VIIRS/NPP Snow Cover Daily L3 Global 375m SIN Grid, Version 1

USER GUIDE

How to Cite These Data

As a condition of using these data, you must include a citation:

Riggs, G. A., D. K. Hall, and M. O. Román. 2019. *VIIRS/NPP Snow Cover Daily L3 Global 375m SIN Grid, Version 1.* [Indicate subset used]. Boulder, Colorado USA. NASA National Snow and Ice Data Center Distributed Active Archive Center. https://doi.org/10.5067/VIIRS/VNP10A1.001. [Date Accessed].

FOR QUESTIONS ABOUT THESE DATA, CONTACT NSIDC@NSIDC.ORG

FOR CURRENT INFORMATION, VISIT https://nsidc.org/data/VNP10A1

National Snow and Ice Data Center

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1 DATA DESCRIPTION

Snow covered land typically has very high reflectance in visible bands and very low reflectance in shortwave infrared bands. The Normalized Difference Snow Index (NDSI) reveals the magnitude of this difference. The snow cover algorithm calculates NDSI for all land and inland water pixels during daylight. This data set includes NDSI snow cover, raw NDSI, data quality, geolocation, and ancillary parameters written to HDF-EOS formatted data files. The parameters included with this data set are described in the following table.

1.1 Parameters

Table 1. Parameter Details

Parameter	**Description**	**Values**
`NDSI_Snow_Cover`	Gridded NDSI snow cover. This parameter is made with the best selected observations from the VIIRS/NPP Snow Cover 6-Min L2 Swath 375m, Version 1 (VNP10) product where the snow detection algorithm was run.	NDSI snow cover values and data flags values, stored as 8-bit unsigned integers. 0 - 100: NDSI snow cover (no snow to completely snow covered) 201: no decision 211: night 237: lake 239: ocean 250: cloud 251: missing data 252: unusable L1B (input) data 253: bowtie trim* 254: L1B (input) fill 255: fill
`NDSI`	Gridded NDSI values for all land and inland water pixels provided without the cloud mask applied. These are the NDSI values calculated in VNP10 V1 and correspond to the ‘best’ observation selected.	NDSI values and data flag values, stored as 16-bit integers. The NDSI is packed data that can be unpacked using the scale_factor of .001. -1000 to 1000: NDSI 21100s: night 23900s: ocean 25100s: L1B_missing 25200s: L1B_unusable 25300s: bowtie_trim* 25400s: L1B_fill

Parameter	Description	Values
`Algorithm_bit_flags_QA`	Algorithm-specific flag masks in this variable are the result of data screens that were applied in VNP10 Version 1. These flag masks provide QA information regarding an observation and can be used to determine if a snow detection was flagged as uncertain or reversed to no snow by one or more data screens applied in the algorithm.	Bit flag values 0: Inland water 1: Low visible screen failed, snow detection reversed to no snow 2: Low NDSI screen failed, snow detection reversed to no snow 3: Combined temperature/height screen failed 4: Spare 5: Shortwave IR (SWIR) reflectance anomalously high 6: Spare 7: Uncertain snow detection due to low illumination
`Basic_QA`	General quality estimate for pixels processed for snow in VNP10 V1.	Quality assessment flag values 0: good 1: poor 2: bad 3: other 211: night 239: ocean 250: cloud 252: no decision 253: bowtie trim* 255: fill
`Projection`	Sinusoidal projection attributes.	N/A
`granule_pnt`	Includes pointer values for referencing the input swath/s (VNP10 V1) mapped to the tile. For details, see the section 'Using the granule_pnt field' below.	0-254: valid data range 255: fill
`XDim`	Projected upper left X coordinate for each pixel in km	Coordinate value range for data set -20015.109354 to 20015.109354
`YDim`	Projected upper left Y coordinate for each pixel in km	Coordinate value range for data set -10007.554677 to 10007.554677
*Bowtie trim pixels caused by overlapping instrument scans are removed from the data. However, the bowtie trim attribute remains in the file level metadata to preserve consistency with lower level products.		

