to a target C12.22 Node across heterogeneous networks.

6.4.1.2.8 EPSEM Service Responses (required)

6.4.1.2.9 Error codes (required)

EPSEM responses always include a one-byte response code

<nok> ::= <sns>|<isss>|<iar>|<sme>|<isc>|<onp>|<bsy>|<dlk>|

<dnr>|<rno>|<uat>|<netr>|<nett>|<rqtl>|<rstl>|<sgnp>|<sgerr>|<err>

6.4.1.2.10 Application Timers

6.4.1.2.10.1 Application Session-mode Timeout (required)

Each session established with a C12.22 Server shall be monitored by the C12.22 Server and shut down when the session becomes inactive.

The Session Time-out value is set by the Logon Service request and can be temporarily modified for the next request through the use of the Wait Service.

Note: Interoperability requires support for Logon (for sessions) and Wait (for timeout).

6.4.1.2.10.2 Application Layer Response Time-out (required)

The Application Layer Response Timeout is used by a C12.22 Node that issues service requests to another C12.22 Node and needs to know how long to wait for responses.

A non-recoverable Application Layer Response Timeout shall terminate the associated session if one exists.

6.4.1.2.11 Compliance with Normative Sections of ANSI C12.22 (required)

All specifications cited in all normative sections that touch upon the required and optional services cited above shall be implemented for compliance and interoperability.

6.4.1.2.12 C12.22 Communication Module (optional)

The use or presence of a C12.22 Communication module is not pertinent for the SmartGrid operations. It is only pertinent for the interoperability and assets used to build C12.22 Nodes from the two parts a C12.22 Communication Module + a C12.22 Device.

6.4.1.2.13 C12.22 Local Optical Port (required)

The use or presence of a C12.22 Local (optical) port (that is compatible backward with ANSI C12.18) is pertinent for the SmartGrid operations and deployment. It is pertinent for the interoperability and provision of guaranteed and reliable access to the C12.22 Node under conditions where it may not be possible or desirable to access the C12.22 Node from the C12.22 Network Segment.

6.4.1.2.14 C12.22/C12.19 Network Support Tables (required)

6.4.1.2.14.1 C12.22/C12.19 Network Tables (all C12.22 Nodes: required)

Provide information and list tables that are used and assumed operational limits.

6.4.1.2.15 C12.22/C12.19 Relay Tables (C12.22 Relays only: required)

Provide information and list tables that are used and assumed operational limits.

6.4.1.2.16 Security-key and Authentication Tables (all C12.22 Nodes: required)

Described the Network Security Access models required and supported by this Standard. Include clear-text, plain-text and cipher-text messaging. Include message acceptance and rejection windows. Include multicast and uni-cast requirements. Provide information and list tables that are used and assumed operational limits in support of the security models described.

6.4.1.3 *ANSI C12.22 Application Messaging Using the Internet Protocol*

The interface transport protocol used by C12.22 IP Nodes shall be as defined by [14], IETF RFC C1222 Transport Over IP - 2009: Draft ANSI C12.22, IEEE 1703 and MC1222 Transport Over IP, A. Moise et. al.

7.0 C12.19 Data Model General Requirements

The five meter classifications listed are near-future projections for revenue applications with requirements for reasonably high functionality. The single-phase meters might be applied at the service of a small commercial or special residential customer. One of the polyphase meters (in either a self contained or transformer-rated configuration) might be applied on a commercial or small industrial account requiring more data. The highest functionality type of meter are for industrial or other special accounts with high conventional data requirements.

These projections of functionality assume the quantities in general usage for most billing applications will not change dramatically in the near future. In addition, the remote retrieval of data will add functional requirements that increase customer service quality and provide the Utility with operating information. These selections and recommendations represent a compromise by the working group on practical requirements versus design capabilities found within ANSI C12.19. Future developments in the utility industry may quickly change the functions required. Because the mechanisms exist in ANSI C12.19 to accommodate innovation and change when implemented holistically as a system, the user is not confined or bound when following these guidelines. The guidelines are simply one expression of the capability of the Standard while using "standard tables" to reflect conventional functionality.

1. Residential single phase
2. Commercial polyphase
3. Industrial polyphase

The following lists the various smart meter classifications recommended to be used for billing applications at most utilities. These classifications are currently represented in existing product lines from multiple sources and are expected to continue for the foreseeable future. Some variation in parameters from utility to utility may be expected according to individual requirements for billing rates and tariffs. For example, demand may be accumulated in either block or sliding

mode. Demand interval lengths may vary from rates to rate, and there may be sub-intervals. Current production devices have been designed to accommodate this variability. It is expected that devices complying with the guidelines would continue that flexibility. In addition, remote communications to the meter, either network or dial-up, will facilitate the use of customer service information and will become an expectation rather than an exception.

7.1 Meter Classifications

The minimum functionality requirements for the device classes listed below are also delineated in Table 7.2.1 and Table 7.2.2. It is understood that the utilities may use some or all of the defined functionality, as dictated by their business model and/or customer/regulatory requirements.

7.1.1 Residential Single Phase; Self-contained, Class 200 or 320 amps

7.1.1.1 *The minimum revenue billing data functionality requirements are:*

1. Energy (Default) KWH delivered Register Only
2. KWH received Register Only
3. Energy Net Metering (Delivered - Received) Register Only
4. Energy Detent Metering (Delivered, disable received) Register Only
5. Energy Secure Metering (Delivered + Received) Register Only
6. Demand (Block or Rolling Sub) kW Register Only
7. Instantaneous KW Register Only
8. TOU 4 Tiers
9. TOU 4 Tiers + CPP Tier
10. More Than 4 TOU Tiers
11. Up to 4 Daily Schedules (weekdays, Sat , Sun, Holiday)
12. Up to 4 Seasons
13. 2 TOU Registers (current and previous Season)
14. Real Time Pricing Tier
15. Reactive Energy KVARH delivered (Q1+Q2)
16. Apparent Energy (KVAh)
17. Load Profile (2 Chanels) 1st Channel Default kW

7.1.1.2 *The minimum operational data functionality requirements are:*

1. Outage/Restoration Reporting
2. Tamper Detection Reporting
3. Voltage Min/Max During Reporting Period
4. Integrated Voltage for Period (average voltage)
5. Instantaneous Voltage
6. Other Power Quality Reporting
7. Event Log
8. Disconnect Count
9. Disconnect Status
10. HAN Interface

11. HAN Interface Firmware
12. Optical Port
13. Voltage & Current Phase Angle Measurements (Phasor Analysis)

7.1.2 Residential Single Phase; Transformer Rated, 10 or 20 amps

7.1.2.1 *The minimum revenue billing data functionality requirements are:*

1. Energy (Default) KWH delivered Register Only
2. KWH received Register Only
3. Energy Net Metering (Delivered - Received) Register Only
4. Energy Detent Metering (Delivered, disable received) Register Only
5. Demand (Block or Rolling Sub) kW Register Only
6. Instantaneous KW Register Only
7. TOU 4 Tiers
8. TOU 4 Tiers + CPP Tier
9. More Than 4 TOU Tiers
10. Up to 4 Daily Schedules (weekdays, Sat , Sun, Holiday)
11. Up to 4 Seasons
12. 2 TOU Registers (current and previous Season)
13. Real Time Pricing Tier
14. Reactive Energy KVARH delivered (Q1+Q2)
15. Apparent Energy (KVAh)
16. Load Profile (2 Channels) 1st Channel Default kW

7.1.2.2 *The minimum operational data functionality requirements are:*

1. Outage/Restoration Reporting
2. Tamper Detection Reporting
3. Voltage Min/Max During Reporting Period
4. Integrated Voltage for Period (average voltage)
5. Instantaneous Voltage
6. Other Power Quality Reporting
7. Event Log
8. Disconnect Count
9. Disconnect Status
10. HAN Interface
11. HAN Interface Firmware
12. Optical Port
13. Voltage & Current Phase Angle Measurements (Phasor Analysis)

7.1.3 Poly- Phase -Self-contained, 200 or 320 amps

7.1.3.1 *The minimum revenue billing data functionality requirements are:*

1. Energy (Default) KWH delivered Register Only

2. KWH received Register Only
3. Energy Net Metering (Delivered - Received) Register Only
4. Energy Detent Metering (Delivered, disable received) Register Only
5. Energy Secure Metering (Delivered + Received) Register Only
6. Demand (Block or Rolling Sub) kW Register Only
7. Instantaneous KW Register Only
8. TOU 4 Tiers
9. TOU 4 Tiers + CPP Tier
10. More Than 4 TOU Tiers
11. Up to 4 Daily Schedules (weekdays, Sat , Sun, Holiday)
12. Up to 4 Seasons
13. 2 TOU Registers (current and previous Season)
14. Real Time Pricing Tier
15. Reactive Energy KVARH delivered (Q1+Q2)
16. Apparent Energy (KVAh)
17. Load Profile (2 Channels) 1st Channel Default kW
18. Load Profile (4 Channels) 1st Channel Default kW

7.1.3.2 ***The minimum operational data functionality requirements are***

1. Outage/Restoration Reporting
2. Tamper Detection Reporting
3. Voltage Min/Max During Reporting Period
4. Integrated Voltage for Period (average voltage)
5. Instantaneous Voltage
6. Harmonic Measurements
7. Other Power Quality Reporting
8. Event Log
9. Disconnect Count
10. Disconnect Status
11. HAN Interface
12. HAN Interface Firmware
13. Optical Port
14. Voltage & Current Phase Angle Measurements (Phasor Analysis)

7.1.4 Commercial Poly- Phase -Transformer Rated, 10 or 20 amps

7.1.4.1 ***The minimum revenue billing data functionality requirements are:***

1. Energy (Default) KWH delivered Register Only
2. KWH received Register Only
3. Energy Net Metering (Delivered - Received) Register Only

4. Energy Detent Metering (Delivered, disable received) Register Only
5. Energy Secure Metering (Delivered + Received) Register Only
6. Demand (Block or Rolling Sub) kW Register Only
7. Instantaneous KW Register Only
8. TOU 4 Tiers
9. TOU 4 Tiers + CPP Tier
10. More Than 4 TOU Tiers
11. Up to 4 Daily Schedules (weekdays, Sat , Sun, Holiday)
12. Up to 4 Seasons
13. 2 TOU Registers (current and previous Season)
14. Real Time Pricing Tier
15. Reactive Energy KVARH delivered (Q1+Q2)
16. Reactive Energy KVARH received (Q3+Q4)
17. Four Quadrant Reactive Energy
18. Apparent Energy (KVAh)
19. Load Profile (2 Channels) 1st Channel Default kW
20. Load Profile (4 Channels) 1st Channel Default kW
21. Load Profile (more than 4 channels) 1st Channel Default kW
22. Transformer and Line Loss Compensation

7.1.4.2 ***The minimum operational data functionality requirements are:***

1. Outage/Restoration Reporting
2. Tamper Detection Reporting
3. Voltage Min/Max During Reporting Period
4. Integrated Voltage for Period (average voltage)
5. Instantaneous Voltage
6. Harmonic Measurements
7. Other Power Quality Reporting
8. Event Log
9. Disconnect Count
10. Disconnect Status
11. HAN Interface
12. HAN Interface Firmware
13. Optical Port
14. Voltage & Current Phase Angle Measurements (Phasor Analysis)

7.1.5 Industrial Polyphase

7.1.5.1 ***The minimum revenue billing data functionality requirements are:***

1. Energy (Default) KWH delivered Register Only

2. KWH received Register Only
3. Energy Net Metering (Delivered - Received) Register Only
4. Energy Detent Metering (Delivered, disable received) Register Only
5. Energy Secure Metering (Delivered + Received) Register Only
6. Demand (Block or Rolling Sub) kW Register Only
7. Instantaneous KW Register Only
8. TOU 4 Tiers
9. TOU 4 Tiers + CPP Tier
10. More Than 4 TOU Tiers
11. Up to 4 Daily Schedules (weekdays, Sat , Sun, Holiday)
12. Up to 4 Seasons
13. 2 TOU Registers (current and previous Season)
14. Real Time Pricing Tier
15. Reactive Energy KVARH delivered (Q1+Q2)
16. Reactive Energy KVARH received (Q3+Q4)
17. Four Quadrant Reactive Energy
18. Apparent Energy (KVAh)
19. Load Profile (2 Channels) 1st Channel Default kW
20. Load Profile (4 Channels) 1st Channel Default kW
21. Load Profile (more than 4 channels) 1st Channel Default kW
22. Transformer and Line Loss Compensation

7.1.5.2 ***The minimum operational data functionality requirements are:***

1. Outage/Restoration Reporting
2. Tamper Detection Reporting
3. Voltage Min/Max During Reporting Period
4. Integrated Voltage for Period (average voltage)
5. Instantaneous Voltage
6. Harmonic Measurements
7. Other Power Quality Reporting
8. Event Log
9. Disconnect Count
10. Disconnect Status
11. HAN Interface
12. HAN Interface Firmware
13. Optical Port
14. Voltage & Current Phase Angle Measurements (Phasor Analysis)

7.2 Data Model General Requirements

The following tables define the minimum requirements and functionality supported by these Guidelines.

7.2.1 Revenue Billing Data Requirements

	Smart Grid Meter Category				
Revenue Billing Data Requirements	Residential Single Phase Self Contained (Class 200 & 320)	Residential Single Phase Transformer rated (Class 10 & 20)	Commercial Polyphase Self Contained (Class 200 & 320)	Commercial Polyphase Transformer Rated (Class 10 & 20)	Industrial Polyphase Transformer Rated (Class 10 & 20)
Energy (Default) KWH delivered Register Only	X	X	X	X	X
KWH received Register Only	X	X	X	X	X
Energy Net Metering (Delivered - Received) Register Only	X	X	X	X	X
Energy Detent Metering (Delivered, disable received) Register Only	X	X	X	X	X
Energy Secure Metering (Delivered + Received) Register Only	X	X	X	X	X
Demand (Block or Rolling Sub) kW Register Only	X	X	X	X	X
Instantaneous KW Register Only	X	X	X	X	X
TOU 4 Tiers	X	X	X	X	X
TOU 4 Tiers + CPP Tier	X	X	X	X	X
More Than 4 TOU Tiers	X	X	X	X	X
Up to 4 Daily Schedules (weekdays, Sat , Sun, Holiday)	X	X	X	X	X
Up to 4 Seasons	X	X	X	X	X
2 TOU Registers (current and previous Season)	X	X	X	X	X
Real Time Pricing Tier	X	X	X	X	X
Reactive Energy KVARH delivered	X	X	X	X	X

Revenue Billing Data Requirements	Smart Grid Meter Category				
	Residential Single Phase Self Contained (Class 200 & 320)	Residential Single Phase Transformer rated (Class 10 & 20)	Commercial Polyphase Self Contained (Class 200 & 320)	Commercial Polyphase Transformer Rated (Class 10 & 20)	Industrial Polyphase Transformer Rated (Class 10 & 20)
(Q1+Q2) Reactive Energy KVARH received				X	X
(Q3+Q4) Four Quadrant Reactive Energy				X	X
Apparent Energy (KVAh)	X	X	X	X	X
Load Profile (2 Chanels) 1st Channel Default kW	X	X	X	X	X
Load Profile (4 Channels) 1st Channel Default kW			X	X	X
Load Profile (more than 4 channels) 1st Channel Default kW				X	X
Transformer and Line Loss Compensation				X	X

7.2.2 Operational Requirement Data ("Metadata" Not Critical To Billing)

Operational Requirement Data ("Metadata" Not Critical To Billing)	Smart Grid Meter Category				
	Residential Single Phase Self Contained (Class 200 & 320)	Residential Single Phase Transformer rated (Class 10 & 20)	Commercial Polyphase Self Contained (Class 200 & 320)	Commercial Polyphase Transformer Rated (Class 10 & 20)	Industrial Polyphase Transformer Rated (Class 10 & 20)
Outage/Restoration Reporting	X	X	X	X	X
Tamper Detection Reporting	X	X	X	X	X
Voltage Min/Max During Reporting Period	X	X	X	X	X
Integrated Voltage for Period (average voltage)	X	X	X	X	X
Instantaneous Voltage	X	X	X	X	X
Harmonic Measurements			X	X	X

Operational Requirement Data ("Metadata" Not Critical To Billing)	Smart Grid Meter Category				
	Residential Single Phase Self Contained (Class 200 & 320)	Residential Single Phase Transformer rated (Class 10 & 20)	Commercial Polyphase Self Contained (Class 200 & 320)	Commercial Polyphase Transformer Rated (Class 10 & 20)	Industrial Polyphase Transformer Rated (Class 10 & 20)
Other Power Quality Reporting	X	X	X	X	X
Event Log	X	X	X	X	X
Disconnect Count	X	X	X	X	X
Disconnect Status	X	X	X	X	X
HAN Interface	X	X	X	X	X
HAN Interface Firmware	X	X	X	X	X
Optical Port	X	X	X	X	X
Voltage & Current Phase Angle Measurements (Phasor Analysis)	X	X	X	X	X
*Device Descriptors and Protocol Descriptors To Be Discussed					

~~**7.3TO DO Section**~~

~~Define terms here:~~

~~1.TO DO: count number of tables which need to be specified, (Refer to NBR_PERM_USED, Table 3141, Column 1)~~

~~I think that this should be worded as follows:~~

~~a.NBR_PERM_USED in security tables shall be large enough to provide individual table security attributes for all accessible tables; and~~

~~b.Display tables selections should be set to allow xxx final elements to be selected in up to yyy display lists.~~

~~2.FLC/FLC+1 requirements (see definitions and Standard) state that if FLC+1 is writable then FLC shall be available; otherwise FLC+1 or FLC or both shall be present, i.e. do not refer or require FLC if FLC+1 is present and not writable.~~

~~3.DEVICE_ID and IDNETIFICATION in tables 5/6 shall be identical.~~

8.0 C12.19 Registered Semantic Models

8.1 Common Requirements

8.1.1 Classification of Features

The following subsections list the complete Tables and Procedures inventory of ANSI C12.19 and related communication protocols. The Tables and Procedures are each associated with communication properties and attributes. Of special significance is the accessibility attribute, which determines the user's ability to access or to modify the related elements values. The accessibility attribute **AM** tag is described below.

AM	Description
W	The end device Table entity (or entries) are expected to be writable by the user (utility, programmer) in accordance with access security constraints. A writable table shall also be readable by the user (utility, programmer) in accordance with access security constraints. Some exception may apply to certain Table elements (e.g. Table 42 – PASSWORD, which may be read back as random text due to security considerations).
R	The end device Table entity (or entries) should not be writable by the user (utility, programmer).

All end devices, regardless of type, being residential single phase meters, commercial polyphase meters, or Industrial polyphase meters, may support one or more of the features listed in the table below.

Feature ID	Feature Name	Feature Description
FA	All devices	An AMI end device that records data with no special or extra capability
FD	Demand	An end device that in addition to being a simple end device (FA) also supports demand measurements.
FT	TOU	An end device that in addition to being a simple end device (FA) also supports time-of-use measurements.
FS	Self-read	An end device that in addition to being a simple end device (FA) also supports trigger-based or calendar-based capture of historical or metrological data or measurements.
FL	Load Profile	An end device that in addition to being a simple end device (FA) also supports load profile recorder measurements.
FQ	Quality-of-service	An end device that in addition to being a simple end device (FA) also supports quality of service measurement (e.g. power quality measurement and waveform capture.)
FH	History logs	An end device that in addition to being a simple end device (FA) also supports session and activity logging.
FE	Event logs	An end device that in addition to being a simple end device (FA) also supports secured audit logs that capture firmware upgrade/updates changes, secured register reading and tracking of end device programming to metrological tables.
FC	Load Control	An end device that in addition to being a simple end device (FA) also supports load control capability or remote switch (connect/disconnect) functions.
FR	Demand Response and Real-time Pricing	An end device that in addition to being a simple end device (FA) also supports load real-time-pricing and interactions with the customer in support of demand response requirements.

8.1.2 Standard Tables Needed

The following chart lists the standard tables from ANSI C12.19 that are needed for interoperability for the feature described by these guidelines in the previous section. A mandatory table is tagged with a “M” and an optional Table is tagged with an “O”. “M” and “O” tags that are grayed out represent inherited features from the minimum subset represented by column “FA”. If such a feature is listed as mandatory in the “FA” column then it shall be mandatory throughout. If such a feature is listed as optional in the “FA” column then it may be optional throughout, unless called for specifically by an end device feature.

The charts shown below apply primarily to end devices that are also meters. When the end device acts strictly as a C12.22 Master Relay or a C12.22 Relay then it is exempt from implementing decades 1, 2, 3, and 14. For more details consult the charges in below.

Decade 0 – General Configuration Tables				Features								
	Table Number and Name	AM	FA	FD	FT	FS	FL	FQ	FH	FE	FC	FR
0	General Configuration	R	M	M	M	M	M	M	M	M	M	M
1	General Manufacturer Identification	R	M	M	M	M	M	M	M	M	M	M
2	Device Nameplate	W	M	M	M	M	M	M	M	M	M	M
3	End Device Mode Status	R	M	M	M	M	M	M	M	M	M	M
4	Pending Status	R	M	M	M	M	M	M	M	M	M	M
5	Device Identification	W	M	M	M	M	M	M	M	M	M	M
6	Utility Information*	W	M	M	M	M	M	M	M	M	M	M
7	Procedure Initiate	W	M	M	M	M	M	M	M	M	M	M
8	Procedure Response	R	M	M	M	M	M	M	M	M	M	M
9												

* COORDINATE_1, COORDINATE_2 and COORDINATE_3 are redefined to contain the end device location coordinates. Each coordinate encoded as STRING(10) that holds a floating point string number (see C12.19 / BNF. floatingPointCHAR for encoding details) as follows: LATITUDE_N (in decimal degrees and fraction of a degree, positive values are North of the equator), LONGITUDE_E (in decimal degrees and fraction of a degree, positive values are east of the Prime Meridian) and ALTITUDE_M (in meters and fraction of a meter, positive values are above sea level). For example the latitude 33° 45′ 18″ N, longitude 84° 23′ 24″ W and altitude 308m shall be encoded in LATITUDE_N = “33.755”, LONGITUDE_E = “-84.39” and ALTITUDE = “308.0” (Atlanta WGS84). When not in used these elements should each be filled with ten (10) spaces (20_H).

	Decade 1 – Data Source Tables			Features								
	Table Number and Name	AM	FA	FD	FT	FS	FL	FQ	FH	FE	FC	FR
10	Data Source Dimension Limits	R	M	M	M	M	M	M	M	M	M	M
11	Actual Data Sources Limiting	W	M	M	M	M	M	M	M	M	M	M
12	Units of Measure Entry	W	M	M	M	M	M	M	M	M	M	M
13	Demand Control	W	M	M	M	M	M	M	M	M	M	M
14	Data Control	W	O	O	O	O	O	O	O	O	O	O
15	Constants Table	W	M	M	M	M	M	M	M	M	M	M
16	Source Definition	W	M	M	M	M	M	M	M	M	M	M
17	Transformer Loss Compensation	W	O*	O	O	O	O	O	O	O	O	O
18												
19												

* Transformer based End Devices only.

	Decade 2 – Register Tables			Features								
	Table Number and Name	AM	FA	FD	FT	FS	FL	FQ	FH	FE	FC	FR
20	Register Dimension Limits	R	M	M	M	M	M	M	M	M	M	M
21	Actual Register Limiting	W	M	M	M	M	M	M	M	M	M	M
22	Data Selection	W	O	M	M	M	O	O	O	O	O	O
23	Current Register Data	R	O*	M	M	M	O	O	O	O	O	O
24	Previous Season Data	R	O†	O	O	O	O	O	O	O	O	O
25	Previous Demand Reset Data	R	O†	M	M	M	O	O	O	O	O	O
26	Self-read Data	R	O†	O	O	M	O	O	O	O	O	O
27	Present Register Selection	W	M	M	M	M	M	M	M	M	M	M
28	Present Register Data	R	M	M	M	M	M	M	M	M	M	M
29												

* When this table is present in the End Device then Table 22 shall also be present.

† When this table is present in the End Device then Table 22 and 23 shall also be present.

	Decade 3 – Local Display Tables*	Features										
	Table Number and Name	AM	FA	FD	FT	FS	FL	FQ	FH	FE	FC	FR
30	Display Dimension Limits	R	M	M	M	M	M	M	M	M	M	M
31	Actual Display Limiting	W	M	M	M	M	M	M	M	M	M	M
32	Display Source	W†	M	M	M	M	M	M	M	M	M	M
33	Primary Display List	W	M	M	M	M	M	M	M	M	M	M
34	Secondary Display List	W‡	O	O	O	O	O	O	O	O	O	O
35												
36												
37												
38												
39												

* Local display represents any display that is controlled by the End Device.

