Rijkswaterstaat
Ministerie van Infrastructuur en Waterstaat

Technical Requirements for InSAR Processing

Object Monitoring based on InSAR-analysis (ID: 31212460)

Contractor: Klik of tik om tekst in te voeren.

Date	September 1st, 2025
Version	1.0
Status	Finalized

RWS PUBLIC

Document Control Information

Type	**Value**
Document title	Technical Requirements for InSAR Processing
Project title	Object Monitoring based on InSAR-analysis
Project ID	31212460
Author(s)	Lars Keuris, Niels van Boldrik, Emile Nieuwstraten, Gert Mulder, Rinus Schroevers
Document status	Finalized
Document version	1.0
Document distribution	Public
Document date	September 1st, 2025

Document History

Name	**Comment**	**Date**
Final 1.0	Initial version	01-09-2025

Table of Contents

1 Introduction

This document contains the Technical Requirements for the European tender project **Object Monitoring based on InSAR-analysis** both **Lot 1: monitoring of tunnels and historical analysis of other objects** and **Lot 2: developing and applying InSAR analysis to bridges and viaducts.**

To meet the project objective, we request a set of deformation products, which we require to be generated through the interferometric processing of Synthetic Aperture Radar (SAR) image stacks of the Netherlands. To safeguard the usability of the final products, we outline the technical requirements in this document for the:

1. InSAR deformation product; and the
2. InSAR documentation.

A detailed description of the requested end product(s) is given in section 3 and 4.

The requested time period, list of available SAR image stacks and area with objects of interest are available in the project description.

2 Evaluation Procedure

All delivered products and documentation will be verified by Rijkswaterstaat in relation to the requirements included in this document and any annexes.

In brief, the project deliverables are checked for its integrity, structure, naming and completeness. Furthermore, the reports are checked for its motivation of methods, treatment of uncertainties and applicability in the context of the project objective. The latter check also applies to the data. At last, the data is checked for processing errors and invalid data. This assessment is performed in a systematic manner with a checklist, the Delivery Assessment Report. The assessment results will be shared with the contractor in a timely manner after delivery.

The Delivery Assessment Report (DAR) will be made available to the contractor.

3 Project Deliverables

The following types of requested information are derived from the dataset through interferometric SAR (InSAR) processing of SLC SAR data.

3.1 InSAR Deformation Products

3.1.1 Level 2 Deformation Data

- The level 2 point deformation (vector) data in the line of sight (LOS) direction for each available track. This dataset contains both persistent scatterer (PS) and distributed scatterer (DS) information.

3.1.2 Level 3 Deformation Data

- The level 3 polygon deformation (vector) data in the line of sight direction for each available track.
- The level 3 polygon deformation (vector) data decomposed into horizontal and vertical deformation time series.

3.2 InSAR Documentation

The documentation consists of two separate reports, namely 1) the project report and 2) the quality report. The required report structures and report contents are provided in the Appendix (section 6.3).

3.2.1 Project Report

The project report is primarily for our client(s) within Rijkswaterstaat, e.g. the asset manager, but may be distributed to a wider audience. The project report must be written in Dutch (preferred) or English. The project report is **not confidential**.

3.2.2 Quality Report

The quality report describes the InSAR processing background and the product quality. This report is written for specialists at Rijkswaterstaat with a geodetic background. The quality report must be written in Dutch or English. The quality report is **confidential**.

4 Technical Requirements

4.1 Level 2 Data Processing Requirements

The level 2 data requirements in line with the project objective are as follows:

1. Individual SAR images must be accurately co-registered in range and azimuth direction. Co-registration must be checked using a number of strong scatterers, preferably from corner reflectors.
2. The deformation time series must be referenced in the line of sight of the satellite for individual tracks. Suggested methods include referencing based on reference areas or multiple stable reference points.
3. Persistent and Distributed (-like) Scatterers (PS and DS) Interferometry processing is required to maximize point density and coverage while retaining individual point quality.
4. Sub-pixel position of the persistent scatterers must be determined to improve the geolocation.
5. The product must be georeferenced with recent *Actueel Hoogtebestand Nederland* (AHN) data (see section 5.2.2) and spatially referenced. Any manual shifting must be reported and justified.
6. The final height and geolocation of the measurements points must each be snapped to the most likely scattering location in the physical world using one or more additional sources, e.g. the AHN data (see section 5.2.2).
7. Temporally coherent scatterers with two or more independent coherent periods must be connected into one deformation time series for unwrapping and parameter estimation. We encourage the use of step functions for permanent offsets. The point positioning must be consistent for the full time period and must be derived from the longest coherent time-period.
8. The unwrapping method must accommodate the physical deformation behavior of the objects of interest spatially and temporally to produce representative and consistent level 2 data. See section 5.1.2 for auxiliary (object) information
9. Point quality parameters used for the generation of the level 2 data product must be specified, described and provided as indicated by Table 3. Additional point quality parameters may be introduced.
10. The sign of the line of sight deformation is positive towards the satellite and negative away from the satellite.
11. The processing requirements from the object information annex must be followed for the respective object (see section 5.1.2).