1.1.1 Interpreting Algorithm_bit_flags_QA

Pixels determined to have some snow present are subjected to a series of screens to alleviate snow commission errors (false snow detection) and to flag uncertain snow detections. In addition, snow-free pixels are screened for very low illumination conditions to prevent possible snow omission errors. Screen results, as well as the location of inland water, are stored as bit flags in the 'Algorithm_Bit_Flags_QA' field. For a detailed description of the Snow Cover QA flags see the Data Screens section in the VIIRS Snow Products User Guide (Riggs et al. 2019).

To identify bit flag values, convert the decimal grid cell value to its binary equivalent. Bit values default to 0 and are set to 1 if the screen result is true. An example of the bit flag format for the decimal value '129' is provided in Figure 1.

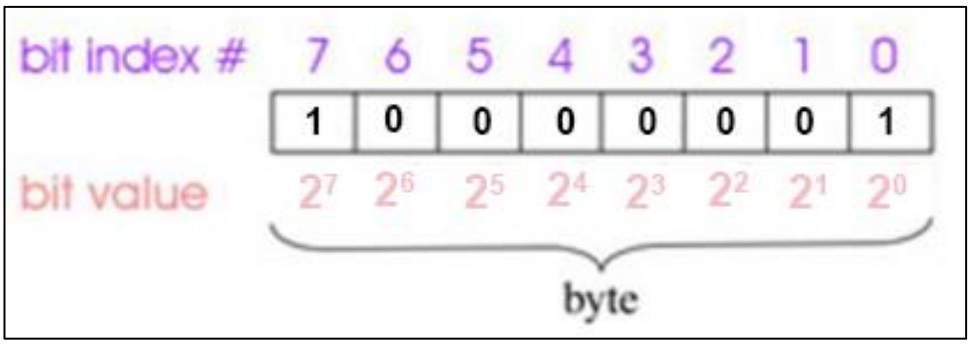

Figure 1. This figure shows the bit flag format. The bit index positions are numbered from right (bit index 0) to left (bit index 7), and each index stores the result of a screen test. The bit values from right to left solve respectively to 1, 2, 4, 8, 16, 32, 64, and 128. In this example, bit index 0 and bit index 7 are set to true (1) with corresponding bit values 20 and 27 equaling '1' and '128'; which when summed equal '129'.

1.1.2 Using the granule_pnet field

The granule_pnt field includes pointer values used to reference the granule or granules (VNP10 swath) from which each observation was selected. The values in this field can be matched with values stored in the GranulePointerArray. Each granule overlapping the tile is assigned a unique positive pointer value in the GranulePointerArray, while granules that do not overlap the tile are assigned a value of -1. GranulePointerArray values are encoded to match the array index position of date/time values in the GranuleBeginningDateTime or GranuleEndingDateTime attributes. The date/time value specified in the file name/s can then be used to identify the source VNP10 granule.

Note, the GranulePointerArray includes a value for all VPN10 swaths that overlap the tile location. This number is also provided in the NumberOfOverlapGranules attribute. Only the 'best' swath observations are mapped to the tile. Figure 2 shows how to use the granule_pnt field, GranulePointerArray attribute, and GranuleBeginningDateTime attribute to identify the VNP10 swath granules mapped to the tile.

