Engineering Manual File Format Specification
Version: EM15-P Pipeline Specification

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1 Overview

The purpose of this document is to provide a detailed technical specification of the U.S. Army Corps of Engineers Engineering Manual (EM) survey file format. EM is an ASCII text-based file format, designed to be easy to create from survey data collector output, easy to read and understand, and easy to process with a computer program. The development of the EM file format was motivated by a desire to create a stand-alone survey data file with internally self-documenting metadata. Surveyors can use this document as a guide for creating EM files. Likewise, software developers can use this document as a basis for developing systems to read, write, and otherwise process survey data.

Version EM09-P Pipeline Specification was developed in April 2013 as a simplified version of the EM09 file format to be used for digital data exchange for permit coordinates and asbuilt coordinates for pipelines. Pipelines are recorded as linear profile features in EM09-P Pipeline Specification. Applications that can read and process the full EM09 file format will automatically be able to read and process the EM09-P Pipeline Specification file format. Each EM09-P Pipeline Specification file should include a Pipeline declaration (a #P01 record that marks the beginning of the pipeline information) and the coordinate list for that pipeline feature. If a permit application or asbuilt submission covers multiple pipelines, a separate EM file must be submitted for each individual pipeline.

Version EM15-P Pipeline Specification was developed in Fall 2015 to refine the header records that record company and point of contact information and to update domains for horizontal and vertical coordinate reference systems. For more details on revision history, refer to Section 7 of this document.

2 Organization

An EM file is divided into lines delimited by the newline character. Each line is limited to 80 characters in length. The character in the first column of a line determines how the line should be interpreted. There should be no blank lines in the file.

2.1 Comments

If the first column of a line is a semicolon (;), the line is treated as a comment. Comments are ignored by programs that read EM files. As such, comments are typically used to annotate different file sections or improve readability of the survey file. The first line in Listing 1 is an example of a comment.

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---------------------------------------------------------------------------
Listing 1 EM header example.
;This is a comment
#H02 02/20/2013
---------------------------------------------------------------------------
```

2.2 Records

If the first column of a line contains a hash symbol (#), then the line is a record. Records define metadata information about the survey or attribution of survey features. The hash symbol is followed by a letter and two digits that determine the record type. The special feature record code #P01 is used to define a pipeline or other profile feature that is measured along its length from start to ending location.

The text that follows the record declaration is the record's contents. For example, line 2 in Listing 1 contains an #H02 record, which represents a survey date. In this case, the date is February 20, 2013. Under no circumstances should a record include a placeholder for unknown information. For example, a survey should not include #V03 N/A to indicate the surveyor does not know the vertical datum of the survey. In such cases, the record should be omitted entirely.

2.3 Survey Points

All lines not beginning with either a semicolon or a hash symbol are treated as survey points. Survey points represent individual locations, elevations, and classifications collected during the survey (or significant points defining the planned path for a pipeline which is advancing through the permitting process).

Survey points must be comma delimited and must contain a point identifier followed by a northing, an easting, five vertical measurements, and a feature code (see Table 1 for an overview of the 9 elements that compose an EM15-P survey point). The first vertical measurement is the top of pipeline elevation, and it must be placed in the fourth position. A numeric value is required for top of pipeline elevation for all pipeline points. If the pipeline is an asbuilt survey, top of pipeline elevation must be a surveyed elevation. If the pipeline is a proposed feature, the value 0.0 should be entered as a placeholder value for top of pipeline elevation. A null value should not be entered for top of pipeline elevation.

There are four additional vertical measurements that follow the top of pipeline elevation that is required in the fourth position. These are depth of water over, depth of mud cover, top of pipeline depth (water plus earth) and water or ground surface elevation. If any of these four vertical measurements is unknown or not applicable, that position should be left empty.

Sequence	Definition	Type	Null Allowed?	Comments
1	Coordinate ID	String	N	Every survey point in a survey file must have a unique coordinate ID. An integer value is preferred.
2	Northing	Real	N	The northing value must be based on the units defined in the survey's units record (#H06), coordinate system (#H07), horizontal datum (#H04) and horizontal epoch (#H16).
3	Easting	Real	N	The easting value must be based on the units defined in the survey's units record (#H06), coordinate system (#H07), horizontal datum (#H04) and horizontal epoch (#H16).
4	Top of Pipeline Elevation	Real	N	The top of pipeline elevation value must be based on the preceding vertical datum (#V04), epoch (#V03), and the survey's units (#H06). For an asbuilt survey, top of pipeline elevation should be a surveyed elevation. For a proposed pipeline, the placeholder value 0.0 should be entered if top of pipeline elevation is unknown.
5	Depth of Water Over	Real	Y	The depth of water over a planned or asbuilt point, recorded in the survey's units (#H06).
6	Depth of Mud Cover	Real	Y	The depth of mud over a planned or asbuilt point, recorded in the survey's units (#H06).

Table 1 – Point Structure for Survey Points for EM15-P Pipeline Specification. The sequence column represents the order in which the value appears in the survey point. Values should be comma-separated.

7	Total Pipeline Depth	Real	Y	The depth of water plus mud on top of the pipeline, recorded in the survey's units (#H06).
8	Water or Ground Surface Elevation	Real	Y	A surveyed elevation of the water surface elevation or ground surface elevation at the pipeline location, recorded in the survey's units (#H06).
9	Feature Code	String	N	Survey point code classification. Preferably this value should be one of the codes listed in Table 14 or in the survey's CODES.DAT file.

Table 1 – Point Structure for Survey Points for EM15-P Pipeline Specification. The sequence column represents the order in which the value appears in the survey point. Values should be comma-separated.

Listing 2 shows an example of a typical survey point from an asbuilt pipeline survey file. The point has unique identifier 101, a northing of 450601.99 and an easting of 3457829.99. The top of pipeline elevation of this survey point is -37.0 feet. There is 29.0 feet of water over the pipeline and 10.0 feet of mud cover on the pipeline, for a combined top of pipeline depth of 39.0. The water surface elevation of the point is 2.0 feet (which solves out to the Top of Pipeline elevation of -37.0). The feature code for this point is PPE.

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Listing 2 – EM15-P Survey point example for Asbuilt Pipeline
;This is a comment
#H02 01/20/2013
#H06 USFEET
101,450601.99,3457829.99,-37.0,29.0,10.0,39.0,2.0,PPE
-------------------------------------------------------------------
```