† When registering a device class, the End Device Manufacturer should register a device class that overrides the definition of DISP_SOURCE_DESC_RCD.DISPLAY_SOURCE to provide the missing display identifications and format characteristics.

‡ The secondary display list may be used to drive a remote in-home display.

	Decade 4 – Security Tables‡	Features										
	Table Number and Name	AM	FA	FD	FT	FS	FL	FQ	FH	FE	FC	FR
40	Security Dimension Limits	R	M	M	M	M	M	M	M	M	M	M
41	Actual Security Limiting	W	M	M	M	M	M	M	M	M	M	M
42	Security*	W	M	M	M	M	M	M	M	M	M	M
43	Default Access Control	W	M	M	M	M	M	M	M	M	M	M
44	Access Control	W	M	M	M	M	M	M	M	M	M	M
45	Key	W	O†	O	O	O	O	O	O	O	O	O
46	Extended Key	W	M	M	M	M	M	M	M	M	M	M
47	Host Access Security	W	M	M	M	M	M	M	M	M	M	M
48												
49												

* Contains the Table access roles that are bound to passwords. Access roles are independent of the manner in which the tables are transported. Implementers of the ANSI C12.21 protocol should ensure that passwords that used by ANSI C12.18, optical-port access, are disables when the End Device is accessed by ANSI C12.21, and visa versa. This can be accomplished by assigning the first *n* of ACT_SECURITY_LIMITING_TBL.NBR_PASSWORDS passwords in the list to ANSI C12.18 protocol access and the remainder to ANSI C12.21 protocol. All passwords may be used by ANSI C12.22 since it provides for password encryption.

† Mandatory when the End Device (or Comm. Module) implements the ANSI C12.21 protocol.

‡ Although some secured Elements within tables may be read back, some of values reported back are not defined in order to avoid revealing secured information when read back.

Decade 5 – Time and Time-of-Use Tables		Features										
	Table Number and Name	AM	FA	FD	FT	FS	FL	FQ	FH	FE	FC	FR
50	Time and TOU Dimension Limits	R	M	M	M	M	M	M	M	M	M	M
51	Actual Time and TOU Limiting	W	M	M	M	M	M	M	M	M	M	M
52	Clock	R	M†	M	M	M	M	M	M	M	M	M
53	Time Offset	W	M	M	M	M	M	M	M	M	M	M
54	Calendar	W	O*	O	M	M	O	O	O	O	O	O
55	Clock State	R	O	O	M	O	O	O	O	O	O	O
56	Time Remaining	R	O	M	M	M	M	O	O	O	O	O
57	Precision Clock State	R	O†	O	O	O	O	M	O	O	O	O
58												
59												

* If the End Device internal clock requires a "calendar action" to switch daylight saving on/off then Table 54 is mandatory as an "FA" feature.

†The operator of the End Device should always set the clock.

Decade 6 – Load Profile Tables		Features										
	Table Number and Name	AM	FA	FD	FT	FS	FL	FQ	FH	FE	FC	FR
60	Load Profile Dimension Limits	R	O*	O	O	O	M	O	O	O	O	O
61	Actual Load Profile Limiting	W	O*	O	O	O	M	O	O	O	O	O
62	Load Profile Control	W	O	O	O	O	M	O	O	O	O	O
63	Load Profile Status	R	O	O	O	O	M	O	O	O	O	O
64	Load Profile Data Set One	R	O	O	O	O	M	O	O	O	O	O
65	Load Profile Data Set Two	R	O	O	O	O	O	O	O	O	O	O
66	Load Profile Data Set Three	R	O	O	O	O	O	O	O	O	O	O
67	Load Profile Data Set Four	R	O	O	O	O	O	O	O	O	O	O
68												
69												

* Mandatory (M) if any tables in Decade 6 are implemented by the End Device.

Decade 7 – History Log & Event Log Tables		Features										
	Table Number and Name	AM	FA	FD	FT	FS	FL	FQ	FH	FE	FC	FR
70	Log Dimension Limits	R	M*	M	M	M	M	M	M	M	M	M
71	Actual Log Limiting	W	M*	M	M	M	M	M	M	M	M	M
72	Events Identification	W	M*	M	M	M	M	M	M	M	M	M
73	History Log Control	W	O	O	O	O	O	O	M	O	O	O
74	History Log Data	R	O	O	O	O	O	O	M	O	O	O
75	Event Log Control	W	M†	M	M	M	M	M	M	M	M	M
76	Event Log Data	R	M†	M	M	M	M	M	M	M	M	M
77	Event Log and Signatures Enable	W	M†	M	M	M	M	M	M	M	M	M
78	End Device Program State	R	M†	M	M	M	M	M	M	M	M	M
79	Event Counters	R	M†	M	M	M	M	M	M	M	M	M

* Mandatory (M) if any tables in Decade 7 are implemented by the End Device.

† Event log tables are not mandatory (M) when the End Device does not support secured register reads, and its firmware is not upgradable/updatable and its metrological parameters cannot be re-programmed.

Decade 8 – User-defined Tables		Features										
	Table Number and Name	AM	FA	FD	FT	FS	FL	FQ	FH	FE	FC	FR
80	User-defined Tables Dimension Limits	R	O*	O	O	O	O	O	O	O	O	O
81	Actual User-defined Tables Limiting	W	O*	O	O	O	O	O	O	O	O	O
82	User-defined Tables List Table	W	O*	O	O	O	O	O	O	O	O	O
83	User-defined Tables Selections	W	O*	O	O	O	O	O	O	O	O	O
84	User-defined Table Zero	R	O*	O	O	O	O	O	O	O	O	O
85	User-defined Table Zero	R	O*	O	O	O	O	O	O	O	O	O
86	User-defined Table One	R	O*	O	O	O	O	O	O	O	O	O
87	User-defined Table Two	R	O	O	O	O	O	O	O	O	O	O
88	User-defined Table Three	R	O	O	O	O	O	O	O	O	O	O
89	User-defined Table Four	R	O	O	O	O	O	O	O	O	O	O

* Mandatory (M) if any tables in Decade 8 are implemented by the End Device. Use of Extended User Defined Tables is mandatory by these guidelines.

Decade 9 – Telephone Control Tables				Features								
	Table Number and Name	AM	FA	FD	FT	FS	FL	FQ	FH	FE	FC	FR
90	Telephone Dimension Limits	R	O†	O	O	O	O	O	O	O	O	O
91	Actual Telephone Limiting	W	O†	O	O	O	O	O	O	O	O	O
92	Telephone Global Parameters	W	O*	O	O	O	O	O	O	O	O	O
93	Telephone Call Originate Parameters	W	O*	O	O	O	O	O	O	O	O	O
94	Telephone Call Originate Schedule	W	O†	O	O	O	O	O	O	O	O	O
95	Telephone Call Answer Parameters	W	O*	O	O	O	O	O	O	O	O	O
96	Originating Telephone Call Purpose	R	O*	O	O	O	O	O	O	O	O	O
97	Last Telephone Call Status	R	O*	O	O	O	O	O	O	O	O	O
98	Telephone Call Originate Status	R	O*	O	O	O	O	O	O	O	O	O
99												

* Mandatory (M) if ANSI C12.21 / IEEE 1702 / MC1221 communication protocol is implemented by the end device.

† Mandatory (M) if ANSI C12.21 / IEEE 1702 / MC1221 communication protocol is implemented by the end device. Also, ANSI C12.22 / IEEE 1703 / MC1222 do not provide end device call originating schedule tables. Table 90, 91 and 94 should be used when the end device implements a call originating capability using the network. When call scheduling is used from the network then the members CTRL_BFLD.PRIMARY_PHONE_NUMBER and CTRL_BFLD.SECONDARY_PHONE_NUMBER shall be ignored (redefined to be ignored); use Table 123, Exception Report Configuration Table's APTITLE_NOTIFY corresponding element instead. The APTITLE_NOTIFY element that is associated with scheduled calls shall be any end device access for read event code 7.

Decade 10 – Not Used by ANSI C12.19				Features								
	Table Number and Name	AM	FA	FD	FT	FS	FL	FQ	FH	FE	FC	FR
100	Not Used											
101	Not Used											
102	Not Used											
103	Not Used											
104	Not Used											
105	Not Used											
106	Not Used											
107	Not Used											
108	Not Used											
109	Not Used											

Decade 11 – Load Control and Pricing Tables			Features								
Table Number and Name	AM	FA	FD	FT	FS	FL	FQ	FH	FE	FC	FR
110 Load Control Dimension Limits	R	O*	O	O	O	O	O	O	O	M	M
111 Actual Load Control Limiting	W	O*	O	O	O	O	O	O	O	M	M
112 Load Control Status	R	O	O	O	O	O	O	O	O	M	O
113 Load Control Configuration	W	O	O	O	O	O	O	O	O	M	O
114 Load Control Schedule	W	O	O	O	O	O	O	O	O	M	O
115 Load Control Conditions	W	O	O	O	O	O	O	O	O	M	O
116 Prepayment Status	R	O	O	O	O	O	O	O	O	O	M
117 Prepayment Control	W	O	O	O	O	O	O	O	O	O	M
118 Billing Control	W	O	O	O	O	O	O	O	O	O	M
119											

* Mandatory (M) if any tables in Decade 11 are implemented by the End Device.

Decade 12 – Node Network Control Tables			Features								
Table Number and Name	AM	FA	FD	FT	FS	FL	FQ	FH	FE	FC	FR
120 Node Network Control Dimension Limits	R	M*	M	M	M	M	M	M	M	M	M
121 Actual Node Network Control Limiting	W	M*	M	M	M	M	M	M	M	M	M
122 Interface Control	W	M*	M	M	M	M	M	M	M	M	M
123 Exception Report Configuration	W	O	O	O	O	O	O	O	M*	O	O
124 Filtering Rules Table	W	O†	O	O	O	O	O	O	O	O	O
125 Interface Status	R	M*	M	M	M	M	M	M	M	M	M
126 Registration Status	R	M*	M	M	M	M	M	M	M	M	M
127 Network Statistics Selections	W	O	O	O	O	O	O	O	O	O	O
128 Network Statistics	R	O‡	O	O	O	O	O	O	O	O	O
129											

* Mandatory (M) when the end device is deployed in any AMI / SmartGrid network.

† Provides interface “fire-wall” capability within the end device that are interoperable across any-network.

‡ Mandatory (M) when Table 127, Network Statistics Selections, is implemented.

Decade 13 – Network Relay Control Tables			Features								
Table Number and Name	AM	FA	FD	FT	FS	FL	FQ	FH	FE	FC	FR
130 Relay Network Control Dimension Limits	R	M*	M	M	M	M	M	M	M	M	M
131 Actual Network Relay Limiting	W	M*	M	M	M	M	M	M	M	M	M
132 Registration List	R	M*	M	M	M	M	M	M	M	M	M
133 Static Routing	W	M*	M	M	M	M	M	M	M	M	M
134 Host Notification Table	W	M†	M	M	M	M	M	M	M	M	M
135 Master Relay Assignment	W	M*	M	M	M	M	M	M	M	M	M
136 Dynamic Routing Report	R	M*	M	M	M	M	M	M	M	M	M
138											
139											

* Mandatory (M) when the end device is deployed in any AMI / SmartGrid network and it is a Relay or a Master Relay.

† Mandatory (M) when the end device is deployed in any AMI / SmartGrid network and it is a Mater Relay.

Decade 14 – Extended User-defined Tables			Features								
Table Number and Name	AM	FA	FD	FT	FS	FL	FQ	FH	FE	FC	FR
140 Extended User-defined Tables Function Limiting	R	M	M	M	M	M	M	M	M	M	M
141 Extended User-defined Tables Actual Limits	W	M	M	M	M	M	M	M	M	M	M
142 Extended User-defined Selections	W	M	M	M	M	M	M	M	M	M	M
143 Extended User-defined Constants	W	M	M	M	M	M	M	M	M	M	M
145											
146											
147											
148											
149											

Decade 15 – Quality-of-Service Tables			Features								
Table Number and Name	AM	FA	FR	FT	FS	FL	FQ	FH	FE	FC	FR
150 Quality-of-service Dimension Limits	R	O*	O	O	O	O	M	O	O	O	O
151 Actual Quality-of-Service Limiting	W	O*	O	O	O	O	M	O	O	O	O
152 Quality-of-service Control	W	O	O	O	O	O	M	O	O	O	O
153 Quality-of-service Incidents	R	O	O	O	O	O	M	O	O	O	O
154 Quality-of-service Log	R	O	O	O	O	O	M	O	O	O	O
155 Asynchronous Time-Domain Waveforms	R	O	O	O	O	O	O	O	O	O	O
156 Asynchronous Frequency-Domain Spectrum	R	O	O	O	O	O	O	O	O	O	O
157 Periodic Time Domain Waveforms	R	O	O	O	O	O	O	O	O	O	O
158 Periodic Frequency-Domain Spectrum	R	O	O	O	O	O	O	O	O	O	O
159											

* Mandatory (M) if any tables in Decade 15 are implemented by the End Device.

Decade 16 – One-way Devices Tables			Features								
Table Number and Name	AM	FA	FD	FT	FS	FL	FQ	FH	FE	FC	FR
160 One-way Dimension Limits	R	O*	O	O	O	O	O	O	O	O	O
161 Actual One-way	W	O*	O	O	O	O	O	O	O	O	O
162 One-way Control	W	O	O	O	O	O	O	O	O	O	O
163 One-way Data Table	R	O	O	O	O	O	O	O	O	O	O
164 One-way Commands/Responses/Extended User-defined Tables	R	O	O	O	O	O	O	O	O	O	O
165											
166											
167											
168											
169											

* Mandatory (M) if any tables in Decade 16 are implemented by the End Device.

8.1.3 Standard Procedures Needed

The following chart lists the standard procedures from ANSI C12.19 that are needed for interoperability for the feature described by these guidelines in the previous section. A mandatory procedure is tagged with a “M” and an optional Table is tagged with an “O”. “M” and “O” tags that are grayed out represent inherited features from the minimum subset represented by column “FA”. If such a feature is listed as mandatory in the “FA” column then it shall be mandatory

throughout. If such a feature is listed as optional in the “FA” column then it may be optional throughout, unless called for specifically by an end device feature.

Procedure Number and Name		Features									
		FA	FD	FT	FS	FL	FQ	FH	FE	FC	FR
0	Cold Start	M	M	M	M	M	M	M	M	M	M
1	Warm Start	M	M	M	M	M	M	M	M	M	M
2	Save Configuration	M*	M	M	M	M	M	M	M	M	M
3	Clear Data	O	O	O	O	O	O	O	O	O	O
4	Reset List Pointers	O	O	M	M	M	M	M	M	O	O
5	Update Last Read Entry	O	O	M	M	M	M	M	M	O	O
6	Change End Device Mode	M	M	M	M	M	M	M	M	M	M
7	Clear Standard Status Flags	M	M	M	M	M	M	M	M	M	M
8	Clear Manufacturer Status Flags	O	O	O	O	O	O	O	O	O	O
9	Remote Reset	O	M	M	M	O	O	O	O	O	O
10	Set Date and/or Time	M	M	M	M	M	M	M	M	M	M
11	Execute Diagnostics Procedure	O	O	O	O	O	O	O	O	O	O
12	Activate All Pending Tables	M	M	M	M	M	M	M	M	M	M
13	Activate Specific Pending Tables	M	M	M	M	M	M	M	M	M	M
14	Clear All Pending Tables	M	M	M	M	M	M	M	M	M	M
15	Clear Specific Pending Tables	M	M	M	M	M	M	M	M	M	M
16	Start Load Profile	O	O	O	O	M	O	O	O	O	O
17	Stop Load Profile	O	O	O	O	M	O	O	O	O	O
18	Log In	O†	O	O	O	O	O	O	O	O	O
19	Log Out	O†	O	O	O	O	O	O	O	O	O
20	Initiate an Immediate Call	O‡	O	O	O	O	O	O	O	O	O
21	Direct Load Control	O	O	O	O	O	O	O	O	M	O
22	Modify Credit	O	O	O	O	O	O	O	O	O	M
23	Register	M¥	M	M	M	M	M	M	M	M	M
24	Deregister	M¥	M	M	M	M	M	M	M	M	M
25	Network Interface Control	M¥	M	M	M	M	M	M	M	M	M
26	Exception Report	M¥	M	M	M	M	M	M	M	M	M
27	Clear Pending Call Status	O‡	O	O	O	O	O	O	O	O	O
28	Start Quality-of-service Monitors	O	O	O	O	O	M	O	O	O	O
29	Stop Quality-of-service Monitors	O	O	O	O	O	M	O	O	O	O
30	Start Secured Registers	O	O	O	O	O	O	O	M	O	O

Procedure Number and Name		Features									
		FA	FD	FT	FS	FL	FQ	FH	FE	FC	FR
31	Stop Secured Registers	O	O	O	O	O	O	O	M	O	O
32	Set Precision Date and/or Time	O	O	O	O	O	M	O	O	O	O

* The end device "program" may be "lost" after a "Warm Start" or power restoration if the Save Configuration procedure did not execute to a successful completion.

† The "Log in" / "Log out" Procedures are mandatory (M) in implementations that do not implement a login/logout services in support of role-based table security and audit trail / history log management.

‡ This procedure is mandatory when implementing ANSI C12.21. It is also recommended that implementations of ANSI C12.22 implement this procedure, in this case the PHONE_NUMBER_INDEX should be redefined to be an index into EXCEPTION_REPORT of Table 123 that supplies APTITLE_NOTIFY.

¥ This procedure is mandatory in support of network service establishment, diagnosis, management and end device commissioning.

8.2 AMI Common Requirements

8.2.1 Default Read Schedule

AMI Meters shall be able to:

1. Send all interval read data at least once per day.
2. Recognize and log when it cannot send a scheduled read.

8.2.2 Demand Response

AMI Meters shall be able to:

1. Automatically launch and terminate demand response events, once it has received the event message from the ~~collection engine~~head end.
2. Receive and process demand response event cancellations or reschedule messages.
3. Log demand response events and send acknowledgement of successful receipt of message by the load control device to the ~~collection engine~~head end.

8.2.3 Distributed Generation Support

AMI Meters shall be able to:

1. Be re-programmed remotely to support bi-directional metering. This reprogramming event will be logged in the meter and sent back with the next regular meter read.
2. Respond to a request from an authorized source for present voltage (line-to-line voltage only).

8.2.4 Event/Message Management & Logs

AMI Meter shall be able to:

1. Reject and log messages/requests that are received from unauthorized systems or devices.
2. Send an acknowledgement of receipt of event and informational messages to the ~~collection engine~~head end.
3. Send an acknowledgement of receipt of event and informational messages to the ~~collection engine~~head end within a configurable length of time (>= 60 seconds - this does not include on-demand read scenarios or other time critical response)..
4. Log all messages sent to and received from the ~~collection engine~~head end.
5. Include the following information at a minimum:
   a. Message type;

b. Process status;
c. System/device source;
d. Date/time received or sent (internal meter clock);
e. Event schedule (start and end) date/time (if applicable);
f. Hourly and/or time-of-use price information (if applicable for the event type).

8.2.5 Installation

Upon installation, AMI Meters shall be able to

1. Perform a self diagnostic and detect and log all failures. Utility defined critical failures shall be reported to ~~collection engine~~head end immediately (at a minimum: check sum error, meter failure from firmware upgrade, metrology failure, program or memory failure, time synch failure). Fatal errors can send exception today which is configurable.
2. Communicate to Installer:
   a. Meter health check/diagnostic results
   b. Communications network check results (WAN & HAN)

8.2.6 Internal Clock

AMI Meter's internal clock shall be capable of

1. Being validated with an external time source at least once per day.
2. Automatically synchronizing during the daily time validation if meter time is greater than some configurable value out of synch with the external time source.
3. Automatically flagging during the daily time validation if meter time is greater than some configurable value out of synch with the external time source.
4. Being synchronized within a recording interval, but not at an interval boundary.
5. Logging all successful and failed internal clock time corrections or adjustments.
6. Keeping time even if there is no communication with the network and shall maintain holdover accuracy to ANSI C12.1 specifications.
7. The ~~collection engine~~head end shall validate the internal clock time for AMI Meters and all other field communications components at least once per day and synchronize it with system time if the difference exceeds a configurable tolerance.

8.2.7 Service/Load Control

AMI Meter shall be able to

1. Receive, log, and execute secure load control/curtailment requests, via AMI communications system.
2. Receive load control/curtailment event messages (to be sent to meter display or local display device) that differentiate between predicted (override available) and emergency (no override) energy shortage curtailment requests.
3. Enable a grace period allowing the customer to reduce load after receiving a curtailment event. Grace period shall be configurable based on event type (predicted or emergency).
4. Receive and simultaneously store at least two separate scheduled curtailment requests.
5. Receive, log, and process secure load control/curtailment END messages, so that the curtailment can be ended (with full restoration of service) earlier than specified in the original request.
6. Allow curtailment events to expire (with full restoration of service), if no load restoration message is received before the curtailment end time specified in the curtailment initiation message.
7. Support a curtailment override option at the customer site for non-emergency events. This override function could be implemented directly through the use of a button / data link to the meter or indirectly via communications equipment and back.
8. Monitor and log customer non-compliance with curtailment requests (load level above curtailment threshold). AMI Meters will support this requirement as defined at

the remote communication network AMI profile level. Data is retrieved as regularly scheduled reads as meter log events.

9. If requested, the AMI Meter shall send log of curtailment requests (and corresponding compliance/non-compliance) to the ~~collection engine~~head end within 24 hours for compliance evaluation, and at least once per week for system auditing.
10. Support on-demand request for log of curtailment requests/events (and corresponding compliance/non-compliance).
11. Measure power quality (sags and surges on a one (1) second or faster basis). Harmonics would be useful for a sample of meters, but not required for all meters.
12. Detect loss of voltage on a single leg and report as an outage.

8.2.8 Local Connectivity

Upon completion of proper authorization by the AMI Meter of a field tool, AMI Meters shall be able to:

1. Identify itself to the field tool and provide access to its data and configuration settings at installation time, and later in support of ongoing operations & maintenance activities.
2. Communicate bi-directionally locally (e.g., C12.18 Optical Port) to a field tool.
3. Support local download to a field tool of all AMI Meter and communications data and logs stored in AMI Meter.
4. Provide security / authentication for local AMI Meter data download attempts via optical or RF to ensure downloads can only be executed by authorized utility or third party personnel.
5. Log all local AMI Meter data download attempts.

8.2.9 Memory/Storage

AMI Meters shall able to:

1. Store five (5) minute interval data for a minimum of 45 days for two channels.
2. Store at least the last 100 diagnostic events/errors in a log with a timestamp indicating the occurrence of the event/error.
3. Store at least the last 100 informational messages in a log with a timestamp indicating the receipt of the message.
4. Store at least the last 420 communications events in a log with a timestamp indicating the occurrence of the event.

8.2.10 Meter (Residential)

AMI Meter shall be able to:

1. Act on the meter data request (up to 24 hours of data) within two (2) seconds of the receipt of the request.
2. Start return requests for On Demand meter data (up to seven days of data) within two (2) seconds of the meter receipt of the request.
3. Allow a reconnect event to occur following a disconnect event only after a configurable amount of time (e.g. at least 1 to 2 minutes) has elapsed since the disconnect event.
4. Be remotely limited on demand and have acknowledgement received by the requesting system within 1 minute of request being initiated.
5. Receive, log, and update tariff and rate information received from the ~~collection engine~~head end at midnight on the day it is received, and send an acknowledgement to the ~~collection engine~~head end within five (5) minutes of completed processing.
6. Be remotely configurable to record customer's instantaneous demand (e.g. W or kW) so that it can be displayed on a premise device and/or meter display (and updated as frequently as every three (3) seconds).
7. Transmit utility messages and/or energy information to a display device and/or load control equipment within ten (10) seconds of being received or recorded by the meter.

8. AMI Meter shall be capable of local and remote configuration.
9. Complete remotely initiated meter display configuration requests within 60 seconds of being received.
10. The AMI Meter shall at least daily perform self-tests and have pre-defined fatal and non-fatal errors that can be generated. These would be available in the meter event log if configured and the Utility elects this configuration.
11. AMI Meter shall be capable of reporting a set of events.
12. The set of events to be reported shall be configurable.
13. An AMI Meter that contains an optical port shall support local download to a field tool of all AMI Meter and communications data and logs stored in AMI Meter memory at a minimum rate of 512 bytes per second.