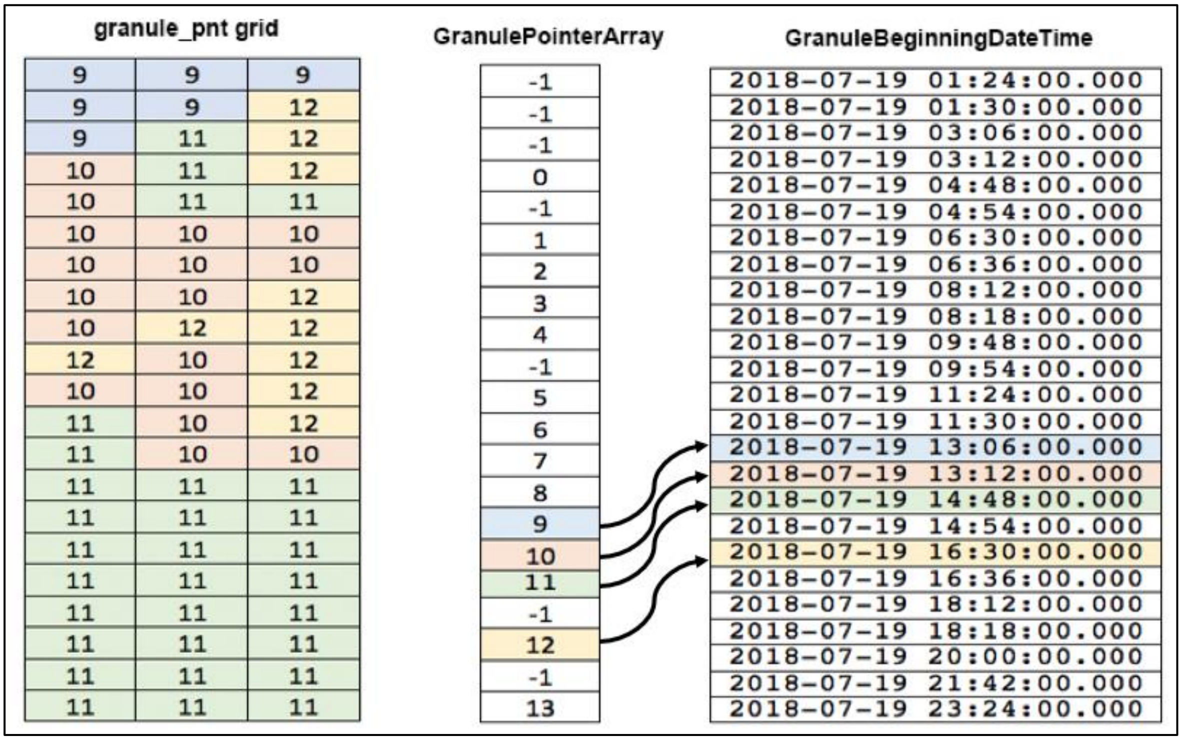

Figure 2. The granule_pnt field, GranulePointerArray attribute and GranuleBeginningDateTime or GranuleEndingDateTime attribute can be used to identify the VNP10 granules mapped to the tile. In this example the granule_pnt field contains four distinct grid cell values (9, 10, 11, and 12). The GranulePointerArray attribute contains a value for each VNP10 swath scan that overlaps the tile location, and the GranuleBeginningDateTime attribute contains an array of date/time values that show the starting date and time of each overlapping scan. The GranulePointerArray attribute and the GranuleBeginningDateTime attribute values are positionally indexed to match one another. To identify the swath observations mapped to the tile, associate granule_pnt grid values with GranulePointerArray values and GranuleBeginningDateTime values. The selected GranuleBeginningDateTime values can then be used to identify the VNP10 file names that were mapped to the tile.

1.2 File Information

1.2.1 Format

Data are provided in HDF-EOS5 32-bit signed integer format and include additional variables and attributes that conform to the netCDF CF-1.6 convention for local attributes, global attributes and georeferencing. For software and more information, visit the HDF-EOS website.

1.2.2 Contents

As shown in Figure 3, each data file includes two data fields (NDSI and NDSI_Snow_Cover), two data quality fields (Basic_QA and Algorithm_bit_flags_QA), two ancillary data fields (Projection and granule_pnt fields), and one metadata field (StructMetadata).

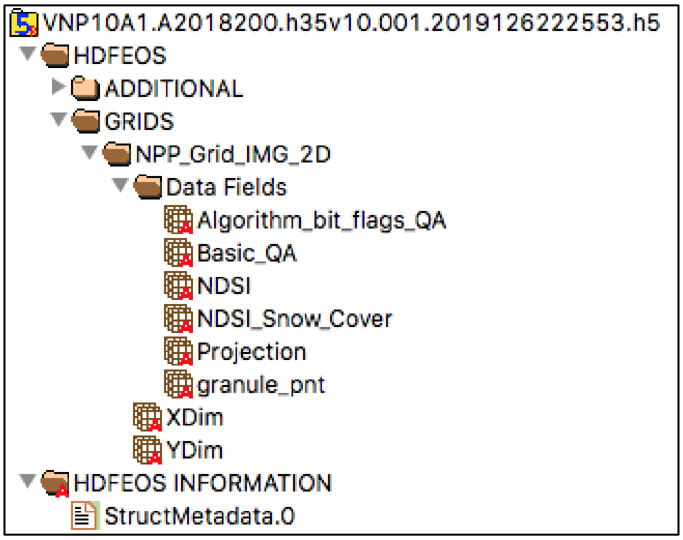

Figure 3. This figure shows the fields included in each VNP10A1 data file as displayed with HDFView software.

