July 15, 2016

**USGS Guidelines for LAS 1.4 Well-Known-Text (WKT)**

**Addendum to USGS Lidar Base Specification v1.2**

The current USGS Lidar Base Specification v1.2 incorporates LAS v1.4 which references and incorporates OGC(2001) for well-known-text (WKT). Enforcement of the requirement to deliver LAS data compliant with OGC(2001) WKT specifications will begin with deliveries received on or after August 15, 2016. As of that date, non-compliant OGC(2001) WKT will not be accepted for GPSC contract deliveries unless they are reworked delivery lots. To view the OGC(2001) WKT specification visit: [https://web.archive.org/web/20040804093025/http://www.opengis.org/docs/01-009.pdf](https://web.archive.org/web/20040804093025/http:/www.opengis.org/docs/01-009.pdf) .

For verification or generation of properly formatted OGC(2001) WKT, the USGS recommends the use of the gdalsrsinfo (<http://www.gdal.org/gdalsrsinfo.html>) tool. gdalsrsinfo is a command line tool that can be downloaded and installed using the OSGeo4W installer ( <https://trac.osgeo.org/osgeo4w/>). The following command will produce OGC(2001) WKT that USGS considers to have valid form:

**$ gdalsrsinfo -o wkt "EPSG:<code>"**

However**, t**he USGS recommends three exceptions to the gdalsrsinfo output:

* gdalsrsinfo adds an EXTENSION[] tag to capture geoid information in the VERT\_DATUM[] section that may or may not be acceptable under the WKT specification. USGS recommends removal of the extension tag if it is shown. The geoid model used to convert elevations from the ellipsoid to orthometric heights must be identified in the <lidar><ldrinfo><ldrgeoid> tag within the FGDC metadata files. The NGS model filename is sufficient, i.e., <ldrgeoid>g2012Bu0.bin</ldrgeoid>
* In cases where the datum name output from gdalsrsinfo differs from that listed by the epsg-registry.org database, the USGS would prefer that the name be changed to match the EPSG Registry; however, the GDAL output will be accepted. For example, EPSG:1116 is named “NAD83\_National\_Spatial\_Reference\_System\_2011” in the output from GDAL but the name on epsg-registry is "NAD83 (National Spatial Reference System 2011)” and the only listed alias is "NAD83(2011)”
* For all projected coordinate systems the USGS recommends the OGC(2001) specification default values: AXIS[“X,EAST], AXIS[“Y”,NORTH]; however, the GDAL output (‘easting, northing’ rather than ‘X,Y’) will be accepted.

Note: gdalsrsinfo output uses ‘metre’ instead of the US convention ‘meter’. Either spelling is acceptable to the USGS.

The USGS recognizes that the GDAL tool is not a rigorous standards-based solution, but, it is a mutually convenient open source tool suitable for GPSC purposes at this time. If WKT conforming to that of this tool is found to be non-compliant in the future, the USGS will notify contractors of this discrepancy, corrections expected, and the date by which all new deliveries must conform to the corrections.

USGS directions for specific WKT format and content effective on the enforcement date of this Base Specification Addendum:

* User-defined entities *will not be allowed* for capturing specific geoid information in the WKT (example: GEOID\_MODEL[], etc.); because, these non-standard entity entries are not specified anywhere in the OGC specification and will not be machine readable unless the program using the data is programmed to specifically look for that tag. If geoid name in the WKT is desired, it is recommended to append it to the VERT\_CS[] name field (example: VERT\_CS["NAVD88 - Geoid12B (Feet)",..]). Identifying the geoid name in the VERT\_CS[] name field remains optional.
* There is no current requirement to include the Vertical CRS in the LAS file, but, because lidar is 3D data it is strongly encouraged
* If both a horizontal and a vertical CRS are being entered, they *must* be wrapped together as a COMPD\_CS
* *Regarding multiple CRS records in a LAS file:* A given LAS file may contain any number of CRS entries, as VLRs and/or EVLRs in any combination, as WKT and/or GeoTIFF in any combination, regardless of PDRF type, provided that:
  + ALL entries must be tagged as "Superseded" (see LAS v1.4r13) -- EXCEPT for the single valid entry to be used.
  + For PDRF 6+, the valid entry must be OGC(2001) WKT compliant.
  + For PDRF 6+, the Global Encoding Bit for CRS must be set to 1
* The WKT *must* contain valid EPSG codes for all horizontal and vertical elements.
  + ALL elements of the CRS record *must* include the AUTHORITY[] entry, except where no EPSG code exists for the element.
  + EPSG code AUTHORITY[] *shall not be* entered for a compound coordinate system and will not be allowed

**OGC WKT example with compound coordinate system {NAD83(2011) + NAVD88 height (meters)}**

*Command string:*

$ gdalsrsinfo -o wkt "EPSG:6427+5703"

