Raster Well Log Depth Registration Usage Guide

For use with WITSML V1.4.1

WITSML Overview	Data object definitions and a Web services specification for the right-time, seamless flow of well data between operators and service companies to speed and enhance decision making.
Version of data object	1.0
Abstract	Provides an overview and usage guidelines for the set of data objects/schemas that define data for depth registration of raster well logs.
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Amendment History			
Version	**Date**	**Comment**	**By**
1.0rc	10 July 2015	First release for public review.	Energistics and Raster Well Log Work Group
1.0	30 July 2016	Final release.	Energistics and Raster Well Log Work Group

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1 Introduction

The set of data objects for Raster Well Log Depth Registration provides a common, industry-standard depth calibration (registration) format that improves on and replaces existing proprietary standards. The new data objects allow service companies, data vendors, and customers to more readily associate depth registration information with the correct log and move well logs and registration information between software systems.

The work to design these data objects began with an assessment of current popular, proprietary formats contributed by team members as well as work done previously by the Energistics WITSML Special Interest Group (SIG).

This new set of data objects is an add-on that is compatible with the WITSML v1.4.1 standard. All data objects for raster well log calibration have been patterned after v1.4.1 data objects. Some additional data (for example, one unit of measure) unique to raster log have also been added. (For more information, see Chapter 3 (page 10).

1.1 Business Case

Well logs have been used in oil and gas operations for more than 100 years. Today, log data is captured digitally. But until about 1980, logs were recorded on paper. Because the life cycle of an oil field is long, “old logs” provide vital data for modern-day operations.

Paper logs are scanned and saved as a raster format (for example, a .TIF file format), which are converted to digital data—or digitized. However, accurate interpretation of the raster format requires additional processing and the resulting data.

A depth registration is performed that provides digital depth references on the raster log image. The results of the calibration are stored in another file, separate from the image, which is commonly known as the depth registration file. The primary role of the depth registration file is to match pixels from the well log image with depth pixels represented in the wellbore. This file acts as a vehicle for the storage, maintenance, and continuity of the raster image and its calibration for future use.

Understanding the data in these logs requires both the image file and the depth registration file. But in the course of business, problems arise and the files get separated (often resulting in someone calibrating the file again), then multiple versions of the file may exist and there is uncertainty on which is the correct version.

Additionally, various vendors offer depth calibration services—but each vendor’s depth calibration file had proprietary and incompatible formats.

1.2 Audience, Purpose, and Scope

This usage guide has been developed to provide an overview of the object and usage information to help software developers who want to implement it into their software, so the software can read and write the common format.

The scope of the first version of the data object includes:

- Registration file format
- Metadata about a well log
- Metadata about the wellbore the log belongs to

1.3 Use Case: Digitizing Raster Well Logs

Depth registration allows for the measured depth to be derived from a given location on the image. Advanced depth registrations may allow for obtaining additional information such as the curves present and their corresponding values at a given depth. For a complete description of this use case, see Chapter 2 (page 7).

1.4 Resource Set

The following resources are available for the Raster Well Log Depth Registration set of data objects, available on the Energistics website: http://www.energistics.org/standards-portfolio/standards-download. Unless otherwise specified, these resources are included in the download.

For direct access to PDFs of the documentation, go to: http://www.energistics.org/drilling-completions-interventions/witsml-standards/current-standards (scroll down).

	Document/Resource	Description
1.	Schemas	Define the data objects and associated data need to capture raster well log depth registration information.
2.	*Raster Well Log Depth Registration Usage Guide* (This document.)	Lists and provides an overview of the data objects that define data for depth registration of well logs.
3.	*WITSML STORE Application Program Interface (API) v1.4.1* Available on the Energistics website at: http://www.energistics.org/standards-portfolio/standards-download	Describes the components of the WITSML API, which consist of the client/server Web service interfaces.

2 Use Cases

2.1 Digitizing Depth-Registered Raster Well Logs

Depth registration allows for the measured depth to be derived from a given location on a printed or raster image (**Figure 2-1**). Advanced depth registrations may allow for obtaining additional information such as the curves present and their corresponding values at a given depth.

