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NGA STANDARDIZATION DOCUMENT

Implementation Profile

for

High Resolution Elevation (HRE) Products

Specification of the data content, structure and metadata
for raster elevation data products

(2009-10-23)

Version 1.0

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TBD/TBR Listing

Page #	TBD/TBR	Description
91-93	TBD	Description of coverage class of features not included in current version of NSG Entity Catalog

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Foreword

Overview

The Implementation Profile for High Resolution Elevation (HRE) Products describes the data content, structure and metadata requirements required to create a suite of raster elevation data products. These products are defined within this document as a set of spatial resolution layers and are named High Resolution Elevation (HRE) data. HRE data is intended for a wide variety of National Geospatial-Intelligence Agency (NGA) and National System for Geospatial Intelligence (NSG) partners and members, and customers external to the NSG, to access and exploit standardized data products. HRE data replaces the current non-standard High Resolution Terrain Elevation/Information (HRTE/HRTI) products and also replaces non-standard products referred to as DTED level 3 thru 6. This profile is not intended to replace standard DTED 0, 1 and 2 products which will continue to be supported by NGA.

The intent of this profile is to increase the level of interoperability with and between organizations producing and using topographic elevation data within the elevation community of interest. The elevation data described in this implementation profile is typically used for mission planning, terrain modeling and other related applications. Elevation data is often fused with other Geospatial products to provide enhanced visualization capabilities for analysts and mission planners.

1. Scope

The Implementation Profile for High Resolution Elevation (HRE) Products has been developed by NGA to support the requirement for a uniform, orthogonal grid-based geospatial elevation topographic model for a wide range of geospatial resolutions. The profile specifies the content, structure, and format for NGA gridded topographic (land) elevation datasets in support of data discovery, access, processing, exploitation, and exchange.

The Implementation Profile for High Resolution Elevation (HRE) Products is an integral part of the overall NGA elevation strategy to adopt a two-tiered architecture. This architecture enables storage and accessibility of native format high resolution data from a variety of sources that can then be used to create a suite of standard elevation product layers for the traditional geospatial customer. These standard products are addressed by this profile. This architecture will also enable customers within the NSG to access and exploit the native format data to create custom products for specific intelligence/application requirements. These custom products may or may not be addressed by this profile depending on the mission specific nature of the requirement.

This profile defines the elevation data content and structure, spatial resolution, format, accuracy and metadata for HRE data. HRE data share a common file format and encoding, common quality/accuracy definitions, as well as common metadata elements. The profile is designed primarily for a bare earth or reflective surface models. It does not address the design or implementation of a database to store native format data.

This profile is authored and maintained by NGA and will be reviewed on a periodic basis and updated in concert with advances in technology and subsequent advances in data sources and production capabilities.

2. Conformance

Any application or system claiming conformance for generating data in compliance with this implementation profile shall meet the following criteria for data conformance.

2.1. File Format

The data file format and structure is as specified by NITF version 2.1, and as further constrained by this profile. The data complies with the NITF version 2.1 compliance criteria specified in NGA document, N0105 - National Imagery Transmission Format Standard (NITFS) Standards Compliance and Interoperability Certification Test and Evaluation Program Plan, that pertain to the NITFS features, options and capabilities selected for use in this profile.

2.2. Completeness

All field values and data elements defined as mandatory (required) are present and populated with meaningful values as defined by the profile. All field values and data elements defined as conditional are present, and meaningfully populated, when the conditions described in the profile apply.

2.3. Maximum occurrence (all levels of obligation)

Each field value and data element occurs no more than the number of times specified.

2.4. Data Type (all levels of obligation)

The value of each provided field value and data element adheres to the data type specified.

2.5. Domain (all levels of obligation)

The values of each field value and data element fall within the specified domain.

2.6. Schema (XML-instance data only, all levels of obligation)

Each data element is contained within the specified schema entity.

Note 1: Minimum conformance requires that the supplemental metadata instance (XML) documents can be validated without error against the XML schemas defined by this profile. While many tools are available to test validation of XML instance documents against provided XML Schemas, it is important to understand that not all validation tools implement the full W3C XML Schema recommendation and not all validation tools interpret the W3C XML Schema recommendation in the same manner. It is recommended that a tool with strict interpretation of XML Schema and full support for the W3C XML Schema recommendation be used to ensure conformance.

Note 2: Validation of XML instance documents against the schemas described in this document is not all that is required for conformance to this profile. A property element is designed to have content (by-value) or attributes (by-reference or NULL with reason). However, because of the design, the property element may have no content or attributes, or it may have both content and attributes and still be XML Schema-valid. It is not possible to constrain the co-occurrence of content or attributes. Some mechanism in addition to an XML

Schema validation must be used to restrict a property to be exclusively by-value, or by-reference, or expressing a NULL reason.

Note 3: XML Schema does not support the enforcement of certain types of constraints documented in this profile. For example, conditional constraints to force selection of one or more items from a list of optional items are not always enforceable within XML schema. Neither are co-constraints enforceable such as requirements to include elements based on values contained in other elements. These conditions must be evaluated through inspection.

2.7. Horizontal Accuracy

Datasets conform to the predefined thresholds (Tables 8-1 and 8-2) for horizontal accuracy. An absolute horizontal accuracy estimate is reported for each dataset.

2.8. Vertical Accuracy

Datasets conform to the predefined thresholds (Tables 8-3 and 8-4) for vertical accuracy. An absolute vertical accuracy estimate is reported for each dataset.

2.9. Production Specific Guidance

When production specific guidance is provided, dataset content complies with the provisions of the guidance.

3. Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

- ISO 19107:2003 Geographic information – Spatial schema
- ISO 19115:2003 Geographic information - Metadata
- ISO 19115-2:2008 Geographic information - Metadata: Extensions for imagery and gridded data
- ISO 19123:2005 Geographic information - Schema for coverage geometry and functions
- ISO 639-2:1998 Codes for the representation of names and languages
- MIL-STD-2500C National Imagery Transmission Format Version 2.1
- STANAG 4545, NATO Secondary Imagery Format (NSIF)
- STANAG 7074, Digital Geographic Information Exchange Standard (DIGEST)

4. Terms and definitions

4.1. Terms and definitions

4.1.1. Absolute Horizontal Accuracy

Statistical evaluation of all random and systematic errors encountered in determining the horizontal position of a single data point with respect to a specified geodetic horizontal reference datum, expressed as a circular error at the 90 percent probability level (CE90). [adapted from DMA-TR-8400.1].

4.1.2. Absolute Vertical Accuracy

Statistical evaluation of all random and systematic errors encountered in determining the elevation of a single point with respect to a vertical reference datum, expressed as a linear error at the 90 percent probability level (LE90). [adapted from DMA-TR-8400.1].

4.1.3. Accuracy

Closeness of agreement between a test result and the accepted reference value.
[ISO19113]

4.1.4. Continuous Coverage

Coverage that returns different values for the same feature attribute at different direct positions within a single spatial object, temporal object, or spatiotemporal object in its domain.
[ISO 19123]

4.1.5. Coordinate

One of a sequence of numbers designating the position of a point in N-dimensional space.
[ISO 19111]

4.1.6. Coordinate Reference System

Coordinate system which is related to the real world by a datum.
[ISO 19111]

4.1.7. Coverage

A feature that acts as a function to return values from its range for any direct position within its spatial, temporal, or spatiotemporal domain.
[ISO 19123]

Examples include a digital image, polygon overlay, or digital elevation matrix.

NOTE: In other words, a coverage is a feature that has multiple values for each attribute type, where each direct position within the geometric representation of the feature has a single value for each attribute type.

4.1.8. Data Compression

Compression reduces the amount of storage space required to store a given amount of data, or reducing the length of message required to transfer a given amount of information.
[ANS T1.523-2001]

4.1.9. Dataset

Identifiable collection of data.
[ISO 19115:2003]

4.1.10. Direct Position

Position described by a single set of coordinates within a coordinate reference system.
[ISO 19107]

4.1.11. Elevation

Distance measured along a plumb line between a point and the geoid, upward is positive (+), downward is negative (-).

NOTE The elevation of a point is normally the same as its orthometric height. This is the “official” geodesy definition of elevation, but the term “elevation” is also used more generally for height above a specific vertical reference, not always the geoid.

4.1.12. Feature

Abstraction of real world phenomena.
[ISO 19101]

4.1.13. Feature Attribute

Characteristic of a feature.
[ISO 19109]

NOTE: A feature attribute type has a name, a data type and a domain associated to it. A feature attribute instance has an attribute value taken from the value domain of the feature attribute type.

4.1.14. Geometric Object

Spatial object representing a set of direct positions.
[ISO 19107]

NOTE: A geometric object consists of a geometric primitive, a collection of geometric primitives, or a geometric complex treated as a single entity. A geometric object may be the spatial characteristics of an object such as a feature or a significant part of a feature

4.1.15. Grid

Network composed of two or more sets of curves in which the members of each set intersect the members of the other sets in a systematic way.
[ISO 19123]

NOTE: The curves partition a space into grid cells.

4.1.16. Grid Point

Point located at the intersection of two or more curves in a grid.
[ISO 19123]

4.1.17. Height

Distance of a point from a chosen reference surface measured (upward +, downward -) along a line perpendicular to that surface.

NOTE: Height is distinguished from elevation in that it is a directional measurement.

4.1.18. Point

0-dimensional geometric primitive, representing a position.
[ISO 19107]

4.1.19. Predicted Error

Measure of the likely error at a point, often assumed (but not required) to be normally distributed in nature and often provided as a variance (1-D case) or covariance matrix (otherwise).

4.1.20. Random Error

Random errors are those not classified as blunders, systematic errors, or periodic errors. They are numerous, individually small, and each is as likely to be positive as negative. [MIL-HDBK 850]

4.1.21. Random Horizontal Error

Combination into a 2D error of variations remaining observable in the x and y components of the HRE dataset after blunders, biases, and systematic errors have been accounted for.

$$\text{Random HE} = \left[\left((X_{\text{meas}} - \mu_{\Delta X}) - X_{\text{true}} \right)^2 + \left((Y_{\text{meas}} - \mu_{\Delta Y}) - Y_{\text{true}} \right)^2 \right]^{1/2}$$

4.1.22. Random Vertical Error

Variations remaining observable in the vertical component of the HRE dataset after blunders, biases, and systematic errors have been accounted for.

$$\text{Random VE} = (Z_{\text{meas}} - \mu_{\Delta Z}) - Z_{\text{true}}$$

4.1.23. Record

Finite, named collection of related items (objects or values).
[ISO 19107]

NOTE: Logically, a record is a set of pairs <name, item >.

4.1.24. Relative Accuracy

Evaluation of the random errors in determining the position of one point or feature with respect to another.

[adapted from MIL-HDBK 850]

4.1.25. Relative Horizontal Accuracy

Statistical evaluation of all random errors encountered in determining the horizontal position of one data point with respect to another, expressed as a circular error over a specified distance at the 90 percent probability level. [adapted from DMA-TR-8400.1]

4.1.26. Relative Vertical Accuracy

Statistical evaluation of all random errors encountered in determining the elevation of one data point with respect to another, expressed as a linear error over a specified distance. [adapted from DMA-TR-8400.1]

4.1.27. Tessellation

Partitioning of a space into a set of conterminous geometric objects having the same dimension as the space being partitioned.

[ISO 19123]

4.1.28. Vector

Quantity having direction as well as magnitude.

[ISO 19123]

NOTE: A directed line segment represents a vector if the length and direction of the line segment are equal to the magnitude and direction of the vector. The term vector data refers to data that represents the spatial configuration of features as a set of directed line segments.

4.2. Symbols and abbreviated terms

CE90 – Circular Error measured at the 90% confidence interval.

DEM – Digital Elevation Model

DSM – Digital Surface Model

DTEM – Digital Terrain Elevation Model

EGM - Earth Gravitational Model

ETS – Executable Test Suite

HRE – High Resolution Elevation data

HREGP – High Resolution Elevation Geographic Projection
(see Section 5.4)

HRE80-HRE01 – High Resolution Elevation Universal Transverse Mercator Projection
(see Section 5.4)

LE90 – Linear Error measured at the 90% confidence interval.

LSB – Least Significant Bit

MSB – Most Significant Bit

MSL – Mean Sea Level

NITF – National Imagery Transmission Format

UTM - Universal Transverse Mercator coordinate system

WGS-84 – World Geodetic System 1984

5. Data Content and Structure

The High Resolution Elevation (HRE) data structure is a uniform, orthogonal grid-based geospatial elevation topographic model. The Implementation Profile for High Resolution Elevation (HRE) Products supports a wide range of geospatial resolutions. The profile supports geographic (HREGP) and Universal Transverse Mercator projections (HRE80-HRE01), multiple

spatial resolutions, and multiple elevation data coverages where the various coverages allow for different surface classifications, such as reflective surface or bare earth.

