IEEE Standard for the Electronic Reporting of Transformer Test Data

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Abstract: A basis for the electronic reporting of transformer test data on liquid immersed distribution transformers as defined in the ANSI C57.12.2X standards series is provided. The specific set of test data to be reported and the format in which it is to be reported is detailed along with an extended set of data as an option for the user.
Keywords: distribution transformers, electronic reporting, test data

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Introduction

(This introduction is not part of IEEE Std 1388-2000, IEEE Standard for the Electronic Reporting of Transformer Test Data.)

This is a new standard, and so far is as known, the first document to be written covering electronic reporting of transformer test data, either nationally or internationally.

Producers of transformers have always provided users with transformer test data when requested. However, as the majority of users incorporated lifetime owning costs of distribution transformers into their purchasing decisions through loss evaluation in the late seventies and early eighties, they also began to request producers to report loss data on each transformer shipped. The amount of test data supplied by producers to users increased dramatically.

In order to handle the volume of data, distribution transformer producers automated the collection of this data in their factories and began supplying computer generated hardcopy test data reports to users. This solution initially benefited the producers because it solved the problem of economically reporting large volumes of data. It also initially satisfied the user's need to be able to verify that they were indeed receiving product that performed as promised.

However, as users began tracking the data and using it for other purposes, they found that having the data on hardcopy reports required them to re-enter the data on their computers. This seemed particularly unproductive since producers already had the data on computers and begged the question of why the data could not just be reported electronically. Many users subsequently began requiring producers to report the data electronically.

A new problem arose. Although differently formatted data on hardcopy reports was highly inconvenient to the users, at least communication was successful. With electronic test data reporting, successful communication could not take place until an agreement on reporting format was reached. As a result, individual users requesting electronic test data reports worked with individual producers and agreed on reporting formats.

The current situation is that producers are incurring the cost of supplying test data in many different formats and users are incurring the cost of negotiating formats with each of their distribution transformer producers.

In summary, the need for this standard evolved as loss evaluation of distribution transformers became widespread, resulting in the need to report large volumes of data, and the need of users to store this data on their computers. The purpose of this standard is to address the need to standardize electronic test data reporting on distribution transformers and eliminate the unnecessary costs that are being incurred by producers and users due to the lack of a standard.

This standard is a voluntary consensus standard. Its use should become mandatory only when required by a duly constituted legal authority, or when specified in a contractual relationship. To meet specialized needs and to allow innovation, specific changes are permissible when determined by the user and the producer, provided such changes do not violate existing laws, and are considered technically adequate for the function intended.

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Contents

1. Overview 1

1.1 Scope 1
1.2 Purpose 1

2. References 2

3. Definition 2

4. Test data requirements 3

4.1 General 3
4.2 Standard data set 3
4.3 Extended data set 6
4.4 Calculated data 8

5. Test data file format 8

5.1 General 8
5.2 Flat file format 9
5.3 Comma delimited variable format 11

6. Test data file transfer 12

6.1 General 12
6.2 Transfer by mail service 12
6.3 Transfer by telecommunications 12

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IEEE Standard for the Electronic Reporting of Transformer Test Data

1. Overview

This standard is divided into six clauses. Clause 1 provides the scope and purpose of this standard. Clause 2 lists references to other standards that are useful in applying this standard. Clause 3 provides a definition that is either not found in other standards, or has been modified for use with this standard. Clause 4 provides a listing of the data elements in the standard data set and the additional data elements included with the extended data set. Clause 5 gives the specifics of the two test data file formats. Clause 6 addresses the methods of file transfer.

1.1 Scope

This standard provides a basis for electronic reporting of transformer test data on liquid immersed distribution transformers, specifically, those defined in the ANSI C57.12.2X[1] standards series. This standard defines the standard set of test data to be reported and the format in which it is to be reported when electronic reporting of the test data is specified. In addition, it defines an extended set of data for those users who have greater need for data.

