



CS-5 Curve Joining Standard

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OVERVIEW

Joined raw curves are of use to a variety of industry professionals for interpretation and correlation work. The following standard was prepared by DataCo for CDA and is designed to ensure that joined curves which are uploaded to CDA are created to a consistent standard of quality and specification and, therefore, of use to the widest possible user community.

Typical use cases for these CDA submitted joined logs would be for quick look, correlation and regional interpretations. Work flows for detailed reservoir work or petrophysical interpretation would generally start with the raw logs.

REQUIREMENTS

DATASET REQUIREMENTS

A joined dataset uploaded to CDA should as a minimum represent seven basic tool types (where logged)

- Gamma Ray
- Resistivity
- Sonic
- Density
- Neutron
- Caliper
- SP

Joined curves should contain all data from borehole TD (or the first response of the deepest curve if TD is not reached) to the shallowest depth logged. In the case of gamma ray data, if the curve in the shallowest open hole section has been logged continuously through casing back to surface, the cased hole section should be included in the joined curve, with the top of the curve cut at seabed. The cased hole interval should be recorded in the audit trail. No joined curve other than the gamma curve should contain cased hole data.

Curves from sidetrack holes should be spliced, at the kick off point or above the kick off point where the sidetrack data overlaps the curves from the parent hole above. Where the DECC do not recognise the sidetrack, the spliced curves from this hole should be stored with the parent hole data and annotated with the operator's name for the sidetrack, by adding a suffix to the joined curve name, e.g. GR_ST, DEN_ST.

Resistivity curves

- Must not combine laterolog data with induction data
- Must, where possible, include a separate curve for deep, medium, shallow and micro depths of investigation, in accordance with the following tool spacings

- Deep >60 inches
- Medium 24 – 60 inches
- Shallow 9 – 24 inches
- Micro <8 inches

Sonic curves must, where possible, include a compressional sonic curve and a shear sonic curve.

Joined SP curves should have any mechanical shifts removed, using baseline shifts.

Wireline data should be used in preference to LWD data. Where in upper hole sections there is only LWD data the LWD memory data (not real time data) should be spliced to wireline data.

PROCESSING REQUIREMENTS

As end users of the data from different professional disciplines have differing, and sometimes conflicting needs of the data, no specialised processing, editing or interpretation work should be carried out. The only exception to this rule is depth matching (and depth shifting if necessary). The processing involved in producing the joined curves from raw data should be restricted to four basic stages;

1. Verification
2. Depth Reference Curve
3. Depth Matching
4. Editing and Splicing of raw data

The required minimum standards to which these processing stages must be carried out are defined below.

1. Verification

All raw data used to construct a joined curve must, wherever possible, be verified against the original logging contractor's final version of the hard copy display of the logging run. These may exist as paper prints, films, scanned images of the paper/film copies, or as digital files supplied by the logging contractor (such as .pds format). It is recognised, however that the print or image may not always be available. In these cases, it is acceptable to verify raw data using a composite well log or similar.

The documentation used to verify the raw data must be detailed in the audit trail. In cases where there is no appropriate documentation for verification, the data must be flagged in the audit trail as being unverified.

The verification process will provide guarantees of the following;

- Accuracy
 - The raw data is loaded to the correct wellbore. (Where data is logged in a sidetrack which is not recognised by the DECC, the data will reside in the parent hole)
 - The raw data has in no way been edited or altered
- Completeness
- All relevant raw curves logged in the borehole are present in the dataset. Where gaps are present, and the missing data cannot be sourced, the gaps or omissions must be detailed in the audit trail
- Depth consistency
 - The curves from any one tool are corrected for tool offset from the bottom of the tool string

2. Depth Reference Curve

Each well bore must contain a single depth reference curve, to which all other joined curves in the well bore are tied. The default curve type for the depth reference curve is the gamma ray curve. If for any reason a different curve type has been chosen as the depth reference curve, then the curve type used and the reason for its use should be specified in the audit trail.

The depth reference curve must be constructed using the raw curve logged in the shallowest open hole section as the primary depth reference. (In a sidetrack wellbore, this will be in the parent hole). Curves from deeper hole sections must be on depth with the primary depth reference, in their overlapping intervals, within a tolerance of 1 metre or 3 feet.