5.1. Grid Structure

A grid structure is the most common geospatial data model used for modeling topographic elevation data. The HRE grid structure is represented by a collection of regularly or uniformly spaced points as shown in Figure 5.1. This structure provides several advantages over other types of elevation geospatial data models in that a regular spacing of elevation points requires that only one elevation point be referenced to a horizontal coordinate. From this one point and its horizontal coordinate value and the ground sampling distance (GSD) between grid elevation points, the horizontal coordinate values of all other points can be determined. This eliminates the need to explicitly define the horizontal coordinate values of each elevation point and helps to minimize file size. The grid structure is also an efficient structure for data processing.

Within a HRE dataset, only one grid spatial resolution will be represented. The grid point locations for each elevation value are fixed within the coordinate system. The minimum grid sampling distance (see Table 5.1 and Table 5.2) should be chosen to most efficiently represent the resolution of the source native dataset. Grids may not model all terrain features smaller or narrower than the grid spacing when the feature lies between grid points.

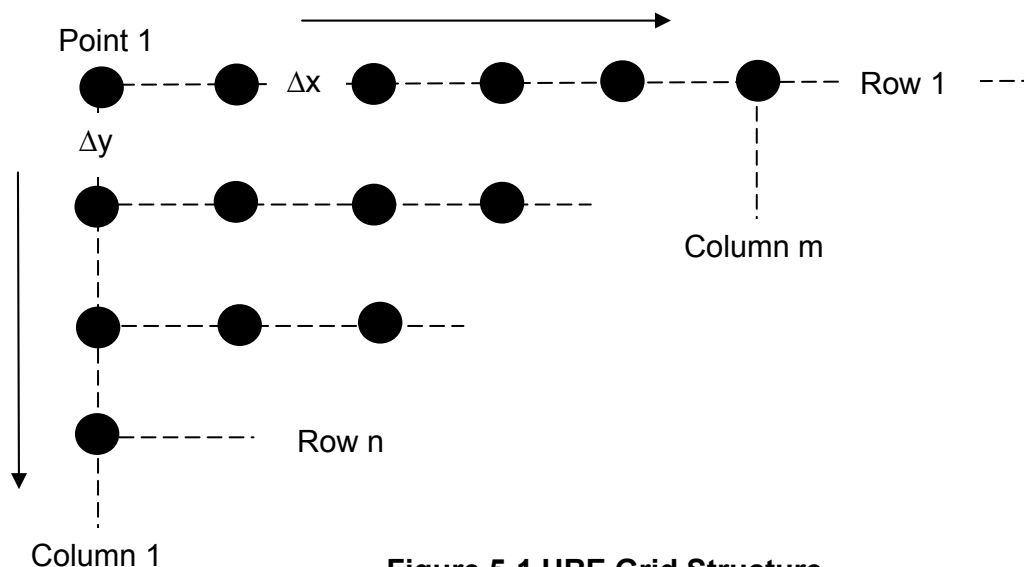


Figure 5-1 HRE Grid Structure

HRE grid records are structured in row major order such that the sequential order of the data within each record comprises a row of data for which the horizontal coordinates of each elevation point for that row has the same northing coordinate value. The records are sequenced north to south (1 to n) by a distance Δy , such that the first record in the dataset is the northern most row and subsequent records are the rows sequentially ordered to the south. The first elevation point value in a record is the western most elevation point for that row / record with subsequent elevation point values progressing west to east a distance Δx . The last elevation

point value in the dataset is the elevation point in the southeastern most location. See Figure 5.1 – HRE Grid Structure.

5.2. Grid Point Coordinate locations

HRE grid points are 0-dimensional geometric primitives representing a coordinate location that is defined by the intersections of the curves that make up the grid.

HRE grid point coordinate locations shall adhere to a set of predefined elevation point locations within the horizontal coordinate reference system. This is to ensure points from different datasets with overlapping horizontal spatial extents are horizontally coincident.

5.2.1. Geographic Point Locations

For geographic data the predefined reference origin is the elevation point at the southwest corner elevation point of the one degree cell in which the southwest corner of the HREGP data is located. The origin must be evenly divisible by the GSD (.4 arc seconds) to ensure alignment between datasets. If the point spacing is specified as $\{\Delta\phi, \Delta\lambda\}$ and the southwest corner of dataset with which it is associated is $\{\phi, \lambda\}$ then point location coordinates will be defined at $\{\phi + j*\Delta\phi, \lambda + i*\Delta\lambda\}$ [NOTE: the data are stored in row/column order – see B.1.8] The values i and j are integer values of points in the Longitude and Latitude direction (respectively), $+i*\Delta\lambda$ signifies an easterly direction from the origin and $+j*\Delta\phi$ signifies a northerly direction from the origin. See Figure 5.2 – Example of geographic projected point locations.

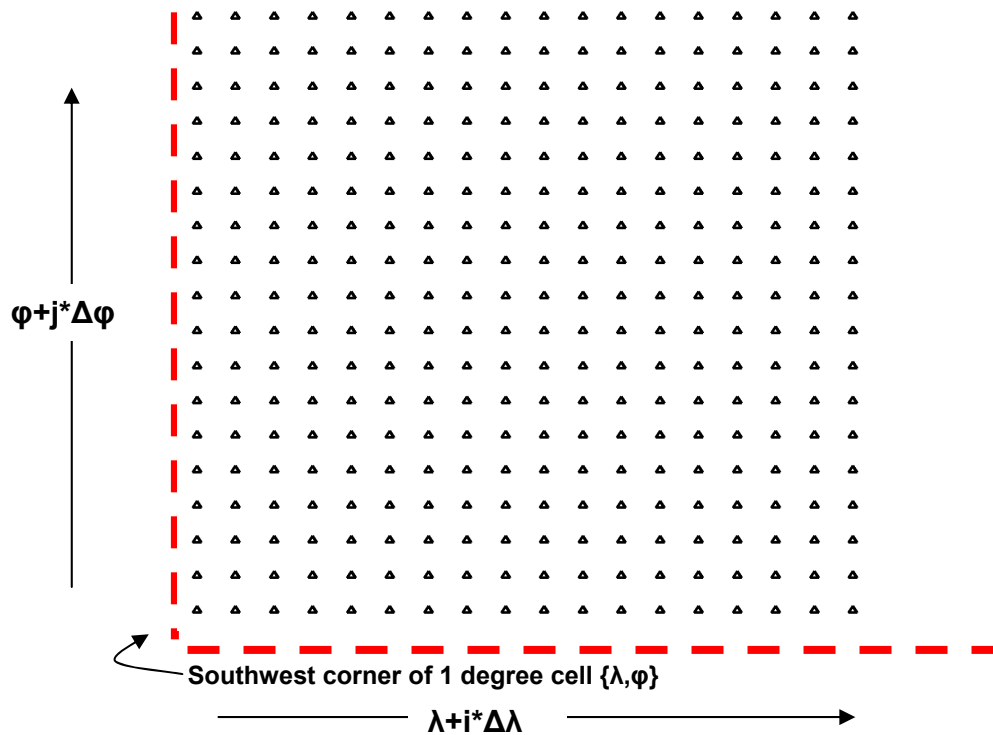


Figure 5-2 Example of Origin and Point Locations for Geographic Data

5.2.2. UTM Point Locations

For a HRE data file, the reference origin for UTM products will be the origin of the UTM zone in which the HRE data is located. UTM zone origins are specified by the intersection of the UTM zone central meridian with the equator. This intersection is assigned the UTM coordinates 500000.0 E, 0.0 N for zones in the northern hemisphere and coordinates 500000.0 E, 10000000.0 N for zones in the southern hemisphere. If the point spacing of a given HRE level is specified as $\{\Delta E, \Delta N\}$, then points for a HRE Level in the Northern hemisphere will be defined at $\{500000 \pm i \cdot \Delta E, 0 + j \cdot \Delta N\}$. The values i and j are integer values of points in the Easting and Northing direction (respectively), $+i \cdot \Delta E$ signifies an easterly direction from the central meridian, $-i \cdot \Delta E$ signifies a westerly direction from the central meridian, and $+j \cdot \Delta N$ signifies a northerly direction from the equator. In a similar fashion, points in the Southern hemisphere are specified by $\{500000 \pm i \cdot \Delta E, 10000000 - j \cdot \Delta N\}$, where i and j are integer values of points in the Easting and Northing direction (respectively), $+i \cdot \Delta E$ signifies an easterly direction from the central meridian, $-i \cdot \Delta E$ signifies a westerly direction from of the central meridian, and $-j \cdot \Delta N$ signifies a southerly direction from the equator [NOTE: the data are stored in row/column order – see B.1.8]. Adhering to this system will assure that coincident points are maintained across the various HRE levels within a zone. This will allow for direct comparison between datasets and direct decimation of high-resolution data to lower resolutions. See Figure 5.3 Example of UTM Point Locations in Northern Hemisphere

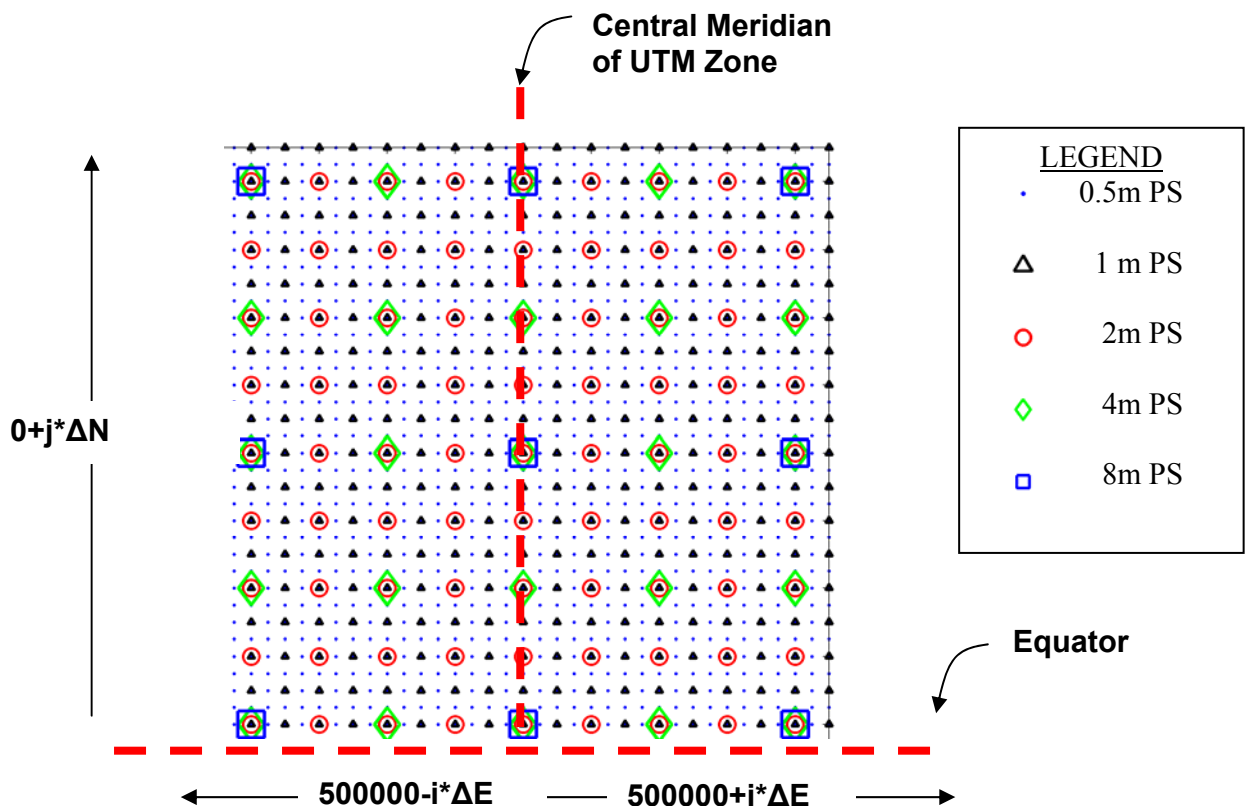


Figure 5-3 Example of UTM Point Location In Northern Hemisphere

Note that the various symbols represent different HRE levels, but illustrate collocated points.

5.3. Product Name/Level:

HRE data Product Names and Levels are associated with the dataset projection and spatial resolution. Table 5.1 identifies the 8 HRE levels and the associated product name.

5.4. Horizontal Spatial Extent and Projection

The horizontal spatial extent of HRE data vary based on a number of factors. These factors can include but are not limited to spatial resolution, geographic location, customer requirements and file size limitations (see Section 12.3 – File Size Estimates). Typically as the horizontal spatial resolution of the data set increases (points are closer together geographically) the horizontal spatial extent decreases in size.