Digitizing is the process of converting graphical features into vector values. In the case of well logs, and in particular scanned well logs, the process involved creating depth/value pairs of the well log curves on the log from an image of the log. Digitizing is often required when the only available well log existing is in hardcopy or scanned format. As a result of well logs being created since the 1930s for millions of wells in the US alone, digitizing a log is often the only way to obtain digital values of the well log curves. Obtaining the well log curve values may be required to perform log editing, splicing or other advanced petrophysical calculations.

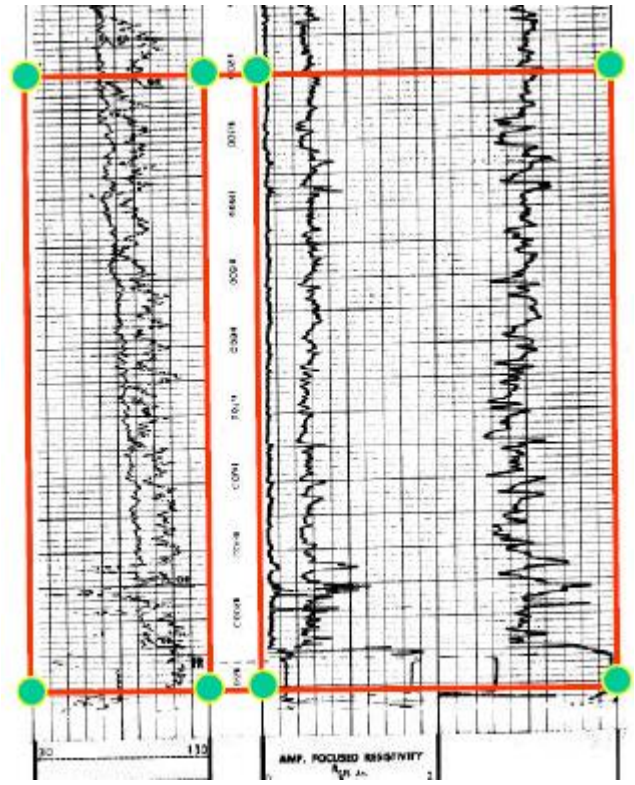

Figure 2-1. Registration data required to understand a digitized log image includes specifying coordinates of rectangular areas on the log.

2.1.1 Process for Digitizing a Log

To digitize a log, the following process must be followed:

1. Identify the associated well using header information.
2. Identify the well log tracks, for each track:
   - Identify track left and right edges
   - Identify depth markers in the track, tag depth
3. For each curve on a well log track, do the following:
   - Identify track left and right scale values

- Identify curve backup regime
- Capture curve points either manually or using an automated process

4. For all captured curve information, use mathematical transformations to convert the captured curve pixel locations to depth/value pairs for each curve.
5. Resample curve depth value points to industry standard depth step (i.e. 0.5ft, 0.1524m).
6. Generate flat file of the curves and metadata in industry standard format, such as LAS, ASCII or Excel.

2.1.2 Key Metadata to Support Digitization

- Well Information
  - UWI
  - Log Datum
  - Location
- Logging Information
  - Log Service
  - Logging Vendor
  - Logging Parameters (BHT, Mud Resistivity, date, etc)
- Raster Image Depth Registration Information:
  - Well log header rectangle
  - Well log interval(s)—array of:
    - Log Scale (i.e., 1”/100’, 1:1000)
    - Description (i.e. Main Pass, Repeat Section)
    - Upper Scale Section Rectangle
    - Lower Scale Section Rectangle
    - Depth Registered Log Interval
      - Well Log Track(s)—array of:
        - Track depth segments - array of
          - Segment spanning left and right sides of track
          - Associated depth value
        - Associated curve(s)—array of:
          - Curve Mnem
          - Line Style (solid, dashed)
          - Line Color
          - Curve Scale Information:
            - Scale Type (Linear, Logarithmic)
            - Units (GAPI, MV, OHMM)
            - Left and Right Scale Values
            - Backup Scale Type (Offscale Left/Right, x10, etc)

2.1.3 Example

Figure 2-2 shows how a properly depth-calibrated raster log can be digitized. Note that the depth track grid lines span the track and each depth grid segment overlays the corresponding depth timing mark. The digitized curves overlay the actual curves in the image. The pixel curve overlays can be converted to depth/value pairs using the registration information.