1.2 Purpose

The purpose of this standard is to define standard methods of reporting and communicating transformer test data in order to allow users and producers to design computer based systems for preparing, communicating, and storing test data. The standard includes test data content, test data format, and test data communications methods.

[1]Information of references is available in Clause 2.

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2. References

This standard shall be used in conjunction with the following publications. Only the specified revision dates apply.

ANSI C57.12.20-1997, American National Standard Requirements Overhead-Type Distribution Transformers, 500 kVA and Smaller: High Voltage, 34 500 Volts and Below: Low Voltage, 7970/13 800 Y Volts and Below.[2]

ANSI C57.12.22-1989, American National Standard Requirements for Pad-Mounted, Compartmental-Type, Self-Cooled, Three-Phase Distribution Transformers With High-Voltage Bushings, 2500 kVA and Smaller: High-Voltage, 34 500 GrdY/19 920 Volts and Below; Low Voltage, 480 Volts and Below.

ANSI C57.12.24-1988, American National Standard Requirements for Underground-Type Three-Phase Distribution Transformers, 2500 kVA and Smaller: High-Voltage, 34 500 GrdY/19 920 Volts and Below; Low-Voltage, 480 Volts and Below.

ANSI C57.12.25-1990, American National Standard Requirements for Pad-Mounted, Compartmental-Type, Self-Cooled, Single-Phase Distribution Transformers with Separable Insulated High-Voltage Connectors: High-Voltage, 34 500 GrdY/19 920 Volts and Below; Low-Voltage, 240/120 Volts; 167 kVA and Smaller.

IEEE Std C57.12.00-2000, IEEE Standard General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers.[3]

IEEE Std C57.12.23-1992 (Reaff 1999), IEEE Standard for Transformers—Underground-Type, Self-Cooled, Single-Phase Distribution Transformers With Separable, Insulated, High-Voltage Connectors; High Voltage (24 940 GrdY/14 400 V and Below) and Low Voltage (240/120 V, 167 kVA and Smaller).

IEEE Std C57.12.35-1996, IEEE Standard for Bar Coding for Distribution Transformers.

IEEE Std C57.12.80-1978 (Reaff 1992), IEEE Standard Terminology for Power and Distribution Transformers.

IEEE Std C57.12.90-1999, IEEE Standard Test Code for Liquid-Immersed Distribution, Power, and Regulating Transformers and IEEE Guide for Short Circuit Testing of Power and Distribution Transformers.

3. Definition

3.1 standard reference temperature: The temperature that is used as a standard reference for a particular test parameter.

NOTE—For no-load losses the standard reference temperature is 20 °C unless modified by 4.3.10 in IEEE Std 1388-2000. For load losses and all other temperature-dependent data, the standard reference temperature is 85 °C unless modified by 4.3.11 in IEEE Std 1388-2000.

[2]ANSI C57 publications are available from the Institute of Electrical and Electronics Engineers, 445 Hoes Lane, P.O. Box 1331, Piscataway, NJ 08855-1331, USA (http://standards.ieee.org/).

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4. Test data requirements

4.1 General

This standard defines two different sets of test data the user should request. They will be referred to as the standard data set and the extended data set. The standard data set should be adequate for purposes of loss test data reporting and will be supplied unless the user specifies otherwise. The extended data set is included as a means of satisfying users with a need for additional data.

The definition of each data element field includes the data element field name, the data element field length and format, a description of the data element that attempts to define the data element unambiguously, and brief data validation rules.

NOTE—The convention used to define the format of each data element field is as follows: "A*n*" where A indicates the field content is alpha-numeric, the number *n* indicates the number of characters in the field, "I*n*" where I indicates the field content is an integer value, the number *n* indicates the number of characters in the field, "F*n*.*n*" where F indicates the field content is a real number, the first *n* indicates the number of characters in the field, and the second n indicates the number of significant digits to the right of the decimal place.

4.2 Standard data set

The standard data set consists of the data element fields listed in 4.2.1 through 4.2.26.

4.2.1 User name (A25)

The name of the transformer purchaser.