- HREGP data are cast on a geographic projection and primarily cover large geospatial areas (nominally region sized). HREGP products are typically tiled to allow them to be joined into these large area configurations. HREGP dataset horizontal and vertical values will be horizontally and vertically coincident at the dataset edges. That is, the adjacent HREGP product coincident points horizontal coordinates and vertical elevation values will be the same.
- HRE80-HRE01 data are cast on the Universal Transverse Mercator projection and primarily cover localized area dataset extents. HRE80-HRE01 datasets are designed to be spatially contained within a single UTM zone. Adjacent datasets within one UTM zone will be horizontally coincident at the dataset edge but adjacent dataset in adjacent UTM zones will not be horizontally coincident at the dataset edge. Vertical elevation values may (not required) match across HRE80-HRE01 levels for the same geographic area or elevation point.

5.5. Horizontal Spatial Resolution

HREGP datasets have a horizontal spatial latitudinal resolution of 0.4 arc-seconds and a varying longitudinal resolution of 0.4 to 2.4 arc seconds based upon latitude (see Table 5.2). HRE80-HRE01 datasets have 7 levels of spatial resolutions; where in ascending HRE level order, the spatial resolution of a particular level is twice that of the previous level and in descending HRE level order, half that of the previous level (see Table 5.1 HRE Level Point Spacing). This enables horizontal coordinates for elevation to be consistent across HRE Levels. For the sake of clarity, the product names will be used throughout this document to distinguish the differences among the levels.

Table 5-1 HRE Level Point Spacing

Level	Product Name	Horizontal Grid spatial resolution	Horizontal Units
1	HREGP	0.4	arc-seconds
2	HRE80	8	meters
3	HRE40	4	meters
4	HRE20	2	meters
5	HRE10	1	meters
6	HRE05	0.50	meters
7	HRE02	0.25	meters
8	HRE01	0.125	meters

With convergence of meridians in higher latitudes, the longitudinal arc-second point spacing of the HREGP product varies as a function of latitude and is defined in five zones of latitude shown below in Table 5-2 HREGP Point Spacing

Table 5-2 HREGP Point Spacing

Zone	Latitude Range in Degrees	Latitudinal grid point spacing (arc seconds)	Longitudinal grid point spacing (arc seconds)
1	00-50 North-South	0.40	0.40
2	50-70 North-South	0.40	0.80
3	70-75 North- South	0.40	1.20
4	75-80 North-South	0.40	1.60
5	80-90 North-South	0.40	2.40

6. Elevation Values and Units

HRE elevation values will contain valid elevation values and may contain null (no-data) values.

6.1. Valid Elevation values

Valid elevation point values exist in geographic areas where the elevation point value can be accurately determined. For grid points with valid elevations, the data type will be specified in the Pixel Value Type (PVTTYPE) field in the HRE NITF Image Subheader. All numeric values are encoded in Most Significant Byte (MSB) first order known as the "big endian" convention.

- Valid elevation values for HREGP data shall be a signed 16 bit integer value. The PVTTYPE value shall be SI (Signed Integer) designating that the data values are encoded using 2's complement representation. The SI type indicates the data bits shall appear in the file in order of significance, beginning with the MSB and ending with the LSB.
- Valid elevation values for HRE80-HRE01 shall be a 32 bit floating point value. The PVTTYPE value shall be R. The data values shall be represented according to IEEE 32-bit floating point representation (IEEE-754).

6.2. Null Values

Null (No-Data) values are used for geographic areas when the elevation point values can not be accurately determined due to various factors, often related to source anomalies, metrological or topography related conditions. Reasons for Null Values may be because of image cloud cover, shadows or obscuration due to topographic conditions. The Null value, when used, will be specified in the NITF Image Data Mask Table, Pad Output Pixel Code (TPXCD) field in the HRE NITF Image Subheader for Elevation Data.

- Null values for HREGP data will be a signed 16 bit integer value encoded as hexadecimal 0x8001, decimal -32767.
- Null values for HRE80-HRE01 data will be an IEEE-754 floating point value encoded as hexadecimal 0xFFFFFFFF. This value is not in the range of valid IEEE-754 floating point numbers and is known as "Not a number" (NaN).

6.3. Vertical Units of Measure

The vertical unit of measure for HREGP elevation points shall be integer meters. The vertical unit of measure for HRE80-HRE01 shall be decimal meters. The unit of measure code 'M' will be specified in the Band Subcategory (ISUBCAT01) field in the HRE NITF Image Subheader.

7. Reference Datums

7.1. Horizontal Reference Datum

The Horizontal reference datum for HRE data shall be the World Geodetic System - WGS-84 and the specific epoch will be identified in metadata.

7.2. Vertical Reference Datum

The baseline vertical reference datum for all HRE data stored at NGA will be ellipsoid height as defined by WGS-84. HRE data may optionally be distributed to customers referenced to the current Earth Gravitational Model (EGM) implementation of WGS-84. Metadata will be populated to indicate the vertical reference system.

8. Data Quality

HRE data quality characteristics are defined by five factors: (1) point spacing, (2) random horizontal error per point, (3) relative horizontal accuracy between points, (4) random vertical error per point, and (5) the relative vertical accuracy between points. Additionally, goal levels for absolute horizontal and vertical accuracy have been established. The specifics of these accuracy requirements are provided in the following sections. Optional accuracy information for per point and regional error estimates are also provided in Section 14.4

8.1. Horizontal Accuracy:

HRE elevation datasets shall conform to the predefined thresholds for horizontal accuracy. Randomly selected datasets may be tested to assure that the random horizontal error per point and relative horizontal accuracy between points meets or exceeds the thresholds detailed in Table 8-1 and Table 8-2. Additionally, there is a goal that the absolute horizontal accuracy meet or exceed the values established in Table 8-1 HREGP Horizontal Accuracy Requirements and Table 8-2 HRE80-HRE01 Horizontal Accuracy Requirements. Although not required to meet a threshold requirement an absolute horizontal accuracy estimate will be reported for each data set.

Table 8-1 HREGP Horizontal Accuracy Requirements

Product name	Spatial resolution in arc seconds	Random Horizontal Error Per Point (σ_H – meters)	Relative Horizontal Accuracy Between Points (R_h – meters)	Goal: Absolute Horizontal Accuracy CE90 (meters)
HREGP	0.4	4.4	12.4	15.0

Table 8-2 HRE80-HRE01 Horizontal Accuracy Requirements

Product Name	Grid spatial resolution in meters	Random Horizontal Error Per Point (σ_H – meters)	Relative Horizontal Accuracy Between Points (R_h – meters)	Goal: Absolute Horizontal Accuracy CE90 (meters)
HRE80	8	2.83	8.00	10.00
HRE40	4	1.41	4.00	5.00
HRE20	2	0.71	2.00	3.00
HRE10	1	0.35	1.00	2.00
HRE05	0.50	0.18	0.50	1.00
HRE02	0.25	0.09	0.25	0.50*
HRE01	0.125	0.04	0.125	0.25*

Horizontal Accuracy notes:

1. The random horizontal error is the random circular error at point (reported at 90% confidence)
2. The Relative Horizontal Accuracy (point-to-point) between points is calculated at the 90% confidence interval.
3. The relative (point-to-point) horizontal accuracy is based on a distance (“D”) which is determined by the size of a standard HRE dataset at a given HRE Level. “D” is defined as the maximum radial distance between any two points in the said tile. The relative error is expected to vary as a function of distance between points, and its value ranges from R_0 for points within one point spacing to the table value for points at distance “D”.
4. The absolute horizontal accuracy is a goal value, but not a requirement. Although not required to meet a threshold, the Absolute Horizontal Accuracy should be reported in the metadata and is measured at the 90% confidence interval as a CE90.
5. Relative Horizontal Accuracy and random horizontal error may be difficult to assess in the coarse datasets. In these datasets, very large targets (which may not be available) would be required for such assessment. Therefore, the relative horizontal accuracy may not be evaluated for HREGP, HRE80 and HRE40 (Levels 1, 2, and 3).

*Note: These absolute horizontal accuracy values may be beyond current capabilities.

8.2. Vertical Accuracy:

HRE products at a given Level, shall conform with the predefined thresholds for vertical accuracy. Randomly selected datasets will be tested to assure that the random vertical error per point and relative vertical accuracy between points meets or exceeds the thresholds detailed in the tables below. Additionally, there is a goal that the absolute vertical accuracy meet or exceed the values established in Table 8-3 HREGP Vertical Accuracy Requirements and Table 8-4 HRE80-HRE01 Vertical Accuracy Requirements

Table 8-3 HREGP Vertical Accuracy Requirements

Product Name	Spatial resolution in arc seconds	Random Vertical Error Per Point (σ_v – meters)	Relative Vertical Accuracy Between Points (R_v – meters)	Goal: Absolute Vertical Accuracy LE90 (meters)
HREGP	0.4	2.2	6.2	12.4

Table 8-4 HRE80-HRE01 Vertical Accuracy Requirements

Product Name	Grid spatial resolution in meters	Random Vertical Error Per Point (σ_v – meters)	Relative Vertical Accuracy Between Points (R_v – meters)	Goal: Absolute Vertical Accuracy LE90 (meters)
HRE80	8	1.41	4.00	8.00
HRE40	4	0.71	2.00	4.00
HRE20	2	0.35	1.00	2.00
HRE10	1	0.18	0.50	1.00
HRE05	0.50	0.09	0.25	0.50
HRE02	0.25	0.04	0.12	0.25
HRE01	0.125	0.02	0.06	0.12

Vertical Accuracy notes:

1. The random vertical error per point is the random linear error per point (reported at 90% confidence)
2. The Relative Vertical Accuracy (point-to-point) between points is defined at the 90% confidence
3. The relative (point-to-point) vertical accuracy is based on a distance (“D”) which is determined by the size of a standard HRE tile at a given HRE Level. “D” is defined as the maximum radial distance between any two points in the said tile. The relative error is expected to vary as a function of distance between points, and its value ranges from R_0 for points within one point spacing to the table value for points at distance “D”.
4. The vertical accuracies described above are based on low to medium relief areas (predominant slope from 0 to 20 percent) within the data cell. In areas where the predominant slope exceeds 20 percent, the vertical accuracies listed in the table above can be scaled by 1.4 to account for increased inaccuracies.
5. The Absolute Vertical Accuracy is a goal value, but not a value that is required to meet a threshold in a HRE product. Although not required to meet a threshold, the Absolute Vertical Accuracy is measured at the 90% confidence interval as a LE90 and should be reported in the metadata.

9. Data Capture

HRE datasets are a derived dataset and may be generated from a variety of sources and production processes. Resolution and accuracy are critical criteria when deriving datasets. Where deemed necessary or appropriate, finer resolution elevation datasets may be used to derive coarser resolution elevation datasets, however coarser resolution datasets must not be used to derive finer resolution datasets. Equally only elevation datasets of higher accuracy shall be used to derive elevation datasets of lower accuracy. Specific HRE data capture requirements will be defined in product specific guidance documentation that will accompany production assignments. Typical guidance would include specific instruction for surface type depiction, water body portrayal, optional accuracy derivation (per point or regional) or other data portrayal requirements.

10. Data Maintenance

HRE datasets will be maintained and updated as requirements dictate. Data maintenance criteria will vary by data level. Higher resolution elevation data is more likely to need updates or replacement due to the temporal nature of high resolution details.

11. Data Product Delivery

HRE elevation layers will be stored and disseminated to NGA geospatial customers using NGA distribution capabilities and the NGA Product Gateway. Data delivery media and specific instruction will vary for the HRE data types. Specific instructions are documented in the product specific guidance for HRE products.

11.1. File Naming Convention

HRE datasets will follow the file naming convention as described below. Data delivery media and specific instruction will vary for the HRE data types. Specific instructions are documented in the product specific guidance for HRE products. Table 11-1 File Name Extension defines the standard file naming convention.

Table 11-1 File Name Extension

Level	Product Name	File Name Extension
1	HREGP	.hr1
2	HRE80	.hr2
3	HRE40	.hr3
4	HRE20	.hr4
5	HRE10	.hr5

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6	HRE05	.hr6
7	HRE02	.hr7
8	HRE01	.hr8

File Name:

HRErrtDDMMSShDDDMSSe_cxx.hrf

where

rr = resolution/projection (2 character alpha-numeric projection/post spacing)

- The rr value will use letters "GP" for Geographic Unprojected Position.
- The rr value will be the truncated decimeter value of the post spacing. This value will be from the enumerated list: 80, 40, 20, 10, 05, 02 or 01.

t = data type code (1 alpha-numeric character)

Code Key

A = optical source, unedited reflective surface

B = optical source, edited reflective surface

C = optical source, edited bare earth surface

D = Reserved for future use

E = Reserved for future use

F = IFSAR source, unedited reflective surface

G = IFSAR source, edited reflective surface

H = IFSAR source, edited bare earth surface

I = Reserved for future use

J = Reserved for future use

K = LIDAR source, unedited first return

L = LIDAR source, unedited last return

M = LIDAR source, unedited bare earth

N = LIDAR source, edited first return

O = LIDAR source, edited last return

P = LIDAR source, edited bare earth

Q = Reserved for future use

R = Reserved for future use

S = Reserved for future use

T = SAR source, unedited reflective surface

U = SAR source, edited reflective surface

V = SAR source, edited bare earth

W = Reserved for future use

X = unidentified source, reflective surface

Y = unidentified source, bare earth surface

Z = Reserved for future use

DDMMSShDDDMSSe = SW corner of DEM (Degree, Minute, Second, hemisphere (h – N for North, S for South, e – E for East, W for West)

c = security classification (T, S, C, R, U)
xx = Release Code (2 character code)
z = level code (see Table 11.1)

12. HRE Product Files

The HRE Product files shall consist of a number of standardized components. Some HRE components are required, while other components are optional depending on mission requirements. The required components, as shown in Table 12-1, are those directly associated with expressing the elevation matrix data and associated metadata in an NITF 2.1 file. The optional HRE components include Shapefile data, and NITF segments and XML metadata modules supporting error propagation.