4.1.1 Time Series Classification

1. The offset, trend, acceleration and an annual periodic signal must be extracted from the level 2 time series (see Table 6). The trend and acceleration must be estimated independently. All level 2 (and level 3) data must use the same starting time for the parameter estimations (i.e. the time of the first radar observation in the overall dataset).

4.2 Level 3 Data Processing Requirements

The processing of level 3 data has to meet the following minimum requirements:

1. Only measurement points inside a polygon may be used for the decomposition of the deformation of the respective polygon[1]. For the DS(-like) point selection, only measurement points within the same polygon may be grouped together. The measurement points must be unambiguously close (along the vertical axis) to the surface of the object of interest (use e.g. use AHN data for comparison, see section 5.2.2).
2. A (weighted) method must be used to derive representative level 3 time series from the level 2 time series. This must include a clear strategy on how to:
    a. Compute a weighted average from measurement points using a level 2 quality parameter(s).
    b. Reduce the impact of outliers, whilst retaining anomalous physical deformation.
3. Polygon quality parameters used for the generation of the level 3 data product must be specified, described and provided as indicated by Table 4. Additional polygon quality parameters may be introduced.
4. The level 3 data has a singular and homogenous time axis for all polygons for each area of interest.
5. The deformation sign in the vertical direction is positive upward and negative downward. The sign of the deformation in the horizontal direction is dictated by the object type that the polygon covers.
6. The processing requirements from the object information annex must be followed for the respective object (see section 5.1.2).

4.2.1 Time Series Classification

1. The offset, trend, acceleration and an annual periodic signal must be extracted from the level 3 time series (see Table 6). The trend and acceleration must be estimated independently. All (level 2 and) level 3 data must use the same starting time for the parameter estimations (i.e. the time of the first radar observation in the overall dataset).

[1] By point position, the pixel center of a geocoded original (or oversampled) SLC pixel is meant. For DS(-like) points, the pixel center is the pixel center of one of the included pixels that is closest to the weighted or mean position of the included pixels.

5 Information Sources

The SAR input data will be provided at the start of the project. Before the start of the project, the contracting party provides the items in section 5.1, (parts of) which are required for the project. Section 5.2 lists auxiliary sources which could augment the data during or after processing.

5.1 Auxiliary Information

5.1.1 Area of Interest

Polygons of the area of interest(s) (AOI) and polygons of the objects within the AOI will each be delivered as a GeoPackage[2] (.gpkg). The individual object polygons are necessary for the generation of level 3 data and they each have a unique ID.

5.1.2 Object Information

Phase unwrapping and decomposition of the line of sight during the level 2 and level 3 data processing, respectively, benefit from a-priori information on the behavior of an object under normal circumstances. Additional object information is provided via an annex which 1) provides the contractor with a *starting point* to tailor and improve the processing to the project goal(s) and 2) lists processing requirements for different object types.

5.2 Auxiliary Sources

5.2.1 Aerial Imagery Data

- Aerial imagery, recorded annually with national coverage and a resolution of 8 or 25 cm, is available via *Beeldmateriaal* and can be found at https://opendata.beeldmateriaal.nl/.

5.2.2 Elevation Data

- Dutch height (surface and terrain) models and the original point clouds of the Netherlands is available via the Actueel Hoogtebestand Nederland (AHN) and can be found at https://www.ahn.nl/.

5.2.3 Topographic/Geographic Data

- Detailed infrastructure vector data is available within the *Digitaal Topografisch Bestand* (DTB). The DTB is often used to define the level 3 polygons for the decomposition of vertical and horizontal deformation. The DTB viewer and data are available via https://geoweb.rijkswaterstaat.nl/ModuleViewer/?app=1c8c833022c04e63a0f74533c19a6a27 and https://www.pdok.nl/ogc-webservices/-/article/digitaal-topografisch-bestand-dtb-, respectively.