*Output:*

COMPD\_CS["NAD83(2011) / Colorado Central + NAVD88 height",

PROJCS["NAD83(2011) / Colorado Central",

GEOGCS["NAD83(2011)",

DATUM["NAD83\_National\_Spatial\_Reference\_System\_2011",

SPHEROID["GRS 1980",6378137,298.257222101,

AUTHORITY["EPSG","7019"]],

AUTHORITY["EPSG","1116"]],

PRIMEM["Greenwich",0,

AUTHORITY["EPSG","8901"]],

UNIT["degree",0.0174532925199433,

AUTHORITY["EPSG","9122"]],

AUTHORITY["EPSG","6318"]],

PROJECTION["Lambert\_Conformal\_Conic\_2SP"],

PARAMETER["standard\_parallel\_1",39.75],

PARAMETER["standard\_parallel\_2",38.45],

PARAMETER["latitude\_of\_origin",37.83333333333334],

PARAMETER["central\_meridian",-105.5],

PARAMETER["false\_easting",914401.8289],

PARAMETER["false\_northing",304800.6096],

UNIT["meter",1,

AUTHORITY["EPSG","9001"]],

AXIS["X",EAST],

AXIS["Y",NORTH],

AUTHORITY["EPSG","6427"]],

VERT\_CS["NAVD88 height",

VERT\_DATUM["North American Vertical Datum 1988",

AUTHORITY["EPSG","5103"]],

UNIT["meter",1,

AUTHORITY["EPSG","9001"]],

AXIS["Up",UP],

AUTHORITY["EPSG","5703"]]]

**OGC WKT example with compound coordinate system {NAD83(2011) + NAVD88 height (ftUS)}**

*Command string:*

$ gdalsrsinfo -o wkt "EPSG:6434+6360"

*Output:*

COMPD\_CS["NAD83(2011) / Connecticut (ftUS) + NAVD88 height (ftUS)",

PROJCS["NAD83(2011) / Connecticut (ftUS)",

GEOGCS["NAD83(2011)",

DATUM["NAD83\_National\_Spatial\_Reference\_System\_2011",

SPHEROID["GRS 1980",6378137,298.257222101,

AUTHORITY["EPSG","7019"]],

AUTHORITY["EPSG","1116"]],

PRIMEM["Greenwich",0,

AUTHORITY["EPSG","8901"]],

UNIT["degree",0.0174532925199433,

AUTHORITY["EPSG","9122"]],

AUTHORITY["EPSG","6318"]],

PROJECTION["Lambert\_Conformal\_Conic\_2SP"],

PARAMETER["standard\_parallel\_1",41.86666666666667],

PARAMETER["standard\_parallel\_2",41.2],

PARAMETER["latitude\_of\_origin",40.83333333333334],

PARAMETER["central\_meridian",-72.75],

PARAMETER["false\_easting",1000000],

PARAMETER["false\_northing",500000],

UNIT["US survey foot",0.3048006096012192,

AUTHORITY["EPSG","9003"]],

AXIS["X",EAST],

AXIS["Y",NORTH],

AUTHORITY["EPSG","6434"]],

VERT\_CS["NAVD88 height (ftUS)",

VERT\_DATUM["North American Vertical Datum 1988",2005,

AUTHORITY["EPSG","5103"]],

UNIT["US survey foot",0.3048006096012192,

AUTHORITY["EPSG","9003"]],

AXIS["Up",UP],

AUTHORITY["EPSG","6360"]]]

**OGC WKT example without compound coordinate system in meters**

*Command string:*

$ gdalsrsinfo -o wkt -p "EPSG:6427"

*Output:*

PROJCS["NAD83(2011) / Colorado Central",

    GEOGCS["NAD83(2011)",

        DATUM["NAD83\_National\_Spatial\_Reference\_System\_2011",

            SPHEROID["GRS 1980",6378137,298.257222101,

                AUTHORITY["EPSG","7019"]],

            AUTHORITY["EPSG","1116"]],

        PRIMEM["Greenwich",0,

            AUTHORITY["EPSG","8901"]],

        UNIT["degree",0.0174532925199433,

            AUTHORITY["EPSG","9122"]],

        AUTHORITY["EPSG","6318"]],

    PROJECTION["Lambert\_Conformal\_Conic\_2SP"],

    PARAMETER["standard\_parallel\_1",39.75],

    PARAMETER["standard\_parallel\_2",38.45],

    PARAMETER["latitude\_of\_origin",37.83333333333334],

    PARAMETER["central\_meridian",-105.5],

    PARAMETER["false\_easting",914401.8289],

    PARAMETER["false\_northing",304800.6096],

    UNIT["meter",1,

        AUTHORITY["EPSG","9001"]],

    AXIS["X",EAST],

    AXIS["Y",NORTH],

    AUTHORITY["EPSG","6427"]]

**OGC WKT example without compound CRS in State Plane US Survey Feet**

*Command string:*

$gdalsrsinfo -o wkt -p "EPSG:6434"

*Output:*

PROJCS["NAD83(2011) / Connecticut (ftUS)",

    GEOGCS["NAD83(2011)",

        DATUM["NAD83\_National\_Spatial\_Reference\_System\_2011",

            SPHEROID["GRS 1980",6378137,298.257222101,

                AUTHORITY["EPSG","7019"]],

            AUTHORITY["EPSG","1116"]],

        PRIMEM["Greenwich",0,

            AUTHORITY["EPSG","8901"]],

        UNIT["degree",0.0174532925199433,

            AUTHORITY["EPSG","9122"]],

        AUTHORITY["EPSG","6318"]],

    PROJECTION["Lambert\_Conformal\_Conic\_2SP"],

    PARAMETER["standard\_parallel\_1",41.86666666666667],

    PARAMETER["standard\_parallel\_2",41.2],

    PARAMETER["latitude\_of\_origin",40.83333333333334],

    PARAMETER["central\_meridian",-72.75],

    PARAMETER["false\_easting",1000000],

    PARAMETER["false\_northing",500000],

    UNIT["US survey foot",0.3048006096012192,

        AUTHORITY["EPSG","9003"]],

    AXIS["X",EAST],

    AXIS["Y",NORTH],

    AUTHORITY["EPSG","6434"]]