Valid values: Any alpha-numeric combination of 25 characters or less.

4.2.2 User order number (A25)

The transformer purchaser's order number.

Valid values: Any alpha-numeric combination of 25 characters or less.

4.2.3 User stock number (A16)

The material and store's identification number used by the user for the order item.

Valid values: Any alpha-numeric combination of 16 characters or less.

4.2.4 Producer identification (A2)

The two character ID of the transformer producer as used on the nameplate.

Valid values: See ANSI C57.12.35-1996.

4.2.5 Producer order number (A12)

The transformer producer's order number.

Valid values: Any alpha-numeric combination of 12 characters or less.

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4.2.6 Producer catalog number (A15)

The material and store's identification number used by the producer for the order item.

Valid values: Any alpha-numeric combination of 15 characters or less.

4.2.7 Producer serial number (A13)

The unique identification number assigned by the producer to the individual transformer to specify which test data is being reported.

Valid values: Any alpha-numeric combination of 13 characters or less. This matches the number of characters allowed for Producer Serial Number in ANSI C57.12.35-1996.

4.2.8 Product type (A2)

The product type of the order item.

Valid values: OV, PD, UG, OT

4.2.9 Number of phases (I1)

Number of phases of order item, standards being single phase, two phase (duplex), or three phase.

Valid values: Integer values of 1, 2, or 3.

4.2.10 kVA rating (I5)

Nominal ONAN kVA rating of the order item in kilovoltamperes. See ANSI C57.12.00-2000.

Valid values: Any integer from 0 to 99 999. Decimal fractions of kVA rating will be truncated for test data reporting purposes.

4.2.11 Primary voltage (A47)

Order item nominal rated primary voltage in volts using standard ANSI nomenclature for nameplate markings. See ANSI C57.12.00-2000.

Valid values: Any alpha-numeric values of 47 characters or less. The data in this field should duplicate the primary voltage and connection as they appear on the nameplate, unless space does not permit, then voltage abbreviations should be used. Abbreviations used shall be by mutual agreement with the end user.

4.2.12 Secondary voltage (A28)

Order item nominal rated secondary voltage in volts using standard ANSI nomenclature for nameplate markings. See ANSI C57.12.00-2000.

Valid values: Any alpha-numeric values of 28 characters or less. The data in this field should duplicate the secondary voltage and connection as they appear on the nameplate, unless space does not permit, then voltage abbreviations should be used. Abbreviations used shall be by mutual agreement with the end user.

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4.2.13 Polarity (A1)

Transformer polarity for single phase only. Three phase units and phase displacement is not reported.

Valid values: A = Additive, S = Subtractive

4.2.14 Quoted no-load loss (I5)

Quoted no-load losses in watts at nominal ONAN kVA, nominal primary voltage, and standard reference temperature.

Valid values: Any integer from 0 to 99 999.

4.2.15 Quoted load loss (I6)

Quoted load losses in watts at nominal ONAN kVA, nominal primary voltage, and standard reference temperature.

Valid values:Any integer from 0 to 999 999.

4.2.16 Quoted impedance voltage (IZ) (F4.2)

Quoted per unit impedance voltage in percent at nominal ONAN kVA, nominal voltage, and standard reference temperature.

Valid values: Real numbers from 0.00 to 9.99.

4.2.17 Quoted exciting current (IEX) (F4.2)

Quoted per unit exciting current in percent at nominal ONAN kVA and nominal primary voltage.

Valid values: Real number from 0.00 to 9.99.

4.2.18 Tested no-load loss (I5)

Tested no-load losses in watts at nominal ONAN kVA, nominal primary voltage, and standard reference temperature.

Valid values: Any integer from 0 to 99 999.

4.2.19 Tested load loss (I6)

Tested load losses in watts at nominal ONAN kVA, nominal primary voltage, and standard reference temperature.

Valid values:Any integer from 0 to 999 999.

4.2.20 Tested impedance voltage (IZ) (F4.2)

Tested per unit impedance voltage in percent at nominal ONAN kVA, nominal voltage, and standard reference temperature.