8.2.11 Meter Communications

1. AMI Meters shall be enabled for two-way secure communications with authorized systems and devices. This applies to all communication interfaces including optical port, Home Area Network, and communication back to the Utility.
2. AMI Meter shall have a unique identity to enable targeted messaging and communications (i.e. individually addressable AMI Meters).
3. AMI Meters shall be capable of continuing to record data during a communications failure.
4. AMI Meters shall be capable of keeping an on-board log of communications events:
    a. link fail
    b. link switch
    c. link up
    d. link quality."
5. AMI Meters shall be capable of separately identifying communications event data from metering data to prevent loss of meter data (e.g., interval usage data, demand response events, pricing event data, etc) to excessive communication event messages.

8.2.12 Meter Display - Config

1. AMI Meters shall be able to execute and log meter display provisioning and configuration requests.
2. AMI Meter display shall be capable of being configurable to customize individual information attributes as available or not available for display.

8.2.13 Meter Display - Energy

AMI Meters shall be able to:

1. Be remotely configurable to record the amount of gross and/or net energy consumed and generated (kWh) within the current bill cycle so that it can be displayed on a premise device and/or meter display.
2. Be remotely configurable to record the peak demand in kW (consumed and generated) recorded to date in the current bill cycle with the date/time it occurred so that it can be displayed on a premise device and/or meter display.
3. Be remotely configurable to record the energy consumed and generated in kWh, in time-of-use periods, for energy consumed and generated within the current bill cycle so that it can be displayed on a premise device and/or meter display.
4. Be remotely configurable to record the peak demand (consumed and generated) in kW, in time-of-use-periods, recorded to date in the current bill cycle with the date/time it occurred so that it can be displayed on a premise device and/or meter display.

8.2.14 Meter Display - Info

AMI Meter shall be able to:

1. Communicate information (e.g., price signal, etc.) to any compatible authenticated in-home device including in-home display, smart appliances, PCTs, etc.
2. Provide date and time in "local time", displaying the time in Local Daylight Time or Local Standard Time as appropriate.
3. Externally indicate electric service connect/disconnect status so that it is visible to customer or Utility employee on site.
4. Be configurable to deliver the Meter Tables subject to Utility's permission so that it can be displayed on a premise device and/or meter display.

8.2.15 Metrology

AMI Meter shall be able to:

1. Record self reads at midnight for each register and channel every day.
2. Support interval data collection for energy consumption.
3. Support a minimum of 4 channels of interval data.
4. Support measurement of voltage data (line-to-line) through the load profile channel. This data shall be the average over a programmable interval of 15, 30, or 60 minutes with timestamp.
5. Support measurement of voltage data (line-to-line) and its storage in a profile. This data shall be the average, maximum and minimum over a programmable interval of 15, 30, or 60 minutes with timestamp.
6. Support measurement of peak demand.
7. Support measurement of time-of-use kWh and kW demand.
8. Support interval data of 5, 15, 30, or 60 minutes in length.
9. AMI Meter's recording interval length shall be capable of being remotely configurable.
10. When an AMI Meter gets a re-configuration request where the new configuration changes either the interval length or number of intervals, the meter will be capable of automatically returning the interval data from the previous interval stop time of uploaded data through the end of the current interval. Additionally, the meter will return the current register read.
11. Support bi-directional metering to support distributed generation measurement.
12. Distinguish between a missing interval and zero consumption.
13. Distinguish between a power outage and zero consumption.
14. The ~~collection engine~~head end shall be able to remotely configure the AMI Meter's recording interval length (to all interval lengths supported by the AMI Meter).
15. Support interval data of one (1) minute in length.

8.2.16 Non-Default Read Schedule

1. AMI Meters shall be capable of sending all read data at a frequency configurable down to the meter's interval data recording length.
2. The AMI Meter is fully programmable to any supported interval length. MDMS can request data at the interval length of the AMI Meter for a subset that is interval dependent (less than 2% spread across the system assuming 1 minute intervals or 100% assuming 15 minute intervals) of the system."

8.2.17 On Demand Reads

AMI Meter shall be able to:

1. Respond to requests for on-demand access to meter and log data.
2. Log failed on demand reads (meter unable to respond to on demand request) in the communications log along with all information available to define the cause of the failure. The ~~collection engine~~head end logs failed requests.
3. The communication engine shall be able to automatically issue a remote AMI Meter test upon on-demand read request failure. The AMI Meter shall be able to continuously perform self tests and has pre-defined fatal and non-fatal errors that can be generated. These would be available in the meter event log if configured if the

Utility elects such configuration and will be available on a pull basis, but not a push basis.

8.2.18 Outage Detection / Management

AMI Meters shall be able to:

1. Communicate its energized status (i.e. has voltage).
2. Detect and communicate a power outage at the premise prior to communications loss.
3. Report restoration information (voltage quality and quantity).
4. Disconnect/reconnect switch shall be able to be configured to open during an outage when certain set thresholds are reached. Configuration thresholds should include minimum voltage and duration of that voltage to trigger disconnects. For over-voltage, maximum voltage and duration will also be supported.
5. Reconnect automatically (i.e., close disconnect/reconnect switch) after voltage has returned to and remained within configurable voltage thresholds for a configurable amount of time (e.g., voltage is within limits and remained above 90% of nominal voltage for at least 3 sec.)

8.2.19 Prepayment Metering

1. AMI prepayment Meters shall use C12.19 Standard Tables and Procedures for this purpose.

8.2.20 Service Switch

AMI Meter shall be able to:

1. Be remotely disconnected / reconnected.
2. Remain energized and continue to monitor and record consumption (i.e. zero consumption for each interval) when disconnect switch is the open/disconnected position.
3. Be remotely disconnected/ reconnected on demand.
4. Detect duplicate service disconnect/ reconnect events and ignore the duplicate events (e.g. Meter is already on -- reconnect event accepted with no action taken).
5. Cancel or update/reschedule scheduled disconnect/ reconnect events prior to their completion.
6. Send a meter read and acknowledgement to the ~~collection engine~~head end upon a successfully completed or failed electric service disconnect/ reconnect event.
7. Enable an Utility Employee working on-site at the customer premise to be able to physically operate its service disconnect/reconnect switch through the optical port or via applicable remote communication network (e.g., ZigBee, HAN, RF) at any time (including when the communication network is down).
8. Support an external authorization/ authentication routine (i.e. by remote systems or field tool) to enable only active and eligible Utility employees to operate its service disconnect/reconnect switch on-site at the customer premise.
9. Allow authorized Utility employee (while on-site at the customer premise) to operate the service disconnect/reconnect switch immediately (regardless of interval) or to schedule a connect/ disconnect for a future interval.
10. Log date/time and status of attempts to operate the service disconnect/reconnect switch remotely or on-site at the customer premise. Log entries will include requesting user or system identity and authorization status.
11. Send a command result back to the requesting system with the result of the service switch command including response codes of "Success" or "Failed" with reason codes in the event of a failure.
12. Should a disconnect event and reconnect event be scheduled to occur for the same AMI Meter on the same day, AMI Meter shall be able to log the events and automatically provide an on-demand read to the ~~collection engine~~head end without operating the disconnect/reconnect switch.

13. If the AMI meter detects load side voltage during a connect, the meter shall not complete the connect and shall send a failure command result back to the requesting system.
14. Determine if there is load side voltage "before" and "after" processing a remote service switch command.
15. Provide the requesting system a failure command result (e.g., Job EndPoint Does Not Support This Operation) if the meter receives a connect or disconnect command request but the meter does not have an integrated service switch.
16. Receive and process remote service switch connect or disconnect command and provide command results to the requesting system by receiving one command from the requesting system (i.e., second command for command result not required).
17. Be configurable to not provide an IDR read (interval data) when completing a service switch connect or disconnect command.
18. Execute connect/disconnect commands upon receipt.
19. The AMI meter shall have the ability to receive and process commands to "open or close" the service switch based on a command received locally through an optical port or remote communication network from the Utility employee (e.g., OpenWay Tool).
20. Log, reject, and send an command result to the requesting system when remote service switch commands received either locally or remotely that cannot be authenticated.
21. The AMI meter shall be capable of providing the following information (command result) back to the requesting system after processing a service switch command
    a. Date/time command processed:
    b. ~~Collection Engine~~Head end Job ID
    c. Meter ID
    d. Message ID Result (only one command result, actual text TBD):
    e. Success =
    f. Disconnect success
    g. Reconnect success
    h. Failure =
    i. Disconnect failed
    j. Reconnect failed
    k. Load Side voltage present during reconnect
    l. Job Endpoint Does not support this operation"
22. Successfully process remote service switch commands as requested (i.e. open or close) and provide command results back to the requesting system (i.e., ~~collection engine~~head end, field tool or HAN) 99% of the time.
23. Provide command results back to the requesting system (i.e. ~~collection engine~~head end, field tool or HAN) when the service switch command cannot be completed successfully.
24. Provide command results back to the requesting system (i.e. ~~collection engine~~head end, field tool or HAN) when the service switch command is completed.
25. Log the date and time each time a service switch connect/disconnect command is executed.
26. Remain energized and continue to monitor and record consumption (i.e. zero consumption for each interval) when disconnect switch is in the open/disconnected position.
27. Allow authorized utility employees (while on-site at the customer premise) to operate the service disconnect/reconnect switch immediately (regardless of interval).
28. Receive and process requests from the ~~collection engine~~head end to determine if load side voltage is present on the customer side of the meter and provide the result back to the requesting system (e.g., load side voltage present or no load side voltage present).

29. Receive and process requests to determine if load side voltage is present and provide the result back to the requesting system within one minute of the original command date and time.
30. Be configured to NOT retry processing a service switch command (within the same command). Only one attempt shall be made by the meter to process a service switch connect/disconnect command per request.
31. Allow a utility employee working on-site at the customer premises to physically operate its service disconnect/reconnect switch through the optical port or via remote communication network (using a field tool) at any time (including when the communication network is down).
32. Receive, log and process commands to "open or close" the service switch from an authenticated system (e.g., ~~collection engine~~head end, field tool or HAN).
33. Log if a service switch command was received locally or via network, as well as, the user ID if received locally.

8.2.21 Secure Communications

The AMI Meter shall be able to:

a. Log the number of invalid login attempts.
b. Log the number of invalid login attempts and support a lockout for a configurable amount of time.
c. Each optical port password shall be capable of being individually changeable by AMI Meter
d. Comply with FIPS 140-2 (Level 1) Security Requirements for Cryptographic Modules (dated 5/25/2001).
e. Support, at minimum, symmetric key lengths of 128 bits.
f. Support Advanced Encryption Standard, FIPS-197.
g. Create mechanisms that ensure device integrity from external tamper and compromise.
h. Create mechanisms that allow for additional security functionality to be remotely added during operation (i.e. after initial installation).
i. Supply a meter to head-end, cryptographic solution which assures the confidentiality of the AMI Meter's data while in transit.
j. Supply a meter to head-end, cryptographic solution which assures the integrity of the AMI Meter's data while in transit.
k. Supply mechanisms which allow for secure device authentication, registration, and revocation.
l. Supply cryptographic mechanisms or materials which allow for unique device identification, authentication and communications.
m. Supply cryptographic mechanisms or materials which allow for non-unique device access (groups).
n. Shall supply mechanisms which audit and store all security related events including all access and modifications events within the system.
o. Supply a security audit store which includes the date and time of the event, type of event, subject identity, and the outcome (success or failure) of the event.
p. Supply access control mechanisms (i.e., Identification & Authentication mechanisms) which prevent unauthorized access of information and resource.

8.2.22 Self-Monitoring & Alarms

AMI Meter shall be able to:

1. Initiate meter tests (Diagnostic) automatically based on a schedule stored within the meter, or based on a command from an external system / source, or based upon the detection of certain events by the meter. The AMI Meter shall continuously perform self tests and have pre-defined fatal and non-fatal errors that can be generated. These would be available in the meter event log if configured and the Utility elects this configuration.

2. Send non-usage messages and alarms to the ~~collection engine~~head end that contain date/time from internal meter clock, message code/type, and meter identifier.
3. Diagnose a variety of self-test results and determine if failures are critical or non-critical to determine what kind of notification should be provided (e.g. immediate, nightly, only upon request, etc.).
4. Test / check that it is recording data correctly and consistently. Detected failures shall be logged and generate an event specific to that measurement to report to the ~~collection engine~~head end.
5. Perform self check at least once per month and as often as once per day and results logged and sent in with next scheduled read.
6. Detect, log, and report program or memory failure.
7. Detect and log communications link failures upon failed communications initiated from the meter.
8. Send an alarm/event to the ~~collection engine~~head end when a configurable number of consecutive communications link failures are detected (e.g. three consecutive link failures).
9. Periodically record the communication signal strength and report it back to the ~~collection engine~~head end.
10. Prioritize failures by safety /service versus other failure types. Priorities will be provided by the utility. Fatal errors can send exception today which is configurable.
11. Make diagnostic log information available either on-demand or by regularly sending to the ~~collection engine~~head end.

8.2.23 Service Limiting

AMI Meter shall have the ability to:

1. Limit service to customers upon a remote utility request (on-demand, scheduled, or via pre-configured rules).
2. Detect duplicate service limiting events and ensure the duplicate event is ignored (e.g. AMI Meter is already limited -- identical limit event accepted with no action taken).
3. Cancel or update/reschedule scheduled service limiting events prior to their completion.
4. Send a meter read and acknowledgement to the ~~collection engine~~head end upon a successfully completed or failed electric service limiting event.
5. Have service limited at configurable set points.
6. Disconnect (i.e. open disconnect switch) if customer load is above agreed configured limiting level.
7. Reconnect automatically after a configurable amount of time (e.g., two [2] minutes) to its presently configured limiting level if meter disconnects because the configured limit is exceeded.
8. Attempt automatic reconnection a set number of times per 24 hour period if meter disconnects because configured limit is exceeded.
9. Attempt automatic reconnection a configurable number of times (e.g., only once) after a configurable duration (e.g., two [2] minutes) per 24 hour period if meter disconnects because configured limit is exceeded. Meter shall be able to generate an alarm after it exceeds the limit and fails to reclose.

8.2.24 Software/ Firmware Upgrades

AMI Meter shall be able to:

1. Accept and install software/firmware upgrades provided remotely via the AMI communications network
2. Accept and install software/firmware upgrades provided locally on site either through both wireless and optical port communications
3. Continue normal operation while downloading software/firmware upgrades until instructed to change to the new version

4. Permit remotely or locally initiated reversion of software/firmware to a previous version.
5. AMI Meter full firmware upgrade logic shall be capable of containing mechanisms to protect against critical failures including but not limited to loading incomplete or corrupted firmware images, or loading invalid firmware images. Firmware image shall contain CRC. It is checked for integrity prior to activation. Exception errors are sent to head end of the NMS. AMI firmware image will not activate a new version of firmware that does not pass the data integrity check at the time of the activation
6. AMI Meter's current software/firmware version shall be capable of being remotely and locally readable
7. Be configurable to retain stored register reads over a full software/firmware upgrade
8. Be configurable to reset stored register reads over a full software/firmware upgrade.
9. Retain all AMI Meter configuration settings, statuses, customer information, and event logs over a full software/firmware upgrade (
10. AMI Meter shall be designed with failsafe logic to minimize mis-operation of the disconnect switch and load control/distributed generation during full software/firmware upgrades
11. To log firmware download and upgrade attempts, failures, successes, reversions, etc. with timestamp.
12. Report non-critical failures following a full software/firmware upgrade with the next regularly scheduled meter read
13. When upgrading large number of AMI Meters, AMI Meter shall be able to report software/ firmware upgrade failures (where reversion is required) at the next meter read

8.2.25 Tamper Detection

AMI Meter shall be able to

1. Detect removal from its socket and generate a tamper event before it loses ability to communicate with the communications network
2. Detect voltage at the load side when the disconnect switch in the AMI Meter is open (for the purpose of detecting AMI Meter bypass) and generate a tamper event.
3. Detect physical inversion and generate a tamper event.
4. For each tamper event, the AMI Meter shall be able to, at a minimum, transmit and locally log the following information:
    a. Event Timestamp
    b. Tamper status (event type)
    c. AMI Meter ID."
5. Communicate tamper events to the ~~collection engine~~head end as soon as they occur (when possible).
6. Tamper events shall be able to be sent with a higher priority than normal status messages.
7. If the AMI Meter is unable to communicate at the time the tamper event is detected, the AMI Meter shall be capable of storing tamper events and transmit them when meter communications are re-established.
8. Distinguish initial installation events and re-energize events (i.e., after an outage) from meter removal and reinstallation (potential tampering) to avoid transmission of non tamper related events. The AMI Meter shall be able to detect removal and tamper and “clean” install events, but not repeated install events.
9. Distinguish initial installation events and re-energize events (i.e., after an outage) from meter removal and reinstallation (potential tampering) to avoid transmission of non tamper related events. Initial installation events shall be distinguished.

8.2.26 Tariff/Rate Configuration

1. AMI Meter shall be able to receive, log, and update tariff and rate information received from the ~~collection engine~~head end.

8.2.27 Testing & Diagnostics

AMI Meter shall be able to:

1. Support on-demand or scheduled meter tests issued remotely via the NMS or locally on-site (e.g., via a field tool) through both wireless and optical port communications. The AMI Meter shall be able to continuously perform self tests and have pre-defined fatal and non-fatal errors that can be generated. These would be available in the meter event log if configured.
2. Support a remotely or locally initiated meter test for communications connection status. Local diagnostic will include the capability to perform meter ping and obtain RFLAN, link information, sync status, level status. Backhaul connectivity can be viewed through the communication engine, not locally through the Cell Relay.
3. Support a remotely or locally initiated meter test for HAN operation.
4. Support a remotely or locally initiated meter test for energized status.
5. Support a remotely or locally initiated meter test for load side voltage line-to-line voltage only).
6. Support a remotely or locally initiated meter test for disconnect switch status.
7. Support a remotely or locally initiated meter test for internal clock time accuracy - to be checked against Network Clock as provided by the communication network.

AMI Common Requirements Table

Category	Description
Default Read Schedule	AMI Meter shall be capable of sending all interval read data at least once per day.
Default Read Schedule	AMI Meter shall have the ability to recognize and log when it cannot send a scheduled read.
Demand Response	AMI Meter shall be able to automatically launch and terminate demand response events, once it has received the event message from the collection Engine.
Demand Response	AMI Meter shall be able to receive and process demand response event cancellations or reschedule messages.
Demand Response	AMI Meter shall be able to log demand response events and send acknowledgement of successful receipt of message by the load control device to the collection engine.
Distributed Generation Support	AMI Meter shall be able to be re-programmed remotely to support bi-directional metering. This reprogramming event will be logged in the meter and sent back with the next regular meter read.
Distribution Functions	AMI Meter shall be capable of responding to a request from an authorized source for present voltage (line-to-line voltage only).
Event/Message Management & Logs	AMI Meter shall be able to receive and send, store, log, and process many types of event and informational messages including Disconnect, Reconnect, Prepayment, AMI Meter Read Schedule maintenance, demand response curtailment start/end, customer override, etc.
Event/Message Management & Logs	AMI Meter shall be able to authenticate message/request sources (systems or devices) prior to processing or displaying such information.
Event/Message Management & Logs	AMI Meter shall be able tp reject and log messages/requests that are received from unauthorized systems or devices.
Event/Message Management & Logs	AMI Meter shall be able to send an acknowledgement of receipt of event and informational messages to the collection engine.
Event/Message Management & Logs	AMI Meter shall be able to send an acknowledgement of receipt of event and informational messages to the collection engine within a configurable length of time (>= 60 seconds - this does not include on-demand read scenarios or other time critical response).
Event/Message Management & Logs	AMI Meter shall be able to log all messages sent to and received from the collection engine.

Category	Description
Event/Message Management & Logs	AMI Meter's message logs shall be capable of including the following information at a minimum: message type, process status, system/device source, date/time received or sent (internal meter clock), event schedule (start and end) date/time (if applicable), hourly and/or time-of-use price information (if applicable for the event type). The communication engine initiates this request.
General	These requirements are based on SCE Specification E-100 SSM for Induction and Solid State Watt hour Meters, Revision 5.1.2
Installation	Upon installation, AMI Meter shall be able to perform a self diagnostic and detect and log all failures. Utility defined critical failures shall be reported to communication engine immediately (at a minimum: check sum error, meter failure from firmware upgrade, metrology failure, program or memory failure, time synch failure). Fatal errors can send exception today which is configurable.
Installation	Upon installation, AMI Meter shall be able to communicate to Installer: 1.Meter health check/diagnostic results 2.Communications network check results (WAN & HAN)
Internal Clock	AMI Meter's internal clock shall be capable of being validated with an external time source at least once per day.
Internal Clock	AMI Meter's internal clock shall be automatically synchronized during the daily time validation if meter time is greater than 20 seconds but less than 120 seconds out of synch with the external time source
Internal Clock	AMI Meter's internal clock shall be capable of being synchronized within a recording interval, but not at an interval boundary.
Internal Clock	AMI Meter shall be capable of logging all successful and failed internal clock time corrections or adjustments.
Internal Clock	AMI Meter's internal clock shall be capable of keeping time even if there is no communication with the network and shall maintain holdover accuracy to ANSI C12.1 specifications.
Internal Clock	The collection engine shall validate the internal clock time for AMI Meters and all other field communications components at least once per day and synchronize it with system time if the difference exceeds a configurable tolerance. This is managed by Cell Relay via ntp server on the communication engine.
Load Control	AMI Meter shall be able to receive, log, and execute secure load control/curtailment requests, via AMI communications system.

Category	Description
Load Control	AMI Meter shall be able to receive load control/curtailment event messages (to be sent to meter display or local display device) that differentiate between predicted (override available) and emergency (no override) energy shortage curtailment requests.
Load Control	AMI Meter shall be able to enable a grace period allowing the customer to reduce load after receiving a curtailment event. Grace period shall be configurable based on event type (predicted or emergency).
Load Control	AMI Meter shall be capable of receiving and simultaneously storing at least two separate scheduled curtailment requests.
Load Control	AMI Meter shall be able to receive, log, and process secure load control/curtailment END messages, so that the curtailment can be ended (with full restoration of service) earlier than specified in the original request.
Load Control	AMI Meter shall be capable of allowing curtailment events to expire (with full restoration of service), if no load restoration message is received before the curtailment end time specified in the curtailment initiation message.
Load Control	AMI Meter shall be able to support a curtailment override option at the customer site for non-emergency events. This override function could be implemented directly through the use of a button/ data link to the meter or indirectly via communications equipment and back.
Load Control	AMI Meter shall be able to support a curtailment override option at the customer site for non-emergency events. This override function could be implemented directly through the use of a button/ data link to the meter or indirectly via communications equipment and back.
Load Control	AMI Meter shall be able to monitor and log customer non-compliance with curtailment requests (load level above curtailment threshold). AMI Meter will support this requirement as defined at the remote communication network AMI profile level. HAN events are stored in AMI Meter. Data is retrieved as regularly scheduled reads as meter log events.
Load Control	AMI Meter service switch shall be able to support from 10 to 100 curtailment requests during 1 year. This would be the equivalent of 150 to 1500 curtailment requests during its life cycle. Requirement is implemented via unacknowledged broadcast command. In all cases the AMI meter shall support a minimum of 10,000 operations over the 20 year meter life.

Category	Description
Load Control	If requested, the AMI Meter shall send log of curtailment requests (and corresponding compliance/non-compliance) to the collection engine within 24 hours for compliance evaluation and at least once per week for system auditing.
Load Control	AMI Meter shall be able to support on-demand request for log of curtailment requests/events (and corresponding compliance/non-compliance).
Load Control	Meters will be able to measure power quality (sags and surges on a 1 second or faster basis). Harmonics would be useful for a sample of meters, but not required for all meters.
Load Control	Meter will be able to detect loss of voltage on a single leg and report as an outage.
Local Connectivity	Upon completion of proper authorization by the AMI Meter of a field tool, AMI Meter shall be able to identify itself to field tool and provide access to its data and configuration settings at installation time, and later in support of ongoing operations & maintenance activities.
Local Connectivity	AMI Meter shall be able to communicate bi-directionally locally (e.g., C12.18 Optical Port) to a field tool.
Local Connectivity	AMI Meter shall be capable of supporting local download to a field tool of all AMI Meter and communications data and logs stored in AMI Meter.
Local Connectivity	AMI Meter shall be able to provide security/ authentication for local AMI Meter data download attempts via optical or RF to ensure downloads can only be executed by authorized utility or third party personnel.
Local Connectivity	AMI Meter shall log be able to all local AMI Meter data download attempts.
Memory/Storage	AMI Meter shall be capable of storing 5-minute interval data for a minimum of 45 days for two channels.
Memory/Storage	AMI Meter shall be capable of storing at least the last 100 diagnostic events/errors in a log with a timestamp indicating the occurrence of the event/error.
Memory/Storage	AMI Meter shall be capable of storing at least the last 100 informational messages in a log with a timestamp indicating the receipt of the message.
Memory/Storage	AMI Meter shall be capable of storing at least the last 420 communications events in a log with a timestamp indicating the occurrence of the event.
Meter (Residential)	AMI Meter shall be able to act on the meter data request (up to 24 hours of data) within 2 seconds of the receipt of the request.