12.1. HRE NITF files

NITF Headers and Extensions are detailed in Annex A.

Each HRE NITF file shall contain:

- File Header
- Extended Header Data to include the PIAPRD Tagged Record Extension (TRE)
- Image Subheader for DEM Height Data
- DEM Height Data
- XML Metadata Data Extension Segment (Annexes A and B)
- Accuracy summary statistics (Annex B)
- Optional error propagation data (Annexes A, B, C)

Table 12-1 HRE File Components Requirements

HRE Component	NITF Header	Image Segment Sub header & Data	XML DES	Shapefile DES	Comments
File Header	Required				{1}
PIAPRD TRE	Required				{1}
Elevation Data		Required			{1}
XML Metadata			Required		{1}
Accuracy Summary Statistics			Required		{4 to 12}
Shapefile Data				Optional	{Multiple sets may be included.}
Error Propagation Data to be included in XML DES metadata (Optional, but recommended)					
Region Definition by Polygons – Method 1			{1 to N}		Two alternate methods are provided to define regions. They are mutually exclusive.
Region Definition per Post – Method 2		{1}	{1} *		
Accuracy Summary Statistics per Region			{{4 to 12}N}		Summary statistics may optionally be defined for each region.
Systematic Error per			{1 to N}		Always included

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Region					
Cross Region Systematic Error			{N/2 (N-1)}		Included for 2 or more regions.
Relative Error Covariance by Region			{2 to 2N}		Always included. Relative error requires 2 covariance matrices per region (U and V directions)
Random Error Covariance – Method 1					Two alternate methods are provided to define random error covariance terms. They are mutually exclusive.
Random Error Covariance per Region			{1 to N}		
Random Error Scale Factor per Post		{1}	{1} *		
Random Error Covariance – Method 2					
Random Error Variance Terms per Post		{1}	{1} *		
Random Error Cross Correlation Terms per Post		{1}	{1} *		
* Error components stored in NITF image segments are always also referenced in the XML metadata. NOTE: Item in brackets refers to number of instances in the file. "N" refers to the number of the regions defined.					

Optionally the NITF file may contain Error data associated with the elevation data. These include Error propagation region point-by-point values, Error propagation random error point-by-point scale factor values, Error propagation random error point-by-point covariance values, and Error propagation random error point-by-point correlation coefficient values. For each of these data types the NITF file will contain:

- Image Subheader for Error Data type
- Error Data

One image segment containing the elevation data is always present in an HRE NITF file. When error propagation metadata is included, the NITF file may contain 1, 2 or 3 additional image segments. One of these image segments may contain region definitions per post, dependent on the method used to define the regions. Additionally, when error propagation data is included, image segments (one or two) will be used to capture the random error per post. If the scale factor method is used for the random errors, this will consist of one image segment. Alternatively, the random errors could be expressed with one image segment for random error variance terms and a second segment for the cross-correlation terms. So, a complete HRE NITF file will contain from one to four image segments.

The detailed specifics of the encapsulation of this Error data into NITF are referenced in Annex A.

When possible, systems (i.e. mission planners, targeting systems, etc.) using this data should make use of the errors / uncertainty, to provide some estimation of the risk. In addition, this information could be used for weighting, when combining multiple datasets in one area.

In addition to the above NITF structures the following inclusions into the dataset are dependent on product specific guidance:

- Shapefile Data Extension Segments (Annex A)

Multiple types of ancillary shapefile data may be included in the HRE NITF datasets. Specific content and structure will be defined in the unique product specific guidance documentation. Shapefiles would typically be used to delineate water bodies, void areas, alternate source fill, or known anomalous data.

12.2. Data Compression

Compression of HRE datasets may be desirable; however current compression capabilities typically do not work well on raster elevation data sets. Consequently compression is currently not implemented for HRE data. Data compression may be adopted when suitable compression techniques are developed. The allowed codes for the NITF Image Segment Subheader Image Compression (IC) field are NC and NM. Use the code NM when a pad pixel mask table is included following the Image Segment Subheader. If no compression is applied use code NC.

12.3. File Size Estimates

HRE datasets have a recommended maximum elevation data size of 200 Mega bytes (MB). This size is recommended with the intent to limit network resources needed for electronic distribution. Table 12.2 Elevation Data File Size Estimates displays approximate limits for square shaped matrices (rows and columns with same counts). The elevation data size shall be reported in the NITF File header field LI001 and the row and column counts are reported in NROWS and NCOLS fields in the Image Subheader. The HRE NITF files themselves may be larger than these elevation data estimates when accompanied by a full set of Error data, shapefiles and metadata.

Table 12-2 Elevation Data File Size Estimates

	GSD	Rows/Columns	Area (sq km)	Size (MB)
HREGP	12	10200	14981	198.44
HRE80	8	7200	3317	197.75
HRE40	4	7200	829	197.75
HRE20	2	7200	207	197.75
HRE10	1	7200	51	197.75
HRE05	0.5	7200	12	197.75
HRE02	0.25	7200	3	197.75
HRE01	0.125	7200	1	197.75

13. Security

HRE data shall comply with all DOD data security classifications and markings directives as specified in US Code Title 50, the National Security Act of 1947, NSG Directive FM1100, and Executive Order 12958.

Individual HRE data and supporting files may have different security classifications and markings but when provided as one dataset or combined, the results shall be marked with the highest security level of the individual datasets.

14. Metadata

14.1. General

Details for metadata content are found in Annex B Metadata Specification

Metadata may be associated with elevation data in several ways:

- with an elevation collection or series;
- with a single fundamental elevation dataset;
- with particular regions of a dataset or with some other grouping of dataset elements;
- with individual elevation points.

The description of metadata is hierarchical, so that any metadata element at a higher association level applies unless superseded by more detailed metadata at a lower association level.

14.2. Metadata uses

Among the fundamental purposes for compiling and maintain metadata, two are of particular relevance for this profile. They are:

- To assist users in discovering and obtaining elevation data sets that may be capable of supporting their applications for elevation data;
- To assist users in exploiting elevation data sets once obtained.

14.3. Metadata Data Types

Listed below are the metadata data type definitions.

Boolean

truth Enumeration whose domain of values is { TRUE, FALSE }, representing the true and false values in a two-valued logic system

CharacterString

character string with optional character encoding and localization attributes

Codelist

value domain including a code for each permissible value

NOTE It is an open Enumeration that may be extended during system runtime by adding additional named literal values.

Date

indication of date expressed as a year, year-month, or year-month-day

NOTE As specified by ISO 8601.

DateTime

indication of time expressed as a year, year-month, year-month-day, or year-month-day and time of day

NOTE As specified by ISO 8601.

Enumeration

data type whose instances form a finite list of distinguished values

NOTE 1 The extension of an Enumeration type implies a schema modification.

NOTE 2 An Enumeration should be used only when it is clear that there will be no extensions, otherwise a Codelist should be used.

Integer

whole number (a number that does not have a fractional part)

Real

number that is either rational or irrational

URI

CharacterString containing a Uniform Resource Identifier corresponding to the World Wide Web Consortium (W3C) recommendation

URL

CharacterString containing a Uniform Resource Locator corresponding to the W3C recommendation

14.4. Metadata modules

Elevation Data Accuracy Summary Statistics for HRE Products

This section describes the minimum accuracy related metadata elements to be reported for every HRE Standard dataset.

The HRE NITF file will contain XML metadata in a DQ_DataQuality module for the following values and the data vendor is required to provide the following values and store them in the HRE Standard product metadata for all HRE standard products (HREGP and HRE80 thru HRE01):

- Predicted / vendor measured Absolute Horizontal Accuracy ($CE90_{ABS,Pre}$)
- Predicted / vendor measured Absolute Vertical Accuracy ($LE90_{ABS,Pre}$)
- Predicted / vendor measured Relative Vertical Accuracy ($LE90_{REL,Pre}$)
- Predicted / vendor measured Random Vertical Error ($\sigma_{V,Pre}$)

Please note that these required reported values are to be representative of the entire dataset and not relate to a specific sub-cell, sub-section, or region. However, the file format does support the storage of these values on a per region basis when this information is available.

For HRE20 thru HRE01, the following values (in addition to the above values) are also required to be provided by the data vendor in the HRE Standard product metadata and stored in a DQ_DataQuality module:

- Predicted / vendor measured Random Horizontal Error ($\sigma_{H,Pre}$)
- Predicted / vendor measured Relative Horizontal Accuracy ($CE90_{REL,Pre}$)

Although random horizontal and relative horizontal values are not required for HREGP and HRE80-40, they can (and should) be reported if they were measured or if representative predictive values are available.

The HRE NITF file XML metadata will contain additional record sets of DQ_DataQuality modules that apply to the entire DEM if the dataset has been tested (by NGA or others) for validation. When tested, the following fields will be populated for all HRE standard products (HREGP and HRE80 thru HRE01):

- NGA measured / validated Absolute Horizontal Accuracy ($CE90_{ABS,Val}$)
- NGA measured / validated Absolute Vertical Accuracy ($LE90_{ABS,Val}$)
- NGA measured / validated Relative Vertical Accuracy ($LE90_{REL,Val}$)
- NGA measured / validated Random Vertical Error ($\sigma_{V,Val}$)

NOTE: If similar values have been created on a per region level, these can be reported and stored in the metadata. However, these values are not required by the Implementation Profile for High Resolution Elevation (HRE) Products.

The goal of this section is to provide the team testing the data (NGA or others) a place to report summary results of their evaluation of the dataset. These fields will provide the user with the information required to determine if a dataset (or region in some cases) accuracy can support

certain critical applications. The absence of these fields would indicate to the user that the dataset was not tested against ground truth.

When HRE20 thru HRE01 are evaluated, the following values (in addition to the above values) will also be recorded in the metadata:

- NGA measured / validated Random Horizontal Error ($\sigma_{H,Val}$)
- NGA measured / validated Relative Horizontal Accuracy ($CE90_{REL,Val}$)

If possible, these values should be provided when assessing HREGP and HRE80-40. However, this will not always be possible.

Table 14-1 HRE Accuracy Metadata Reporting Requirements and Table 14-2 HRE Accuracy Metadata Reporting Requirements if dataset accuracy is tested summarize these reporting requirements:

Table 14-1 HRE Accuracy Metadata Reporting Requirements

Source	Accuracy Value	Required for all HRE Datasets, HREGP and HRE80 thru HRE01	Required for HRE20 thru HRE01 and reported for all HRE levels if measured or predicted by vendor
Vendor Provided	Predicted / vendor measured Absolute Horizontal Accuracy ($CE90_{ABS,Pre}$)	✓	✓
	Predicted / vendor measured Absolute Vertical Accuracy ($LE90_{ABS,Pre}$)	✓	✓
	Predicted / vendor measured Relative Vertical Accuracy ($LE90_{REL,Pre}$)	✓	✓
	Predicted / vendor measured Random Horizontal Error Per Point ($\sigma_{H,Pre}$)		✓
	Predicted / vendor measured Relative Horizontal Accuracy ($CE90_{REL,Pre}$)		✓
	Predicted / vendor measured Random Vertical Error ($\sigma_{V,Pre}$)	✓	✓

Table 14-2 HRE Accuracy Metadata Reporting Requirements if dataset accuracy is tested

Source	Accuracy Value	Required for all HRE Datasets, HREGP and HRE80 thru HRE01, if dataset tested by NGA	Required for HRE 20-01 if dataset tested by NGA and reported for all HRE levels if measured
NGA Provided	NGA measured / validated Absolute Horizontal Accuracy ($CE90_{ABS,Val}$)	✓	✓
	NGA measured / validated Absolute Vertical Accuracy ($LE90_{ABS,Val}$)	✓	✓
	NGA measured / validated Relative Vertical Accuracy ($LE90_{REL,Val}$)	✓	✓
	NGA measured / validated Random Horizontal Error ($\sigma_{H,Val}$)		✓
	NGA measured / validated Relative Horizontal Accuracy ($CE90_{REL,Val}$)		✓
	NGA measured / validated Random Vertical Error ($\sigma_{V,Val}$)	✓	✓

Per Point Error Estimate

The use of high resolution elevation data for tasks that require a specified level of geolocation accuracy necessitates the inclusion of data to estimate geolocation errors anywhere within the elevation data coverage area. To support this need, this document proposes a new error metadata storage scheme within the NITF file using a series of DQ_DataQuality modules in conjunction with a series of NITF image segments. This error storage scheme provides the uncertainty data needed to compute estimated horizontal and vertical errors (both absolute and relative) for each point in the associated high resolution elevation image segment. This is accomplished by defining the fields needed to specify the covariance data for an accompanying data set. Standard error propagation techniques (i.e., linear combinations of Gaussian random variables) may then be used to compute a unique 3 by 3 covariance matrix for each point in the data set.