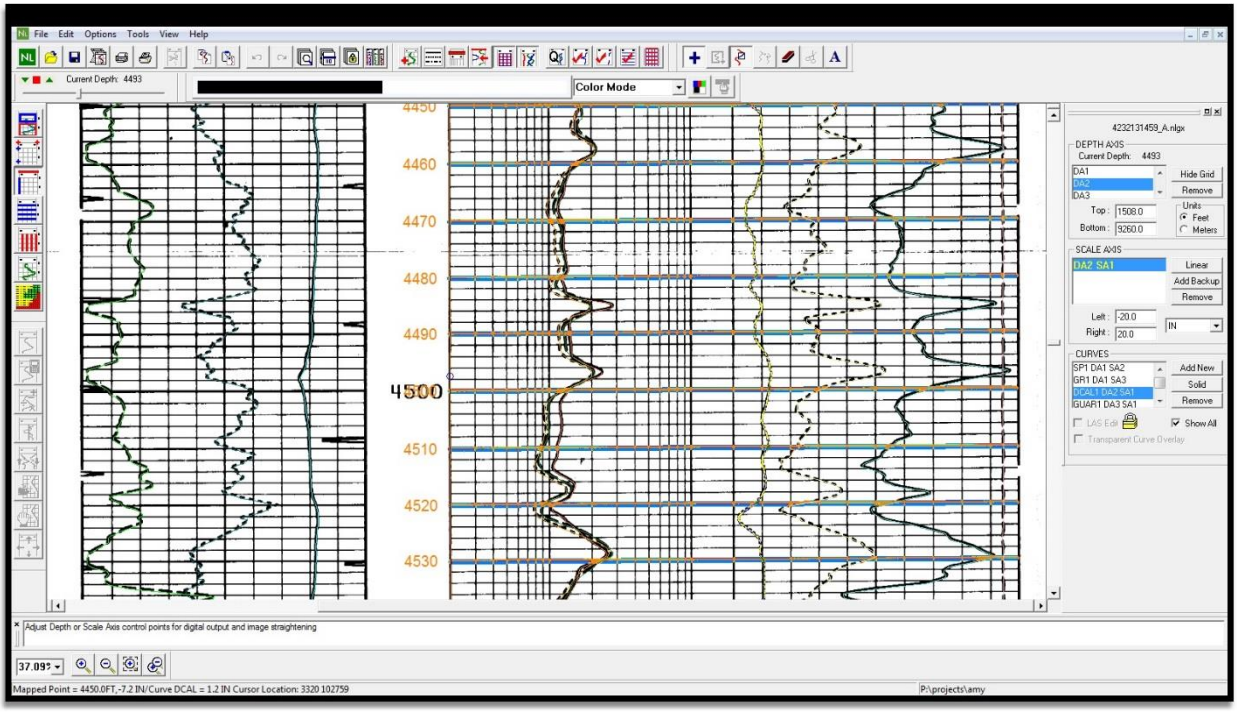

Figure 2-2. To accurately digitalize a raster log, you must first calibrate it. (Image courtesy of Neuralog, Inc.)

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3 Overview of Data Objects

Figure 3-1 is the top portion of a raster well log, which includes the header and the top part of a log section. The data objects that comprise raster well log depth registration define the log as a series of rectangles and the contents of each rectangle.

The data model is shown in **Figure 3-2** and explained in the next section.