1.2.3 Directory Structure

A data directory exists for each day of data and includes data files, browse image files, and metadata files for each granule. A granule exists for each tile in the MODIS Sinusoidal Tile Grid. See the Grid Description section below for tile grid details.

1.2.4 Naming Convention

VIIRS file names begin with a product identifier (VNP10A1) followed by the acquisition date, the horizontal and vertical tile number, the data set version, and data set production date and time. The following section describes the full VIIRS file naming convention:

File naming convention

`VNP[PID].A[YYYY][DDD].h[NN]v[NN].[VVV].[yyyy][ddd][hhmmss].h5`

File name example

`VNP10A1.A2018200.h35v10.001.2019126222553.h5`

Table 2. File Name Variables

Variable	Description
VNP	VIIRS Suomi NPP
PID	10A1
A	Acquisition date follows
YYYY	Acquisition year
DDD	Acquisition day of year
h[NN]v[NN]	Horizontal tile number and vertical tile number (See Grid Description below)
VVV	Version (Collection) number
yyyy	Production year
ddd	Production day of year
hhmmss	Production hour/minute/second in GMT
.h5	HDF-EOS5 formatted data file

1.3 Spatial Information

1.3.1 Coverage

The spatial coverage is global. The following sites offer tools that track and predict NPP's orbital path:

- Space Science and Engineering Center (SSEC) NPP Orbit Tracks
- NASA LaRC Satellite Overpass Predictor (includes viewing zenith, solar zenith, and ground track distance to specified lat/lon)

1.3.2 Projection

This data set is georeferenced to an equal-area sinusoidal projection. Areas on the grid are proportional to the same areas on Earth and distances are correct along all parallels and the central meridian. Shapes become increasingly distorted away from the central meridian and near the poles. The data are neither conformal, perspective, nor equidistant. Meridians, except for the central meridian, are represented by sinusoidal curves and parallels are represented by straight lines. The central meridian and parallels are lines of true scale.

1.3.3 Grid Description

As shown in Figure 4, data are gridded using the MODIS Sinusoidal Tile Grid, which comprises 460 non-fill tiles that each cover 10° by 10° at the equator or approximately 1200 km by 1200 km. Each data granule covers one tile and consists of 3,000 rows and 3,000 columns.

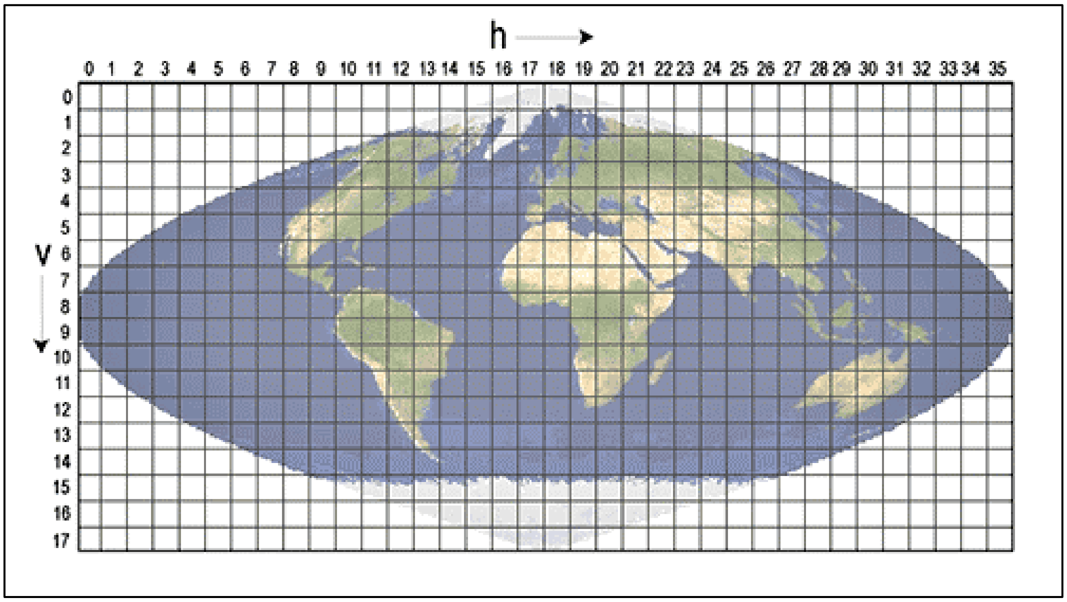

Figure 4. MODIS Sinusoidal Tile Grid

1.3.4 Spatial Resolution

The nominal spatial resolution is 375 meters.