The metadata required to generate the per point error estimates consists of several sections. First, it consists of the definition of regions within which, uniform systematic errors are expected. Second, the information required to develop a 3x3 covariance matrix for the systematic errors within a region is stored along with the information necessary to develop the cross correlation between regions. Finally, the metadata required to build the 3x3 covariance matrix of random errors per point is stored. These individual pieces are then combined and exploited to determine the predicted errors at a single point or between a series of points.

This predicted error metadata is not required for HRE datasets. However, as mentioned above, as the exploitation capabilities on HRE datasets continue to expand, the necessity for such error prediction capabilities increases. For detailed guidance on the storage and exploitation, refer to Annex C (HRE Metadata in Support of Error Propagation).

ANNEX A – HRE NITF File Format (Normative)

A.1 Introduction

A.1.1 Overview

This annex specifies the requirements for formatting High Resolution Elevation Data (HRE) within a National Imagery Transmission Format (NITF) file. This includes the NITF File Header format, the NITF Image Segment format for containing HRE elevation data and related error propagation data, and the NITF Data Extension Segment (DES) format for metadata describing the HRE dataset. (See Figure A-1).

A.1.2 Metadata Overview

Metadata embedded within the HRE NITF file provides information about the organization, content, and structure of the NITF file, and information about the elevation data, to include data about the sensor that captured the elevations, support information about the elevations, and a host of other values. The main purpose of this annex is to describe the NITF file formatting required for specifying High Resolution Elevation Data (HRE). This includes specifying NITF header, sub-header, and Data Extension Segment (DES) field values, and the elevation data, error propagation data, and metadata (XML-formatted) contained within the NITF file structure. For convenience, this document contains excerpts and tables from standards documents (MIL-STD-2500C for example) so that referencing these documents can be kept to a minimum. For implementation of this profile, all documentation should be reviewed for accuracies before proceeding.

A.1.3 Coordinate System

A.1.3.1 Ground Space

Ground space coordinates expressed in the NITF Image Segments and Data Extension Segments are referenced to the World Geodetic System 1984 (WGS-84) coordinate system. They are expressed in decimal degrees as a bounding 4-point polygon with precision suitable for cataloging the data for discovery. The ground space coordinates and coordinate reference system for the actual elevation postings is identified in the XML_DATA_CONTENT DES using the metadata specified in section Annex B.

A.1.3.2 Image Space

Image (elevation post) space coordinates are defined in the NITF row and column coordinates indexing system. When the row/column coordinate system is positioned such that the origin (0,0) of the array is at the upper left, the integer or integral image space coordinates associated with a single cell are assigned to the upper left corner of the cell.

The corresponding geospatial coordinates are associated with the center of the cell (e.g. cell index 0.5,0.5 for the origin cell). This reflects the value is point case (vice the value is area case) applicable to elevation postings.

A.2 Terms and Definitions

A.2.1 NITF References

The following definitions were extracted from the NITF Version 2.10 (MIL-STD-2500C 1 May 2006). The Compendium of Controlled Extensions for the National Imagery Transmission Format (STDI-0002 version 3.0 - 01 August 2007) is the source definition for the PIAPRD Tagged Record Extension (TRE) used with HRE data. STDI-0006, NITF2.1 Commercial Dataset Requirements Document (NCDRD), 20 December 2006, is the source definition for the CSSHPA Data Extension Segment (DES) optionally used with HRE data.

A.2.2 Field Format Definitions

Basic Character Set (BCS) –

A subset of the Basic Multilingual Plane (BMP). The Basic Character Set consists of the characters defined in the first row (row 0x00) of the BMP A-zone. For this reason the first octet normally used to define character positions in the BMP will be omitted when expressing BCS character codes. Valid BCS character codes, therefore, shall range from 0x00 through 0xFF.

Basic Character Set-Alphanumeric (BCS-A) –

A subset of the Basic Character Set. The range of allowable characters consists of space through tilde (codes 0x20 through 0x7E); and line feed, form feed, and carriage return (0x0A, 0x0C, and 0x0D).

Basic Character Set-Numeric (BCS-N) –

A subset of the Basic Character Set-Alphanumeric. The range of allowable characters consists of minus through the number “9”, BCS codes 0x2D through 0x39, and plus, code 0x2B.

BCS Space –

BCS code 0x20.

Field structure and default values. The NITF uses byte counts to delimit header fields, as opposed to special end-of-field characters or codes or direct addressing. These counts are provided in the tables detailing the NITF header and subheader field specifications. All data in fields designated “BCS-A” shall be left justified and padded to the right boundary with BCS spaces. All data in numeric fields (BCS-Numeric (BCS-N)) shall be right justified and padded to the left boundary with leading zeros. Where a BCS-N field allows a plus sign (code 0x2B)

or a minus sign (code 0x2D), it is the left most character of the integer value. The standard default value shall be spaces for alphanumeric fields and zero for numeric fields. For a few fields, a specific default may be indicated in the field description. In this case, the field description shall take precedence. All header and subheader fields contained in a NITF file shall contain either meaningful data (that is, data in accordance with the restrictions specified for the contents of the field in this document) or the specified default value.

A.2.3 Field Type Definitions

Required (R)

Designates a NITF header or subheader field that must be present and filled with valid data.

Conditional (C) –

A state applied to a NITF header or subheader data field whose existence and content is dependent on the existence and/or content of another field.

<R> or <C>

BCS Spaces allowed for entire field when no specific default value is specified.

[PSG]

PSG designates a NITF header or subheader field for which 'production-specific guidance' for population of the field will be provided by the HRE production sponsoring activity.

A.3 High Resolution Elevation Product Format

A.3.1 High Resolution Elevation Product Format Overview

High Resolution Elevation data is a product consisting of elevation data and associated metadata.

A.3.2 HRE NITF File Contents

The following diagram (Figure A-1) provides an overview of the NITF structure of an HRE product in block format. Subsequent sections provide further clarification of the format

including NITF TRE(s).

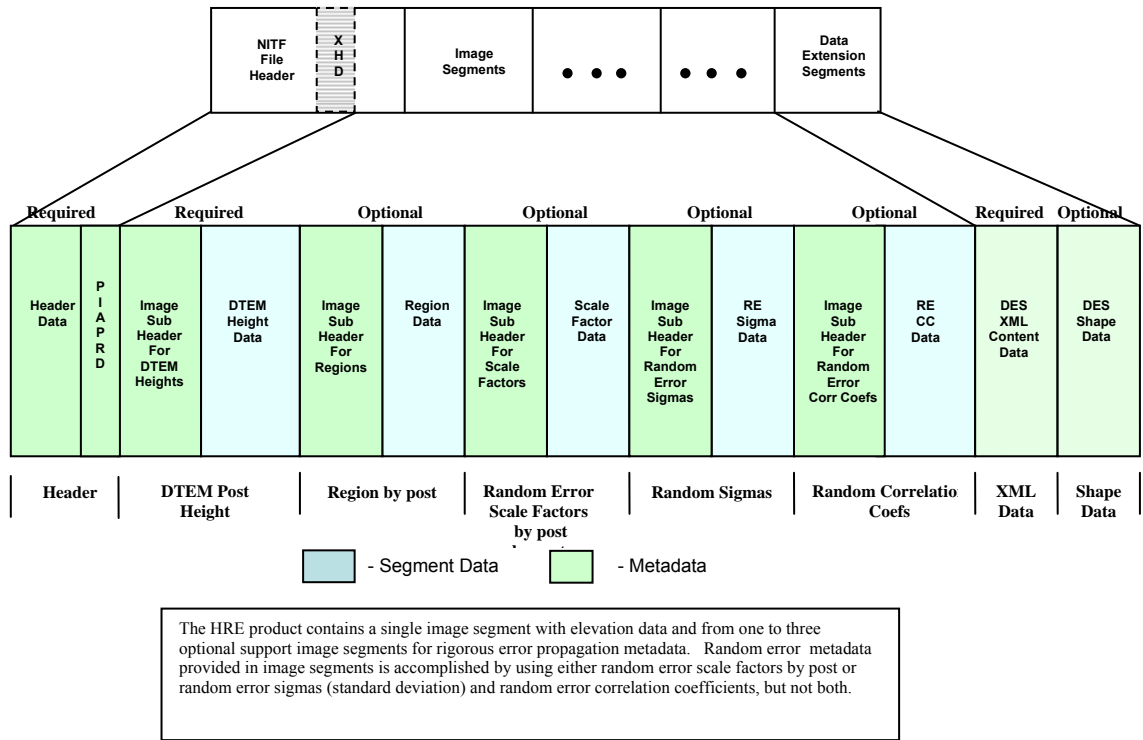
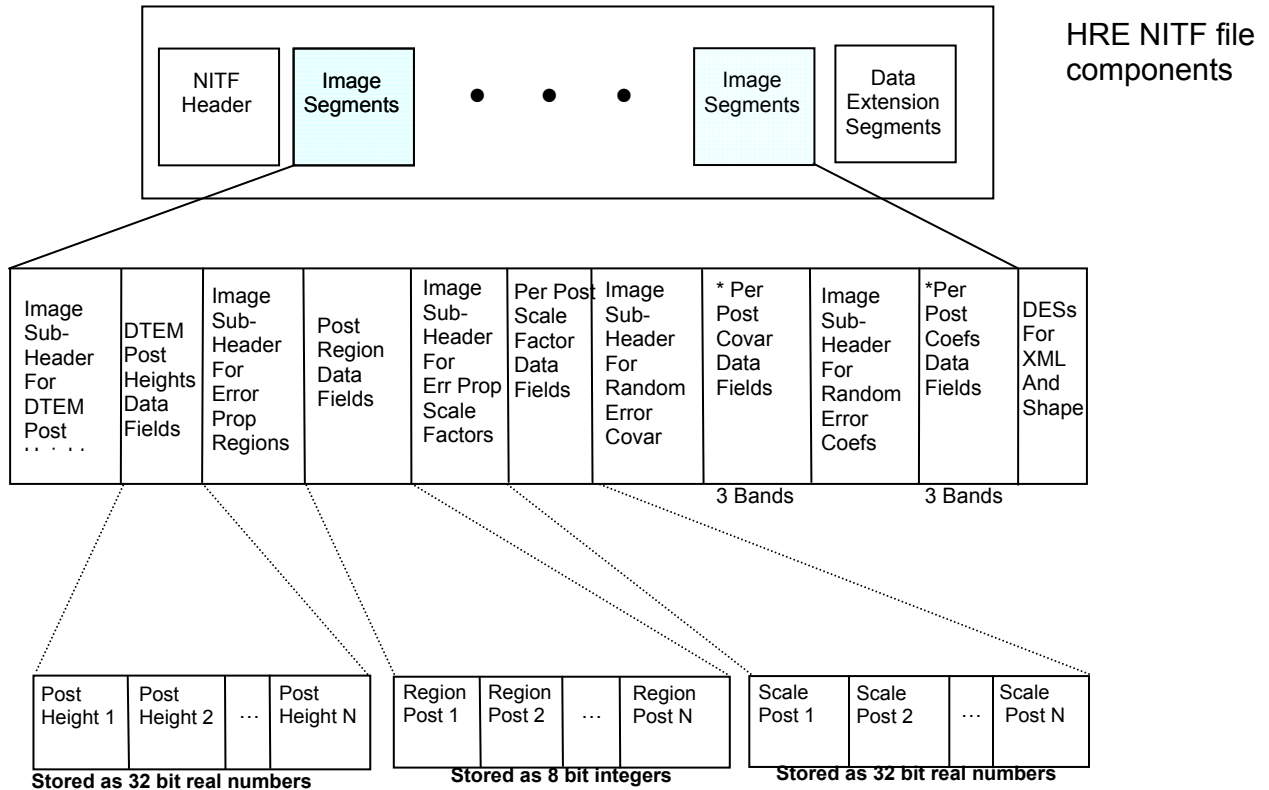


Figure A-1 Diagram showing NITF HRE File Format

A.3.3 DTEM Post Height and Optional Error Propagation Image Segment Layout

Figure A.2 describes the storage layout of the DTEM Post Heights and optional rigorous error propagation image segments associated with DTEM posts (See Tables 5-2 to A-8). These values (when present) will be stored as separate image segments (DTEM Post Heights, Error propagation region post-by-post values, Error propagation random error post-by-post scale factor values, Error propagation random error post-by-post covariance values, and Error propagation random error post-by-post correlation coefficient values). As specified in section 12.1, metadata is also supplied in the NITF XML_DATA_CONTENT DES. The XML metadata can be in addition to, in conjunction with or in place of the image segment metadata.