Listing 3 shows an example of a typical survey point from an proposed pipeline submission file. The point has unique identifier 102, a northing of 450701.99 and an easting of 3457729.99. A value of 0.0 is recorded as the elevation of this point, indicating that top of pipeline elevation has not been calculated or is unknown for this point location. The water depth of the pipeline point is unknown, but the depth of mud cover is planned to be 5 feet of mud cover. Total pipeline depth and water surface elevation/ground surface elevation are both unknown. The unknown top of pipeline elevation is represented with a value of 0.0 in the Top of Pipeline Elevation position (position 4). Each additional unknown elevation measurement is represented with no value entered between its comma separators.

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Listing 3 – EM15-P Survey point example for Proposed Pipeline
;This is a comment
#H02 01/20/2013
#H06 USFEET
102,450701.99,3457729.99,0.0,,5.0,,,PPE
-------------------------------------------------------------------------------------------------------
```

3 Pipeline Header Records

Pipeline header records define general metadata applicable to the pipeline file. These records are distinguished by an #H prefix and should be placed before any other records in the file. Table 2 lists the subset of header records that are applicable for EM15-P Pipeline Specification data files:

Record	Description	Type	Domain	Optional	Comments
#H00	Version	String	EM15-P	N	Version of EM specification used to create the survey file. If this record is used, it must be the first line in the file that is not a comment.
#H01	Filename	String		N	Original name of the submitted file.
#H02	Date	Date (MM/DD/YYYY)		N	All records and survey point entries are interpreted as having been collected on the date of the last preceeding #H02 record.
#H03	Vertical Accuracy	String	+-accuracy	N	An absolute accuracy specified with +- followed by a numeric value in units specified by the #H06 record.
#H04	Horizontal Datum	String	NAD83, NAD27	N	Horizontal datum of the surveyed coordinates.
#H05	Permit Number	String		N	USACE-assigned Permit tracking number used to uniquely identify the permit under which the pipeline is installed, modified, or removed.
#H06	Units of Measure	String	USFEET, METERS, FT, M	N	Units of measure used for horizontal and vertical components of survey coordinates. USFEET and FT represent U.S. Survey Feet. METERS and M represent meters.
#H07	Zone	String	1701,1702, UTM15, UTM16*	N	State Plane or Universal Transverse Mercator (UTM) zone to which coordinates are referenced. UTM Zones must be prefixed with the letters 'UTM'. (*Listed domain values are examples that are applicable for Louisiana; domain values vary from state to state.)
#H08	Location	String		N	Textual description of the location of the pipeline described in the survey file.
#H09	Owner	String		N	Name of the company that owns the pipeline.
#H13	Parish/Offshore Area Name	String		Y	Parish or offshore area in which the survey was primarily conducted.

Table 2 – Header Records that are applicable for EM15-P Pipeline Specification

Record	Description	Type	Domain	Optional	Comments
#H16	Horizontal Epoch	String	1986, HARN, CORS96, NSRS2007, NA2011	Y	Horizontal epoch reference of the surveyed points. No #H16 record is required if #H04 horizontal datum is NAD27. If #H04 horizontal datum is NAD83, then #H16 horizontal epoch is required. In order to designate plain old NAD83, specify #H16 1986 and #H04 NAD83.
#H17	Horizontal Accuracy	String	+-accuracy	Y	An absolute accuracy specified with +- followed by a numeric value in units specified by the #H06 record.
#H20-#H29	Permit Title	String		N	Permit Title.
#H30-#H39	Comments	String		Y	General comments about the pipeline feature. Comments should include a description of origin location and destination location for pipeline, and pipeline size and product type. If comments are longer than 80 characters, they may be continued on the following line, provided that line is prepended with a #H30 - #H39 record.
#H40	Company Name (Owner)	String		N	The name of the company that owns the pipeline.
#H41	Address Line 1	String		N	Street address for the pipeline owner.
#H42	Address Line 2	String		Y	Line 2 of address for the pipeline owner.