[2] GeoPackage: https://www.geopackage.org/

5.2.4 *Meteorological Data*

- The Royal Netherlands Meteorological Office[3] (KNMI) publishes station data. Daily data is accessible via https://www.knmi.nl/nederland-nu/klimatologie/daggegevens.

5.2.5 *(Sub)surface Data*

- A collection of sources from the Netherlands Geological Survey[4] (GDN) is available at https://www.geologischedienst.nl/producten/ and includes geological, ground mechanical and hydrological data.

5.2.6 *Traffic Data*

- Coarse traffic intensity data for the Dutch national freeways is available through Statistics Netherlands[5] (CBS) at https://research.cbs.nl/verkeerslus/.

5.2.7 *Corner Reflector Data*

- Rijkswaterstaat maintains corner reflectors nationwide for the quality control of radar data. The positions of these corner reflectors are available via https://downloads.rijkswaterstaatdata.nl/rws_hoekreflectoren/.

---

[3] Koninklijk Nederlands Meteorologisch Instituut: https://www.knmi.nl/over-het-knmi/about
[4] Geologische Dienst Nederland: https://www.geologischedienst.nl/
[5] Centraal Bureau voor de Statistiek: https://www.cbs.nl/

6 Appendix

6.1 Coordinate Transformation

The coordinate transformation from EPSG:4326 to EPSG:7415 may not be trivial. It is advised to first assume the latitude and longitude of EPSG:4326 equal to the latitude and longitude of EPSG:4937. This is called a null-transformation. Secondly, EPSG:4937 could be transformed to EPSG:7415 with RDNAPTRANS™[6]. You can find more information on this transformation in Dutch on Geostandaarden.nl.

6.2 InSAR Deformation Data Structure and Content

The deformation data is stored as a GeoPackage[7] (version 1.4.0 or later) with valid geometries only. The geometry column of the GeoPackage is based on the X, Y, Z coordinates in EPSG:7415 for level 2 data and on X, Y coordinates in EPSG:28992 for level 3 data. Each InSAR deformation data product is stored in a separate GeoPackage file with the layer name equal to the filename without extension.

The InSAR deformation data is stored in vector format with attribute columns. The attribute columns are ordered, starting with an index number (fid) and a unique point or polygon ID (of data type SMALLINT or MEDIUMINT) followed by the attributes in Table 1 through Table 6 (in order). More specifically:

- For the level 2 (point) data the attributes from Table 1, Table 2, Table 3 and Table 6 must be used*. Table 4 and Table 5 are omitted.*
- For the level 3 (polygon) data with the line of sight deformations Table 2, Table 4 and Table 6 must be used. *Table 1, Table 3 and Table 5 are omitted.*
- For the decomposed level 3 (polygon) data Table 5 and Table 6 must be used, where Table 6 is used twice, once for the vertical and once for the horizontal deformations. *Table 1 through Table 4 are omitted.*

6.2.1 Positional Information

Table 1 Positional information.

Description	Attribute name	Unit [range] (context)	Data type
Latitude in ETRS89	latitude	decimal degree[-90,90]	DOUBLE
Longitude in ETRS89	longitude	decimal degree [0,360>	DOUBLE
Ellipsoidal height in GRS80h	height	meter	DOUBLE
X coordinate in EPSG:7415	rd_x	meter	DOUBLE
Y coordinate in EPSG:7415	rd_y	meter	DOUBLE
Z coordinate in EPSG:7415	rd_h	meter	DOUBLE
Range coordinate in original SLC image	pixel	pixels [0,-> (ascending with time)	(MEDIUM)INT
Azimuth coordinate in original SLC image	line	pixels [0,-> (ascending with time)	(MEDIUM)INT

[6] NSGI (RDNAPTRANS™, in Dutch): https://www.nsgi.nl/coordinatenstelsels-en-transformaties
[7] OCG GeoPackage: https://www.geopackage.org/spec/

6.2.2 *Observational Geometry Information*

Table 2 Observational geometry information.

Description	Attribute name	Unit [range] (context)	Data type
Local incidence angle	incidence_angle	decimal degree [0,90]	DOUBLE
Satellite track angle	track_angle	decimal degree [0,360>	DOUBLE
LoS in Northern direction	los_north	[-1,1]	DOUBLE
LoS in Eastern direction	los_east	[-1,1]	DOUBLE
LoS in Up direction	los_up	[0,1]	DOUBLE

6.2.3 *Scattering Point Quality Information*

Table 3 Scattering point quality information.