NOTE: Asterisk (*) indicates the additional optional two image segments needed to specify the post-by-post random error covariance matrix elements. These are each 3-band image segments. One image segment consists of the three diagonal term standard deviations, stored as 4-byte real numbers. So, a given band within a segment contains values representing a specific location within the covariance matrix, for example the σ_x location. The other two bands permit storage for σ_y and σ_z . The second image segment of the set consists of the three off-diagonal correlation coefficients, stored as 1-byte integers. A given band then represents a specific off-diagonal term, σ_{xy} , σ_{xz} , or σ_{yz} .

Figure A-2 Diagram indicating potential image segment components for the HRE product

A.4 NITF File Header Layout

A.4.1 Header Format

Table A-1 shows how the NITF File Header shall be populated during the creation of the HRE product. The table provides details for populating header fields and places HRE-specific constraints for use of NITF (e.g. tighter value range constraints and obligations than allowed in the NITF standard). In some instances, the desired field value is not known until a data production order or plan is in place. Those fields for which Production Specific Guidance (PSG) is anticipated are designated with the letters 'PSG'.

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Table A-1 NITF File Header Format for NITF 2.10 images
(Type "R"=Required, "C" = Conditional, "<>" BCS Spaces allowed for entire field)

FIELD	NAME	SIZE	VALUE RANGE	TYPE	COMMENTS
FHDR	<u>File Profile Name</u> The valid value for this field is NITF.	4	BCS-A NITF	R	Data written in NITF format.
FVER	<u>File Version</u> The valid value for this field is 02.10.	5	BCS-A 02.10	R	Data written in NITF version 02.10 format.
CLEVEL	<u>Complexity Level</u> The complexity level required to interpret fully all components of the file.	2	BCS-A 03 to 09	R	Primarily related to the number of DTEM posts. This is based on a value derived from Table A-11.
STYPE	<u>Standard Type</u> Standard type or capability. BF01 indicates that this file is formatted using ISO/IEC IS 12087-5.	4	BCS-A BF01	R	NITF version 02.10 is an internationally registered profile of ISO/IEC 12087-5.
OSTAID	<u>Originating Station ID</u> Identification code or name of the originating organization, system, station, or product.	10	BCS-A NGA	R	"NGA" Indicates that NGA was responsible for producing the final data file. The value 'NGA' shall be followed by seven BCS spaces (0x20).
FDT	<u>File Date & Time</u> The date and time (UTC) of the file's origination.	14	BCS-N CCYYMMDDhhmmss	R	Date and time of the creation of the HRE file. Format: CCYYMMDDhhmmss
FTITLE	<u>File Title</u> This field contains the title of the file.	80	BCS-A	R [PSG]	"HRE High Resolution Elevation Data HRErrtDDMMSShDDDM MSSe_cxx.hrf " This is the file name as defined in Section 11.1.
FSCLAS	<u>File Security Classification</u> This value contains a valid value representing the classification level of the entire file.	1	BCS-A T, S, C, R, or U	R [PSG]	For fields FSCLAS through FSCTLN, consult Production Specific Guidance (PSG) for applicable security field population values.

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FSCLSY	<u>File Security Classification System</u> This field shall contain valid values indicating the national or multinational security system used to classify the file.	2	BCS-A US Note: As an option, this field may contain two space characters when the FSCLAS value is 'U'.	<R> [PSG]	<i>Refer to MIL-STD-2500C for general description of these fields. Consult current security guidelines at the time of production to determine proper markings.</i>
FSCODE	<u>File Codewords</u> This field shall contain a valid indicator of the security compartments associated with the file	11	BCS-A	<R> [PSG]	<i>Consult current security guidelines at the time of production to determine proper markings.</i>
FSCTLH	<u>File Control and Handling</u> This field shall contain valid additional security control and/or handling instructions (caveats) associated with the file.	2	BCS-A	<R> [PSG]	<i>Consult current security guidelines at the time of production to determine proper markings.</i>
FSREL	<u>File Releasing Instructions</u> This field shall contain a valid list of country and/or multilateral entity codes to which countries and/or multilateral entities the file is authorized for release.	20	BCS-A	<R> [PSG]	<i>Consult current security guidelines at the time of production to determine proper markings.</i>
FSDCTP	<u>File Declassification Type</u> This field shall contain a valid indicator of the type of security declassification or downgrading instructions which apply to the file.	2	BCS-A	<R> [PSG]	<i>Consult current security guidelines at the time of production to determine proper markings.</i>

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FSDCDT	<u>File Declassification Date</u> This field shall contain a date on which a file is to be declassified if the value in the File Declassification Type is DD, DE, GD, GE, O, and X.	8	BCS-A When populated with other than space characters, the format is: CCYYMMDD	<R> [PSG]	<i>Consult current security guidelines at the time of production to determine proper markings.</i>
FSDCXM	<u>File Declassification Exemption</u> This field shall indicate the reason the file is exempt from automatic declassification if the value in File Declassification Type is X.	4	BCS-A	<R> [PSG]	<i>Consult current security guidelines at the time of production to determine proper markings.</i>
FSDG	<u>File Downgrade</u> This field shall contain the classification level to which a file is to be downgraded if the value in the File Declassification Type is GD or GE.	1	BCS-A	<R> [PSG]	<i>Consult current security guidelines at the time of production to determine proper markings.</i>
FSDGDT	<u>File Downgrade Date</u> This field shall indicate the date on which a file is to be downgraded if the File Declassification Type is GD.	8	BCS-A When populated with other than space characters, the format is: CCYYMMDD	<R> [PSG]	<i>Consult current security guidelines at the time of production to determine proper markings.</i>

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FSCLT	<u>File Classification Text</u> This field shall be used to provide additional information about file classification to include identification of a declassification or downgrading event if the values in the File Classification Type are DE or GE.	43	BCS-A	<R> [PSG]	Consult current security guidelines at the time of production to determine proper markings.
FSCATP	<u>File Classification Authority Type</u> This field shall indicate the type of authority used to classify the file.	1	BCS-A When populated with other than space characters, valid values are O, D, and M	<R> [PSG]	Consult current security guidelines at the time of production to determine proper markings.
FSCAUT	<u>File Classification Authority</u> This field shall identify the classification authority for the file dependent upon the value in File Classification Authority Type.	40	BCS-A	<R> [PSG]	Consult current security guidelines at the time of production to determine proper markings.
FSCRSN	<u>File Classification Reason</u> This field shall contain values indicating the reason for classifying the file.	1	BCS-A When populated with other than space characters, valid values include A through G.	<R> [PSG]	Consult current security guidelines at the time of production to determine proper markings.
FSSRDT	<u>File Security Source Date</u> This field shall indicate the date of the source used to derive the classification of the file.	8	BCS-A When populated with other than space characters, the format is: CCYYMMDD	<R> [PSG]	Consult current security guidelines at the time of production to determine proper markings.

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FSCTLN	<u>File Security Control Number</u> This field shall contain a valid security control number associated with the file.	15	BCS-A	<R> [PSG]	Consult current security guidelines at the time of production to determine proper markings.
FSCOP	<u>File Copy Number</u> This field shall contain the copy number of the file.	5	BCS-N 00000	R	If the field is all zeros, this shall imply that there is no tracking of the number of copies.
FSCPYS	<u>File Number of Copies</u> This field shall contain the total number of copies of the file.	5	BCS-N 00000	R	If the field is all zeros, this shall imply that there is no tracking of the number of copies.
ENCRYP	<u>Encryption</u> This field shall contain the value BCS zero (0x30).	1	BCS-N 0	R	Default 0 = Not Encrypted
FBKGC	<u>File Background Color</u> This field shall contain the three color components of the file background in the order Red, Green, Blue.	3	Unsigned Binary Integer 0x00, 0x00, and 0x00	R	This field contains unsigned binary integer values with a range of 0x00, 0x00, and 0x00 (Black) to 0xFF, 0xFF, 0xFF (White).
ONAME	<u>Originator's Name</u> This field shall contain a valid name for the operator who originated the file.	24	BCS-A	R [PSG]	Lists the organization responsible for creating the final data product and shall be followed by BCS spaces to reach size.
OPHONE	<u>Originator's Phone Number</u> This field shall contain a valid phone number for the operator who originated the file.	18	BCS-A	R [PSG]	Originator's phone number followed by BCS spaces to fill size.
FL	<u>File Length</u> This field shall contain the length in bytes of the entire file including all headers, subheaders, and data.	12	BCS-N 000000000388 to 999999999998	R	BCS-N positive integer Calculated length of entire file in bytes, including all headers, subheaders and data.

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HL	<u>NITF File Header Length</u> This field shall contain a valid length in bytes of the NITF file header.	6	BCS-N 000388 to 999998	R	<i>BCS-N positive integer. Length of NITF file header in bytes</i>
NUMI	<u>Number of Image Segments</u> Indicates the number of image segments in the NITF file.	3	BCS-N 001 to 004	R	<i>Reference Table 12-1.</i>
LISH001	<u>Length of 1st Image Subheader</u> This field shall contain a valid length in bytes for the image subheader.	6	BCS-N 000439 to 999998	R	<i>Length of the DTEM Post Height image subheader</i>
LI001	<u>Length of 1st Image</u> This field shall contain a valid length in bytes of the image data.	10	BCS-N 0000000001 to 9999999998	R	<i>Length of the DTEM Post Heights image segment</i>
LISHn	<u>Length of nth Image Subheader</u>	6	BCS-N 000439 to 999998	C	<i>Length of the Rigorous Error Propagation Region Definition image subheader, if present.</i>
LIn	<u>Length of nth Image</u>	10	BCS-N 0000000001 to 9999999998	C	<i>Length of the Rigorous Error Propagation Region Definition image segment, if present.</i>
LISHn	<u>Length of nth Image Subheader</u>	6	BCS-N 000439 to 999998	C	<i>Length of the Rigorous Error Propagation Scale Factor Definition image subheader, if present.</i>
LIn	<u>Length of nth Image</u>	10	BCS-N 0000000001 to 9999999998	C	<i>Length of the Rigorous Error Propagation Scale Factor Definition image segment, if present.</i>
LISHn	<u>Length of nth Image Subheader</u>	6	BCS-N 000439 to 999998	C	<i>Length of the Rigorous Error Propagation Random Error Covariance Definition image subheader, if present.</i>
LIn	<u>Length of nth Image</u>	10	BCS-N 0000000001 to 9999999998	C	<i>Length of the Rigorous Error Propagation Random Error Covariance Definition image segment, if present.</i>
LISHn	<u>Length of nth Image Subheader</u>	6	BCS-N 000439 to 999998	C	<i>Length of the Rigorous Error Propagation Random Error Correlation Coefficient Definition image subheader, if present.</i>

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Lin	<u>Length of nth Image</u>	10	BCS-N 0000000001 to 9999999998	C	<i>Length of the Rigorous Error Propagation Random Error Correlation Coefficient Definition image segment, if present.</i>
NUMS	<u>Number of Graphics</u> This field shall contain the number of separate graphic segments included in the file.	3	BCS-N 000-999 Default value is 000	R [PSG]	<i>This shall be "000" unless graphics are added. Inclusion of Graphics is optional.</i>
LSSHn	<u>Length of nth Graphic Subheader</u> This field shall contain a valid length in bytes for the n th graphic subheader, where n is the number of the graphic segment counting from the first graphic (n=001) in the order of the graphic segments' appearance in the file.	4	BCS-N 0258 to 9998	C	<i>Inclusion of Graphics is optional.</i>
LSn	<u>Length of the nth Graphic</u> This field shall contain a valid length in bytes of the n th graphic, where n is the number of the graphic segment counting from the first graphic (n=001) in the order of the graphic segments' appearance in the file.	6	BCS-N 000001 to 999998	C	<i>Inclusion of Graphics is optional.</i>
NUMX	<u>Reserved for Future Use</u> This field is reserved for future use.	3	BCS-N 000	R	<i>This field shall be filled with BCS zeros (0x30)</i>