Category	Description
Meter (Residential)	AMI Meter shall be able to start return requests for On Demand meter data (up to seven days of data) within 5 - 10 seconds of the meter receipt of the request.
Meter (Residential)	AMI Meter shall be able to start return requests for On Demand meter data (up to seven days of data) within two seconds of the meter receipt of the request.
Meter (Residential)	AMI Meter shall be able to be remotely disconnected/reconnected on demand and have acknowledgement received by requesting system within 2 minutes and 10 seconds of request being initiated.
Meter (Residential)	AMI Meter shall be able to be remotely disconnected/reconnected on demand and have acknowledgement received by requesting system within 1 minute of request being initiated.
Meter (Residential)	AMI Meter shall allow a reconnect event to occur following a disconnect event only after a non configurable amount of time (e.g. at least 1 to 2 minutes) has elapsed since the disconnect event.
Meter (Residential)	AMI Meter shall be able to allow a reconnect event to occur following a disconnect event only after a configurable amount of time (e.g. at least 1 to 2 minutes) has elapsed since the disconnect event.
Meter (Residential)	AMI Meter shall be able to be remotely limited on demand and have acknowledgement received by requesting system within 1 minute of request being initiated.
Meter (Residential)	AMI Meter shall be able to receive, log, and update tariff and rate information received from the collection engine at midnight on the day it is received, and send an acknowledgement to the collection engine within 5 minutes of completed processing.
Meter (Residential)	AMI Meter shall be capable of being remotely configurable to record customer's instantaneous demand (e.g. W or kW) so that it can be displayed on a premise device and/or meter display (and updated as frequently as every 3 seconds).
Meter (Residential)	AMI Meter shall be able to transmit utility messages and/or energy information to a display device and/or load control equipment within 10 seconds of being received or recorded by the meter.
Meter (Residential)	AMI Meter shall be able to complete remotely initiated meter display configuration requests within 60 seconds of being received.

Category	Description
Meter (Residential)	AMI Meter shall be able to return results for all remote or local meter tests within 60 seconds of receipt of the message. The AMI Meter shall continuously perform self tests and has pre-defined fatal and non-fatal errors that can be generated. These would be available in the meter event log if configured and the Utility elects this configuration.
Meter (Residential)	AMI Meter shall be able to send safety / service failure events to the collection engine within 15 minutes of detection.
Meter (Residential)	AMI Meter shall be able to report important or critical failures following a software/firmware upgrade within 15 minutes after start-up of new program. Critical failures could include billing information loss or loss of electric service. Ability to program what failures report immediately needs to be configurable.
Meter (Residential)	AMI Meter shall be capable of supporting local download via optical port to a field tool of all AMI Meter and communications data and logs stored in AMI Meter memory up to 16kB within 1 minute or less. Data volume above 16kB will take up to 6 minutes to download.
Meter (Residential)	AMI Meter shall be capable of supporting local download via optical port and home area network to a field tool of all AMI Meter and communications data and logs stored in AMI Meter memory within 6 minutes. A complete set of data will include 144kB of load profile data, register data, log and event data.
Meter Communications	AMI Meters shall be enabled for two-way secure communications with authorized systems and devices. This applies to all communication interfaces including optical port, Home Area Network, and communication back to the Utility.
Meter Communications	AMI Meter shall have a unique internal and external identity to enable targeted messaging and communications (i.e. individually addressable AMI Meters).
Meter Communications	AMI Meter shall be capable of continuing to record data during a communications failure.
Meter Communications	AMI Meter shall be capable of keeping an on-board log of communications events: 1. link fail 2. link switch 3. link up 4. link quality.

Category	Description
Meter Communications	AMI Meter shall be capable of separately identifying communications event data from metering data to prevent loss of meter data (e.g., interval usage data, demand response events, pricing event data, etc) to excessive communication event messages.
Meter Communications	AMI Meter shall be able to support communications to Energy Services Portal.
Meter Display - Config	AMI Meter shall be able to execute and log remote meter display provisioning and configuration requests.
Meter Display - Config	AMI Meter display shall be capable of being remotely configurable to customize individual information attributes as available or not available for display.
Meter Display - Energy	AMI Meter shall be capable of being remotely configurable to record the amount of gross and/or net energy consumed and generated (kWh) within the current bill cycle so that it can be displayed on a premise device and/or meter display.
Meter Display - Energy	AMI Meter shall be capable of being remotely configurable to record the peak demand in kW (consumed and generated) recorded to date in the current bill cycle with the date/time it occurred so that it can be displayed on a premise device and/or meter display.
Meter Display - Energy	AMI Meter shall be capable of being remotely configurable to record the energy consumed and generated in kWh, in time-of-use periods, for energy consumed and generated within the current bill cycle so that it can be displayed on a premise device and/or meter display.
Meter Display - Energy	AMI Meter shall be capable of being remotely configurable to record the peak demand (consumed and generated) in kW, in time-of-use periods, recorded to date in the current bill cycle with the date/time it occurred so that it can be displayed on a premise device and/or meter display.
Meter Display - Info	AMI Meter shall be able to communicate information (i.e., price signal, etc.) to any compatible authenticated in-home device including in-home display, smart appliances, PCTs, etc.
Meter Display - Info	AMI Meter display shall be able to provide date and time in "local time", displaying the time in Local Daylight Time or Local Standard Time as appropriate.
Meter Display - Info	AMI Meter shall be able to externally indicate electric service connect/disconnect status so that it is visible to customer or Utility employee on site.

Category	Description
Meter Display - Info	AMI Meter shall be capable of being remotely configurable to record the customer's current rate schedule (e.g. TOU-GS1, etc.) so that it can be displayed on a premise device and/or meter display.
Meter Management	AMI Meter shall be physically assigned a utility meter number (before it arrives at utility) which identifies manufacturer, meter form, voltage, communications type, etc.
Metrology	AMI Meter shall be capable of recording self reads at midnight for each register and channel every day.
Metrology	AMI Meter shall be capable of supporting interval data collection for energy consumption.
Metrology	AMI Meter shall be capable of supporting a minimum of 4 channels of interval data.
Metrology	AMI Meter shall be capable of supporting measurement of voltage data (line-to-line) through the load profile channel. This data shall be the average over a programmable interval of 15, 30, or 60 minutes with timestamp.
Metrology	AMI Meter shall be capable of supporting measurement of voltage data (line-to-line) and its storage in a profile. This data shall be the average, maximum and minimum over a programmable interval of 15, 30, or 60 minutes with timestamp.
Metrology	AMI Meter shall be capable of supporting measurement of peak demand
Metrology	AMI Meter shall be capable of supporting measurement of time-of-use kWh and kW demand
Metrology	AMI Meter shall be capable of supporting interval data of 5, 15, 30, or 60 minutes in length.
Metrology	AMI Meter's recording interval length shall be capable of being remotely configurable.
Metrology	When an AMI Meter gets a re-configuration request where the new configuration changes either the interval length or number of intervals, the meter will be capable of automatically returning the interval data from the previous interval stop time of uploaded data through the end of the current interval. Additionally, the meter will return the current register read.
Metrology	AMI Meter shall be capable of supporting bi-directional metering to support distributed generation measurement.
Metrology	AMI Meter shall be capable of distinguishing between a missing interval and zero consumption.
Metrology	AMI Meter shall be capable of distinguishing between a power outage and zero consumption.

Category	Description
Metrology	The collection engine shall be able to remotely configure the AMI Meter's recording interval length (to all interval lengths supported by the AMI Meter).
Metrology	AMI Meter shall be able to support interval data of 1 minute in length.
Non-Default Read Schedule	AMI Meter shall be capable of sending all read data at a frequency configurable down to the meter's interval data recording length. The AMI Meter is fully programmable to any supported interval length. MDMS can request data at the interval length of the AMI Meter for a subset that is interval dependent (less than 2% spread across the system assuming 1 minute intervals or 100% assuming 15 minute intervals) of the system.
On Demand Reads	AMI Meter shall be able to respond to requests for on-demand access to meter and log data.
On Demand Reads	AMI Meter shall be able to log failed on demand reads (meter unable to respond to on demand request) in the communications log along with all information available to define the cause of the failure. The collection engine logs failed requests.
On Demand Reads	The communication engine shall be able to automatically issue a remote AMI Meter test upon on-demand read request failure. The AMI Meter shall be able to continuously perform self tests and has pre-defined fatal and non-fatal errors that can be generated. These would be available in the meter event log if configured if the Utility elects such configuration and will be available on a pull basis, but not a push basis.
Outage Detection / Management	AMI Meter shall be able to communicate its energized status (i.e. has voltage).
Outage Detection / Management	The AMI Meter shall be able to detect and communicate a power outage at the premise prior to communications loss.
Outage Detection / Management	AMI Meter shall be able to report restoration information (voltage quality and quantity).
Outage Detection / Management	AMI Meter disconnect/reconnect switch shall be able to be configured to open during an outage when certain set thresholds are reached. Configuration thresholds should include minimum voltage and duration of that voltage to trigger disconnects. For over-voltage, maximum voltage and duration will also be supported.

Category	Description
Outage Detection / Management	AMI Meter shall be able to reconnect automatically (i.e., close disconnect/reconnect switch) after voltage has returned to and remained within configurable voltage thresholds for a configurable amount of time (e.g., voltage is within limits and remained above 90% of nominal voltage for at least 3 sec.)
Prepaid Metering	AMI Meter shall be able to support both prepayment services and regular billing and payment services (i.e. no special prepayment meter required).
Prepaid Metering	AMI Meter shall be able to be converted to/from a prepayment program at the end of a recording interval without disruption to service.
Prepaid Metering	AMI Meter shall be able to receive and process informational and transactional prepayment messages from the collection engine.
Prepaid Metering	AMI Meter shall be capable of sending an acknowledgement message to the collection engine whenever informational and transactional prepayment messages are received and processed.
Remote Service Switch	AMI Meter shall be able to be remotely disconnected/ reconnected.
Remote Service Switch	AMI Meter shall remain energized and continue to monitor and record consumption (i.e. zero consumption for each interval) when disconnect switch is the open/disconnected position.
Remote Service Switch	AMI Meter shall be able to be remotely disconnected/ reconnected on demand.
Remote Service Switch	AMI Meter shall be able to detect duplicate service disconnect/ reconnect events and ignore the duplicate events (e.g. Meter is already on -- reconnect event accepted with no action taken).
Remote Service Switch	AMI Meter shall be able to cancel or update/reschedule scheduled disconnect/ reconnect events prior to their completion.
Remote Service Switch	AMI Meter shall be able to send a meter read and acknowledgement to the collection engine upon a successfully completed or failed electric service disconnect/ reconnect event.
Remote Service Switch	AMI Meter shall be able to enable an Utility Employee working on-site at the customer premise to be able to physically operate its service disconnect/reconnect switch through the optical port or via applicable remote communication network (e.g., ZigBee, HAN, RF) at any time (including when the communication network is down).

Category	Description
Remote Service Switch	AMI Meter shall be able to support an external authorization/ authentication routine (i.e. by remote systems or field tool) to enable only active and eligible Utility employees to operate its service disconnect/reconnect switch on-site at the customer premise.
Remote Service Switch	AMI Meter shall allow authorized Utility employee (while on-site at the customer premise) to operate the service disconnect/reconnect switch immediately (regardless of interval) or to schedule a connect/ disconnect for a future interval.
Remote Service Switch	AMI Meter shall be able to log date/time and status of attempts to operate the service disconnect/reconnect switch remotely or on-site at the customer premise. Log entries will include requesting user or system identity and authorization status.
Remote Service Switch	The AMI meter shall be able to send a command result back to the requesting system with the result of the service switch command including response codes of "Success" or "Failed" with reason codes in the event of a failure.
Remote Service Switch	Should a disconnect event and reconnect event be scheduled to occur for the same AMI Meter on the same day, AMI Meter shall be able to log the events and automatically provide an on-demand read to the collection engine without operating the disconnect/reconnect switch.
Remote Service Switch	If the AMI meter detects load side voltage during a connect, the meter shall not complete the connect and shall send a failure command result back to the requesting system.
Remote Service Switch	The AMI meter shall be able to determine if there is load side voltage "before" and "after" processing a remote service switch command.
Remote Service Switch	The AMI meter shall be able to provide the requesting system a failure command result (e.g., Job EndPoint Does Not Support This Operation) if the meter receives a connect or disconnect command request but the meter does not have an integrated service switch.
Remote Service Switch	The AMI meter shall be able to receive and process remote service switch connect or disconnect command and provide command results to the requesting system by receiving one command from the requesting system (i.e., second command for command result not required).

Category	Description
Remote Service Switch	The AMI meter shall capable of being be configurable to not provide an IDR read (interval data) when completing a service switch connect or disconnect command.
Remote Service Switch	The AMI meter shall be able to execute connect/disconnect commands upon receipt.
Remote Service Switch	The AMI meter shall have the ability to receive and process commands to "open or close" the service switch based on a command received locally through an optical port or remote communication network from the Utility employee (e.g., OpenWay Tool).
Remote Service Switch	The AMI meter shall be able to log, reject, and send an command result to the requesting system when remote service switch commands received either locally or remotely that cannot be authenticated.
Remote Service Switch	The AMI meter shall be capable of providing the following information (command result) back to the requesting system after processing a service switch command - Date/time command processed; - Collection Engine Job ID - Meter ID - Message ID Result (only one command result, actual text TBD): 1. Success = a. Disconnect success b. Reconnect success 2. Failure = a. Disconnect failed b. Reconnect failed c. Load Side voltage present during reconnect d. Job Endpoint Does not support this operation
Remote Service Switch	The AMI Meter shall be able to successfully process remote service switch commands as requested (i.e. open or close) and provide command results back to the requesting system (i.e., collection engine, field tool or HAN) 99% of the time.
Remote Service Switch	The AMI remote service switch meter shall be able to provide command results back to the requesting system (i.e. collection engine, field tool or HAN) when the service switch command cannot be completed successfully.
Remote Service Switch	The AMI remote service switch meter shall be able to provide command results back to the requesting system (i.e. collection engine, field tool or HAN) when the service switch command is completed.

Category	Description
Remote Service Switch	The AMI meter shall be able to log the date and time each time a service switch connect/disconnect command is executed.
Remote Service Switch	The AMI meter shall be cagpable of remaining energized and continuing to monitor and record consumption (i.e. zero consumption for each interval) when disconnect switch is in the open/disconnected position.
Remote Service Switch	The AMI meter shall be capable of allowing authorized utililty employees (while on-site at the customer premise) to operate the service disconnect/reconnect switch immediately (regardless of interval).
Remote Service Switch	The AMI meter shall be able to receive and process requests from the collection engine to determine if load side voltage is present on the customer side of the meter and provide the result back to the requesting system (e.g., load side voltage present or no load side voltage present).
Remote Service Switch	The AMI Meter shall be able to receive and process requests to determine if load side voltage is present and provide the result back to the requesting system within one minute of the original command date and time.
Remote Service Switch	The AMI meter shall be capabled of being configured to NOT retry processing a service switch command (within the same command). Only one attempt shall be made by the meter to process a service switch connect/disconnect command per request.
Remote Service Switch	The AMI meter shall be capable of allowing a utililty employee working on-site at the customer premise to physically operate its service disconnect/reconnect switch through the optical port or via remote communiucation network (using a field tool) at any time (including when the communication network is down).
Remote Service Switch	The AMI meter shall have the ability to receive, log and process commands to "open or close" the service switch from an authenticated system (e.g., collection engine, field tool or HAN).
Remote Service Switch	The AMI meter shall be able to log if a service switch command was received locally or via network, as well as, the user ID if received locally.
Secure Communications	The AMI Meter shall be able to log the number of invalid login attempts.
Secure Communications	The AMI Meter shall be able to log the number of invalid login attempts and support a lockout for a configurable amount of time.

Category	Description
Secure Communications	Each optical port password shall be capable of being individually changeable by AMI Meter
Secure Communications	AMI Meter shall at a minimum comply with FIPS 140-2 (Level 1) Security Requirements for Cryptographic Modules (dated 5/25/2001).
Secure Communications	AMI Meter shall be able to support, at minimum, symmetric key lengths of 128 bits.
Secure Communications	AMI Meter shall support Advanced Encryption Standard, FIPS-197.
Secure Communications	AMI Meter shall be able to create mechanisms that ensure device integrity from external tamper and compromise.
Secure Communications	AMI Meter shall be able to create mechanisms that allow for additional security functionality to be remotely added during operation (i.e. after initial installation).
Secure Communications	AMI Meter shall be able to supply a meter to head-end, cryptographic solution which assures the confidentiality of the AMI Meter's data while in transit.
Secure Communications	AMI Meter shall be able to supply a meter to head-end, cryptographic solution which assures the integrity of the AMI Meter's data while in transit.
Secure Communications	AMI Meter shall be able to supply mechanisms which allow for secure device authentication, registration, and revocation.
Secure Communications	AMI Meter shall be able to supply cryptographic mechanisms or materials which allows for unique device identification, authentication and communications.
Secure Communications	AMI Meter shall be able to supply cryptographic mechanisms or materials which allows for non-unique device access (groups).
Secure Communications	AMI Meter shall supply mechanisms which audit and store all security related events including all access and modifications events within the system.
Secure Communications	AMI Meter shall be able to supply a security audit store which includes the date and time of the event, type of event, subject identity, and the outcome (success or failure) of the event.
Secure Communications	AMI Meter shall be able to supply access control mechanisms (i.e., Identification & Authentication mechanisms) which prevent unauthorized access of information and resource.

Category	Description
Self-Monitoring & Alarms	AMI Meter shall be able to initiate meter tests (Diagnostic) automatically based on a schedule stored within the meter, or based on a command from an external system / source, or based upon the detection of certain events by the meter. The AMI Meter shall continuously perform self tests and has pre-defined fatal and non-fatal errors that can be generated. These would be available in the meter event log if configured and the Utility elects this configuration and will be available on a pull basis, but not a push basis.
Self-Monitoring & Alarms	AMI Meter shall be able to send non-usage messages and alarms to the collection engine that contain date/time from internal meter clock, message code/type, and meter identifier.
Self-Monitoring & Alarms	AMI Meter shall be able to diagnose a variety of self-test results and determine if failures are critical or non-critical to determine what kind of notification should be provided (e.g. immediate, nightly, only upon request, etc.).
Self-Monitoring & Alarms	AMI Meter shall be able to test / check that it is recording data correctly and consistently. Detected failures shall be logged and generate an event specific to that measurement to report to the collection engine.
Self-Monitoring & Alarms	AMI Meter shall be able to perform self check at least once per month and as often as once per day and results logged and sent in with next scheduled read.
Self-Monitoring & Alarms	AMI Meter shall be able to detect, log, and report program or memory failure.
Self-Monitoring & Alarms	AMI Meter shall be able to detect and log communications link failures upon failed communications initiated from the meter.
Self-Monitoring & Alarms	AMI Meter shall be able to send an alarm/event to the collection engine when a configurable number of consecutive communications link failures are detected (e.g. three consecutive link failures).
Self-Monitoring & Alarms	AMI Meter shall be able to periodically record the communication signal strength and report it back to the collection engine.
Self-Monitoring & Alarms	AMI Meter shall be able to prioritize failures by safety /service versus other failure types. Priorities will be provided by the utility. Fatal errors can send exception today which is configurable.
Self-Monitoring & Alarms	AMI Meter shall be able to make diagnostic log information available either on-demand or by regularly sending to the collection engine.

Category	Description
Service Limiting	AMI Meter shall have the ability to limit service to customers upon a remote utility request (on-demand, scheduled, or via pre-configured rules).
Service Limiting	AMI Meter shall be able to detect duplicate service limiting events and ensure the duplicate event is ignored (e.g. AMI Meter is already limited -- identical limit event accepted with no action taken).
Service Limiting	AMI Meter shall be able to cancel or update/reschedule scheduled service limiting events prior to their completion.
Service Limiting	AMI Meter shall be able to send a meter read and acknowledgement to the collection engine upon a successfully completed or failed electric service limiting event.
Service Limiting	AMI Meter shall be able to have service limited at configurable set points.
Service Limiting	AMI Meter shall be able to disconnect (i.e. open disconnect switch) if customer load is above agreed configured limiting level.
Service Limiting	AMI Meter shall be able to reconnect automatically after a configurable amount of time (e.g. 2 minutes) to its presently configured limiting level if meter disconnects because the configured limit is exceeded.
Service Limiting	AMI Meter shall be able to attempt automatic reconnection a set number of times per 24 hour period if meter disconnects because configured limit is exceeded.
Service Limiting	AMI Meter shall be able to attempt automatic reconnection a configurable number of times (e.g. only once) after a configurable duration (e.g. 2 minutes) per 24 hour period if meter disconnects because configured limit is exceeded. Meter shall be able to generate an alarm after it exceeds the limit and fails to reclose.
Software/ Firmware Upgrades	AMI Meter shall be able to accept and install software/firmware upgrades provided remotely via the AMI communications network (See C12.10 Guidelines Sections 4.3, 6.1.5 & 6.1.6.)
Software/ Firmware Upgrades	AMI Meter shall be able to accept and install software/firmware upgrades provided locally on site either through both wireless and optical port communications(See C12.10 Guidelines Sections 4.3, 6.1.5 & 6.1.6.).
Software/ Firmware Upgrades	AMI Meter shall be able to continue normal operation while downloading software/firmware upgrades until instructed to change to the new version(See C12.10 Guidelines Sections 4.3, 6.1.5 & 6.1.6.).

Category	Description
Software/ Firmware Upgrades	AMI Meter shall be capable of permiting remotely or locally initiated reversion of software/firmware to a previous version.
Software/ Firmware Upgrades	AMI Meter full firmware upgrade logic shall be capable of containing mechanisms to protect against critical failures including but not limited to loading incomplete or corrupted firmware images, or loading invalid firmware images. Firmware image shall contain CRC. It is checked for integrity prior to activation. Exception errors are sent to head end of the NMS. AMI firmware image will not activate a new version of firmware that does not pass the data integrity check at the time of the activation (See C12.10 Guidelines Sections 4.3, 6.1.5 & 6.1.6.).
Software/ Firmware Upgrades	AMI Meter's current software/firmware version shall be capable of being remotely and locally readable (See C12.10 Guidelines Sections 4.3, 6.1.5 & 6.1.6.).
Software/ Firmware Upgrades	AMI Meter shall be capable of being configurable to retain stored register reads over a full software/firmware upgrade (See C12.10 Guidelines Sections 4.3, 6.1.5 & 6.1.6.).
Software/ Firmware Upgrades	AMI Meter shall be capable of being configurable to reset stored register reads over a full software/firmware upgrade.
Software/ Firmware Upgrades	AMI Meter shall be able to retain all AMI Meter configuration settings, statuses, customer information, and event logs over a full software/firmware upgrade (See C12.10 Guidelines Sections 4.3, 6.1.5 & 6.1.6.).
Software/ Firmware Upgrades	AMI Meter shall be designed with failsafe logic to minimize mis-operation of the disconnect switch and load control/distributed generation during full software/firmware upgrades (See C12.10 Guidelines Sections 4.3, 6.1.5 & 6.1.6.).
Software/ Firmware Upgrades	AMI Meter shall be able to log firmware download and upgrade attempts, failures, successes, reversions, etc. with timestamp.
Software/ Firmware Upgrades	AMI Meter shall able to report non-critical failures following a full software/firmware upgrade with the next regularly scheduled meter read (See C12.10 Guidelines Sections 4.3, 6.1.5 & 6.1.6.).
Software/ Firmware Upgrades	When upgrading large number of AMI Meters, AMI Meter shall be able to report software/ firmware upgrade failures (where reversion is required) at the next meter read (See C12.10 Guidelines Sections 4.3, 6.1.5 & 6.1.6.).
Tamper Detection	AMI Meter shall be able to detect removal from its socket and generate a tamper event before it loses ability to communicate with the communications network

Category	Description
Tamper Detection	AMI Meter shall be able to detect voltage at the load side when the disconnect switch in the AMI Meter is open (for the purpose of detecting AMI Meter bypass) and generate a tamper event.
Tamper Detection	AMI Meter shall be able to detect physical inversion and generate a tamper event.
Tamper Detection	For each tamper event, the AMI Meter shall be able to, at a minimum, transmit and locally log the following information: 1. Event Timestamp 2. Tamper status (event type) 3. AMI Meter ID.
Tamper Detection	AMI Meter shall be able to communicate tamper events to the collection engine as soon as they occur (when possible).
Tamper Detection	AMI Meter tamper events shall be able to be sent with a higher priority than normal status messages.
Tamper Detection	If the AMI Meter is unable to communicate at the time the tamper event is detected, AMI Meter shall be capable of storing tamper events and transmit them when meter communications are re-established.
Tamper Detection	AMI Meter shall be able to distinguish initial installation events and re-energize events (i.e. after an outage) from meter removal and reinstallation (potential tampering) to avoid transmission of non tamper related events. AMI Meter detects removal and tamper and "clean" install events, but not repeated install events.
Tamper Detection	AMI Meter shall be able to distinguish initial installation events and re-energize events (i.e. after an outage) from meter removal and reinstallation (potential tampering) to avoid transmission of non tamper related events. Initial installation events shall be distinguished.
Tariff/Rate Configuration	AMI Meter shall be able to receive, log, and update tariff and rate information received from the collection engine.
Testing & Diagnostics	AMI Meter shall be able to support on demand or scheduled meter tests issued remotely via the NMS or locally on-site (e.g. via a field tool) through both wireless and optical port communications. The AMI Meter shall be able to continuously perform self tests and have pre-defined fatal and non-fatal errors that can be generated. These would be available in the meter event log if configured and will be available on a pull basis, but not a push basis.

