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WECC Joint Synchronized Information Subcommittee

Guideline for Data Format Used in Engineering Analysis Applications of Disturbance and Simulated Data

1. Requirements

1. The data format shall accommodate data generated by dynamic simulations and data from dynamic disturbance recorders, such as synchrophasor data. Data generated by transient simulations is usually not equally spaced and may have two records for the same time when a switching event occurs.

2. The metadata shall be permanently attached to the data. Metadata, including narrative, channel headings, start times must be contained in the same file as the data itself.

2. Proposed File Structure # 1 (XML)

XML-type file structure is proposed as a preferred option.

2.1 General Principles

Data blocks open with *<block>* line and close with *</block>* line.

Blank lines are allowed between the blocks.

No blank lines are permitted within a block.

Text must be left-aligned.

Lines starting with a space are ignored.

Coma is the only permitted delimiter, spaces or tabs preceding or following a coma are ignored.

All headers and names are case sensitive.

2.2 Metadata

The metadata is a part of the data file. The metadata includes title, signal headers, start date and time, and time format.

The following metadata fields are allowed:

2.2.1 File identifier (required)

The files shall start with the file identifier

```
<?xml version="1.0" ?>
```

The line must be exactly as described above for the file to be compatible with standard XML readers.

2.2.2 Body definition (required)

The data body of the file must start with `<CASE>` and end with `</CASE>`

```
<CASE>
    {metadata}
    {data}
</CASE>
```

2.2.3 Version of Data Format (optional)

Version of the data format is specified:

```
<version>
2013a
</version>
```

2.2.4 Title of the file (optional)

```
<title>
TITLE
</title>
```

Example

```
<title>
WISP Recordings for PDCI event on May 30, 2013 2,800 MW generation
drop in Pacific Northwest
</title>
```

2.2.5 Start Date and Time (optional)

Start date and time for the recording format must follow ISO 8601 standard:

```
<tstart>
YYYY-MM-DDThh:mm:ss.sTZD
</tstart>
```

where:
YYYY = four digit year
MM = two digit month (01=January, etc)
DD = two digit day of the month
T = indicated the beginning of time element
hh = two digit of hour (00 through 23) (am/pm NOT allowed)
mm = two digit minute (00 through 59)
ss = two digit second (00 through 59)
s = zero to six digits representing a decimal fraction of a second
TZD = time zone designator (+hh:mm or – hh:mm)

Example
```
<tstart>
2013-05-31T15:57:30.0-08:00
</tstart>
```

Times are expressed in local time, together with a time zone offset in hours and minutes relative to UTC (Coordinated Universal Time). Pacific Standard Time is –07:00, Pacific Daylight Time is –08:00.

2.2.6 Time and date format in data section (optional)

Time and date column is the first column in the data section.

```
<tformat>
FORMAT
</tformat>
```
Other data formats can be specified:

- cycle
- millisecond
- second
- minute
- ISO8601

If the record is not present in metadata, by default, time is in seconds.

Examples

```
<tformat>
second
</tformat>
```


or

```
<tformat>
ISO8261
</tformat>
```


2.2.7 Signal Headers (required)

Time is required to be the first column in the data section.

```
<headers>
T,     second, Time    , Description,
Type,  Units,  Signal_Name_A,  Description,
Type,  Units,  Signal_Name_B,  Description,
Type,  Units,  Signal_Name_C,  Description,
. . .
Type,  Units,  Signal_Name_X,  Description
</headers>
```

Type, Unit, Signal_Name, and Description must be present.

- Signal type is 20 characters max
- Signal units 20 characters max
- Signal name 120 characters max

Fields must be coma-separated, each line ends with coma, except the last line.

The number of lines in the header must be the same as the number of coma separated columns in the data section.

The following signal types are reserved:

Type	Description	Units
F	Bus frequency	Hz
VPM	Positive sequence RMS value of voltage	kV, PU
VPA	Positive sequence phasor angle	DEG
IPM	Positive sequence RMS value of current	Amps, kAmps
IPA	Positive sequence phasor angle	DEG
P	Active power	MW
Q	Reactive power	MVAR
IFD	Synchronous generator field current	PU / AmpDC
EFD	Synchronous generator field voltage	PU / VoltDC
SPD	Generator speed	PU / RPM

User-defined signal types are permitted, but should not conflict with the signal types listed above.

PMU data example, where the description references historian tags:

```
<headers>
T, second, Time,                        Time
VPM, KV,    DodgeJct230_Voltage,        W001DODGEJCT__01.B230MAIN_____1VP.M,
VPA, DEG,   DodgeJct230_VAngle,         W001DODGEJCT__01.B230MAIN_____1VP.A,
F,   Hz,    DodgeJct230_Freq,           W001DODGEJCT__01.A230FREQ_____1F_,
P,   MW,    DodgeJct230_Tx1_Power,      W001DODGEJCT__01.A230MAIN_____1MW,
Q,   MVAR,  DodgeJct230_Tx1_React,      W001DODGEJCT__01.A230MAIN_____1MV,
IPM, AMP,   DodgeJct230_Tx1_Current,    W001DODGEJCT__01.B230MAIN_____1IP.M,
IPA, DEG,   DodgeJct230_Tx1_CurAngle,   W001DODGEJCT__01.B230MAIN_____1IP.A,
VPM, KV,    DodgeJct34.5_Voltage,       W001DODGEJCT__01.B034MAIN_____1VP.M,
VPA, DEG,   DodgeJct34.5.VAnge,         W001DODGEJCT__01.B034MAIN_____1VP.A
</headers>
```