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NUMT	<u>Number of Text Files</u> This field shall contain the number of separate text segment(s) included in the file.	3	BCS-N 000-999 Default value is 000	R [PSG]	<i>This shall be "000" unless text segments are added. Inclusion of text segments is optional.</i>
LTSHn	<u>Length of the nth text subheader</u> This field shall contain a valid length in bytes for the n th text subheader, where n is the number of the text segment, counting from the first text segment (n=001) in the order of the text segments' appearance in the file.	4	BCS-N 0282 to 9998	C	<i>Inclusion of text segments is optional.</i>
LTn	<u>Length of the nth Text file</u> This field shall contain a valid length in bytes of the n th text segment, where n is the number of the text segment, counting from the first text segment (n=001) in the order of the text segments' appearances in the file.	5	BCS-N 00001 to 99998	C	<i>Inclusion of text segments is optional.</i>
NUMDES	<u>Number of Data Extension Segments</u> This field shall contain the number of separate data extension segments included in the file.	3	BCS-N 001 to 010	R [PSG]	<i>An HRE NITF file will always have at least one DES to contain XML-formatted metadata. The file may also include DES(s) with Shapefiles.</i>

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LDSH001	<u>Length of the 1stData Extension Segment Subheader</u> This field shall contain a valid length in bytes for the 1 st data extension segment subheader.	4	BCS-N 0200 to 9998	R	<i>Length in bytes of the XML_DATA_CONTENT DES subheader.</i>
LD001	<u>Length of 1stData Extension Segment Data</u> This field shall contain a valid length in bytes of the data in the 1 th data extension segment.	9	BCS-N 000000001 to 999999998	R	<i>Length in bytes of the data in the XML_DATA_CONTENT DES.</i>
LDSHn	<u>Length of the nthData Extension Segment Subheader</u> This field shall contain a valid length in bytes for the n th data extension segment subheader, where n is the number of the data extension segment counting from the first data extension segment (n=001) in order of the data extension segment's appearance in the file.	4	BCS-N 0200 to 9998	C	<i>Length in bytes of the CSSHPA DES subheader, if present.</i>

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LDn	<u>Length of nth Data Extension Segment Data</u> This field shall contain a valid length in bytes of the data in the n th data extension segment, where n is the number of the data extension segment counting from the first data extension segment (n=001) in order of the data extension segment's appearance in the file.	9	BCS-N 000000001 to 999999998	C	<i>Length in bytes of the data in the CSSHPA DES, if present.</i>
NUMRES	<u>Number of Reserved Extension Segments</u> This field shall contain the number of separate reserved extension segments included in the file.	3	BCS-N 000	R	<i>"000" There are no reserved extension segments included in the file.</i>
UDHDL	<u>User Defined Header Data Length</u> A value of BCS zeros shall represent that no tagged record extensions are included in the UDHD.	5	BCS-N 00000	R	<i>There are no TREs included in the User Defined Header.</i>

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XHDL	<u>Extended Header Data Length</u> This field shall contain a valid length in bytes for all the TREs in the extended header data portion of NITF file. The field shall contain the sum of the length of all the tagged record extensions appearing in the XHD field plus 3 bytes (length of XHDLOFL).	5	BCS-N	R	<i>The only TRE to appear in the Extended Header Data is the PIAPRD TRE.</i>
XHDLOFL	<u>Extended Header Data Overflow</u> This field shall contain BCS zeros (0x30) if the tagged record extensions in XHD do not overflow into a DES, or shall contain the sequence number of the DES into which they do overflow.	3	BCS-N 000	C	<i>A TRE overflow condition does not exist for HRE data.</i>
XHD	<u>Extended Header Data</u> This field shall contain controlled tagged record extensions. The length of this field shall be the length specified by the field XHDL minus 3 bytes. Controlled tagged record extensions shall appear one after the other with no intervening bytes.	† ¹	PIAPRD TRE	C	<i>The PIAPRD TRE is placed in this field.</i>

†¹ - As Specified in XHDL minus 3 bytes

A.4.2 Extended Header Data

A.4.3 PIAPRD TRE Format

Profile for Imagery Access Product Support Extension TRE

Support information about HRE product processing including date/time, software type, and software version will be stored in the PIAPRD TRE. In addition, this TRE will hold information about additional image sections within the product. These sections include unique identifiers (IDs) for the HRE DTEM Post Height segment, and if present, Rigorous Error Propagation Region definition, Rigorous Error Propagation random error Scale Factor definition, Rigorous error Propagation random error Covariance data, and Rigorous Error Propagation random error Correlation Coefficient data image segments. These IDs are used to associate the HRE DTEM Post Heights, with any of the Rigorous Error Propagation image segments that may be included.

Table A-2 PIAPRD TRE Format

(Type "R"=Required, "C" = Conditional, "<>" = BCS Spaces Allowed for Entire Field)

FIELD	NAME	SIZE	VALUE RANGE	TYPE	COMMENTS
CETAG	<u>Unique Extension Identifier</u>	6	BCS-A PIAPRD	R	
CEL	<u>Length of Entire Tagged Record</u>	5	BCS-N 00201-63759	R	
ACCESSID	<u>Access ID</u>	64	BCS-A	<R>	Default – BCS Spaces
FMCONTROL	<u>FM Control Number</u>	32	BCS-A	<R>	Default – BCS Spaces
SUBDET	<u>Subjective Detail</u>	1	BCS-A	<R>	Default – BCS Space
PRODCODE	<u>Product Code</u>	2	BCS-A	<R>	Default – BCS Spaces
PRODUCERSE	<u>Producer Supplement</u>	6	BCS-A	<R>	Default – BCS Spaces
PRODIDNO	<u>Product ID Number</u>	20	BCS-A	<R>	Default – BCS Spaces
PRODSNME	<u>Product Short Name</u> Identifies the abbreviated name of a product stored in the archive.	10	BCS-A HRE	R	"HRE"
PRODUCERCD	<u>Producer Code</u>	2	BCS-A	<R>	Default – BCS Spaces
PRODCERTIME	<u>Producer Time</u> Identifies the date or the date and time that the product was created or last modified, expressed in ZULU time.	14	BCS-A CCYYMMDDHHMMSS (ZULU)	R	
MAPID	<u>Map ID</u>	40	BCS-A	<R>	Default – BCS Spaces
SECTITLEREP	<u>SECTITLE Repetitions</u>	2	BCS-N 00	R	"00" – Indicating zero repeating SECTITLE values
REQORGREP	<u>REQORG Repetitions</u>	2	BCS-N 00	R	"00" – Indicating zero repeating REQORG values

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KEYWORDREP	<u>KEYWORD Repetitions</u>	2	BCS-N 00	R	"00" No keywords are used.
ASSRPTREP	<u>ASSRPT Repetitions</u>	2	BCS-N 00	R	"00" – Indicating zero repeating ASSRPT values
ATEXTREP	<u>ATEXT Repetitions</u> Identifies the number of times the ATEXTREP field repeats per extension instance.	2	BCS-N 01 - 05	R	For HRE, this is the number of Image Segments contained within the HRE (Typically 01 to 05). This number is used to determine how many ATEXT fields will follow. These ATEXT fields represent unique Segment IDs contained in the IID2 (NITF 2.10) fields of the image segments.
ATEXTnn	<u>Associated Text nn</u> Provides the nnth text block further describing the imagery product. The number of ATEXTs between the previous field and this is represented in the ATEXTREP field.	255	BCS-A <i>HRELLyyyyymmdd</i>	C	This is used as an internal HRE identification number mechanism. The format for the DTEM Post Heights, identification tags is: <i>HRELLyyyyymmdd</i>
<p>Where:</p> <ul style="list-style-type: none"> ○ HRE – required portion of keyword for HRE DTEM segment ○ LL – the two character HRE product designator (e.g. HREGP, LL will be "GP"). ○ yyyyymmdd format, where yyyy is the year, mm is the month, and dd is the day of the month <p>The format for any rigorous error image segments included will follow the same format pattern, with the first three letters changed to one of the following, identification tags:</p> <ul style="list-style-type: none"> ○ REG – required portion of keyword for rigorous error regions segment ○ RSF – required portion of keyword for rigorous error random error scale factor segment ○ COV – required portion of keyword for rigorous error propagation random error covariance segment ○ COR – required portion of keyword for rigorous error propagation random error correlation coefficient segment <p>NOTE: The exploitation system will be able to match these segments by comparing these values.</p>					

A.5 HRE Post Height

A.5.1 HRE Post Height

The first, and possibly only, image segment in the HRE NITF product contains the elevation data post heights. This image segment is comprised of Image subheader information and DTEM post height data. Metadata associated with the DTEM data is contained in the XML_DATA_CONTENT DES.

A.5.2 Image Subheader

This section describes the fields and contents within the IM subheader. For the DTEM Post Heights, this IM subheader will contain the values designated in Table A-3.

Table A-3 HRE Post Height Image Subheader Format
(Type "R"=Required, "C" = Conditional, "<>" BCS Spaces allowed for entire field)

FIELD	NAME	SIZE	VALUE RANGE	TYPE	COMMENTS
IM	<u>File Part Type</u> This field shall contain the characters "IM" to identify the subheader as an image subheader.	2	BCS-A IM	R	"IM"
IID1	<u>Image ID1</u> This field shall contain a valid alphanumeric identification code associated with the image.	10	BCS-A HRE	R	"HRE" Short name that identifies the DTEM Post Height segment.
IDATIM	<u>Image Date & Time</u> This field shall contain the time (UTC) of the image acquisition.	14	BCS-N CCYYMMDDhhmmss	R	Date/Time that best reflects the currency of the elevation postings. Typically the date/time the sensor acquired the data from which the elevation postings were derived.
TGTID	<u>Target ID</u> This field shall contain the identification of the primary target.	17	BCS-A (17 space characters)	<R>	17 BCS spaces (0x20)
IID2	<u>Image IID2</u> This field contains the identification of additional information about the image.	80	BCS-A HRELLyyyyymmdd	R	Unique identifier for the DTEM Post Height Segment. This MUST match the corresponding value found in the PIAPRD TRE field ATEXT of the file header.
ISCLAS	<u>Image Security Classification</u>	1	BCS-A T, S, C, R, U	R [PSG]	For fields ISCLAS through ISCTLN, consult Production Specific Guidance (PSG) for applicable security field population values.
ISCLSY	<u>Image Security Classification System</u>	2	BCS-A US Note: As an option, this field may contain two space characters when the FSCLAS value is 'U'.	<R> [PSG]	Refer to MIL-STD-2500C for general description of these fields. Consult current security guidelines at the time of production to determine proper markings.
ISCODE	<u>Image Codewords</u>	11	BCS-A	<R> [PSG]	Consult current security guidelines at the time of production to determine proper markings.

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ISCTLH	<u>Image Control and Handling</u>	2	BCS-A	<R> [PSG]	Consult current security guidelines at the time of production to determine proper markings.
ISREL	<u>Image Releasing Instructions</u>	20	BCS-A	<R> [PSG]	Consult current security guidelines at the time of production to determine proper markings.
ISDCTP	<u>Image Declassification Type</u>	2	BCS-A	<R> [PSG]	Consult current security guidelines at the time of production to determine proper markings.
ISDCDT	<u>Image Declassification Date</u>	8	BCS-A CCYYMMDD	<R> [PSG]	Consult current security guidelines at the time of production to determine proper markings.
ISDCXM	<u>Image Declassification Exemption</u>	4	BCS-A	<R> [PSG]	Consult current security guidelines at the time of production to determine proper markings.
ISDG	<u>Image Downgrade</u>	1	BCS-A	<R> [PSG]	Consult current security guidelines at the time of production to determine proper markings.
ISDGD	<u>Image Downgrade Date</u>	8	BCS-A CCYYMMDD	<R> [PSG]	Consult current security guidelines at the time of production to determine proper markings.
ISCLTX	<u>Image Downgrade Text</u>	43	BCS-A	<R> [PSG]	Consult current security guidelines at the time of production to determine proper markings.
ISCATP	<u>Image Classification Authority Type</u>	1	BCS-A	<R> [PSG]	Consult current security guidelines at the time of production to determine proper markings.
ISCAUT	<u>Image Classification Authority</u>	40	BCS-A	<R> [PSG]	Consult current security guidelines at the time of production to determine proper markings.
ISCRSN	<u>Image Classification Reason</u>	1	BCS-A	<R> [PSG]	Consult current security guidelines at the time of production to determine proper markings.
ISCRDT	<u>Image Security Source Date</u>	8	BCS-A CCYYMMDD	<R> [PSG]	Consult current security guidelines at the time of production to determine proper markings.
ISCTLN	<u>Image Security Control Number</u>	15	BCS-A	<R> [PSG]	Consult current security guidelines at the time of production to determine proper markings.
ENCRYP	<u>Encryption</u> This field shall contain the value BCS zero (0x30).	1	BCS-N 0	R	"0" HRE data is not encrypted.