#H43	City	String		N	City component of address for the pipeline owner.
#H44	State	String		N	State abbreviation for the address of the pipeline owner. Should be a 2-character state abbreviation.
#H45	Zip Code	String		N	Mailing zip code for the address of the pipeline owner.
#H46	Point of Contact	String		N	Name of the point of contact person from the company that owns the pipeline.
#H47	Email	String		N	Email of the point of contact person for the company that owns the pipeline.
#H48	Phone Number	String		N	Phone number of the point of contact person for the company that owns the pipeline. Should be entered as (xxx) xxx-xxxx.
#H50	Company Name (Consultant)	String		Y	The name of a consultant company that assists with permit application, plat generation, or survey of asbuilt pipeline.
#H51	Address Line 1	String		Y	Street address for the consultant company.

Table 2 – Header Records that are applicable for EM15-P Pipeline Specification

Record	Description	Type	Domain	Optional	Comments
#H52	Address Line 2	String		Y	Line 2 of address for the consultant company.
#H53	City	String		Y	City component of address for the consultant company.
#H54	State	String		Y	State abbreviation for the address of the consultant company. Should be a 2-character state abbreviation.
#H55	Zip Code	String		Y	Mailing zip code for the address of the consultant company.
#H56	Point of Contact	String		Y	Name of the point of contact person from the consultant company.
#H57	Email	String		Y	Email of the point of contact person for the consultant company.
#H58	Phone Number	String		Y	Phone number of the point of contact person for the consultant company. Should be entered as (xxx) xxx-xxxx.

Table 2 – Header Records that are applicable for EM15-P Pipeline Specification (continued).

4 Pipeline Vertical Header Records

Pipeline vertical header records define the vertical coordinate reference system for any elevation readings in the pipeline file. These records are distinguished by a #V prefix and should be placed after the #H records and before the profile declaration and pipeline coordinates. Table 3 lists the subset of vertical header records that are applicable for EM15-P Pipeline Specification data files:

Record	Description	Type	Domain	Optional	Comments
#V03	Vertical Epoch	String	1911, 1912, 1938, 1951, 1955, 1963, 1967, 1970, 1976, 1983, 1984, 1986, 1992, 1994, 1996, 2004.65, 2006.81, 2009.55, OPUS, GULFNET, NO EPOCH, 1960-1978, 1983-2001, 2002-2006, 2007-2011	Y	Name of the time period associated with the vertical datum. If the EM15-P file includes an asbuilt surveyed pipeline, the #V03 and #V04 records should be included and should document the vertical datum and epoch of the survey. If the EM15-P file includes proposed pipeline coordinates, and top of pipeline elevations are unknown, the #V03 and #V04 records should be excluded from the header records. The "NO EPOCH" vertical epoch can be used if vertical datum is NAD83 and the pipeline is located outside of the Gulf subsidence zone. The vertical epoch values 1960-1978 and 1983-2001 represent national tidal datum epochs and should only be used with tidal datums such as LMSL, MLLW, and MLG. The vertical epoch values 2002-2006 and 2007-2011 represent 5-year tidal averages and should only be used with tidal datums such as LMSL, MLLW, and MLG
#V04	Vertical Datum	String	NAVD88, NGVD29, LMSL, MLLW, MLG	Y	Vertical datum used for the elevation reference. If the EM15-P file includes an asbuilt surveyed pipeline, the #V03 and #V04 records should be included and should document the vertical datum and epoch of the survey. If the EM15-P file includes proposed pipeline coordinates, and top of pipeline elevations are unknown, the #V03 and #V04 records should be excluded from the header records.
#V13	Geoid	String	GEOID96, GEOID99, GEOID03, GEOIDO3(2005), GEOID06, GEOID09, GEOID12, GEOID12A, GEOID12B	Y	The model of global mean sea level that is used to measure elevations. The Geoid is defined at the level of the survey and is independent of vertical datum and epoch.

Table 3 – Vertical Header Records that are applicable for EM15-P Pipeline Specification

5 Pipeline Profile Data Records