~~Category~~	~~Description~~
~~Testing & Diagnostics~~	~~AMI Meter shall be able to support a remotely or locally initiated meter test for communications connection status. Local diagnostic will be available using Field Pro as a local tool and will include capability to perform meter ping and obtain RFLAN, link information, sync status, level status. Backhaul connectivity can be viewed through the communication engine, not locally through the Cell Relay.~~
~~Testing & Diagnostics~~	~~AMI Meter shall be able to support a remotely or locally initiated meter test for HAN operation.~~
~~Testing & Diagnostics~~	~~AMI Meter shall be able to support a remotely or locally initiated meter test for energized status.~~
~~Testing & Diagnostics~~	~~AMI Meter shall be able to support a remotely or locally initiated meter test for load side voltage line-to-line voltage only).~~
~~Testing & Diagnostics~~	~~AMI Meter shall be able to support a remotely or locally initiated meter test for disconnect switch status.~~
~~Testing & Diagnostics~~	~~AMI Meter shall be able to support a remotely or locally initiated meter test for internal clock time accuracy - to be checked against Network Clock as provided by the communication network.~~

~~8.1.48~~.3 TABLE 00 GENERAL CONFIGURATION TABLE

Requirements for TABLE 00 configuration are listed below.

IDENTIFIER	RECOMMENDATION
TYPE FORMAT_CONTROL_1	
DATA_ORDER	1: most significant byte first
CHAR_FORMAT	3: UTF-8
MODEL_SELECT	0: default
TYPE FORMAT_CONTROL_2	
TM_FORMAT	4: UINT32 counters where HTIME_DATE, LTIME_DATE and STIME_DATE types are encoded relative to 01/01/1970 @ 00:00:00 UTC), with discrete fields for seconds and fraction of a second.
DATA_ACCESS_METHOD	Manufacturer Defined at time of design Recommendation: PREFER “1”- “2” or "3" ok
ID_FORM	0: string per CHAR_FORMAT
INT_FORMAT	0: signed integer types are represented in two’s complement format
TYPE FORMAT_CONTROL_3	
NI_FORMAT1	0: FLOAT64 (IEEE 754) scaled to natural units (e.g. Watts, Volts etc.)
NI_FORMAT2	1: FLOAT32 (IEEE 754) scaled to natural units (e.g. Watts, Volts etc.)

IDENTIFIER	RECOMMENDATION
DEVICE_CLASS	T.B.D.
NAMEPLATE_TYPE	2: for electric, 1: for gas, 0: for water
DEFAULT_SET_USED	0: Default sets are not used
MAX_PROC_PARM_LENGTH	*MANUFACTURER DEFINED AT TIME OF DESIGN*
MAX_RESP_DATA_LEN	*MANUFACTURER DEFINED AT TIME OF DESIGN*
STD_VERSION_NO	*SELECT "**2**"*
STD_REVISION_NO	*SELECT "**0**"*
DIM_STD_TBLS_USED	Manufacturer defined at time of design based on these guidelines and the features provided in the end device
DIM_MFG_TBLS_USED	Manufacturer defined at time of design
DIM_STD_PROC_USED	Manufacturer defined at time of design based on these guidelines and the features provided in the end device
DIM_MFG_PROC_USED	Manufacturer defined at time of design
DIM_MFG_STATUS_USED	Manufacturer defined at time of design
NBR_PENDING	Minimum 16: in accordance with these guidelines
STD_TBLS_USED	Actual value based on features implemented and in accordance with these guidelines
MFG_TBLS_USED	Manufacturer defined at time of design
STD_PROC_USED	Actual value based on features implemented and in accordance with these guidelines
MFG_PROC_USED	Manufacturer defined at time of design
STD_TBLS_WRITE	Actual value based on the C12.19 Standard and in accordance with these guidelines and features
MFG_TBLS_WRITE	Manufacturer defined at time of design

~~8.2~~8.4 ACTUAL FUNCTION LIMITING CONTROL (FLC+1) Tables

The following chart lists guidelines for three different classes of meters for the parameters in the Actual Function Limiting Control (FLC+1) tables for each Decade of ANSI C12.19 and ANSI C12.22 standard . In this guideline it is assumed that each of the meter classes contain all available functionality proposed at this time. It is assumed the Dimension Function Limiting Control (FLC) table, if used, would indicate functionality equal to or greater than the FLC+1 table specified for each decade. The presence or absence of certain tables and decades shall be governed by the features implemented by the end device (FD, FT, FS, FL, FQ, FH, FE, FC and FR).

It is believed that the implementation of these guidelines in the Actual Function Limiting Control tables will effectively define the implementation of most of the subsequent tables in each decade. The user must be aware that additional selections may be needed in subsequent tables depending upon the features designed into the end device.

For interpretation of the entries the following shall be used:

- "False" means that the Boolean operand of zero (0) is selected
- "True" means that the Boolean operand of one (1) is selected.
- "Programmable" means that the end device shall support the functionality, but the owner can turn it on or off through table-role and access security provisions of the standard.

- Numeric values in **bold** reflect recommendations of choices from a menu within the table parameter
- Other numeric values represent recommendations of integer choices from ranges specified within the table parameter.

~~8.2.1~~8.4.1 ACTUAL FUNCTION LIMITING CONTROL (FLC+1) Table Values - Energy Only

Variable	Desirable Values Single Phase, Self Contained Energy only	Desirable Values Single Phase, Transformer Rated, Energy only	Desirable Values Polyphase, Self Contained Energy Only	Desirable Values Polyphase Transformer Rated, Energy Only
TABLE 11				
PF_EXCLUDE_FLAG	False	False	False	False
RESET_EXCLUDE_FLAG	False	False	False	False
BLOCK_DEMAND_FLAG	False	False	False	False
SLIDING_DEMAND_FLAG	False	False	False	False
THERMAL_DEMAND_FLAG	False	False	False	False
SET1_PRESENT_FLAG	False	False	False	False
SET2_PRESENT_FLAG	False (note: meters with multiple input types with different ratios such as electric/gas/water combination devices may require set2)	False (note: meters with multiple input types with different ratios such as electric/gas/water combination devices may require set2)	False (note: meters with multiple input types with different ratios such as electric/gas/water combination devices may require set2)	False (note: meters with multiple input types with different ratios such as electric/gas/water combination devices may require set2)
NBR_UOM_ENTRIES	Manufacturer defined	Manufacturer defined	Manufacturer defined	Manufacturer defined
NBR_DEMAND_CTRL_ENTRIES	Depends on manufacturers design	Depends on manufacturers design	Depends on manufacturers design	Depends on manufacturers design
DATA_CTRL_LENGTH	Manufacturer defined	Manufacturer defined	Manufacturer defined	Manufacturer defined
NBR_DATA_CTRL_ENTRIES	Manufacturer defined	Manufacturer defined	Manufacturer defined	Manufacturer defined
NBR_CONSTANTS_ENTRIES	Manufacturer defined (1 or more)	Manufacturer defined (1 or more)	Manufacturer defined (1 or more)	Manufacturer defined (1 or more)
CONSTANTS_SELECTOR	Choice **2**	Choice **2**	Choice 2	Choice 2
NBR_SOURCES	Manufacturer defined	Manufacturer defined	Manufacturer defined	Manufacturer defined
TABLE 21				
SEASON_INFO_FIELD_FLAG	False	False	False	False
DATE_TIME_FIELD_FLAG	False	False	False	False
DEMAND_RESET_CTR_FLAG	False (aids in tamper detection)	False (aids in tamper detection)	False (aids in tamper detection)	False (aids in tamper detection)
DEMAND_RESET_LOCK_FLAG	False	False	False	False
CUM_DEMAND_FLAG	False	False	False	False

Variable	Desirable Values Single Phase, Self Contained Energy only	Desirable Values Single Phase, Transformer Rated, Energy only	Desirable Values Polyphase, Self Contained Energy Only	Desirable Values Polyphase Transformer Rated, Energy Only
CONT_CUM_DEMAND_FLAG	False	False	False	False
TIME_REMAINING_FLAG	False	False	False	False
SELF_READ_INHIBIT_OVERFLOW_FLAG	False	False	False	False
SELF_READ_SEQ_NBR_FLAG	False	False	False	False
DAILY_SELF_READ_FLAG	False	False	False	False
WEEKLY_SELF_READ_FLAG	False	False	False	False
SELF_READ_DEMAND_RESET	0	0	0	0
NBR_SELF_READS	>= 0 (if self reads required)	>= 0 (if self reads required)	>= 0 (if self reads required)	>= 0 (if self reads required)
NBR_SUMMATIONS	>= 1 (e.g. KW-Hr or perhaps KVA-Hr)	>= 1 (e.g. KW-Hr or perhaps KVA-Hr)	>= 1 (e.g. KW-Hr or perhaps KVA-Hr)	>= 1 (e.g. KW-Hr or perhaps KVA-Hr)
NBR_DEMANDS	0	0	0	0
NBR_COIN_VALUES	0	0	0	0
NBR_OCCUR	0	0	0	0
NBR_TIERS	0	0	0	0
NBR_PRESENT_DEMANDS	0	0	0	0
NBR_PRESENT_VALUES	Depends on the manufacturer design (useful values include 1 ph. volts, 1 ph. Amps, power factor in addition to billing parameters)	Depends on the manufacturer design (useful values include 1 ph. volts, 1 ph. Amps, power factor in addition to billing parameters)	Depends on the manufacturer design (useful values include per ph. volts, per ph. Amps, power factor in addition to billing parameters)	Depends on the manufacturer design (useful values include per ph. volts, per ph. Amps, power factor in addition to billing parameters)
TABLE 31				
ON_TIME_FLAG	True	True	True	True
OFF_TIME_FLAG	False (Manufacturer may set value to “0” in table 32)	False (Manufacturer may set value to “0” in table 32)	False (Manufacturer may set value to “0” in table 32)	False (Manufacturer may set value to “0” in table 32)
HOLD_TIME_FLAG	False	False	False	False
NBR_DISP_SOURCES	Manufacturer (Minimum 32)	Manufacturer (Minimum 32)	Manufacturer (Minimum 32)	Manufacturer (Minimum 32)
WIDTH_DISP_SOURCES	Manufacturer	Manufacturer	Manufacturer	Manufacturer
NBR_PRI_DISP_LIST_ITEMS	>= 64	>= 64	>= 64	>= 64
NBR_PRI_DISP_LISTS	3 (normal, alternate, test)	3 (normal, alternate, test)	3 (normal, alternate, test)	4 (normal, alternate, test, other)
NBR_SEC_DISP_LIST_ITEMS	0	0	0	0
NBR_SEC_DISP_LISTS	0	0	0	0
TABLE 41				
NBR_PASSWORDS	>= 4 (Master, programmer, read and reset, customer read only)	>= 4 (Master, programmer, read and reset, customer read only)	>= 4 (Master, programmer, read and reset, customer read only)	>= 4 (Master, programmer, read and reset, customer read only)

Variable	Desirable Values Single Phase, Self Contained Energy only	Desirable Values Single Phase, Transformer Rated, Energy only	Desirable Values Polyphase, Self Contained Energy Only	Desirable Values Polyphase Transformer Rated, Energy Only
PASSWORD_LEN	20	20	20	20
NBR_KEYS	>= 4	>= 4	>= 4	>= 4
KEY_LEN	8	8	8	8
NBR_PERM_USED	>= 4	>= 4	>= 4	>= 4
TABLE 51				
TOU_SELF_READ_FLAG	False (If tables 23 and 26 are present)	False (If tables 23 and 26 are present)	False (If tables 23 and 26 are present)	False (If tables 23 and 26 are present)
SEASON_SELF_READ_FLAG	False (If tables 23 and 26 are present)	False (If tables 23 and 26 are present)	False (If tables 23 and 26 are present)	False (If tables 23 and 26 are present)
SEASON_DEMAND_RESET_FLAG	False	False	False	Programmable
SEASON_CHNG_ARMED_FLAG	False	False	False	Programmable
SORT_DATES_FLAG	False	False	False	Programmable
ANCHOR_DATE_FLAG	False	False	False	True
CAP_DST_AUTO_FLAG	False	False	False	False
SEPARATE_WEEKDAYS_FLAG	False	False	False	False
SEPARATE_SUM_DEMANDS_FLAG	False	False	False	False
SORT_TIER_SWITCHES_FLAG	False	False	False	Manufacturer specific
CAP_TM_ZN_OFFSET_FLAG	False	False	False	True
NBR_SEASONS	0	0	0	4
NBR_SPECIAL_SCHED	0	0	0	1
NBR_NON_RECURR_DATES	0 per year	0 per year	0 per year	32 per year
NBR_RECURR_DATES	0	0	0	16
NBR_TIER_SWITCHES	0	0	0	32
CALENDAR_TBL_SIZE	Manufacturer	Manufacturer	Manufacturer	Manufacturer
TABLE 61				
LP_SET1_INHIBIT_OVF_FLAG	Not necessary	Not necessary	Not necessary	Programmable-default is False
LP_SET2_INHIBIT_OVF_FLAG	Not necessary	Not necessary	Not necessary	Not necessary
LP_SET3_INHIBIT_OVF_FLAG	Not Necessary	Not Necessary	Not Necessary	Not Necessary
LP_SET4_INHIBIT_OVF_FLAG	Not necessary	Not necessary	Not Necessary	Not Necessary
BLK_END_READ_FLAG	Not necessary	Not necessary	Not necessary	Not necessary
BLK_END_PULSE_FLAG	Not necessary	Not necessary	Not necessary	Not necessary
SCALAR_DIVISOR_FLAG_SET1	Not necessary	Not necessary	Not necessary	Not necessary
SCALAR_DIVISOR_FLAG_SET2	Not Necessary	Not Necessary	Not Necessary	Not necessary
SCALAR_DIVISOR_FLAG_SET3	Not Necessary	Not Necessary	Not Necessary	Not Necessary
SCALAR_DIVISOR_FLAG_SET4	Not Necessary	Not Necessary	Not Necessary	Not Necessary
EXTENDED_INT_STATUS_FLAG	Not necessary	Not necessary	Not necessary	Not necessary
SIMPLE_INT_STATUS_FLAG	Not necessary	Not necessary	Not necessary	Not necessary
INV_UINT8_FLAG	Not necessary	Not necessary	Not necessary	Not necessary
INV_UINT16_FLAG	Not necessary	Not necessary	Not necessary	Not necessary
INV_UINT32_FLAG	Not necessary	Not necessary	Not necessary	Not necessary
INV_INT8_FLAG	Not necessary	Not necessary	Not necessary	Not necessary
INV_INT16_FLAG	Not necessary	Not necessary	Not necessary	Not necessary
INV_INT32_FLAG	Not necessary	Not necessary	Not necessary	Not necessary

Variable	Desirable Values Single Phase, Self Contained Energy only	Desirable Values Single Phase, Transformer Rated, Energy only	Desirable Values Polyphase, Self Contained Energy Only	Desirable Values Polyphase Transformer Rated, Energy Only
INV_NI_FMAT1_FLAG	False (It is believed that NI_FMAT1 or NI_FMAT2 will depend upon the manufacturer. May be used if implemented)	False (It is believed that NI_FMAT1 or NI_FMAT2 will depend upon the manufacturer. May be used if implemented)	False (It is believed that NI_FMAT1 or NI_FMAT2 will depend upon the manufacturer. May be used if implemented)	False (It is believed that NI_FMAT1 or NI_FMAT2 will depend upon the manufacturer. May be used if implemented)
INV_NI_FMAT2_FLAG	False (It is believed that NI_FMAT1 or NI_FMAT2 will depend upon the manufacturer. May be used if implemented)	False (It is believed that NI_FMAT1 or NI_FMAT2 will depend upon the manufacturer. May be used if implemented)	False (It is believed that NI_FMAT1 or NI_FMAT2 will depend upon the manufacturer. May be used if implemented)	False (It is believed that NI_FMAT1 or NI_FMAT2 will depend upon the manufacturer. May be used if implemented)
LP_MEMORY_LEN	0	0	0	0
NBR_BLKS_SET1	Not necessary	Not necessary	Not necessary	Not necessary
NBR_BLK_INTS_SET1	Not necessary	Not necessary	**Not necessary**	**Not necessary**
NBR_CHNS_SET1	Not necessary	Not necessary	Not necessary	Not necessary
MAX_INT_TIME_SET1	Not necessary	Not necessary	Not necessary	Not necessary
NBR_BLKS_SET2	Not Necessary	Not Necessary	Not Necessary	Not Necessary
NBR_BLK_INTS_SET2	Not Necessary	Not Necessary	Not Necessary	Not Necessary
NBR_CHNS_SET2	Not Necessary	Not Necessary	Not Necessary	Not Necessary
MAX_INT_TIME_SET2	Not Necessary	Not Necessary	Not Necessary	Not Necessary
NBR_BLKS_SET3	Not Necessary	Not Necessary	Not Necessary	Not Necessary
NBR_BLK_INTS_SET3	Not Necessary	Not Necessary	Not Necessary	Not Necessary
NBR_CHNS_SET3	Not Necessary	Not Necessary	Not Necessary	Not Necessary
MAX_INT_TIME_SET3	Not Necessary	Not Necessary	Not Necessary	Not Necessary
NBR_BLKS_SET4	Not Necessary	Not Necessary	Not Necessary	Not Necessary
NBR_BLK_INTS_SET4	Not Necessary	Not Necessary	Not Necessary	Not Necessary
NBR_CHNS_SET4	Not Necessary	Not Necessary	Not Necessary	Not Necessary
MAX_INT_TIME_SET4	Not Necessary	Not Necessary	Not Necessary	Not Necessary
TABLE 71				
EVENT_NUMBER_FLAG	True	True	True	True
HIST_DATE_TIME_FLAG	True	True	True	True
HIST_SEQ_NBR_FLAG	False	False	False	False
HIST_INHIBIT_OVF_FLAG	False	False	False	False
EVENT_INHIBIT_OVF_FLAG	False	False	False	False
NBR_STD_EVENTS	Manufacturer defined	Manufacturer defined	Manufacturer defined	Manufacturer defined
NBR_MFG_EVENTS	Manufacturer defined	Manufacturer defined	Manufacturer defined	Manufacturer defined
HIST_DATA_LENGTH	Manufacturer defined	Manufacturer defined	Manufacturer defined	Manufacturer defined
EVENT_DATA_LENGTH	Manufacturer defined	Manufacturer defined	Manufacturer defined	Manufacturer defined
NBR_HISTORY_ENTRIES	32	32	32	32
NBR_EVENT_ENTRIES	32	32	32	32
TABLE 81				

Variable	Desirable Values Single Phase, Self Contained Energy only	Desirable Values Single Phase, Transformer Rated, Energy only	Desirable Values Polyphase, Self Contained Energy Only	Desirable Values Polyphase Transformer Rated, Energy Only
NBR_UDTS	1 Minimum	1 Minimum	1 Minimum	1 Minimum
INSTANCE_FLAG	False	False	False	False
DATA_ACCESS_METHOD	**1** preferred for simplicity	**1** preferred for simplicity	**1** preferred for simplicity	**1** preferred for simplicity
NBR_XFR_LIST_ITEMS	Suggest that the manufacturer size this parameter such that a maximum of 16 data elements can be created in each user defined table in use.	Suggest that the manufacturer size this parameter such that a maximum of 16 data elements can be created in each user defined table in use.	Suggest that the manufacturer size this parameter such that a maximum of 16 data elements can be created in each user defined table in use.	Suggest that the manufacturer size this parameter such that a maximum of 16 data elements can be created in each user defined table in use.
MAX_INSTANCE	0	0	0	0
UDT_0_SIZE	256	256	256	256
UDT_1_SIZE	Does not apply	Does not apply	Does not apply	Does not apply
UDT_2_SIZE	Does not apply	Does not apply	Does not apply	Does not apply
UDT_3_SIZE	Does not apply	Does not apply	Does not apply	Does not apply
UDT_4_SIZE	Does not apply	Does not apply	Does not apply	Does not apply
UDT_5_SIZE	Does not apply	Does not apply	Does not apply	Does not apply

~~8.2.2~~8.4.2 ACTUAL FUNCTION LIMITING CONTROL (FLC+1) Table Values – Single Phase, Self Contained

Variable	Desirable Values Single Phase, Self Contained Energy, Demand only	Desirable Values Single Phase,Self Contained Energy, Demand, TOU	Desirable Values Single Phase,Self Contained Energy, Demand, TOU, LP
TABLE 11			
PF_EXCLUDE_FLAG	True, may be programmable	True, may be programmable	True, may be programmable
RESET_EXCLUDE_FLAG	True, may be programmable	True, may be programmable	True, may be programmable
BLOCK_DEMAND_FLAG	True if block demand used	True if block demand used	True if block demand used
SLIDING_DEMAND_FLAG	True if sliding demand used	True if sliding demand used	True if sliding demand used
THERMAL_DEMAND_FLAG	True if thermal demand used	True if thermal demand used	True if thermal demand used
SET1_PRESENT_FLAG	False	False	False
SET2_PRESENT_FLAG	False (note: meters with multiple input types with different ratios such as electric/gas/water combination devices may require set2)	False	False
NBR_UOM_ENTRIES	Manufacturer defined	Manufacturer defined	Manufacturer defined
NBR_DEMAND_CTRL_ENTRIES	Depends on manufacturers design (the working group recommends enabling KW and KVAR with others as needed by the functionality	Depends on manufacturers design (the working group recommends enabling KW and KVAR with others as needed by the functionality	Depends on manufacturers design (the working group recommends enabling KW and KVAR with others as needed by the functionality
DATA_CTRL_LENGTH	Manufacturer defined	Manufacturer defined	Manufacturer defined
NBR_DATA_CTRL_ENTRIES	Manufacturer defined	Manufacturer defined	Manufacturer defined
NBR_CONSTANTS_ENTRIES	Manufacturer defined (1 or more)	Manufacturer defined (1 or more)	Manufacturer defined (1 or more)
CONSTANTS_SELECTOR	Choice **2**	Choice 2	Choice 2