Valid values: Real numbers from 0.00 to 9.99.

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4.2.21 Tested resistance voltage (IR) (F4.2)

Tested per unit resistance voltage in percent at nominal ONAN kVA, nominal voltage, and standard reference temperature.

Valid values: Real numbers from 0.00 to 9.99.

4.2.22 Tested exciting current (IEX) (F4.2)

Tested per unit exciting current in percent at nominal ONAN kVA and nominal primary voltage.

Valid values: Real numbers from 0.00 to 9.99.

4.2.23 Total mass (I5)

Total weight in kilograms (or pounds) of the transformer ordered including the core and coil assembly, tank and fitting assemblies, and insulating fluid as marked on the nameplate.

Valid values: Any integer value from 0 to 99 999.

4.2.24 Mass unit of measure (A2)

Units of mass as specified by user.

Valid values: kg - kilograms, lb - pounds

4.2.25 Date of manufacture (A7)

Year and month in which transformer was made.

Valid values: Alpha-numeric in yyyy/mm format.

4.2.26 Test data reporting lot (A7)

Users choose different ways in which to group a “lot” of test data for reporting purposes. This field describes the grouping mechanism. The grouping mechanism should be by user ORDER, user RELEASE, by the time period in which the units were shipped (month, quarter, year) or by some other agreed upon grouping mechanism. Note that due to the financial operating calendars of producers, test data reported for a given month or quarter might not exactly agree with the calendar month or quarter.

Valid values: Any alpha-numeric characters of 7 or less. For time based groupings, periods should be stated as either yyyy/mm or yyyy/qx where yyyy is the year designation, mm is the month, and the quarter is designated in the Q1, Q2, Q3, Q4 format.

4.3 Extended data set

The extended data set consists of all the data element fields in the standard set plus the additional data element fields listed in 4.3.1 through 4.3.13:

4.3.1 User release number (A12)

The transformer purchaser’s release number.

Valid values: Any alpha-numeric combination of 12 characters or less.

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4.3.2 Producer plant location (A10)

The location of the producer's facility in which the product was made. If the producing facility is located in the U.S., provide the two character state abbreviation. If outside the U.S., provide the name, or code, of the province, state, or country.

Valid values: Any alpha-numeric combination of 10 characters or less.

4.3.3 Quoted loss guarantee type (A2)

For standard reporting purposes, losses are assumed to be guaranteed average. This field is to qualify losses guaranteed in some other way.

Valid values: GA = guaranteed average, GM = guaranteed maximum, NG = not guaranteed.

4.3.4 No-load loss evaluation factor (F5.2)

The normalized no-load loss evaluation factor in currency as specified by the user per watt. This will be supplied at time of quote by user.

Valid values: Real numbers from 00.00 to 99.99.

4.3.5 Load loss evaluation factor (F5.2)

The normalized load loss evaluation factor in currency as specified by the user per watt. This will be supplied at time of quote by user.

Valid values: Real numbers from 00.00 to 99.99.

4.3.6 Frequency (I2)

The nominal operating frequency of the transformer.

Valid values: Any integer from 0 to 99.

4.3.7 Cooling class (A9)

The cooling class of the transformer stated per ANSI standard conventions such as ONAN, ONAN/ONAF. See ANSI C57.12.00-2000.

Valid values: ONAN, ONAN/ONAF.

4.3.8 Average winding temperature rise (A5)

The rated average winding temperature rise of the transformer in degrees Celsius.

Valid values: 55, 55/65, 65, or other as agreed upon by the user and producer.

4.3.9 Type of insulating fluid (A8)

The type of insulating fluid in the transformer.

Valid values: Oil, LFHC, silicone, other as agreed upon by the user and producer.

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4.3.10 No-load loss reference temperature (I2)

Any non-standard reference temperature used for quoting and reporting no-load losses in degrees Celsius.

Valid values: Any integer from 0 to 99.