Description	Attribute name	Unit [range] (context)	Data type
Amplitude Dispersion	amplitude_dispersion	[0,->	DOUBLE
Temporal Coherence	temporal_coherence	[0,1]	DOUBLE
Height estimation uncertainty	height_std	meter [0,->	DOUBLE
Number of neighbors	no_neighbours	[0,-> (0 for PS point)	(MEDIUM)INT
Scattering type	mp_type	0 for PS, 1 otherwise	(MEDIUM)INT

6.2.4 *Scattering Point Quality Information*

Table 4 Polygon quality information.

Description	Attribute name	Unit [range] (context)	Data type
Number of scatterers	no_points	[0,->	(MEDIUM)INT
Measurement uncertainty per time step in line of sight	los_time_step_std	[0,->	DOUBLE
Additional quality indicators	*	[0,->	DOUBLE

6.2.5 *Decomposition Point Quality Information*

Table 5 Decomposition point quality information.

Description	Attribute name	Unit [range] (context)	Data type
Number of scatterers used per track	no_points_[track]	[0,->	(MEDIUM)INT
Measurement uncertainty per time step in the vertical	ver_time_step_std	[0,->	DOUBLE
Measurement uncertainty per time step in the horizontal	hor_time_step_std	[0,->	DOUBLE
Horizontal deformation direction	hor_direction	decimal degree [0, 360> (azimuth w.r.t. the positive rd_y axis)	DOUBLE
Vertical deformation direction	ver_direction	decimal degree [0, 90> (tilt w.r.t. the positive rd_h axis)	DOUBLE
Additional quality indicators	*	[0,->	DOUBLE

6.2.6 *Deformation Summary Information*

Table 6 Deformation summary information. The substring '[dir]' should be replaced by 1) 'los' for deformations in the line of sight direction 2) 'ver' for deformations in the vertical direction or 3) 'hor' for deformations in the horizontal direction.

Description	Attribute name	Unit [range] (context)	Data type
Deformation velocity	[dir]_mean_velocity	mm/yr	DOUBLE
Deformation acceleration	[dir]_acceleration	mm/yr^2	DOUBLE
Seasonal amplitude	[dir]_seasonality	mm [0,-> (from annual periodicity)	DOUBLE
Seasonal phase	[dir]_seasonality_phase	days [0, 365] (from annual periodicity, days to peak amplitude from January 1st)	DOUBLE

Deformation velocity standard deviation	[dir]_mean_velocity_std	mm/yr [0,->	DOUBLE
Deformation acceleration standard deviation	[dir]_acceleration_std	mm/yr^2 [0,->	DOUBLE
Seasonal amplitude standard deviation	[dir]_seasonality_std	mm [0,-> (from annual periodicity)	DOUBLE
Seasonal phase standard deviation	[dir]_seasonality_phase_std	days [0,-> (from annual periodicity)	DOUBLE
Root Mean Square Error of model fit	[dir]_rmse	mm [0,->	DOUBLE
Relative decomposed LoS elevation estimate*	[dir]_YYYYMMDDThhmmss	mm (w.r.t. first acquisition, datetime in UTC[8])	DOUBLE
Time series jump position(s), i.e. index	[dir]_index	[0,-> (comma-separated list of indices, zero-based numbering)	TEXT

* this attribute is repeated for each measurement.

Invalid or omitted values must be stored with the native GeoPackage NULL value[9]. Any additional attributes not listed in Table 1 through Table 6 may be added to the end of the (most) relevant table.

The (MEDIUM)INT data type refers to the use of the GeoPackage MEDIUMINT or larger integer data type.

Floating point data may not be rounded in the final stage of the post-processing, or data export step.

6.3 InSAR Documentation Structure and Content

The project report and the quality report are required per object or area of interest. The project report and the quality report are delivered in .pdf format[10] with searchable text and working links.

6.3.1 Figure Formatting

The project report and quality report contain figures for the visualization of the results. For a clear and unambiguous interpretation, the figures must have:

1. a title;
2. a caption (below the figure in the report) with a unique figure number;
3. each subfigure labelled;
4. a minimum font size of 12 points;
5. 300 DPI and dimensions of at least 16 cm (width) by 12 cm (height);
6. a colorblind safe and consistent color scheme across all figures;
7. meaningful value ranges along its axes (e.g. no negative values for standard deviations);

[8] Coordinated Universal Time: https://en.wikipedia.org/wiki/Coordinated_Universal_Time
[9] GeoPackage: https://www.geopackage.org/spec/
[10] Portable Document Format: https://en.wikipedia.org/wiki/PDF

8. consistent axes (i.e. the same axes for different figures with the same parameters on display) and distance axes in meters;

9. relevant aerial imagery as the base layer for spatial figures and sub grid for non-spatial figures.