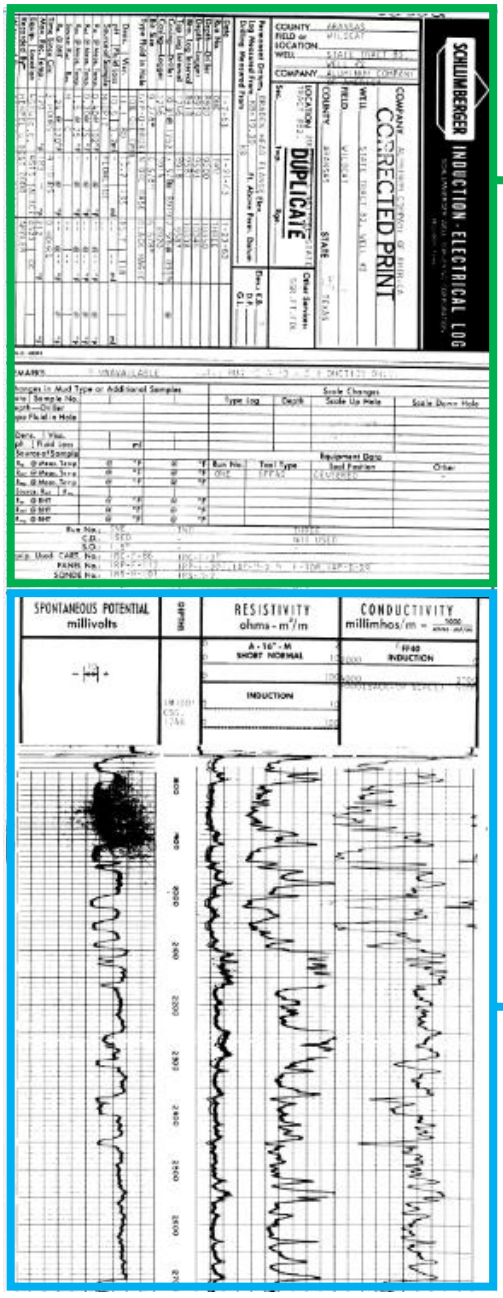

Figure 3-1. Example raster well log, with main areas highlighted.