Variable	Desirable Values Single Phase, Self Contained Energy, Demand only	Desirable Values Single Phase,Self Contained Energy, Demand, TOU	Desirable Values Single Phase,Self Contained Energy, Demand, TOU, LP
NBR_SOURCES	Manufacturer defined	Manufacturer defined	Manufacturer defined
TABLE 21			
SEASON_INFO_FIELD_FLAG	False	True, if season changes in a TOU schedule are performed	True, if season changes in a TOU schedule are performed
DATE_TIME_FIELD_FLAG	False	True	True
DEMAND_RESET_CTR_FLAG	True (aids in tamper detection)	True (aids in tamper detection)	True (aids in tamper detection)
DEMAND_RESET_LOCK_FLAG	Programmable	Programmable	Programmable
CUM_DEMAND_FLAG	Programmable	Programmable	Programmable
CONT_CUM_DEMAND_FLAG	Programmable	Programmable	Programmable
TIME_REMAINING_FLAG	Programmable	Programmable	Programmable
SELF_READ_INHIBIT_OVERFLOW_FLAG	Programmable (however, for most common implementations will be False)	Programmable (however, for most common implementations will be False)	Programmable (however, for most common implementations will be False)
SELF_READ_SEQ_NBR_FLAG	TrueMay be	True	True
DAILY_SELF_READ_FLAG	False	Programmable	Programmable
WEEKLY_SELF_READ_FLAG	False	Programmable	Programmable
SELF_READ_DEMAND_RESET	Programmable	Programmable	Programmable
NBR_SELF_READS	>= 3 (if self reads required)	>= 3	>= 3
NBR_SUMMATIONS	>= 1 (e.g. KW-Hr or perhaps KVA-Hr)	>= 1 (e.g. KW-Hr or perhaps KVA-Hr)	>= e.g. >= 1 (e.g. KW-Hr or perhaps KVA-Hr)
NBR_DEMANDS	1 (KW or perhaps KVA)	1 (KW or perhaps KVA)	1 (KW or perhaps KVA)
NBR_COIN_VALUES	1 (May depend on available functions, for example, volts at peak, etc.)	1 (May depend on available functions, for example, volts at peak, etc.)	1 (May depend on available functions, for example, volts at peak, etc.)
NBR_OCCUR	depends on programming **(**Number of times demand appears in table 22, max-mins, etc.)	depends on programming **(**Number of times demand appears in table 22, max-mins, etc.)	depends on programming **(**Number of times demand appears in table 22, max-mins, etc.)
NBR_TIERS	0	Programmable (Manufacturer design may dictate number of actual choices. The working group envisions scenarios requiring up to 6 tiers in the immediate future)	Programmable (Manufacturer design may dictate number of actual choices. The working group envisions scenarios requiring up to 6 tiers in the immediate future)
NBR_PRESENT_DEMANDS	At least 1 (KW) (Others such as KVAR, etc. may depend on how meter is programmed)	At least 1 (KW) (Others such as KVAR, etc. may depend on how meter is programmed)	At least 1 (KW) (Others such as KVAR, etc. may depend on how meter is programmed)
NBR_PRESENT_VALUES	Depends on the manufacturer design (useful values include 1 ph. volts, 1 ph. Amps, power factor in addition to billing parameters)	Depends on the manufacturer design (useful values include 1 ph. volts, 1 ph. Amps, power factor in addition to billing parameters)	Depends on the manufacturer design (useful values include 1 ph. volts, 1 ph. Amps, power factor in addition to billing parameters)

Variable	Desirable Values Single Phase, Self Contained Energy, Demand only	Desirable Values Single Phase,Self Contained Energy, Demand, TOU	Desirable Values Single Phase,Self Contained Energy, Demand, TOU, LP
TABLE 31			
ON_TIME_FLAG	True	True	True
OFF_TIME_FLAG	False (Manufacturer may set value to "0" in table 32)	False (Manufacturer may set value to "0" in table 32)	False (Manufacturer may set value to "0" in table 32)
HOLD_TIME_FLAG	False	False	False
NBR_DISP_SOURCES	Manufacturer (Minimum 32)	Manufacturer (Minimum 32)	Manufacturer (Minimum 32)
WIDTH_DISP_SOURCES	Manufacturer	Manufacturer	Manufacturer
NBR_PRI_DISP_LIST_ITEMS	>= 64	>= 64	>= 64
NBR_PRI_DISP_LISTS	3 (normal, alternate, test)	3 (normal, alternate, test)	4 (normal, alternate, test, other)
NBR_SEC_DISP_LIST_ITEMS	0	32 (maximum envisioned)	32 (maximum envisioned)
NBR_SEC_DISP_LISTS	04 (Alternate, Test, Marketing, Diagnostic))	4 (Alternate, Test, Marketing, Diagnostic))	4 (Alternate, Test, Marketing, Diagnostic)
TABLE 41			
NBR_PASSWORDS	>= 4 (Master, programmer, read and reset, customer read only)	>= 4 (Master, programmer, read and reset, customer read only)	>= 4 (Master, programmer, read and reset, customer read only)
PASSWORD_LEN	20	20	20
NBR_KEYS	>= 4	>= 4	>= 4
KEY_LEN	8	8	8
NBR_PERM_USED	>= 4	>= 4	>= 4
TABLE 51			
TOU_SELF_READ_FLAG	False (If tables 23 and 26 are present)	Programmable (If tables 23 and 26 are present)	Programmable (If tables 23 and 26 are present)
SEASON_SELF_READ_FLAG	False (If tables 23 and 26 are present)	Programmable (If tables 23 and 26 are present)	Programmable (If tables 23 and 26 are present)
SEASON_DEMAND_RESET_FLAG	False	Programmable	Programmable
SEASON_CHNG_ARMED_FLAG	False	Programmable	Programmable
SORT_DATES_FLAG	False	True	Programmable
ANCHOR_DATE_FLAG	False	True	True
CAP_DST_AUTO_FLAG	False	False	False
SEPARATE_WEEKDAYS_FLAG	False	False	False
SEPARATE_SUM_DEMANDS_FLAG	False	False	False
SORT_TIER_SWITCHES_FLAG	False	Manufacturer specific	Manufacturer specific
CAP_TM_ZN_OFFSET_FLAG	False	True	True
NBR_SEASONS	0	4	4
NBR_SPECIAL_SCHED	0	1	1
NBR_NON_RECURR_DATES	0 per year	32 per year	32 per year
NBR_RECURR_DATES	0	16	16
NBR_TIER_SWITCHES	0	32	32
CALENDAR_TBL_SIZE	Manufacturer	Manufacturer	Manufacturer

Variable	Desirable Values Single Phase, Self Contained Energy, Demand only	Desirable Values Single Phase,Self Contained Energy, Demand, TOU	Desirable Values Single Phase,Self Contained Energy, Demand, TOU, LP
TABLE 61			
LP_SET1_INHIBIT_OVF_FLAG	Not necessary	Not necessary	Programmable-default is False
LP_SET2_INHIBIT_OVF_FLAG	Not necessary	Not necessary	Not necessary
LP_SET3_INHIBIT_OVF_FLAG	Not Necessary	Not Necessary	Not Necessary
LP_SET4_INHIBIT_OVF_FLAG	Not necessary	Not Necessary	Not Necessary
BLK_END_READ_FLAG	Not necessary	Not Necessary	True if not **BLK_END_READ_FLAG**
BLK_END_PULSE_FLAG	Not necessary	Not Necessary	True
SCALAR_DIVISOR_FLAG_SET1	Not necessary	Not Necessary	True
SCALAR_DIVISOR_FLAG_SET2	Not Necessary	Not Necessary	True
SCALAR_DIVISOR_FLAG_SET3	Not Necessary	Not Necessary	Not Necessary
SCALAR_DIVISOR_FLAG_SET4	Not Necessary	Not Necessary	Not Necessary
EXTENDED_INT_STATUS_FLAG	Not necessary	Not necessary	True
SIMPLE_INT_STATUS_FLAG	Not necessary	Not necessary	False
INV_UINT8_FLAG	Not necessary	Not necessary	False
INV_UINT16_FLAG	Not necessary	Not necessary	True
INV_UINT32_FLAG	Not necessary	Not necessary	False
INV_INT8_FLAG	Not necessary	Not necessary	False
INV_INT16_FLAG	Not necessary	Not necessary	False
INV_INT32_FLAG	Not necessary	Not necessary	False
INV_NI_FMAT1_FLAG	False (It is believed that NI_FMAT1 or NI_FMAT2 will depend upon the manufacturer. May be used if implemented)	False (It is believed that NI_FMAT1 or NI_FMAT2 will depend upon the manufacturer. May be used if implemented)	False (It is believed that NI_FMAT1 or NI_FMAT2 will depend upon the manufacturer. May be used if implemented)
INV_NI_FMAT2_FLAG	False (It is believed that NI_FMAT1 or NI_FMAT2 will depend upon the manufacturer. May be used if implemented)	False (It is believed that NI_FMAT1 or NI_FMAT2 will depend upon the manufacturer. May be used if implemented)	False (It is believed that NI_FMAT1 or NI_FMAT2 will depend upon the manufacturer. May be used if implemented)
LP_MEMORY_LEN	0	0	At least one set of 16K
NBR_BLKS_SET1	Not necessary	Not necessary	Manufacturer memory dependent
NBR_BLK_INTS_SET1	Not necessary	**Not necessary**	Capability of at least one block per 24 hour
NBR_CHNS_SET1	Not necessary	Not necessary	8 (Minimum)
MAX_INT_TIME_SET1	Not necessary	Not necessary	Programmable for 1, 5, 10, 15, 30, 60 minute intervals
NBR_BLKS_SET2	Not Necessary	Not Necessary	Manufacturer memory dependent
NBR_BLK_INTS_SET2	Not Necessary	Not Necessary	Capability of at least one block per 24 hour
NBR_CHNS_SET2	Not Necessary	Not Necessary	8 suggested
MAX_INT_TIME_SET2	Not Necessary	Not Necessary	Programmable for 1, 5, 10, 15, 30, 60 minute intervals
NBR_BLKS_SET3	Not Necessary	Not Necessary	Not Necessary
NBR_BLK_INTS_SET3	Not Necessary	Not Necessary	Not Necessary
NBR_CHNS_SET3	Not Necessary	Not Necessary	Not Necessary
MAX_INT_TIME_SET3	Not Necessary	Not Necessary	Not Necessary
NBR_BLKS_SET4	Not Necessary	Not Necessary	Not Necessary

Variable	Desirable Values Single Phase, Self Contained Energy, Demand only	Desirable Values Single Phase,Self Contained Energy, Demand, TOU	Desirable Values Single Phase,Self Contained Energy, Demand, TOU, LP
NBR_BLK_INTS_SET4	Not Necessary	Not Necessary	Not Necessary
NBR_CHNS_SET4	Not Necessary	Not Necessary	Not Necessary
MAX_INT_TIME_SET4	Not Necessary	Not Necessary	Not Necessary
TABLE 71			
EVENT_NUMBER_FLAG	True	True	True
HIST_DATE_TIME_FLAG	True	True	True
HIST_SEQ_NBR_FLAG	True	True	True
HIST_INHIBIT_OVF_FLAG	False	False	False
EVENT_INHIBIT_OVF_FLAG	False	False	False
NBR_STD_EVENTS	Manufacturer defined	Manufacturer defined	Manufacturer defined
NBR_MFG_EVENTS	Manufacturer defined	Manufacturer defined	Manufacturer defined
HIST_DATA_LENGTH	Manufacturer defined	Manufacturer defined	Manufacturer defined
EVENT_DATA_LENGTH	Manufacturer defined	Manufacturer defined	Manufacturer defined
NBR_HISTORY_ENTRIES	32	32	32
NBR_EVENT_ENTRIES	32	32	32
TABLE 81			
NBR_UDTS	1 Minimum	1 Minimum	1 Minimum
INSTANCE_FLAG	False	False	False
DATA_ACCESS_METHOD	**1** preferred for simplicity	**1** preferred for simplicity	**1** preferred for simplicity
NBR_XFR_LIST_ITEMS	Suggest that the manufacturer size this parameter such that a maximum of 16 data elements can be created in each user defined table in use.	Suggest that the manufacturer size this parameter such that a maximum of 16 data elements can be created in each user defined table in use.	Suggest that the manufacturer size this parameter such that a maximum of 16 data elements can be created in each user defined table in use.
MAX_INSTANCE	0	0	0
UDT_0_SIZE	256	256	256
UDT_1_SIZE	Does not apply	Does not apply	Does not apply
UDT_2_SIZE	Does not apply	Does not apply	Does not apply
UDT_3_SIZE	Does not apply	Does not apply	Does not apply
UDT_4_SIZE	Does not apply	Does not apply	Does not apply
UDT_5_SIZE	Does not apply	Does not apply	Does not apply

~~8.2.3~~i. ACTUAL FUNCTION LIMITING CONTROL (FLC+1) Table Values – Single Phase, Transformer Rated

Variable	Desirable Values Single Phase Transformer Rated Energy, Demand	Desirable Values Single Phase Transformer Rated Energy, Demand, TOU	Desirable Values Single Phase Transformer Rated Energy, Demand, TOU, LP
TABLE 11			
PF_EXCLUDE_FLAG	True (False for kWh only meter), may be programmable	True (False for kWh only meter), may be programmable	True, may be programmable
RESET_EXCLUDE_FLAG	True (False for kWh only meter), may be programmable	True (False for kWh only meter), may be programmable	True, may be programmable
BLOCK_DEMAND_FLAG	True if block demand used	True if block demand used	True if block demand used
SLIDING_DEMAND_FLAG	True if sliding demand used	True if sliding demand used	True if sliding demand used
THERMAL_DEMAND_FLAG	True if thermal demand used	True if thermal demand used	True if thermal demand used

Variable	Desirable Values Single Phase Transformer Rated Energy, Demand	Desirable Values Single Phase Transformer Rated Energy, Demand, TOU	Desirable Values Single Phase Transformer Rated Energy, Demand, TOU, LP
SET1_PRESENT_FLAG	True	True	True
SET2_PRESENT_FLAG	False (note: meters with multiple input types with different ratios such as electric/gas/water combination devices may require set2)	False (note: meters with multiple input types with different ratios such as electric/gas/water combination devices may require set2)	False
NBR_UOM_ENTRIES	Manufacturer defined	Manufacturer defined	Manufacturer defined
NBR_DEMAND_CTRL_ENTRIES	Depends on manufacturers design (the working group recommends enabling KW and KVAR with others as needed by the functionality	Depends on manufacturers design (the working group recommends enabling KW and KVAR with others as needed by the functionality	Depends on manufacturers design (the working group recommends enabling KW and KVAR with others as needed by the functionality
DATA_CTRL_LENGTH	Manufacturer defined	Manufacturer defined	Manufacturer defined
NBR_DATA_CTRL_ENTRIES	Manufacturer defined	Manufacturer defined	Manufacturer defined
NBR_CONSTANTS_ENTRIES	Manufacturer defined (1 or more)	Manufacturer defined (1 or more)	Manufacturer defined (1 or more)
CONSTANTS_SELECTOR	Choice **2**	Choice **2**	Choice 2
NBR_SOURCES	Manufacturer defined	Manufacturer defined	Manufacturer defined
TABLE 21			
SEASON_INFO_FIELD_FLAG	False	True, if season changes in a TOU schedule are performed	True, if season changes in a TOU schedule are performed
DATE_TIME_FIELD_FLAG	False	True	True
DEMAND_RESET_CTR_FLAG	True (aids in tamper detection)	True (aids in tamper detection)	True (aids in tamper detection)
DEMAND_RESET_LOCK_FLAG	Programmable if demand or TOU False if summation only	Programmable if demand or TOU False if summation only	Programmable False if summation(s) only
CUM_DEMAND_FLAG	Programmable True if used for demand or TOU False if summation only	Programmable True if used for demand or TOU False if summation only	Programmable
CONT_CUM_DEMAND_FLAG	Programmable True if used for demand or TOU False if summation only	Programmable True if used for demand or TOU False if summation only	Programmable
TIME_REMAINING_FLAG	Programmable True if demand or TOU False if summation only	Programmable True if demand or TOU False if summation only	Programmable
SELF_READ_INHIBIT_OVERFLOW_FLAG	Programmable if self read is implemented (however, for most common implementations will be False)	Programmable if self read is implemented (however, for most common implementations will be False)	Programmable (however, for most common implementations will be False)
SELF_READ_SEQ_NBR_FLAG	True if demand or TOU May be False if summation only	True if demand or TOU May be False if summation only	True
DAILY_SELF_READ_FLAG	False	Programmable	Programmable
WEEKLY_SELF_READ_FLAG	False	Programmable	Programmable
SELF_READ_DEMAND_RESET	Programmable	Programmable	Programmable

Variable	Desirable Values Single Phase Transformer Rated Energy, Demand	Desirable Values Single Phase Transformer Rated Energy, Demand, TOU	Desirable Values Single Phase Transformer Rated Energy, Demand, TOU, LP
NBR_SELF_READS	>= 3 (if self reads required)	>= 3 (if self reads required)	>= 3
NBR_SUMMATIONS	>= 1 (e.g. KW-Hr or perhaps KVA-Hr)	>= 1 (e.g. KW-Hr or perhaps KVA-Hr)	>= 3 (e.g. KW-Hr, KVAR-Hr, avg. PF)
NBR_DEMANDS	2 (KW, KVAR or perhaps KVA)	2 (KW, KVAR or perhaps KVA)	2 (KW, KVAR or perhaps KVA)
NBR_COIN_VALUES	2 (May depend on available functions, for example, volts at peak, etc.)	2 (May depend on available functions, for example, volts at peak, etc.)	2 (KW, KVAR, others may depend on available functions)
NBR_OCCUR	depends on programming **(**Number of times demand appears in table 22, max-mins, etc.)	depends on programming **(**Number of times demand appears in table 22, max-mins, etc.)	depends on programming
NBR_TIERS	0	Programmable (Manufacturer design may dictate number of actual choices. The working group envisions scenarios requiring up to 6 tiers in the immediate future)	Programmable (Manufacturer design may dictate number of actual choices. The working group envisions scenarios requiring up to 6 tiers in the immediate future)
NBR_PRESENT_DEMANDS	At least 1 (KW) (Others such as KVAR, etc. may depend on how meter is programmed)	At least 1 (KW) (Others such as KVAR, etc. may depend on how meter is programmed)	At least 1 (KW) (Others depend on how meter is programmed)
NBR_PRESENT_VALUES	Depends on the manufacturer design (useful values include 1 ph. volts, 1 ph. Amps, power factor in addition to billing parameters)	Depends on the manufacturer design (useful values include 1 ph. volts, 1 ph. Amps, power factor in addition to billing parameters)	Depends on the manufacturer design (useful values include 1 ph. volts, 1 ph. Amps, power factor in addition to billing parameters)
TABLE 31			
ON_TIME_FLAG	True	True	True
OFF_TIME_FLAG	False (Manufacturer may set value to “0” in table 32)	False (Manufacturer may set value to “0” in table 32)	False (Manufacturer may set value to “0” in table 32)
HOLD_TIME_FLAG	False	False	False
NBR_DISP_SOURCES	Manufacturer (Minimum 32)	Manufacturer (Minimum 32)	Manufacturer (Minimum 32)
WIDTH_DISP_SOURCES	Manufacturer	Manufacturer	Manufacturer
NBR_PRI_DISP_LIST_ITEMS	>= 64	>= 64	>= 64
NBR_PRI_DISP_LISTS	3 (normal, alternate, test)	3 (normal, alternate, test)	3 (normal, alternate, test)
NBR_SEC_DISP_LIST_ITEMS	0	0	0
NBR_SEC_DISP_LISTS	0	0	0
TABLE 41			
NBR_PASSWORDS	>= 4 (Master, programmer, read and reset, customer read only)	>= 4 (Master, programmer, read and reset, customer read only)	>= 4 (Master, programmer, read and reset, customer read only)
PASSWORD_LEN	20	20	20

Variable	Desirable Values Single Phase Transformer Rated Energy, Demand	Desirable Values Single Phase Transformer Rated Energy, Demand, TOU	Desirable Values Single Phase Transformer Rated Energy, Demand, TOU, LP
NBR_KEYS	>= 4	>= 4	>= 4
KEY_LEN	8	8	8
NBR_PERM_USED	>= 4	>= 4	>= 4
TABLE 51			
TOU_SELF_READ_FLAG	False (If tables 23 and 26 are present)	Programmable (If tables 23 and 26 are present)	Programmable (If tables 23 and 26 are present)
SEASON_SELF_READ_FLAG	False (If tables 23 and 26 are present)	Programmable (If tables 23 and 26 are present)	Programmable (If tables 23 and 26 are present)
SEASON_DEMAND_RESET_FLAG	False	Programmable	Programmable
SEASON_CHNG_ARMED_FLAG	False	Programmable	Programmable
SORT_DATES_FLAG	False	True	True
ANCHOR_DATE_FLAG	False	True	True
CAP_DST_AUTO_FLAG	False	False	False
SEPARATE_WEEKDAYS_FLAG	False	False	False
SEPARATE_SUM_DEMANDS_FLAG	False	False	False
SORT_TIER_SWITCHES_FLAG	False	Manufacturer specific	Manufacturer specific
CAP_TM_ZN_OFFSET_FLAG	False	True	True
NBR_SEASONS	0	4	4
NBR_SPECIAL_SCHED	0	1	1
NBR_NON_RECURR_DATES	0 per year	32 per year	32 per year
NBR_RECURR_DATES	0	16	16
NBR_TIER_SWITCHES	0	32	32
CALENDAR_TBL_SIZE	Manufacturer	Manufacturer	Manufacturer
TABLE 61			
LP_SET1_INHIBIT_OVF_FLAG	Not necessary	Not necessary	Programmable-default is False
LP_SET2_INHIBIT_OVF_FLAG	Not necessary	Not necessary	Not necessary
LP_SET3_INHIBIT_OVF_FLAG	Not Necessary	Not Necessary	Not Necessary
LP_SET4_INHIBIT_OVF_FLAG	Not necessary	Not necessary	Not Necessary
BLK_END_READ_FLAG	Not necessary	Not necessary	True
BLK_END_PULSE_FLAG	Not necessary	Not necessary	True
SCALAR_DIVISOR_FLAG_SET1	Not necessary	Not necessary	True
SCALAR_DIVISOR_FLAG_SET2	Not Necessary	Not Necessary	Not Necessary
SCALAR_DIVISOR_FLAG_SET3	Not Necessary	Not Necessary	Not Necessary
SCALAR_DIVISOR_FLAG_SET4	Not Necessary	Not Necessary	Not Necessary
EXTENDED_INT_STATUS_FLAG	Not Necessary	Not Necessary	True
SIMPLE_INT_STATUS_FLAG	Not Necessary	Not Necessary	False
INV_UINT8_FLAG	Not Necessary	Not Necessary	False
INV_UINT16_FLAG	Not Necessary	Not Necessary	True
INV_UINT32_FLAG	Not Necessary	Not Necessary	False
INV_INT8_FLAG	Not Necessary	Not Necessary	False
INV_INT16_FLAG	Not Necessary	Not Necessary	False
INV_INT32_FLAG	Not Necessary	Not Necessary	False

Variable	Desirable Values Single Phase Transformer Rated Energy, Demand	Desirable Values Single Phase Transformer Rated Energy, Demand, TOU	Desirable Values Single Phase Transformer Rated Energy, Demand, TOU, LP
INV_NI_FMAT1_FLAG	False (It is believed that NI_FMAT1 or NI_FMAT2 will depend upon the manufacturer. May be used if implemented)	False (It is believed that NI_FMAT1 or NI_FMAT2 will depend upon the manufacturer. May be used if implemented)	False (It is believed that NI_FMAT1 or NI_FMAT2 will depend upon the manufacturer. May be used if implemented)
INV_NI_FMAT2_FLAG	False (It is believed that NI_FMAT1 or NI_FMAT2 will depend upon the manufacturer. May be used if implemented)	False (It is believed that NI_FMAT1 or NI_FMAT2 will depend upon the manufacturer. May be used if implemented)	False (It is believed that NI_FMAT1 or NI_FMAT2 will depend upon the manufacturer. May be used if implemented)
LP_MEMORY_LEN	Not Necessary	Not Necessary	At least one set of 16K (
NBR_BLKS_SET1	Not Necessary	Not Necessary	Manufacturer memory dependent
NBR_BLK_INTS_SET1	Not Necessary	Not Necessary	Capability of at least one block per 24 hour
NBR_CHNS_SET1	Not Necessary	Not Necessary	1 (Minimum)
MAX_INT_TIME_SET1	Not Necessary	Not Necessary	Programmable for 1, 5, 10, 15, 30, 60 minute intervals
NBR_BLKS_SET2	Not Necessary	Not Necessary	Not Necessary
NBR_BLK_INTS_SET2	Not Necessary	Not Necessary	Not Necessary
NBR_CHNS_SET2	Not Necessary	Not Necessary	Not Necessary
MAX_INT_TIME_SET2	Not Necessary	Not Necessary	Not Necessary
NBR_BLKS_SET3	Not Necessary	Not Necessary	Not Necessary
NBR_BLK_INTS_SET3	Not Necessary	Not Necessary	Not Necessary
NBR_CHNS_SET3	Not Necessary	Not Necessary	Not Necessary
MAX_INT_TIME_SET3	Not Necessary	Not Necessary	Not Necessary
NBR_BLKS_SET4	Not Necessary	Not Necessary	Not Necessary
NBR_BLK_INTS_SET4	Not Necessary	Not Necessary	Not Necessary
NBR_CHNS_SET4	Not Necessary	Not Necessary	Not Necessary
MAX_INT_TIME_SET4	Not Necessary	Not Necessary	Not Necessary
TABLE 71			
EVENT_NUMBER_FLAG	True	True	True
HIST_DATE_TIME_FLAG	True	True	True
HIST_SEQ_NBR_FLAG	False	False	True
HIST_INHIBIT_OVF_FLAG	False	False	False
EVENT_INHIBIT_OVF_FLAG	False	False	False
NBR_STD_EVENTS	Manufacturer defined	Manufacturer defined	Manufacturer defined
NBR_MFG_EVENTS	Manufacturer defined	Manufacturer defined	Manufacturer defined
HIST_DATA_LENGTH	Manufacturer defined	Manufacturer defined	Manufacturer defined
EVENT_DATA_LENGTH	Manufacturer defined	Manufacturer defined	Manufacturer defined
NBR_HISTORY_ENTRIES	32	32	32
NBR_EVENT_ENTRIES	32	32	32
TABLE 81			
NBR_UDTS	1 Minimum	1 Minimum	1 Minimum
INSTANCE_FLAG	False	False	False
DATA_ACCESS_METHOD	**1** preferred for simplicity	**1** preferred for simplicity	**1** preferred for simplicity