Each individual figure must also be exported to an individual file in .jpg format[11] (for figures with an aerial image) or in .png format[12] (for figures without an aerial image). The figure name contains the same number (with added leading zeros) as in the corresponding document figure caption. These exported figures at least have 300 DPI and dimensions of 12 cm (width) by 12 cm (height).

6.3.2 Project Report Structure and Content

Project Report	
Summary	Concise summary outlining the actions taken, key findings, and notable highlights (about 150 words).
Background	
1. Introduction	Project context and objective.
2. Project Area	Map with area with individual objects.
3. Processing Method	General description of the applied InSAR processing highlighting its possibilities and limitations.
Results and Interpretation	
1. Findings	• A description of the horizontal and vertical deformations and deformation uncertainties supported by figures (maps and graphs) (see section 6.3.1 for the object visualization guidelines). • Based on the observed horizontal and vertical deformations, describe and visualize consistent and common behavior in time and space. Include the model parameter results (see Table 6) in this discussion. • Formulate a hypothesis regarding the primary factor(s) contributing to the common deformation behavior.
2. Highlights	• Based on the observed horizontal and vertical deformations, describe and visualize anomalous behavior in time and space. This is highlighted in new figures or in figures from the previous section (see section 6.3.1 for the object visualization guidelines). Include the model parameter results (see Table 6) in this discussion. • Discuss significant (spatial and temporal) discontinuities, misfits, unwrapping errors and unexpected output and behavior. • Formulate a hypothesis regarding the primary factor(s) contributing to the anomalous deformation behavior.
Conclusion	
	List of conclusions supported by the results chapter, presenting a brief: • description of objects with common and consistent behavior; • description of objects with anomalous behavior; • summary of implications for the objects.

[11] Joint Photographic Experts Group: https://en.wikipedia.org/wiki/JPEG
[12] Portable Network Graphics: https://en.wikipedia.org/wiki/PNG

6.3.3 Quality Report Structure and Content

Quality Report	
Abbreviations	List of definitions and abbreviations.
Summary	Brief summary describing the purpose of this document within the project context (about 100 words).
Input Data	
1. SAR Image Stack(s)	Summary of all used SAR data in the project • Figure with all track polygons. • Figure with all acquisitions per track. • Figure or table with average perpendicular baselines (e.g. baseline plot). • Figure or table with average viewing geometry per track.
2. Reference Data	• Figure with reference points for vertical (line of sight) reference. • Figure with reference points for horizontal (range/azimuth) reference.
3. Auxiliary Data	• Figure with the extent for raster data or position for vector data the used auxiliary data set(s) with relevant details. • Table with details for any other used datasets not indicated above.
Processing Methods	
1. Referencing	• Description of reference point selection, use and impact. • Description of co-registration of SAR images and alignment of the full stack in range and azimuth with reference points on the ground.
2. Level 2 Processing	• General description of level 2 processing. • Description of any additional processing steps or adjustments that deviate from the general processing steps. • Description of how the technical requirements for the processing of level 2 data are fulfilled.
3. Level 3 Processing	• General description of level 3 processing. • Description of any additional processing steps or adjustments that deviate from the general processing steps. • Description of how the technical requirements for the processing of level 3 data are fulfilled.
Quality Description	
1. Reference	Derivation and presentation of the quality of the geolocation and deformation reference, including: • Uncertainty of individual time steps of the reference deformation time series • Uncertainty of the range and azimuth locations of the SAR image.
2. Level 2 Products	Derivation and presentation of the quality of the level 2 products, including: • A description of the origins and impacts of uncertainties for different spatial scales. • Uncertainty of individual time steps in level 2 time series related to the point quality parameters. • Standard deviation of estimated model parameters.
3. Level 3 Products	Derivation and presentation of the quality of the level 3 products, including: • A description of the origins and impacts of uncertainties for different spatial scales. • Uncertainty of individual time steps in level 3 time series related to the polygon quality parameters. • Differences in uncertainties between horizontal and vertical time series due to the observation geometry (e.g. satellite viewing angles) and decomposition. • Standard deviation of estimated model parameters.
Assumptions and Limitations	List of important assumptions made in processing chain and how they influence 1) the results and 2) the conclusion(s). List of limitations of the chosen processing methods.
Recommendations	List of recommendations for similar future projects.
Appendix	
1. Attributes	List of newly introduced data attributes in the level 2 and level 3 data products with a brief explanation and motivation.
2. References	List of references and relevant literature.