4.3.11 Load loss reference temperature (I2)

Any non-standard reference temperature used for quoting and reporting load losses in degrees Celsius.

Valid values: Any integer from 0 to 99.

4.3.12 Reserved space (Unspecified 45)

This field should be used for any additional data as mutually agreed upon by the user and producer.

Valid values: Any alpha-numeric or integer characters as designated.

4.3.13 Free format text field (A148)

This space should be used for any free format text information as mutually agreed upon by the user and producer.

Valid values: Any alpha-numeric characters.

4.4 Calculated data

There are a number of data that are not included in either the standard data set or the extended data set because they can easily be calculated from the data provided. They include the following:

a) **Total losses.** Total losses would be reported as the sum of the no-load and load losses despite the small discrepancy introduced due to the differences in reference temperatures.

b) **Per unit reactance.** Per unit reactance of a transformer can be calculated from the per unit resistance and per unit impedance as shown in ANSI C57.12.90-1999.

c) **Regulation.** Regulation can be calculated based on per unit resistance, reactance, and impedance along with the chosen load power factor as shown in ANSI C57.12.90-1999.

d) **Efficiency.** Efficiency can be calculated based on the transformer kVA and its losses as shown in ANSI C57.12.90-1999. Approximate efficiency at various loads can be calculated by remembering that the load losses vary roughly as the square of the per unit load. Note that load losses are comprised of the sum of I^2R losses and stray losses. Not accounting for the fact that the stray loss component of load losses does not vary as the square of the load is the major weakness in this efficiency approximation. Note that fractional portions of kVA sizes are truncated as reported in 4.2.10.

5. Test data file format

5.1 General

This standard defines two file formats the user should request. They shall be referred to as the flat file format and the comma delimited variable format. The flat file format is the simplest and shall be used unless the user specifies otherwise.

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5.2 Flat file format

5.2.1 General

The flat file format was chosen over other file formats because it can be easily defined and easily understood. Further, it is equally useful whether the user's computer is a mainframe or a personal computer. The flat file format defined here is kept as simple as possible. No attempt is made to separate header data from line item data. The benefit is that each record in the file completely defines the test data for each transformer on which test data is being reported. Flat files are also referred to as Fixed Length Files in which each line or record (file) consists of a specific number of characters. Each data element field is located in a predefined position in the string of data element fields and each data element field contains a predetermined number of characters. The unused element positions are filled with zeros (0) so that data field position is maintained in a consistent fashion in each record.

The file definition is ASCII format with each record (line) representing an individual transformer in the case of the standard data set. The record layout is given in Table 1 and Table 2 for both the standard data set transformer record and the extended data set transformer record. When the extended data set record is requested, the data elements of the standard data set listed in Table 1 will be shown on one line, immediately followed on a separate line by the data elements shown in Table 2, and together, the two lines will constitute an extended data set transformer record. Alpha-numeric fields are defined as left justified with the balance of the field filled with zeros. Integer and Fixed Decimal fields are right justified with the balance of the field filled with zeros.

Test data element fields could have been defined as either header data or item detail data. Header data applies to all transformers in the report or to a group of transformers. Item data applies to only one transformer in the report. The benefit of excluding header data would have been to eliminate the repetition of data in the file; the cost would have been a loss of simplicity. Therefore, header data is included in each transformer record.

5.2.2 Standard data set transformer record

The record layout for the standard data set is given in Table 1. The field sequence number, field name, field length, and from-to column is given for each data element field in the record. The standard data set transformer record consists of one line.

5.2.3 Extended data set transformer record

The record layout is given in Table 2 for the additional data elements which, when included with the standard data set, comprise the extended data set. The field sequence number, field name, field length, and from-to columns is given for each data element field in the record. The extended data set record consists of two lines.

5.2.4 Consolidated record

If the user's computer system has no limitations that preclude receipt of a single record longer than 255 characters, the user should choose to specify a consolidated flat file record. When the consolidated record is specified, the user will receive a single flat file record that is 510 characters in length. The data in the record will be made up of the standard data set fields followed by the additional fields, which together comprise the extended data set in a single, one line record. Each record will provide data on a single item (transformer).