Variable	Desirable Values Single Phase Transformer Rated Energy, Demand	Desirable Values Single Phase Transformer Rated Energy, Demand, TOU	Desirable Values Single Phase Transformer Rated Energy, Demand, TOU, LP
NBR_XFR_LIST_ITEMS	Suggest that the manufacturer size this parameter such that a maximum of 16 data elements can be created in each user defined table in use.	Suggest that the manufacturer size this parameter such that a maximum of 16 data elements can be created in each user defined table in use.	Suggest that the manufacturer size this parameter such that a maximum of 32 data elements can be created in each user defined table in use.
MAX_INSTANCE	0	0	0
UDT_0_SIZE	256	256	256
UDT_1_SIZE	256	256	256
UDT_2_SIZE	256	256	256
UDT_3_SIZE	Does not apply	Does not apply	Does not apply
UDT_4_SIZE	Does not apply	Does not apply	Does not apply
UDT_5_SIZE	Does not apply	Does not apply	Does not apply

~~8.2.4~~8.4.3 ACTUAL FUNCTION LIMITING CONTROL (FLC+1) Table Values – Poly-Phase, Self Contained

Variable	Desirable Values Self Contained Polyphase Energy, Demand	Desirable Values Self Contained Polyphase Energy, Demand, TOU	Desirable Values Self Contained Polyphase Energy, Demand, TOU, LP
TABLE 11			
PF_EXCLUDE_FLAG	True (False for kWh only meter), may be programmable	True (False for kWh only meter), may be programmable	True, may be programmable
RESET_EXCLUDE_FLAG	True (False for kWh only meter), may be programmable	True (False for kWh only meter), may be programmable	True, may be programmable
BLOCK_DEMAND_FLAG	True if block demand used	True if block demand used	True if block demand used
SLIDING_DEMAND_FLAG	True if sliding demand used	True if sliding demand used	True if sliding demand used
THERMAL_DEMAND_FLAG	True if thermal demand used	True if thermal demand used	True if thermal demand used
SET1_PRESENT_FLAG	True	True	True
SET2_PRESENT_FLAG	False (note: meters with multiple input types with different ratios such as electric/gas/water combination devices may require set2)	False (note: meters with multiple input types with different ratios such as electric/gas/water combination devices may require set2)	False note: meters with multiple input types with different ratios such as electric/gas/water combination devices may require set2)
NBR_UOM_ENTRIES	Manufacturer defined	Manufacturer defined	Manufacturer defined
NBR_DEMAND_CTRL_ENTRIES	Depends on manufacturers design (the working group recommends enabling KW and KVAR with others as needed by the functionality	Depends on manufacturers design (the working group recommends enabling KW and KVAR with others as needed by the functionality	Depends on manufacturers design (the working group recommends enabling KW and KVAR with others as needed by the functionality
DATA_CTRL_LENGTH	Manufacturer defined	Manufacturer defined	Manufacturer defined
NBR_DATA_CTRL_ENTRIES	Manufacturer defined	Manufacturer defined	Manufacturer defined
NBR_CONSTANTS_ENTRIES	Manufacturer defined (1 or more)	Manufacturer defined (1 or more)	Manufacturer defined (1 or more)
CONSTANTS_SELECTOR	Choice **2**	Choice **2**	Choice 2
NBR_SOURCES	Manufacturer defined	Manufacturer defined	Manufacturer defined

Variable	Desirable Values Self Contained Polyphase Energy, Demand	Desirable Values Self Contained Polyphase Energy, Demand, TOU	Desirable Values Self Contained Polyphase Energy, Demand, TOU, LP
TABLE 21			
SEASON_INFO_FIELD_FLAG	False	True, if season changes in a TOU schedule are performed	True, if season changes in a TOU schedule are performed
DATE_TIME_FIELD_FLAG	False	True	True
DEMAND_RESET_CTR_FLAG	True (aids in tamper detection)	True (aids in tamper detection)	True (aids in tamper detection)
DEMAND_RESET_LOCK_FLAG	Programmable if demand or TOU False if summation only	Programmable if demand or TOU False if summation only	Programmable False if summation(s) only
CUM_DEMAND_FLAG	Programmable True if used for demand or TOU False if summation only	Programmable True if used for demand or TOU False if summation only	Programmable True if used for demand or TOU False if summation only
CONT_CUM_DEMAND_FLAG	Programmable True if used for demand or TOU False if summation only	Programmable True if used for demand or TOU False if summation only	Programmable True if used for demand or TOU False if summation only
TIME_REMAINING_FLAG	Programmable True if demand or TOU False if summation only	Programmable True if demand or TOU False if summation only	True if used for demand or TOU False if summation only
SELF_READ_INHIBIT_OVERFLOW_FLAG	Programmable if self read is implemented (however, for most common implementations will be False)	Programmable if self read is implemented (however, for most common implementations will be False)	Programmable if self read is implemented (however, for most common implementations will be False)
SELF_READ_SEQ_NBR_FLAG	True if demand or TOU May be False if summation only	True if demand or TOU May be False if summation only	True if demand or TOU May be False if summation only
DAILY_SELF_READ_FLAG	False	Programmable	Programmable
WEEKLY_SELF_READ_FLAG	False	Programmable	Programmable
SELF_READ_DEMAND_RESET	Programmable	Programmable	Programmable
NBR_SELF_READS	>= 3 (if self reads required)	>= 3 (if self reads required)	>= 3
NBR_SUMMATIONS	>= 3 (e.g. KW-Hr, KVAR-Hr, avg. PF)	>= 3 (e.g. KW-Hr, KVAR-Hr, avg. PF)	>= 3 (e.g. KW-Hr, KVAR-Hr, avg. PF)
NBR_DEMANDS	2 (KW, KVAR or perhaps KVA)	2 (KW, KVAR or perhaps KVA)	2 (KW, KVAR or perhaps KVA)
NBR_COIN_VALUES	3 (May depend on available functions, for example, KVAR. volts at peak, etc.)	3 (May depend on available functions, for example, KVAR. volts at peak, etc.)	3 (May depend on available functions, for example,KVAR volts at peak, etc.)
NBR_OCCUR	depends on programming **(**Number of times demand appears in table 22, max-mins, etc.)	depends on programming **(**Number of times demand appears in table 22, max-mins, etc.)	depends on programming
NBR_TIERS	0	Programmable (Manufacturer design may dictate number of actual choices. The working group envisions scenarios requiring up to 6 tiers in the immediate future)	Programmable (Manufacturer design may dictate number of actual choices. The working group envisions scenarios requiring up to 6 tiers in the immediate future)

Variable	Desirable Values Self Contained Polyphase Energy, Demand	Desirable Values Self Contained Polyphase Energy, Demand, TOU	Desirable Values Self Contained Polyphase Energy, Demand, TOU, LP
NBR_PRESENT_DEMANDS	At least 1 (KW) (Others such as KVAR, etc. may depend on how meter is programmed)	At least 1 (KW) (Others such as KVAR, etc. may depend on how meter is programmed)	At least 1 (KW) (Others depend on how meter is programmed)
NBR_PRESENT_VALUES	Depends on the manufacturer design (useful values include 3 ph. volts, 3 ph. Amps, power factor, in addition to billing parameters)	Depends on the manufacturer design (useful values include 3 ph. volts, 3 ph. Amps, power factor, in addition to billing parameters)	Depends on the manufacturer design (useful values include 3 ph. volts, 3 ph. Amps, power factor, in addition to billing parameters)
TABLE 31			
ON_TIME_FLAG	True	True	True
OFF_TIME_FLAG	False (Manufacturer may set value to "0" in table 32)	False (Manufacturer may set value to "0" in table 32)	False (Manufacturer may set value to "0" in table 32)
HOLD_TIME_FLAG	False	False	False
NBR_DISP_SOURCES	Manufacturer (Minimum 32)	Manufacturer (Minimum 32)	Manufacturer (Minimum 32)
WIDTH_DISP_SOURCES	Manufacturer	Manufacturer	Manufacturer
NBR_PRI_DISP_LIST_ITEMS	>= 64	>= 64	>= 64
NBR_PRI_DISP_LISTS	3 (normal, alternate, test)	3 (normal, alternate, test)	3 (normal, alternate, test)
NBR_SEC_DISP_LIST_ITEMS	0	0	0
NBR_SEC_DISP_LISTS	0	0	0
TABLE 41			
NBR_PASSWORDS	>= 4 (Master, programmer, read and reset, customer read only)	>= 4 (Master, programmer, read and reset, customer read only)	>= 4 (Master, programmer, read and reset, customer read only)
PASSWORD_LEN	20	20	20
NBR_KEYS	>= 4	>= 4	>= 4
KEY_LEN	8	8	8
NBR_PERM_USED	>= 4	>= 4	>= 4
TABLE 51			
TOU_SELF_READ_FLAG	False	Programmable (If tables 23 and 26 are present)	Programmable (If tables 23 and 26 are present)
SEASON_SELF_READ_FLAG	False	Programmable (If tables 23 and 26 are present)	Programmable (If tables 23 and 26 are present)
SEASON_DEMAND_RESET_FLAG	False	Programmable	Programmable
SEASON_CHNG_ARMED_FLAG	False	Programmable	Programmable
SORT_DATES_FLAG	False	True	True
ANCHOR_DATE_FLAG	False	True	True
CAP_DST_AUTO_FLAG	False	False	False
SEPARATE_WEEKDAYS_FLAG	False	False	False
SEPARATE_SUM_DEMANDS_FLAG	False	False	False
SORT_TIER_SWITCHES_FLAG	False	Manufacturer specific	Manufacturer specific

Variable	Desirable Values Self Contained Polyphase Energy, Demand	Desirable Values Self Contained Polyphase Energy, Demand, TOU	Desirable Values Self Contained Polyphase Energy, Demand, TOU, LP
CAP_TM_ZN_OFFSET_FLAG	False	True	True
NBR_SEASONS	0	4	4
NBR_SPECIAL_SCHED	0	1	1
NBR_NON_RECURR_DATES	0 per year	32 per year	32 per year
NBR_RECURR_DATES	0	16	16
NBR_TIER_SWITCHES	0	32	32
CALENDAR_TBL_SIZE	Manufacturer	Manufacturer	Manufacturer
TABLE 61			
LP_SET1_INHIBIT_OVF_FLAG	Not necessary	Not necessary	Programmable-default is False
LP_SET2_INHIBIT_OVF_FLAG	Not necessary	Not necessary	Not necessary
LP_SET3_INHIBIT_OVF_FLAG	Not Necessary	Not Necessary	Not Necessary
LP_SET4_INHIBIT_OVF_FLAG	Not necessary	Not necessary	Not Necessary
BLK_END_READ_FLAG	Not necessary	Not necessary	True
BLK_END_PULSE_FLAG	Not necessary	Not necessary	True
SCALAR_DIVISOR_FLAG_SET1	Not necessary	Not necessary	True
SCALAR_DIVISOR_FLAG_SET2	Not Necessary	Not Necessary	Not Necessary
SCALAR_DIVISOR_FLAG_SET3	Not Necessary	Not Necessary	Not Necessary
SCALAR_DIVISOR_FLAG_SET4	Not Necessary	Not Necessary	Not Necessary
EXTENDED_INT_STATUS_FLAG	Not Necessary	Not Necessary	True
SIMPLE_INT_STATUS_FLAG	Not Necessary	Not Necessary	False
INV_UINT8_FLAG	Not Necessary	Not Necessary	False
INV_UINT16_FLAG	Not Necessary	Not Necessary	True
INV_UINT32_FLAG	Not Necessary	Not Necessary	False
INV_INT8_FLAG	Not Necessary	Not Necessary	False
INV_INT16_FLAG	Not Necessary	Not Necessary	False
INV_INT32_FLAG	Not Necessary	Not Necessary	False
INV_NI_FMAT1_FLAG	False (It is believed that NI_FMAT1 or NI_FMAT2 will depend upon the manufacturer. May be used if implemented)	False (It is believed that NI_FMAT1 or NI_FMAT2 will depend upon the manufacturer. May be used if implemented)	False (It is believed that NI_FMAT1 or NI_FMAT2 will depend upon the manufacturer. May be used if implemented)
INV_NI_FMAT2_FLAG	False (It is believed that NI_FMAT1 or NI_FMAT2 will depend upon the manufacturer. May be used if implemented)	False (It is believed that NI_FMAT1 or NI_FMAT2 will depend upon the manufacturer. May be used if implemented)	False (It is believed that NI_FMAT1 or NI_FMAT2 will depend upon the manufacturer. May be used if implemented)
LP_MEMORY_LEN	Not Necessary	Not Necessary	At least one set of 16K (
NBR_BLKS_SET1	Not Necessary	Not Necessary	Manufacturer memory dependent
NBR_BLK_INTS_SET1	Not Necessary	Not Necessary	Capability of at least one block per 24 hour
NBR_CHNS_SET1	Not Necessary	Not Necessary	1 (Minimum)
MAX_INT_TIME_SET1	Not Necessary	Not Necessary	Programmable for 1, 5, 10, 15, 30, 60 minute intervals
NBR_BLKS_SET2	Not Necessary	Not Necessary	Not Necessary
NBR_BLK_INTS_SET2	Not Necessary	Not Necessary	Not Necessary
NBR_CHNS_SET2	Not Necessary	Not Necessary	Not Necessary
MAX_INT_TIME_SET2	Not Necessary	Not Necessary	Not Necessary
NBR_BLKS_SET3	Not Necessary	Not Necessary	Not Necessary
NBR_BLK_INTS_SET3	Not Necessary	Not Necessary	Not Necessary

Variable	Desirable Values Self Contained Polyphase Energy, Demand	Desirable Values Self Contained Polyphase Energy, Demand, TOU	Desirable Values Self Contained Polyphase Energy, Demand, TOU, LP
NBR_CHNS_SET3	Not Necessary	Not Necessary	Not Necessary
MAX_INT_TIME_SET3	Not Necessary	Not Necessary	Not Necessary
NBR_BLKS_SET4	Not Necessary	Not Necessary	Not Necessary
NBR_BLK_INTS_SET4	Not Necessary	Not Necessary	Not Necessary
NBR_CHNS_SET4	Not Necessary	Not Necessary	Not Necessary
MAX_INT_TIME_SET4	Not Necessary	Not Necessary	Not Necessary
TABLE 71			
EVENT_NUMBER_FLAG	True	True	True
HIST_DATE_TIME_FLAG	True	True	True
HIST_SEQ_NBR_FLAG	False	False	True
HIST_INHIBIT_OVF_FLAG	False	False	False
EVENT_INHIBIT_OVF_FLAG	False	False	False
NBR_STD_EVENTS	Manufacturer defined	Manufacturer defined	Manufacturer defined
NBR_MFG_EVENTS	Manufacturer defined	Manufacturer defined	Manufacturer defined
HIST_DATA_LENGTH	Manufacturer defined	Manufacturer defined	Manufacturer defined
EVENT_DATA_LENGTH	Manufacturer defined	Manufacturer defined	Manufacturer defined
NBR_HISTORY_ENTRIES	32	32	32
NBR_EVENT_ENTRIES	32	32	32
TABLE 81			
NBR_UDTS	1 Minimum	1 Minimum	1 Minimum
INSTANCE_FLAG	False	False	False
DATA_ACCESS_METHOD	**1** preferred for simplicity	**1** preferred for simplicity	**1** preferred for simplicity
NBR_XFR_LIST_ITEMS	Suggest that the manufacturer size this parameter such that a maximum of 16 data elements can be created in each user defined table in use.	Suggest that the manufacturer size this parameter such that a maximum of 16 data elements can be created in each user defined table in use.	Suggest that the manufacturer size this parameter such that a maximum of 32 data elements can be created in each user defined table in use.
MAX_INSTANCE	0	0	0
UDT_0_SIZE	256	256	256
UDT_1_SIZE	256	256	256
UDT_2_SIZE	256	256	256
UDT_3_SIZE	Does not apply	Does not apply	Does not apply
UDT_4_SIZE	Does not apply	Does not apply	Does not apply
UDT_5_SIZE	Does not apply	Does not apply	Does not apply

~~8.2.5~~8.4.4 ACTUAL FUNCTION LIMITING CONTROL (FLC+1) Table Values – Poly-Phase, Transformer Rated

Variable	Desirable Values Poly-phase, Transformer Rated Energy, Demand	Desirable Values Poly-phase, Transformer Rated Energy, Demand, TOU	Desirable Values Poly-phase, Transformer Rated Energy, Demand, TOU 1-4 Ch LP
TABLE 11			
PF_EXCLUDE_FLAG	True (False for kWh only meter), may be programmable	True, may be programmable	True, may be programmable
RESET_EXCLUDE_FLAG	True (False for kWh only meter), may be programmable	True, may be programmable	True, may be programmable

Variable	Desirable Values Poly-phase, Transformer Rated Energy, Demand	Desirable Values Poly-phase, Transformer Rated Energy, Demand, TOU	Desirable Values Poly-phase, Transformer Rated Energy, Demand, TOU 1-4 Ch LP
BLOCK_DEMAND_FLAG	True if block demand used	True if block demand used	True if block demand used
SLIDING_DEMAND_FLAG	True if sliding demand used	True if sliding demand used	True if sliding demand used
THERMAL_DEMAND_FLAG	True if thermal demand used	True if thermal demand used	True if thermal demand used
SET1_PRESENT_FLAG	True	True	True
SET2_PRESENT_FLAG	False (note: meters with multiple input types with different ratios such as electric/gas/water combination devices may require set2)	False (see note to left)	False (see note to left)
NBR_UOM_ENTRIES	Manufacturer defined	Manufacturer defined	Manufacturer defined
NBR_DEMAND_CTRL_ENTRIES	Depends on manufacturers design (the working group recommends enabling KW and KVAR with others as needed by the functionality	Depends on manufacturers design (the working group recommends enabling KW and KVAR with others as needed by the functionality	Depends on manufacturers design (the working group recommends enabling KW and KVAR with others as needed by the functionality
DATA_CTRL_LENGTH	Manufacturer defined	Manufacturer defined	Manufacturer defined
NBR_DATA_CTRL_ENTRIES	Manufacturer defined	Manufacturer defined	Manufacturer defined
NBR_CONSTANTS_ENTRIES	Manufacturer defined (1 or more)	Manufacturer defined (1 or more)	Manufacturer defined (1 or more)
CONSTANTS_SELECTOR	Choice **2**	Choice 2	Choice 2
NBR_SOURCES	Manufacturer defined	Manufacturer defined	Manufacturer defined
TABLE 21			
SEASON_INFO_FIELD_FLAG	True, if season changes in a TOU schedule are performed	True, if season changes in a TOU schedule are performed	True, if season changes in a TOU schedule are performed
DATE_TIME_FIELD_FLAG	True	True	True
DEMAND_RESET_CTR_FLAG	True (aids in tamper detection)	True (aids in tamper detection)	True (aids in tamper detection)
DEMAND_RESET_LOCK_FLAG	Programmable	Programmable	Programmable
CUM_DEMAND_FLAG	Programmable	Programmable	Programmable
CONT_CUM_DEMAND_FLAG	Programmable	Programmable	Programmable
TIME_REMAINING_FLAG	Programmable	Programmable	Programmable
SELF_READ_INHIBIT_OVERFLOW_FLAG	Programmable (however, for most common implementations will be False)	Programmable (however, for most common implementations will be False)	Programmable (however, for most common implementations will be False)
SELF_READ_SEQ_NBR_FLAG	True	True	True
DAILY_SELF_READ_FLAG	Programmable	Programmable	Programmable
WEEKLY_SELF_READ_FLAG	Programmable	Programmable	Programmable
SELF_READ_DEMAND_RESET	Programmable	Programmable	Programmable
NBR_SELF_READS	>= 3 (if self reads required)	>= 3	>= 3

Variable	Desirable Values Poly-phase, Transformer Rated Energy, Demand	Desirable Values Poly-phase, Transformer Rated Energy, Demand, TOU	Desirable Values Poly-phase, Transformer Rated Energy, Demand, TOU 1-4 Ch LP
NBR_SUMMATIONS	>= 1 (e.g. KW-Hr or perhaps KVA-Hr)	>= 3 (e.g. KW-Hr, KVAR-Hr, avg. PF)	>= 3 (e.g. KW-Hr, KVAR-Hr, avg. PF)
NBR_DEMANDS	1 (KW or perhaps KVA)	2 (KW, KVAR or perhaps KVA)	2 (KW, KVAR or perhaps KVA)
NBR_COIN_VALUES	2 (May depend on available functions, for example, volts at peak, etc.)	2 (KW, KVAR, others may depend on available functions)	2 (KW, KVAR, others may depend on available functions)
NBR_OCCUR	depends on programming **(**Number of times demand appears in table 22, max-mins, etc.)	depends on programming	depends on programming
NBR_TIERS	0	Programmable (Manufacturer design may dictate number of actual choices. The working group envisions scenarios requiring up to 6 tiers in the immediate future)	Programmable (Manufacturer design may dictate number of actual choices. The working group envisions scenarios requiring up to 6 tiers in the immediate future)
NBR_PRESENT_DEMANDS	At least 1 (KW) (Others such as KVAR, etc. may depend on how meter is programmed)	2(KW, KVAR (Others depend on how meter is programmed)	2(KW, KVAR (Others depend on how meter is programmed)
NBR_PRESENT_VALUES	Depends on the manufacturer design (useful values include per ph. volts, per ph. Amps, power factor in addition to billing parameters)	Depends on the manufacturer design (useful values include volts and amps per phase, power factor in addition to billing parameters)	Depends on the manufacturer design (useful values include volts and amps per phase, power factor in addition to billing parameters)
TABLE 31			
ON_TIME_FLAG	True	True	True
OFF_TIME_FLAG	False (Manufacturer may set value to “0” in table 32)	False (Manufacturer may set value to “0” in table 32)	False (Manufacturer may set value to “0” in table 32)
HOLD_TIME_FLAG	False	False	False
NBR_DISP_SOURCES	Manufacturer (Minimum 32)	Manufacturer (Minimum 32)	Manufacturer (Minimum 32)
WIDTH_DISP_SOURCES	Manufacturer	Manufacturer	Manufacturer
NBR_PRI_DISP_LIST_ITEMS	>= 64	>= 64	>= 64
NBR_PRI_DISP_LISTS	3 (normal, alternate, test)	3 (normal, alternate, test)	3 (normal, alternate, test)
NBR_SEC_DISP_LIST_ITEMS	32	32 (maximum envisioned)	32 (maximum envisioned)
NBR_SEC_DISP_LISTS	4	4 (Alternate, Test, Marketing, Diagnostic))	4 (Alternate, Test, Marketing, Diagnostic))
TABLE 41			
NBR_PASSWORDS	>= 4 (Master, programmer, read and reset, customer read only)	>= 4 (Master, programmer, read and reset, customer read only)	>= 4 (Master, programmer, read and reset, customer read only)
PASSWORD_LEN	20	20	20