6.4 Data Integrity

We require a MD5 checksum[13] for each InSAR deformation product, document and figure. The checksums must be listed with the corresponding filename on each line a .txt file (*md5sums_v${ve}.txt*, see section 6.5).

It is possible that a delivery may not meet the technical requirements. In that case new delivery could take place. The new delivery must have new, increased, version number. The used version numbers and corresponding changes are stored to a .txt file (*versions_${ve}.txt*, see section 6.5). For the first delivery, the version number is 10 and the description is simply: "*Initial delivery*".

6.5 Delivery Structure and Naming Convention

The following folder and file structure and naming is required for a single area of interest within the project description:

```
${name}_${contractor}_v${ve}
├── md5sums_v${ve}.txt
├── versions_v${ve}.txt
├── doc
│   ├── projectreport_${name}_v${ve}.pdf
│   └── qualityreport_${name}_v${ve}.pdf
├── fig
│   ├── figure_projectreport_n${no}_v${ve}.png
│   ├── …
│   ├── figure_projectreport_n${no}_v${ve}.jpg
│   ├── figure_qualityreport_n${no}_v${ve}.png
│   ├── …
│   └── figure_qualityreport_n${no}_v${ve}.jpg
├── data
│   ├── footprints
│   │   ├──footprints_${st}_${od}_v${ve}.gpkg
│   │   ├── …
│   │   └──footprints_${st}_${od}_v${ve}.gpkg
│   └── aoi
│       └──aoi_${name}_v${ve}.gpkg
└── results
    ├── deformation_${lv}_${st}_${od}_${tr}_${ty}_v${ve}.gpkg
    ├── …
    └── deformation_${lv}_${st}_${od}_${tr}_${ty}_v${ve}.gpkg
```

Folder structure for a single area of interest. Each variable must be replaced by a single value (per folder structure), see Table 7 for more information.

Each footprint file contains one polygon with the corners of each co-registered SAR stack.

Information about the *md5sums_v${ve}.txt* and the *versions_v${ve}.txt* files can be found in section 6.4. The *doc* folder contains the project and the quality report. Information about the figures in the *fig* folder can be found in section 6.3.1. The *data* folder contains 1) the *footprint* folder with a radar stack footprint (polygon) for a single track in each file and 2) the *aoi* folder with the area of interest (polygon) for the level 2/3 results, which are stored in the *results* folder.

[13] MD5 check sum: https://en.wikipedia.org/wiki/Md5sum

Note that PS(-like) and DS(-like) points must be stored to separate vector files. The ${…} indicates a variable name, whose representation can be found below (Table 7). The required format is given in the right-most column with the imposed (Python[14] 3) regular expression between brackets.

Table 7 Naming convention. The last two rows (indicated with a *) are only in use for the .zip file.

Variable	Meaning	Example (required format[15])
`${name}`	Name (e.g. name of object or area of interest)	(^\w{3,12}$)
`${contractor}`	Contractor name	(^\w+$)
`${st}`	Satellite name or sensor name	Sentinel1A (^\w+$)
`${lv}`	Product level	l2 (^l\d$)
`${od}`	Orbit direction	ascending (^(asc|desc)$)
`${tr}`	Track	track012 (^track\w+$)
`${ty}`	Point type	ps (^(ps|ds|na)$)
`${no}`	Figure number	003 (^\d{3}$)
`${ve}`	Version	10 (^\d{2}$)
`${project_name}`	Project name*	Tunnels (^\w{3,12}$)
`${date}`	Delivery date in YYYYMMDD (ISO 8601[16])*	20250331 (^\d{8}$)

All (one or more) folder structures are archived to a single .zip file[17], with the top level folders side by side in the top level of the archive.

The .zip filename is set as *Delivery_RWS_by_${contractor}_${project_name}_${date}.zip*

[14] Python: https://www.python.org/
[15] Python regular expression; see https://docs.python.org/3/howto/regex.html for more information.
[16] ISO 8601 (date time format): https://en.wikipedia.org/wiki/ISO_8601
[17] ZIP file format: https://en.wikipedia.org/wiki/ZIP_(file_format)