Simulation data example, where the description includes simulator channel names and bus numbers:

```
<headers>
Time
F,    Hz,   Garrison500_Freq,      fbus_40459_0_1_1,
VPM, PU,    Garrison500_VMAG,      vbus_40459_0_1_1,
VPA, DEG,   Garrison500_VANG,      abus_40459_0_1_1,
P,    MW,   Garrison_Taft_500_1_P, pbr_40459_41057_1_1,
Q,    MVAR, Garrison_Taft_500_1_Q, qbr_40459_41057_1_1,
P,    MW,   Garrison_Taft_500_2_P, pbr_40459_41057_2_2,
Q,    MVAR, Garrison_Taft_500_2_Q, qbr_40459_41057_2_2
</headers>
```

Generator test file example with user-defined signal types:

```
<headers>
Time
Van,  kV,  TDA17_13.8_Van    The Dalles Unit #17 Phase A voltage,
Vbn,  kV,  TDA17_13.8_Vbn,   The Dalles Unit #17 Phase B voltage,
Vcn,  kV,  TDA17_13.8_Vcn,   The Dalles Unit #17 Phase C voltage,
Ia,   kA,  TDA17_13.8_Ia,    The Dalles Unit #17 Phase A current,
Ib,   kA,  TDA17_13.8_Ib,    The Dalles Unit #17 Phase B current,
Ic,   kA,  TDA17_13.8_Ic,    The Dalles Unit #17 Phase C current,
P,    MW,  TDA17_13.8_P,     The Dalles Unit #17 Transducer Active Power,
EFD,  VDC, TDA17_13.8_Efd,   The Dalles Unit #17 Field Voltage,
IFD,  ADC, TDA17_13.8_Ifd,   The Dalles Unit #17 Field Current,
WREF, PU,  TDA17_13.8_wref,  The Dalles Unit #17 Speed Dial(reference),
GATE, PU,  TDA17_13.8_Gate,  The Dalles Unit #17 Gate Servo stroke,
BLADE,PU,  TDA17_13.8_Blade, The Dalles Unit #17 Blade Servo stroke
</headers>
```

Note, all lines except the last, end with a coma.

2.3 Data Section

1. Data section starts with line `<data>`
2. Data section ends with line `</data>`
3. Data are coma separated values
4. Each lines ends with a coma except the last line
5. Time is always the first column
   - time format is defined by metadata `<tformat>` records,
   - floating number in seconds by default
6. Missing/bad data is defined as `NaN`

Example
```
<data>
0.0,  1.05, 60.0, 125,
0.0333333, 1.051, 60.001, 124.98,
0.0666667, 1.052, 60.002, NaN,
0.1, 1.052, 60.003, 124.95,
. . .
120.0, 1.024, 59.125, 132.75
</data>
```

3. File Structure # 2 (CSV)

Given the fact that there is a large library of synchrophasor recordings already in CSV file format, the engineering applications need to be able to reed and interpret such data for backward compatibility. The simplistic CSV data format is not encouraged for the new data sets.

The simplistic CSV format can be:

Line 1 – signal names

Line 2 – signal type

Line 3 – units

Line 4 – description

The number of columns in "header" rows is the same as the number of columns in "data."

The data is coma separated values.

Example of CSV file opened in Excel:

Time	P001_BC_ALB	P003_BC_NW	P_Malin_RoundMt_1_500	P_Malin_RoundMt_2_500	INGLEDOW_500_VMAG	INGLEDOW_500_VANG
Type	P	P	P	P	VPM	VPA
second	MW	MW	MW	MW	KV	DEG
Time	pif_1_0_1_1	pif_3_0_1_1	pbr_40687_30005_1_1	pbr_40687_30005_2_2	vbus_50194_0_1_1	abus_50194_0_1_1
-0.0083332	-526.588501	-2057.893555	1485.296875	1532.442749	528.065002	84.742546
-0.0041666	-526.591309	-2057.893066	1485.040039	1532.174927	528.065735	84.742561
0.0583324	-526.681396	-2057.911865	1484.336304	1531.438843	528.083374	84.744308
0.1208314	-526.755737	-2057.812744	1484.045532	1531.134277	528.093872	84.745201
0.1833305	-526.848083	-2057.582764	1483.639038	1530.709106	528.097961	84.746063
0.2458295	-526.955383	-2057.321289	1483.314453	1530.370972	528.103638	84.747025
0.3083286	-527.078369	-2057.011719	1482.944824	1529.986816	528.110107	84.748573
0.3708276	-527.212341	-2056.639404	1482.63855	1529.669067	528.118774	84.750961
0.4333267	-527.352661	-2056.23584	1482.444702	1529.468872	528.130737	84.754433