1.3.5 Geolocation

The following tables provide information for geolocating this data set.

Table 3. Projection Details

Region	Global
Geographic coordinate system	WGS84
Projected coordinate system	Sinusoidal Grid
Longitude of true origin	0°
Latitude of true origin	0°
Scale factor at longitude of true origin	1.0
Datum	WGS 84
Ellipsoid/spheroid	6371007.181000 meters
Units	Meter
False easting	0°
False northing	0°
EPSG code	N/A
PROJ4 string	+proj=sinu +lon_0=0 +x_0=0 +y_0=0 +ellps=WGS84 +datum=WGS84 +units=m +no_defs
Reference	https://spatialreference.org/ref/sr-org/6974/html/

Table 4. Grid Details

Region	Global
Grid cell size (x, y pixel dimensions)	375 m
Number of rows	3000
Number of columns	3000
Nominal gridded resolution	375 m
Grid rotation	N/A
Upper left corner point (m)	-20015109.354(x), 10007554.677(y)
Lower right corner point (m)	20015109.354(x), -10007554.677(y)

1.4 Temporal Information

1.4.1 Coverage

The temporal coverage of this data set extends from 19 Jan 2012 to the present. However, because the NDSI depends on visible light, data are not produced for the night phase of each orbital period or for those portions of fall and winter in polar regions when viewing conditions are too dark. If you cannot locate data for a particular date or time, check the VIIRS Data Outages Web page.

1.4.2 Resolution

Daily

1.5 Sample Data Image

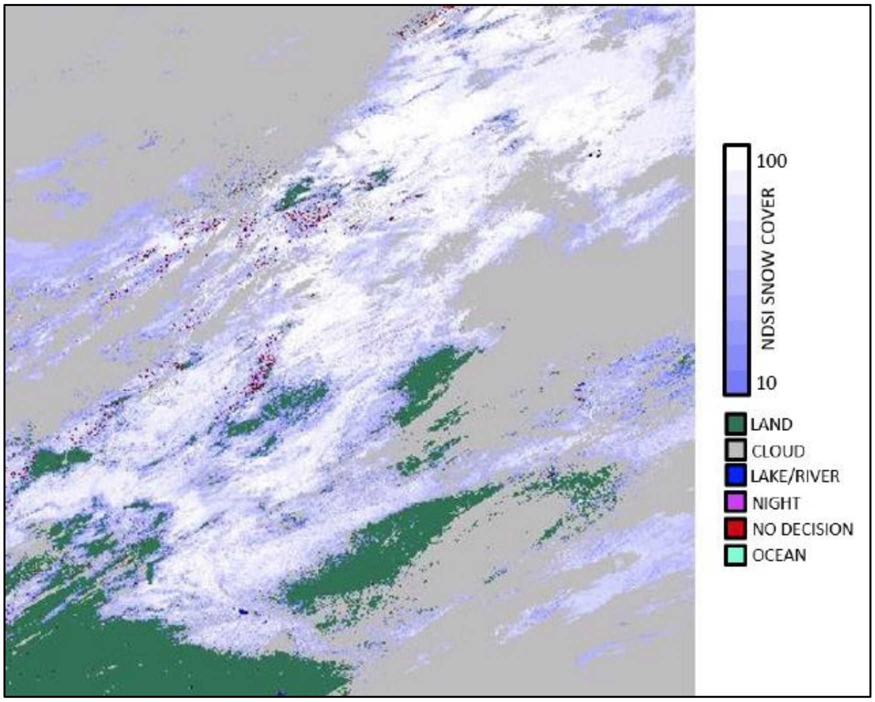

Figure 5. This figure shows snow cover over the Rocky Mountains and High Plains from tile h10v04, detected 7 January 2018.

2 DATA ACQUISITION AND PROCESSING

2.1 Background

Snow cover is detected using the Normalized Difference Snow Index (NDSI). The algorithm for this data set calculates NDSI using VIIRS image bands I1 (0.64 µm, visible red) and I3 (1.61 µm, shortwave near-infrared). A series of data screens are then applied to alleviate likely errors and flag uncertain snow detections. For a detailed description of the data screens see the Data Screens section in the VIIRS Snow Products User Guide (Riggs et al. 2019).