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Table 1—Standard data set

Field	Data element field name	Data type	Field length	Columns
1	User name	A	25	1–25
2	User order number	A	25	26–50
3	User stock number	A	16	51–66
4	Producer identification	A	2	67–68
5	Producer order number	A	12	69–80
6	Producer catalog number	A	15	81–95
7	Producer serial number	A	13	96–108
8	Product type	A	2	109–110
9	Number of phases	I	1	111
10	kVA	I	5	112–116
11	Primary voltage	A	47	117–163
12	Secondary voltage	A	28	164–191
13	Polarity	A	1	192
14	Quoted no-load loss	I	5	193–197
15	Quoted load loss	I	6	198–203
16	Quoted IZ	F	4	204–207
17	Quoted IEX	F	4	208–211
18	Tested no-load loss	I	5	212–216
19	Tested load loss	I	6	217–222
20	Tested IZ	F	4	223–226
21	Tested IR	F	4	227–230
22	Tested IEX	F	4	231–234
23	Total mass	I	5	235–239
24	Mass unit of measure	A	2	240–241
25	Date of manufacture	A	7	242–248
26	Test data reporting lot	A	7	249–255

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Table 2—Additional data

Field	Data element field name	Data type	Field length	Columns
1	User release number	A	12	1–12
2	Producer plant location	A	10	13–22
3	Quoted loss guarantee type	A	2	23–24
4	No-load loss evaluation factor	F	5	25–29
5	Load loss evaluation factor	F	5	30–34
6	Frequency	I	2	35–36
7	Cooling class	A	9	37–45
8	Average winding temperature rise	A	5	46–50
9	Type of insulating fluid	A	8	51–58
10	No-load loss reference temperature	I	2	59–60
11	Load loss reference temperature	I	2	61–62
12	Reserved space (blank)		45	63–107
13	Free format text field	A	148	108–255

5.3 Comma delimited variable format

5.3.1 General

The comma delimited file format is one in which the fields of data are provided in a known sequential order with commas delimiting (separating) successive fields. It is preferred by many PC users. It is a standard option offered in this standard.

5.3.2 Standard data set

When the user specifies the standard data set and a comma delimited file, they will receive the standard set of test data described in 5.3.1 in a comma delimited file.

5.3.3 Extended data set

When the user specifies the extended data set and a comma delimited file, they will receive both the standard data set fields and the additional fields, which together comprise the extended data set described in 5.2.3 in a single comma delimited file with all data items for each transformer record on a single line. Only the single line record is offered when the extended data set is specified.

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6. Test data file transfer

6.1 General

Once the test data requirements and the test data report file are defined, the test data report file can be created. The user can now choose the most convenient method of file transfer. The transfer method can be as simple as mailing the file or as sophisticated as telecommunicating the file. The point in the order cycle at which this information is to be communicated shall be negotiated between the user and the producer.

6.2 Transfer by mail service

For transfer by mail, the standard media for file transfer is a 3.5 inch DS-HD (double sided-high density) floppy disk. The user shall provide a mailing address for the test data on the purchase order if it is different than the order shipping address.

6.3 Transfer by telecommunications

For transfer by telecommunication, the user shall provide detailed instructions to the producer. Data transfer via a service provider is recommended. (See 6.3.1.)

6.3.1 Data transfer via service provider

If data is to be transferred from the producer to the user via a service provider, the user is responsible for providing the producer with the necessary information to establish the communications link and a secure access code. The producer is responsible for taking reasonable measures to ensure the security of the access code.

6.3.2 Data transfer directly to user

If the data is to be transferred directly from the producer to the user, the user is responsible for providing the producer with the necessary information for establishing a communications link. Although the sender is expected to take reasonable measures to prevent sending a file containing a virus or otherwise compromising the security of a receiver's system, the receiver is ultimately responsible for protection of their system from intrusions.

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