Where a component raw curve is found to be off depth with the primary depth reference, outside the stated tolerance, an appropriate bulk shift must be applied. The same bulk shift should be applied to all other curves which were recorded during the same logging run as the curve used in the depth reference curve. All shifts applied must be recorded in the audit trail.

Where there is no interval of overlap between the component curves used to construct the depth reference curve, no shifts should be applied, and the lack of overlap indicated in the audit trail.

3. Depth Matching

It is a requirement that all raw curves used in the construction of the joined dataset must be on depth with the depth reference curve, within a tolerance of 3 feet or 1 metre.

Raw curves which have been acquired during the same logging run, on the same tool string, as a curve which has been used to construct the depth reference curve, are considered to be on depth and no shifts should be applied to these curves.

Curves which have been acquired during different logging runs must be carefully depth matched against the depth reference curve.

All data must be within a tolerance of 1 metre or 3 feet of the depth reference curve. Any curve found to be outside this tolerance must be shifted appropriately. If a depth inconsistency can be satisfactorily corrected using a bulk shift, then this is the preferred action. It is, however, likely that elastic shifting will be required.

In order to minimise the level of interpretation required during the depth matching process, an appropriate single curve should be chosen from each logging run to depth match against the depth reference curve. This should, wherever possible, be of the same curve type as the depth reference curve. Any shift applied to this curve in order to place it on depth with the depth reference curve must be also applied to the other curves from the same logging run.

4. Editing and Splicing of raw data

Wherever possible, splice points should be chosen at points within intervals of overlap where both curves to be spliced have the same character and reading, and the splice will produce a smooth and seamless join. Where this is not possible, a gap of 5 feet or 1.5 metres must be left between the component curves. Interpolation should not be carried out over this gap.

Non lithological responses, end artefacts, should be removed in the final joined curve. These end artefacts include casing effects and rat hole (wash out below casing) effects at the top of the curves, and flat line tail sections below the first response at the base of the curves. In most cases, when joining several runs, this editing will only be applicable to the top of the uppermost curve and base of the final curve. On occasions, however, where there is a lack of depth overlap between the raw curves to be spliced, the end artefacts at the base of the shallower curve and top of the deeper curve, bounding a zone over which no open hole data was logged (a data gap), must also be removed.

No form of internal editing – that is editing within the curve interval as opposed to at the top and base of the curve - should be carried out (such as de-spiking the sonic and density data). This is interpretive work, which should be left to the end user of the data.

AUDIT TRAIL

At well level, the audit trail should include:

- Kick off depth (in the case of a sidetrack)
- Well TD
- Casing shoe depths
- Successful and failed log runs (tool string) with the logging company's allocated run numbers recorded in each hole section

For the above depth records, where known, both driller's and logger's depths should be recorded. If either one of the driller's or logger's depth records is not known, the audit trail must specify which depth record has been noted.

An audit trail must be provided for each joined curve, containing, as a minimum, an accurate record of the following;

- Source curves used and the logging runs from which they are taken – include the raw curve mnemonics, CS3 name and logging run name and run number
- Verification process – what type of documentation has been used to verify the raw data, (for example composite well log, log image) along with the file name if it is in digital format, or a “NON VERIFIED” statement if no documentation was available for verification purposes
- Details of any missing raw data that cannot be sourced, including the top and bottom depths of any data gaps
- Any corrections applied to SP data to remove mechanical shifts
- Any depth shifts applied to the data – the audit must record which component raw curves have been shifted, the direction and value of the shift in the case of a bulk shift, and the depth interval over which shifting has been carried out in the case of an elastic depth shift
- Splice point depths, or top and bottom depths of any gaps present where there is no overlapping data between deeper and shallower raw curves
- Top and bottom depths of intervals over which end artefacts (non lithological response) have been removed from the raw curves, along with detail of end effect – for example casing effects, flat lines, etc.
- Top and bottom depths of any flat line sections, or gaps present within the depth interval of a raw curve, which are legitimate
- A statement confirming that the curve has been quality checked to ensure that the curve complies with CDA CS5 minimum quality standard

It is not necessary to capture log header data/environmental data in the curve joining audit trail.