2.2 Acquisition

VIIRS scans the entire globe every one to two days. As such, most locations on Earth are imaged at least once per day and more frequently where swaths overlap, such as near the poles. Suomi NPP's sun-synchronous, near-circular polar orbit is timed to cross the equator from south to north (ascending mode) at approximately 1:30 P.M. local time. The repeat cycle is 16 days (quasi 8-day).

2.3 Processing

The data source for the VNP10A1 product is the VNP10 product. The VNP10A1 algorithms select the best VNP10 swath observation of the day for the NDSI_Snow_Cover parameter and the NDSI parameter. The data is then mapped to a gridded sinusoidal projection, which is the same grid and projection as the MODIS products but at the VIIRS nominal spatial resolution of 375 meters. The best observation is selected based on the following criteria; observation nearest local solar noon time; observation nearest the orbit nadir track; observation with most coverage in a grid cell; and observation considered to be the best sensor view of the surface days relevant to snow cover detection. For a detailed description of the snow cover detection algorithm see the Data Aquistion and Processing section of the VIIRS/NPP Snow Cover 6-Min L2 Swath 375m, Version 1 User Guide or Section 3.3 of the VIIRS Snow Products User Guide (Riggs et al. 2019).

2.4 Quality

The interpretation for accuracy, uncertainty and errors is the same as for the VNP10 product. For a detailed description, see the Error Sources section in the VIIRS Snow Products User Guide (Riggs et al. 2019).

Geolocation error may be seen in the product due to uncertainty or errors during swath geolocation or when gridding and projecting the swath data to the sinusoidal projection from swath latitude and longitude reference system. These geolocation errors are commonly observed in the location of freshwater bodies over time. In a composite of a tile over the course of several consecutive days the position of a lake shoreline may shift by one or more cells in the horizontal or vertical directions. This results in a blurred outline of the lake composited over time.

2.5 Instrument Description

The VIIRS instrument is a whiskbroom scanning radiometer with 22 bands (see VIIRS Bands and Bandwidths) covering the spectrum between 0.412 μm and 12.01 μm. Sixteen moderate resolution bands (M-bands), five imaging resolution bands (I-bands), and one panchromatic day-night band (DNB) acquire spatial resolutions at nadir of 750 m, 375 m, and 750 m, respectively. M-bands include 11 Reflective Solar Bands (RSB) and 5 Thermal Emissive Bands (TEBs). I-bands include 3 RSBs and 2 TEBs. For more details about the VIIRS instrument see the Visible Infrared Imaging Radiometer Suite (VIIRS) Sensor Data Record (SDR) User's Guide (Changyong et al. 2013) and the Joint Polar Satellite System (JPSS) VIIRS Radiometric Calibration Algorithm Theoretical Basis Document (ATBD) (Baker, 2013).

The following table lists select technical specifications for the VIIRS instrument:

Table 5. VIIRS Specifications

Variable	Description
Orbit	829 km (nominal) altitude, 1:30 P.M. ascending node, sun-synchronous, near-polar, circular
Scan Rate	1.779 sec/rev, 202.3 deg/sec
Scan Width	±56.28° (Earth view)
Imaging Optics	19.1 cm aperture, 114 cm focal length
Swath Dimensions	3060 km cross-track, 12 km along track at nadir
Samples per Band	M-bands: 6304 samples at 0.312 mrad/sample (3200 aggregated pixels) I-bands: 12608 samples at 0.156 mrad/sample (6400 aggregated pixels) DNB: 4064 pixels at 0.149 to 0.894 mrad/pixel
Weight	275 kg
Power	200 W (single orbit average)
Data Rate	10.5 Mbps (max)
Quantization	12 bit –14 bit A/D converters for lower noise
Launch date	28 October, 2011
Design Life	7 years (5 year mission)

3 SOFTWARE AND TOOLS

For general tools that work with HDF-EOS data, see the NSIDC HDF-EOS web page.

4 CONTACTS AND ACKNOWLEDGMENTS

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6 DOCUMENT INFORMATION

6.1 Publication Date

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6.2 Date Last Updated

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