Variable	Desirable Values Poly-phase, Transformer Rated Energy, Demand	Desirable Values Poly-phase, Transformer Rated Energy, Demand, TOU	Desirable Values Poly-phase, Transformer Rated Energy, Demand, TOU 1-4 Ch LP
NBR_KEYS	>= 4	>= 4	>= 4
KEY_LEN	8	8	8
NBR_PERM_USED	>= 4	>= 4	>= 4
TABLE 51			
TOU_SELF_READ_FLAG	False	Programmable (If tables 23 and 26 are present)	Programmable (If tables 23 and 26 are present)
SEASON_SELF_READ_FLAG	False	Programmable (If tables 23 and 26 are present)	Programmable (If tables 23 and 26 are present)
SEASON_DEMAND_RESET_FLAG	False	Programmable	Programmable
SEASON_CHNG_ARMED_FLAG	False	Programmable	Programmable
SORT_DATES_FLAG	False	True	True
ANCHOR_DATE_FLAG	False	True	True
CAP_DST_AUTO_FLAG	False	False	False
SEPARATE_WEEKDAYS_FLAG	False	False	False
SEPARATE_SUM_DEMANDS_FLAG	False	False	False
SORT_TIER_SWITCHES_FLAG	False	Manufacturer specific	Manufacturer specific
CAP_TM_ZN_OFFSET_FLAG	True	True	True
NBR_SEASONS	0	4	4
NBR_SPECIAL_SCHED	0	1	1
NBR_NON_RECURR_DATES	0 per year	32 per year	32 per year
NBR_RECURR_DATES	0	16	16
NBR_TIER_SWITCHES	0	32	32
CALENDAR_TBL_SIZE	Not necessary	Manufacturer	Manufacturer
TABLE 61			
LP_SET1_INHIBIT_OVF_FLAG	Not necessary	Not necessary	Programmable-default is False
LP_SET2_INHIBIT_OVF_FLAG	Not necessary	Not necessary	Not necessary
LP_SET3_INHIBIT_OVF_FLAG	Not Necessary	Not Necessary	Not Necessary
LP_SET4_INHIBIT_OVF_FLAG	Not necessary	Not Necessary	Not Necessary
BLK_END_READ_FLAG	Not necessary	Not necessary	True
BLK_END_PULSE_FLAG	Not necessary	Not necessary	True
SCALAR_DIVISOR_FLAG_SET1	Not necessary	Not necessary	True
SCALAR_DIVISOR_FLAG_SET2	Not Necessary	Not Necessary	Not Necessary
SCALAR_DIVISOR_FLAG_SET3	Not Necessary	Not Necessary	Not Necessary
SCALAR_DIVISOR_FLAG_SET4	Not Necessary	Not Necessary	Not Necessary
EXTENDED_INT_STATUS_FLAG	Not necessary	Not necessary	True
SIMPLE_INT_STATUS_FLAG	Not necessary	Not necessary	False
INV_UINT8_FLAG	Not necessary	Not necessary	False
INV_UINT16_FLAG	Not necessary	True Not necessary	True
INV_UINT32_FLAG	Not necessary	Not necessary	False
INV_INT8_FLAG	Not necessary	Not necessary	False
INV_INT16_FLAG	Not necessary	Not necessary	False

Variable	Desirable Values Poly-phase, Transformer Rated Energy, Demand	Desirable Values Poly-phase, Transformer Rated Energy, Demand, TOU	Desirable Values Poly-phase, Transformer Rated Energy, Demand, TOU 1-4 Ch LP
INV_INT32_FLAG	Not necessary	Not necessary	False
INV_NI_FMAT1_FLAG	False (It is believed that NI_FMAT1 or NI_FMAT2 will depend upon the manufacturer. May be used if implemented)	False (It is believed that NI_FMAT1 or NI_FMAT2 will depend upon the manufacturer. May be used if implemented)	False (It is believed that NI_FMAT1 or NI_FMAT2 will depend upon the manufacturer. May be used if implemented)
INV_NI_FMAT2_FLAG	False (It is believed that NI_FMAT1 or NI_FMAT2 will depend upon the manufacturer. May be used if implemented)	False (It is believed that NI_FMAT1 or NI_FMAT2 will depend upon the manufacturer. May be used if implemented)	False (It is believed that NI_FMAT1 or NI_FMAT2 will depend upon the manufacturer. May be used if implemented)
LP_MEMORY_LEN	Not necessary	64K (15 minute/interval, 96 intervals/day, 45 days/channel, 2 bytes/interval, 8 channels	64K (15 minute/interval, 96 intervals/day, 45 days/channel, 2 bytes/interval, 8 channels
NBR_BLKS_SET1	Not necessary	Not necessary	Manufacturer memory dependent
NBR_BLK_INTS_SET1	Not necessary	Not necessary	Capability of at least one block per 24 hour
NBR_CHNS_SET1	Not necessary	Not necessary	4 (Minimum)
MAX_INT_TIME_SET1	Not necessary	Programmable for 1, 5, 10, 15, 30, 60 minute intervals	Programmable for 1, 5, 10, 15, 30, 60 minute intervals
NBR_BLKS_SET2	Not Necessary	Not Necessary	Not Necessary
NBR_BLK_INTS_SET2	Not Necessary	Not Necessary	Not Necessary
NBR_CHNS_SET2	Not Necessary	Not Necessary	Not Necessary
MAX_INT_TIME_SET2	Not Necessary	Not Necessary	Not Necessary
NBR_BLKS_SET3	Not Necessary	Not Necessary	Not Necessary
NBR_BLK_INTS_SET3	Not Necessary	Not Necessary	Not Necessary
NBR_CHNS_SET3	Not Necessary	Not Necessary	Not Necessary
MAX_INT_TIME_SET3	Not Necessary	Not Necessary	Not Necessary
NBR_BLKS_SET4	Not Necessary	Not Necessary	Not Necessary
NBR_BLK_INTS_SET4	Not Necessary	Not Necessary	Not Necessary
NBR_CHNS_SET4	Not Necessary	Not Necessary	Not Necessary
MAX_INT_TIME_SET4	Not Necessary	Not Necessary	Not Necessary
TABLE 71			
EVENT_NUMBER_FLAG	True	True	True
HIST_DATE_TIME_FLAG	True	True	True
HIST_SEQ_NBR_FLAG	False	True	True
HIST_INHIBIT_OVF_FLAG	False	False	False
EVENT_INHIBIT_OVF_FLAG	False	False	False
NBR_STD_EVENTS	Manufacturer defined	Manufacturer defined	Manufacturer defined
NBR_MFG_EVENTS	Manufacturer defined	Manufacturer defined	Manufacturer defined
HIST_DATA_LENGTH	Manufacturer defined	Manufacturer defined	Manufacturer defined
EVENT_DATA_LENGTH	Manufacturer defined	Manufacturer defined	Manufacturer defined
NBR_HISTORY_ENTRIES	32	128	128
NBR_EVENT_ENTRIES	32	128	128
TABLE 81			

Variable	Desirable Values Poly-phase, Transformer Rated Energy, Demand	Desirable Values Poly-phase, Transformer Rated Energy, Demand, TOU	Desirable Values Poly-phase, Transformer Rated Energy, Demand, TOU 1-4 Ch LP
NBR_UDTS	3 Minimum	3 Minimum	3 Minimum
INSTANCE_FLAG	False	False	False
DATA_ACCESS_METHOD	**1** preferred for simplicity	**1** preferred for simplicity	**1** preferred for simplicity
NBR_XFR_LIST_ITEMS	Suggest that the manufacturer size this parameter such that a maximum of 16 data elements can be created in each user defined table in use.	Suggest that the manufacturer size this parameter such that a maximum of 32 data elements can be created in each user defined table in use.	Suggest that the manufacturer size this parameter such that a maximum of 32 data elements can be created in each user defined table in use.
MAX_INSTANCE	0	0	0
UDT_0_SIZE	256	256	256
UDT_1_SIZE	256	256	256
UDT_2_SIZE	256	256	256
UDT_3_SIZE	Does not apply	Does not apply	Does not apply
UDT_4_SIZE	Does not apply	Does not apply	Does not apply
UDT_5_SIZE	Does not apply	Does not apply	Does not apply

~~8.2.6~~8.4.5 ACTUAL FUNCTION LIMITING CONTROL (FLC+1) Table Values – Poly-Phase, Transformer Rated, Higher Functionality

Variable	Desirable Values Poly-phase, Transformer Rated Energy, Reactive, Demand, TOU 3-8 Ch LP	Desirable Values Poly-phase, Transformer Rated 4Q, Energy, Reactive, Demand, TOU, 4-16 Ch LP, PQ
TABLE 11		
PF_EXCLUDE_FLAG	True, may be programmable	True, may be programmable
RESET_EXCLUDE_FLAG	True, may be programmable	True, may be programmable
BLOCK_DEMAND_FLAG	True if block demand used	True if block demand used
SLIDING_DEMAND_FLAG	True if sliding demand used	True if sliding demand used
THERMAL_DEMAND_FLAG	True if thermal demand used	True if thermal demand used
SET1_PRESENT_FLAG	True	True
SET2_PRESENT_FLAG	False (see note to left)	False (see note to left)
NBR_UOM_ENTRIES	Manufacturer defined	Manufacturer defined
NBR_DEMAND_CTRL_ENTRIES	Depends on manufacturers design (the working group recommends enabling KW and KVAR with others as needed by the functionality	Depends on manufacturers design (the working group recommends enabling KW and KVAR with others as needed by the functionality
DATA_CTRL_LENGTH	Manufacturer defined	Manufacturer defined
NBR_DATA_CTRL_ENTRIES	Manufacturer defined	Manufacturer defined
NBR_CONSTANTS_ENTRIES	Manufacturer defined (1 or more)	Manufacturer defined (1 or more)
CONSTANTS_SELECTOR	Choice 2	Choice 2
NBR_SOURCES	Manufacturer defined	Manufacturer defined
TABLE 21		
SEASON_INFO_FIELD_FLAG	True, if season changes in a TOU schedule are performed	True, if season changes in a TOU schedule are performed

Variable	Desirable Values Poly-phase, Transformer Rated Energy, Reactive, Demand, TOU 3-8 Ch LP	Desirable Values Poly-phase, Transformer Rated 4Q, Energy, Reactive, Demand, TOU, 4-16 Ch LP, PQ
DATE_TIME_FIELD_FLAG	True	True
DEMAND_RESET_CTR_FLAG	True (aids in tamper detection)	True (aids in tamper detection)
DEMAND_RESET_LOCK_FLAG	Programmable	Programmable
CUM_DEMAND_FLAG	Programmable	Programmable
CONT_CUM_DEMAND_FLAG	Programmable	Programmable
TIME_REMAINING_FLAG	Programmable	Programmable
SELF_READ_INHIBIT_OVERFLOW_FLAG	Programmable (however, for most common implementations will be False)	Programmable (however, for most common implementations will be False)
SELF_READ_SEQ_NBR_FLAG	True	True
DAILY_SELF_READ_FLAG	Programmable	Programmable
WEEKLY_SELF_READ_FLAG	Programmable	Programmable
SELF_READ_DEMAND_RESET	Programmable	Programmable
NBR_SELF_READS	>= 3	>= 3
NBR_SUMMATIONS	>= 3 or more depending upon functionality available (e.g. KW-hr, KVAR-Hr, KVAR-HR in or out, others)	>= 3 or more depending upon functionality available (e.g. KW-hr Del, KW-Hr Rcd, KVAR-HR Q1,Q2,Q3,Q4, others)
NBR_DEMANDS	2 or more depending upon functionality available (KW, KVAR, KVAR in or out, 4Q KVAR, others)	2 or more depending upon functionality available (KW, KVAR, KVAR in or out, 4Q KVAR, others)
NBR_COIN_VALUES	At least 3 (KW, KVAR, volts, etc., others may depend on available functions)	At least 3 (KW, KVAR, volts, etc., others may depend on available functions)
NBR_OCCUR	depends on programming	depends on programming
NBR_TIERS	Programmable (Manufacturer design may dictate number of actual choices. The working group envisions scenarios requiring up to 6 tiers in the immediate future)	Programmable (Manufacturer design may dictate number of actual choices. The working group envisions scenarios requiring up to 6 tiers in the immediate future)
NBR_PRESENT_DEMANDS	2 or more (depends on how meter is programmed)	2 or more (depends on how meter is programmed)
NBR_PRESENT_VALUES	Depends on the manufacturer design (useful values include volts and. amps per phase, power factor per phase, total power factor in addition to billing parameters)	Depends on the manufacturer design (useful values include volts and. amps per phase, power factor per phase, total power factor in addition to billing parameters)
TABLE 31		
ON_TIME_FLAG	True	True
OFF_TIME_FLAG	False (Manufacturer may set value to “0” in table 32)	False (Manufacturer may set value to “0” in table 32)
HOLD_TIME_FLAG	False	False
NBR_DISP_SOURCES	Manufacturer (Minimum 32)	Manufacturer (Minimum 32)
WIDTH_DISP_SOURCES	Manufacturer	Manufacturer
NBR_PRI_DISP_LIST_ITEMS	>= 64	>= 64
NBR_PRI_DISP_LISTS	4 (normal, alternate, test, other)	4 (normal, alternate, test, other)
NBR_SEC_DISP_LIST_ITEMS	64 (maximum envisioned)	64 (maximum envisioned)
NBR_SEC_DISP_LISTS	4 (Alternate, Test, Marketing, Diagnostic)	4 (Alternate, Test, Marketing, Diagnostic)

Variable	Desirable Values Poly-phase, Transformer Rated Energy, Reactive, Demand, TOU 3-8 Ch LP	Desirable Values Poly-phase, Transformer Rated 4Q, Energy, Reactive, Demand, TOU, 4-16 Ch LP, PQ
TABLE 41		
NBR_PASSWORDS	>= 4 (Master, programmer, read and reset, customer read only)	>= 4 (Master, programmer, read and reset, customer read only)
PASSWORD_LEN	20	20
NBR_KEYS	>= 4	>= 4
KEY_LEN	8	8
NBR_PERM_USED	>= 4	>= 4
TABLE 51		
TOU_SELF_READ_FLAG	Programmable (If tables 23 and 26 are present)	Programmable (If tables 23 and 26 are present)
SEASON_SELF_READ_FLAG	Programmable (If tables 23 and 26 are present)	Programmable (If tables 23 and 26 are present)
SEASON_DEMAND_RESET_FLAG	Programmable	Programmable
SEASON_CHNG_ARMED_FLAG	Programmable	Programmable
SORT_DATES_FLAG	Programmable	Programmable
ANCHOR_DATE_FLAG	True	True
CAP_DST_AUTO_FLAG	False	False
SEPARATE_WEEKDAYS_FLAG	False	False
SEPARATE_SUM_DEMANDS_FLAG	False	False
SORT_TIER_SWITCHES_FLAG	Manufacturer specific	Manufacturer specific
CAP_TM_ZN_OFFSET_FLAG	True	True
NBR_SEASONS	4	4
NBR_SPECIAL_SCHED	1	1
NBR_NON_RECURR_DATES	32 per year	32 per year
NBR_RECURR_DATES	16	16
NBR_TIER_SWITCHES	32	32
CALENDAR_TBL_SIZE	Manufacturer	Manufacturer
TABLE 61		
LP_SET1_INHIBIT_OVF_FLAG	Programmable-default is False	Programmable-default is False
LP_SET2_INHIBIT_OVF_FLAG	Programmable-default is False	Programmable-default is False
LP_SET3_INHIBIT_OVF_FLAG	Not Necessary	Not Necessary
LP_SET4_INHIBIT_OVF_FLAG	Not Necessary	Not Necessary
BLK_END_READ_FLAG	True	True
BLK_END_PULSE_FLAG	True	True
SCALAR_DIVISOR_FLAG_SET1	True	True
SCALAR_DIVISOR_FLAG_SET2	True	True
SCALAR_DIVISOR_FLAG_SET3	Not Necessary	Not Necessary
SCALAR_DIVISOR_FLAG_SET4	Not Necessary	Not Necessary
EXTENDED_INT_STATUS_FLAG	True	True
SIMPLE_INT_STATUS_FLAG	False	False
INV_UINT8_FLAG	False	False
INV_UINT16_FLAG	True	True
INV_UINT32_FLAG	False	False
INV_INT8_FLAG	False	False
INV_INT16_FLAG	False	False
INV_INT32_FLAG	False	False

Variable	Desirable Values Poly-phase, Transformer Rated Energy, Reactive, Demand, TOU 3-8 Ch LP	Desirable Values Poly-phase, Transformer Rated 4Q, Energy, Reactive, Demand, TOU, 4-16 Ch LP, PQ
INV_NI_FMAT1_FLAG	False (It is believed that NI_FMAT1 or NI_FMAT2 will depend upon the manufacturer. May be used if implemented)	False (It is believed that NI_FMAT1 or NI_FMAT2 will depend upon the manufacturer. May be used if implemented)
INV_NI_FMAT2_FLAG	False (It is believed that NI_FMAT1 or NI_FMAT2 will depend upon the manufacturer. May be used if implemented)	False (It is believed that NI_FMAT1 or NI_FMAT2 will depend upon the manufacturer. May be used if implemented)
LP_MEMORY_LEN	At least two sets of 64K each for 128K total memory	At least two sets of 64K each for 128K total memory
NBR_BLKS_SET1	Manufacturer memory dependent	Manufacturer memory dependent
NBR_BLK_INTS_SET1	Capability of at least one block per 24 hour	Capability of at least one block per 24 hour
NBR_CHNS_SET1	8 (Minimum)	16 (Minimum)
MAX_INT_TIME_SET1	Programmable for 1, 5, 10, 15, 30, 60 minute intervals	Programmable for 1, 5, 10, 15, 30, 60 minute intervals
NBR_BLKS_SET2	Manufacturer memory dependent	Manufacturer memory dependent
NBR_BLK_INTS_SET2	Capability of at least one block per 24 hour	Capability of at least one block per 24 hour
NBR_CHNS_SET2	8 suggested	8 suggested
MAX_INT_TIME_SET2	Programmable for 1, 5, 10, 15, 30, 60 minute intervals	Programmable for 1, 5, 10, 15, 30, 60 minute intervals
NBR_BLKS_SET3	Not Necessary	Not Necessary
NBR_BLK_INTS_SET3	Not Necessary	Not Necessary
NBR_CHNS_SET3	Not Necessary	Not Necessary
MAX_INT_TIME_SET3	Not Necessary	Not Necessary
NBR_BLKS_SET4	Not Necessary	Not Necessary
NBR_BLK_INTS_SET4	Not Necessary	Not Necessary
NBR_CHNS_SET4	Not Necessary	Not Necessary
MAX_INT_TIME_SET4	Not Necessary	Not Necessary
TABLE 71		
EVENT_NUMBER_FLAG	True	True
HIST_DATE_TIME_FLAG	True	True
HIST_SEQ_NBR_FLAG	True	True
HIST_INHIBIT_OVF_FLAG	False	False
EVENT_INHIBIT_OVF_FLAG	False	False
NBR_STD_EVENTS	Manufacturer defined	Manufacturer defined
NBR_MFG_EVENTS	Manufacturer defined	Manufacturer defined
HIST_DATA_LENGTH	Manufacturer defined	Manufacturer defined
EVENT_DATA_LENGTH	Manufacturer defined	Manufacturer defined
NBR_HISTORY_ENTRIES	128	128
NBR_EVENT_ENTRIES	128	128
TABLE 81		
NBR_UDTS	4 Minimum	4 Minimum
INSTANCE_FLAG	False	False
DATA_ACCESS_METHOD	**1** preferred for simplicity	**1** preferred for simplicity
NBR_XFR_LIST_ITEMS	Suggest that the manufacturer size this parameter such that a maximum of 32 data elements can be created in each user defined table in use.	Suggest that the manufacturer size this parameter such that a maximum of 32 data elements can be created in each user defined table in use.

Variable	Desirable Values Poly-phase, Transformer Rated Energy, Reactive, Demand, TOU 3-8 Ch LP	Desirable Values Poly-phase, Transformer Rated 4Q, Energy, Reactive, Demand, TOU, 4-16 Ch LP, PQ
MAX_INSTANCE	0	0
UDT_0_SIZE	256	256
UDT_1_SIZE	256	256
UDT_2_SIZE	256	256
UDT_3_SIZE	256	256
UDT_4_SIZE	Does not apply	Does not apply
UDT_5_SIZE	Does not apply	Does not apply

~~8.2.7~~8.4.6 Display List

The following is a listing of common display values and display modes that might be used within the classifications defined above for the Guidelines. The individual requirements for utilities may increase or decrease the number of quantities utilized.

Application	Display Name	Normal	Alternate	Test
All	Segment Check	Yes	No	No
Billing Data	Total KWH	Yes	No	No
	Max KW	Yes	No	Yes
	Rate A KWH	Yes	No	No
	Rate A Max KW	Yes	No	No
	Rate B KWH	Yes	No	No
	Rate B Max KW	Yes	No	No
	Rate C KWH	Yes	No	No
	Rate C Max KW	Yes	No	No
	Rate D KWH	Yes	No	No
	Rate D Max KW	Yes	No	No
	KVARH Delivered	Yes	No	No
	KVARH Received	Yes	No	No
	Present KW	Yes	No	Yes
	Total KWH Delivered	Yes	No	No
	Total KWH Received	Yes	No	No
	KVAR Q1	Yes	No	No
	KVAR Q2	Yes	No	No
	KVAR Q3	Yes	No	No
	KVAR Q4	Yes	No	No
Last Reset Billing Data	LR Rate A KWH	No	Yes	No
	LR Rate A Max KW	No	Yes	No
	LR Rate B KWH	No	Yes	No
	LR Rate B Max KW	No	Yes	No
	LR Rate C KWH	No	Yes	No
	LR Rate C Max KW	No	Yes	No
	LR Rate D KWH	No	Yes	No
	LR Rate D Max KW	No	Yes	No
	LR KVARH Delivered	No	Yes	No
	LR KVARH Received	No	Yes	No
Past Season Billing Data	PS Rate A KWH	No	Yes	No
	PS Rate A Max KW	No	Yes	No
	PS Rate B KWH	No	Yes	No
	PS Rate B Max KW	No	Yes	No
	PS Rate C KWH	No	Yes	No
	PS Rate C Max KW	No	Yes	No
	PS Rate D KWH	No	Yes	No
	PS Rate D Max KW	No	Yes	No
	PS KVARH Delivered	No	Yes	No
	PS KVARH Received	No	Yes	No
Instantaneous Data	Instantaneous KW	Yes	Yes	Yes
	Instantaneous VRMS Ph A	No	Yes	No

Application	Display Name	Normal	Alternate	Test
	Instantaneous VRMS Ph B	No	Yes	No
	Instantaneous VRMS Ph C	No	Yes	No
	Instantaneous I RMS Ph A	No	Yes	No
	Instantaneous I RMS Ph B	No	Yes	No
	Instantaneous I RMS Ph C	No	Yes	No
	V Angle Phase A	No	Yes	No
	V Angle Phase B	No	Yes	No
	V Angle Phase C	No	Yes	No
	I Angle Phase A	No	Yes	No
	I Angle Phase B	No	Yes	No
	I Angle Phase C	No	Yes	No
	Firmware Version	No	Yes	No
	Hardware Version	No	Yes	No
	Time on Battery	No	Yes	No
	Kh	No	Yes	No
	Time Remaining in Subinterval	No	Yes	Yes
	Demand Interval Length	No	Yes	No
	Number Power Fails	No	Yes	No
	Number Demand Resets	No	Yes	No
	Current Date	No	Yes	No
	Current Time	No	Yes	No
	Cumulative KW	No	Yes	No
	Continuous Cumulative KW	No	Yes	No
	Program ID	No	Yes	No
	Programmer ID	No	Yes	No
	Days Since Reset	No	Yes	No
	Ke	No	Yes	No
	Device ID #1	No	Yes	No
	Device ID #2	No	Yes	No
	Previous Interval KW	No	Yes	No
	Pulses Current Demand Subinterval	No	No	Yes
	Test Timeout	No	No	Yes
	Diagnostic Counter 1	No	No	No
	Diagnostic Counter 2	No	No	No
	Diagnostic Counter 3	No	No	No
	Diagnostic Counter 4	No	No	No
	Diagnostic Counter 5	No	No	No
	Diagnostic Counter 6	No	No	No
	Diagnostic Counter 7	No	No	No
Other Values	Integrated average KW	No	Yes	No
	Integrated average KVAR Lag	No	Yes	No
	Integrated average KVAR Lead	No	Yes	No
	Integrated average VRMS Ph A	No	Yes	No
	Integrated average VRMS Ph B	No	Yes	No
	Integrated average VRMS Ph C	No	Yes	No
	Integrated average I RMS Ph A	No	Yes	No
	Integrated average I RMS Ph B	No	Yes	No
	Integrated average I RMS Ph C	No	Yes	No
	Maximum Integrated average VRMS Ph A	No	Yes	No
	Maximum Integrated average VRMS Ph B	No	Yes	No
	Maximum Integrated average VRMS Ph C	No	Yes	No
	Minimum Integrated average VRMS Ph A	No	Yes	No
	Minimum Integrated average VRMS Ph B	No	Yes	No
	Minimum Integrated average VRMS Ph C	No	Yes	No

~~8.3~~b. **Residential Single Phase**

~~8.4~~c. **Commercial Polyphase**

~~8.5~~d. **Industrial Polyphase**

~~9.0~~2. **C12.19 Registered Tables and Constants**

Listings or reference to registered listings of the XML/TDL and XML/EDL.

~~9.1~~a. **Residential Single Phase**

~~9.2~~b. **Commercial Polyphase**

~~9.3~~c. **Industrial Polyphase**