Header

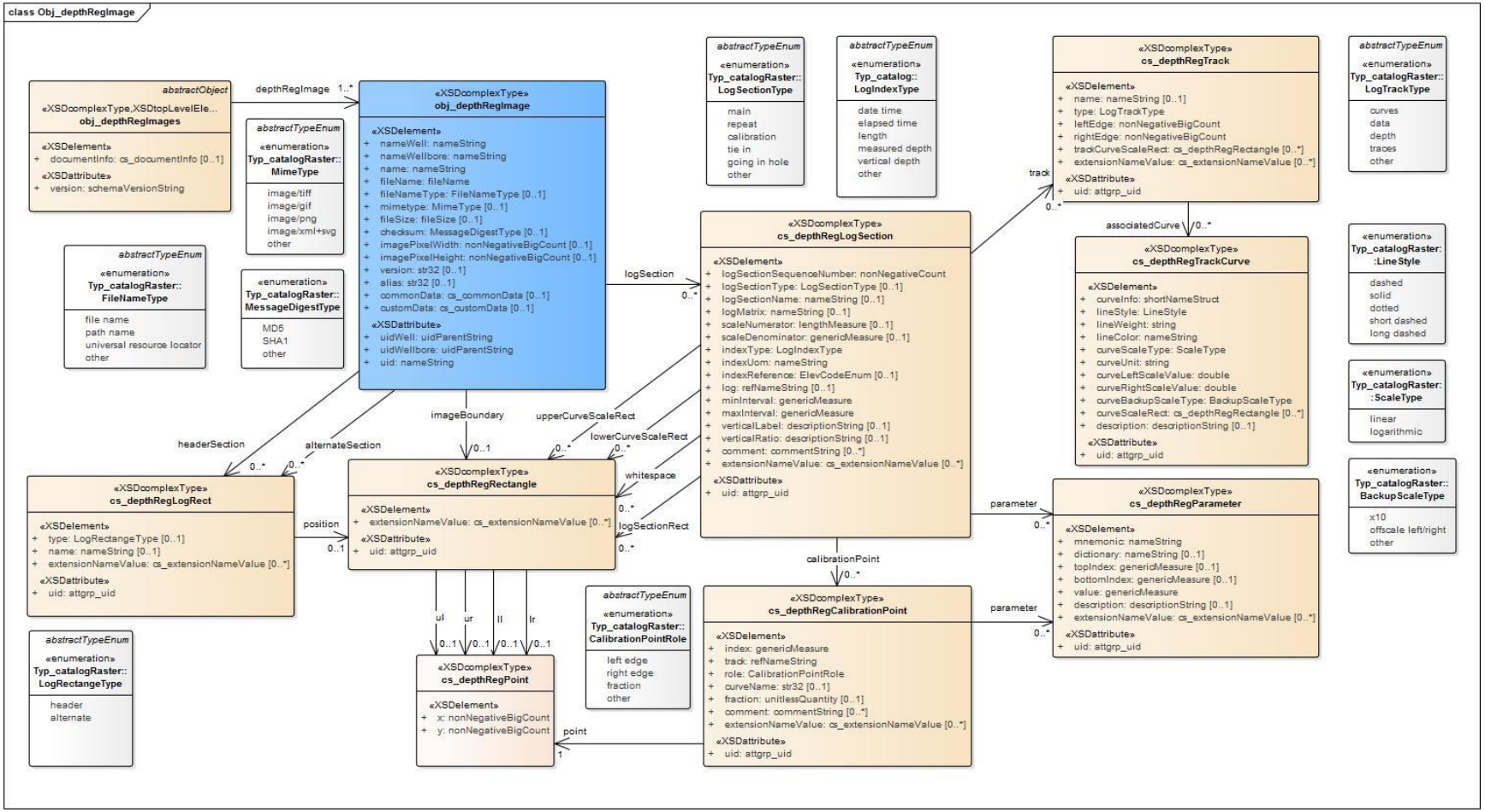

Figure 3-2. UML model of the data objects for Raster Well Log Calibration.

3.1 UML Model and Data Objects

This section provides an overview of the main components of the UML model in **Figure 3-2.** The UML model (which is part of the Raster Well Log Registration download) contains definitions of all elements and attributes in the model.

This set of new data objects is an add-on that works with WITSML v1.4.1. All data objects for raster well log registration have been patterned after v1.4.1 data (for example, plural container objects and singular objects). Some additional data (for example, a new unit of measure) unique to raster log have also been added.

The set of data objects defines the raster log image as a series of rectangles, the contents of each rectangle, and how the rectangles are related. These objects bring together information about the image boundary, the header/alternate sections, metadata on log sections, calibration points, and depth curves. The schemas describe the dimensions of the raster image, rather than a dump of the data points of the raster curves, in a format that all other providers can use.

3.1.1 Top-Level Object: obj_depthRegImage

The top-level object (blue box) is **obj_depthRegImage**, which contains all the information about the composition, layout, and depth registration of the raster well log file.

Like in WITSML, the object can be uniquely identified (within a WITSML server) with a combination of the well, wellbore and the object names and/or the combination of the well, wellbore, and object UIDs.

3.1.2 cs_depthRegLogRect

This object defines a region of an image containing a header or alternate sections as defined on Figure 3-1.

3.1.3 cs_depthRegRectangular

This object uses 4 corner points (ul, ur, ll, lr) to define the position (pixel) of a rectangular area of an image, using x-y coordinates. Most objects point to this object because most are rectangles, and use this schema to define each rectangle.

3.1.4 cs_depthRegLogSection

This object defies the description and coordinates of well log section, the curves on the log. An important XSDelement to note is **log:refNameString**; it is a reference to the actual log/data (in a WITSML server) that this raster image represents; this object does not contain the log data.

The three arrows at the lower left of this object—upperCurveScaleRect, lowerCurveScaleRect, and whitespace—are used to identify the corner points of rectangles bounding those elements of the raster log.

3.1.5 cs_depthRegTrack

This object identifies the rectangle for a single log track.

3.1.6 cs_depthRegTrackCurve

This object is used to provide a description of the actual curve, including elements such as line weight, color, and style, within a log track.

3.1.7 cs_depthRegCalibrationPoint

This object defines a mapping of pixel positions on the log image to significant locations on the log. Specifically, pixels along the depth track are tagged with the matching measured depth for that position.

3.1.8 cs_depthRegParameter

This object defines parameters associated with the log section and includes top and bottom indexes, a description string, and mnemonic.

3.1.9 New Enumerations

Additionally, some new (not included in WITSML 1.4.1) enumerations and a QuantityClass (ResolutionUom) with a matching unit of measure (pixel/in) needed to be added. The enumerations include the objects on the diagram labeled **Typ_catalogRaster**.