Pipeline Profile records precede a collection of survey points that comprise the profile survey of a pipeline (survey along a linear path from beginning to end). A pipeline profile is declared by a #P01 record, which includes the starting point coordinate, starting station, and, optionally, the name of the pipeline. Pipeline profile points must be recorded in order and a pipeline profile line must not intersect itself. An EM15-P Pipeline Specification data file will have a single #P01 record for a single pipeline and its coordinates. The #P10 record will declare whether the coordinate submission type is PERMIT (proposed coordinates) or ASBUILT (surveyed coordinates for constructed pipeline). See Table 4 for an overview of the Pipeline profile records.

Record	Description	Type	Domain	Optional	Comments
#P01	Start of pipeline profile feature	See Comments		N	Pipeline profile initialize. Starting easting and northing of the pipeline profile, followed by the profile's starting station and name (X Y STAT [NAME]). Values are separated by a single space. X, Y, and STAT are real numbers. STAT will normally be 0.0. NAME is an optional text value that may contain spaces. The name will be a short description of the pipeline that identifies it and distinguishes it from other pipelines in the same Permit Application or Asbuilt submission.
#P10	Submission Type	String	PERMIT,ASBUILT	N	Submission type defines whether the pipeline information and coordinates are for a proposed permit application for the pipeline or post-construction asbuilt coordinates for the pipeline.

Table 4 – Pipeline Profile Data Records

Listing 4 shows a single pipeline profile named "3-inch flowline to serve SL XXXX Well #1" that has starting coordinate (3124787.16, 475469.60) and station 0. The pipeline profile is an asbuilt survey of the pipeline feature. The survey points that follow are associated to this pipeline profile.

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Listing 4 Pipeline Profile example.
; begin pipeline profile
#H00 EM15-P
#V03 1986
#V04 NAVD88
;
#P01 3124787.16 475469.60 0 3-inch flowline to serve SL XXXX Well #1
#P10 ASBUILT
1,475469.60,3124787.16,-8.6,4.9,5.7,10.6,2.0,RSR
2,475459.70,3124786.43,-7.8,4.0,5.8,9.8,2.0,PPE
3,475437.75,3124784.16,-6.0,4.0,4.0,8.0,2.0,PPE
4,475430.18,3125002.09,-11.7,3.5,10.2,13.7,2.0,PPE
-------------------------------------------------------------------------------------------------------------
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6 Feature Codes

Feature codes appear at the end of each survey point and typically contain two or three consecutive upper-case characters that store an abbreviated code for the type of survey point. Standard feature codes are shown in Table 5. If a feature code is not listed in Table 5, an additional text file named CODES.DAT may be submitted with the pipeline survey. This file should reside in the same directory as the survey file and should include a semi-colon delimited list of feature codes and their definitions. Each line in the CODES.DAT file must contain only one code/definition pair and the file should not contain any blank lines or codes that are already defined in Table 5. Codes defined in the CODES.DAT file should be upper-case. Software that reads EM files should match codes from surveys to standard code definitions and CODES.DAT definitions without regard as to whether the characters in the code are upper or lower case.

Code	Definition
PPE	PIPE
PLT	PLATFORM
RSR	RISER

Table 5 – Feature codes for EM15-P Pipeline Specification

7 Revision History

7.1 EM09-P

- Initial Specification – EM09-P file format developed as a simplified version of EM09 file format for conventional survey data. EM09-P file format developed to support digital interchange of proposed and asbuilt pipeline routes.

7.2 EM15-P

- Refined the header elements for company name and contact information. These refinements were developed to allow company contact information to be directly uploaded into a pipeline database system and used at a later date to contact pipeline data submitters.
- Added new #V13 declaration for Geoid. A pipeline data submitter can now define the geoid model that was utilized during the survey. Geoid model will provide additional information about the vertical control for the pipeline survey.
- Added new EPOCH values (1960-1978, 1983-2001, 2002-2006, 2007-2011) which can be used in conjunction with tidal datums such as LMSL, MLLW, and MLG. Updated definition text for VERTICAL_DATUM and EPOCH.