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ISORCE	<u>Image Source</u> This field shall contain a description of the source of the image.	42	BCS-A	<R> [PSG]	<i>The general type of the collection source of the data; such as LIDAR, IFSAR, SAR, or EO for sensor-based sources..</i> <i>*When classified, the description shall be preceded by the classification, including codewords.</i>
NROWS	<u>Number of Significant Rows in Image</u> This field shall contain the total number of rows of significant pixels in the in the image.	8	BCS-N 00000001 to 99999999	R	<i>Number of rows in the DTEM.</i>
NCOLS	<u>Number of Significant Columns in Image</u> This field shall contain the total number of columns of significant pixels in the image.	8	BCS-N 00000001 to 99999999	R	<i>Number of columns in the DTEM.</i>
PVTYPE	<u>Pixel Value Type</u> This field shall contain an indicator of the type of computer representation used for the value for each pixel for each band in the image.	3	BCS-A R, SI	R	<i>"R" – indicating 'real' for the HRELL case.</i> <i>"SI" – indicating 'signed integer' for the HREG case.</i>
IREF	<u>Image Representation</u> This field shall contain a valid indicator of the processing required in order to display an image.	8	BCS-A NODISPLY	R	<i>"NODISPLY"</i> <i>Indicating data not intended for display.</i>
ICAT	<u>Image Category</u> This field shall contain a valid indicator of the specific category of image, raster or grid data.	8	BCS-A DTEM	R	<i>"DTEM"- indicating Matrix Data (elevation). The value 'DTEM' shall be followed by 4 BCS spaces (0x20).</i>
ABPP	<u>Actual Bits-Per-Pixel Per Band</u> This field contains the number of significant bits for the value in each band of each pixel without compression.	2	BCS-N 16, 32	R	<i>16 when Signed Integer 32 when Real</i>
PJUST	<u>Pixel Justification</u> When ABPP is not equal to NBPP, this field indicates whether the significant bits are left justified or right justified.	1	BCS-A R	R	<i>"R" – indicating Right Justified</i>
ICORDS	<u>Image Coordinate System</u> This field shall contain a valid code indicating the type of coordinate system used for providing an approximate location of the image in the Image Geographic Location field (IGEOL).	1	BCS-A D, N, S	R	<i>"D"- indicating geodetic decimal degrees (for HRE level 1) or "N" or "S" indicating UTM North or South (for HRE levels 2-8)</i>

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IGEOLO	<u>Image Geographic Location</u> This field shall contain an approximate geographic location, in terms of corner locations, of the image in the coordinate system specified in the ICORDS field.	60	BCS-N $\pm dd.ddd \pm ddd.ddd$ (four times) or zzzzzzzznnnnnnnn (four times)	C	Decimal degrees for HRE level 1 (unprojected) or UTM zone number (zz) and easting (e) and northing (n) in meters for HRE levels 2-8.
NICOM	<u>Number of Image Comments</u> This field shall contain the number of image comment fields to follow.	1	BCS-N 0	R	"0" – indicating no optional comment fields.
IC	<u>Image Compression</u> This field contains a valid code indicating the form of compression used in representing the image data.	2	BCS-A NC, NM	R [PSG]	"NC" – indicating Not Compressed. "NM" – indicating use of a pixel mask table.
NBANDS	<u>Number of Bands</u> This field shall contain the number of data bands within the specified image.	1	BCS-A 1	R	"1" – indicating one band (DTEM Post Height)
IREPBAND1	<u>1st Band Representation</u> This field contains a valid indicator of the interpretation of the 1 st band.	2	BCS-A (2 space characters)	<C>	Default – BCS Spaces
ISUBCAT1	<u>1st Band Significance for Image Category</u> This field provides the significance of the 1 st band of the image.	6	BCS-A M	<R>	"M" Terrain elevation values are in meters.
IFC1	<u>1st Band Image Filter Condition</u> This field shall contain the value N (to represent none).	1	BCS-A N	R	"N" – indicating no band filter condition
IMFLT1	<u>1st Band Standard Image Filter Code</u> Reserved for future use.	3	BCS-A (3 space characters)	<R>	Default – BCS Spaces
NLUTS1	<u>Number of Look-up Tables for the 1st Band</u> This field shall contain the number of LUTs associated with the nth band of the image.	1	BCS-A 0	<R>	"0" – indicating the number of lookup tables
ISYNC	<u>Image Sync Code</u> This field shall contain BCS zero (0x30)	1	BCS-N 0	R	"0" – no sync code
IMODE	<u>Image Mode</u> This field shall contain an indicator of whether the image bands are stored sequentially, or band interleaved by block, or band interleaved by pixel, or band interleaved by row.	1	BCS-A B	R	"B" – indicating data is stored band interleaved by block.
NBPR	<u>Number of Blocks per Row</u> This field shall contain the number of image blocks in a row of blocks in the horizontal direction.	4	BCS-N 0001 to 9999	R	Indicates one or more blocks per row

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NBPC	<u>Number of Blocks per Column</u> This field shall contain the number of image blocks in a column of blocks in the vertical direction.	4	BCS-N 0001 to 9999	R	<i>Indicates one or more blocks per column</i>
NPPBH	<u>Number of Pixels per Block Horizontal</u> This field shall contain the number of pixels horizontally for each block.	4	BCS-N 0001-8192 Or 0000 When count>8192	R	<i>Number of rows of the DTEM. Use 'large block' option when number of rows is greater than 8192.</i>
NPPBV	<u>Number of Pixels per Block Vertical</u> This field shall contain the number of pixels vertically for each block.	4	BCS-N 0001-8192 Or 0000 When count>8192	R	<i>Number of columns of the DTEM. Use 'large block' option when number of columns is greater than 8192.</i>
NBPP	<u>Number of Bits per Pixel per Band</u> This field shall contain the number of storage bits used for the value from each component of a pixel value.	2	BCS-N 16, 32	R	<i>16 when Signed Integer 32 when Real</i>
IDLVL	<u>Display Level</u> This field shall contain a valid value that indicates the graphic display level of the image relative to the other displayed file components.	3	BCS-N 001	R	<i>"001" – for the IM with the DTEM data.</i>
IALVL	<u>Attachment Level</u> This field shall contain a valid value that indicates the attachment level of the image.	3	BCS-N 000	R	<i>"000" – for the IM with the DTEM data.</i>
ILOC	<u>Image Location</u> This field shall contain the location of the first pixel of the first line of the image.	10	BCS-N 0000000000	R	<i>"0000000000"</i>
IMAG	<u>Image Magnification</u> This field shall contain the magnification factor of the image relative to the original source.	4	BCS-A 1.0	R	<i>"1.0"</i>
UDIDL	<u>User defined image data length</u> A value of BCS zeros (0x30) shall denote that no TREs are included in the UDID field.	5	BCS-N 00000	R	<i>"00000" No TREs are included.</i>
IXSHDL	<u>Extended subheader data length</u> A value of BCS zeros (0x30) shall denote that no TREs are included in the IXSHD field.	5	BCS-N 00000	R	<i>"00000" No TREs are included.</i>

A.5.3 Image Data Mask

An image data mask structure follows the image subheader when the Image Compression Field value is "NM". The image data mask identifies those data blocks containing one or more instances of a specified data value that requires special interpretation. The numerical

value of the special data value is specified by the NITF Image Data Mask Table, Pad Output Pixel Code (TPXCD) field. The designated special value can be located anywhere inside the significant image pixels defined by NROWS and NCOLS, and therefore impact the interpretation of the data. For HRE, the image data mask designates the “no-data value” used to indicate that a valid value is missing.

The structure of the image data mask is shown in Table A-4. When applicable, the image data mask is used with the HRE Post Height image subheader, the Random Error Scale Factors by Post image subheader, the Random Error Covariance by Post image subheader, and the Random Error Correlation Coefficients by Post image subheader.

Table A-4 Image Data Mask Table

FIELD	NAME	SIZE	VALUE RANGE	TYPE	COMMENTS
IMDATOFF	<u>Blocked Image Data Offset</u> . This field is included if the IC value contains M. It identifies the offset from the beginning of the Image Data Mask to the first byte of the blocked image data.	4	Unsigned binary integer 0 to 2^{32-1} 0x0000000F or 0x00000010 or 0x00000012	C	<i>For the single block case used for HRE image segments, the offset to the first byte of data depends on the size of the TPXCD field. The offsets (decimal) are: 15, 16, or 18.</i>
BMRLNTH	<u>Block Mask Record Length</u> . This field is included if the IC value contains M. It identifies the length of each Block Mask Record (BMRnBNDm) in bytes.	2	Unsigned binary integer 0x0000	C	<i>0x0000 denotes that no Block Mask Records are recorded.</i>
TMRLNTH	<u>Pad Pixel Mask Record Length</u> . This field is included if the IC value contains M. It identifies the length of each Pad Pixel Mask Record in bytes. When present, the length of each Pad Pixel Mask Record is 4 bytes. The total length of the Pad Pixel Mask Records is equal to TMRLN	2	Unsigned binary integer; 0x0004	C	<i>0x0004 denotes that Pad Pixel Mask Records (4 bytes each) are present.</i>
TPXCDLNTH	<u>Pad Output Pixel Code Length</u> . This field is included if the IC value contains M. It identifies the length in bits of the Pad Output Pixel Code.	2	Unsigned binary integer 0x0008 0x0010 0x0020	C	<i>Length must be as specified in NBPP for the applicable image segment. Allowed NBPP values (decimal) include: 08, 16, and 32.</i>

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TPXCD	<u>Pad Output Pixel Code.</u> This field is included if the IC value contains M and TPXCDLNTH is not zeros (0x0000). It contains the output pixel code that represents a pad pixel in the image. This value is unique within the image, and allows the user to identify pad pixels. The pad output pixel code length is determined by TPXCDLNTH.	1 or 2 or 4	For PVTTYPE=INT and NBPP=08: 0xFF For PVTTYPE=SI and NBPP=16: 0x8001 For PVTTYPE=R and NBPP=32: 0xFFFFFFFF	C	<i>The SIZE (in bytes) of the field is determined by the NBPP value: 1 when NBPP=08 2 when NBPP=16 4 when NBPP=32 The designated 'no-data' values (decimal) are: 8-bit INT: 255 16-bit SI: -32767 32-bit R: 'Not a number'</i>
TMRnBNDm	<u>Pad Pixel n, Band m.</u> This field shall contain the nth Pad Pixel Mask Record for band m. It is recorded/transmitted only if the TMRLNTH field does not contain zeros (0x0000). The field shall contain an offset in bytes from the beginning of the Blocked Image Data to the first byte of block n of the image data of band m if block n contains pad pixels, or the default value 0xFFFFFFFF to indicate that this block does not contain pad pixels.	4	Unsigned binary integer 0xn n n n n n n n n	C	<i>For IMODEs B and P: Increment n only; m is always 1. For HRE, since the data is always a single block, n is also always 1. For HRE, since the data is always a single block, the offset recorded in this field is the same as that recorded in the IMDATOFF field.</i>

A.6 Rigorous Error Propagation Regions

A.6.1 Rigorous Error Propagation Regions

This image segment is comprised of the standard NITF 2.10 Image Subheader information and rigorous error propagation post-by-post region definition data. This is an optional image segment, since the regions may also be defined by specifying polygon boundaries in the XML_DATA_CONTENT DES. The DES specifies which of these two methods of defining the regions is being used. Regions (a minimum of one) are always defined for error propagation metadata since this is how the systematic error covariance data is specified. In addition, the regions can be used in defining the random error nominal covariance terms.

A.6.2 Image Subheader

This section describes the fields and contents within the IM subheader. For the rigorous error propagation region definition, this IM subheader will contain the values designated in Table A-5. Metadata associated with the rigorous error propagation region data is contained in the XML_DATA_CONTENT DES.

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Table A-5 Error Propagation Regions Image Subheader Format

(Type "R"=Required, "C" = Conditional, "<>" BCS Spaces allowed for entire field)

FIELD	NAME	SIZE	VALUE RANGE	TYPE	COMMENTS
IM	<u>File Part Type</u> This field shall contain the characters "IM" to identify the subheader as an image subheader.	2	BCS-A IM	R	"IM"
IID1	<u>Image ID1</u> This field shall contain a valid alphanumeric identification code associated with the image	10	BCS-A EP_REGIONS	R	Short name that identifies the error propagation regions segment – "EP_REGIONS"
IDATIM	<u>Image Date & Time</u> This field shall contain the time (UTC) of the image acquisition.	14	BCS-N DDHHMMSSZMONYY	R	Date/Time that this image segment was created
TGTID	<u>Target ID</u> This field shall contain the identification of the primary target.	17	BCS-A (17 space characters)	<R>	Default – BCS Spaces
IID2	<u>Image IID2</u> This field contains the identification of additional information about the image.	80	BCS-A REGLlyyyymmdd	R	Unique identifier for the rigorous error propagation Regions definition Segment. This MUST match the corresponding value found in the PIAPRD TRE field ATEXT of the file header.
ISCLAS	<u>Image Security Classification</u> This field shall contain a valid value representing the classification level of the image. Valid values are T, S, C, R, and U.	1	BCS-A T, S, C, R, U	R [PSG]	For fields ISCLAS through ISCTLN, consult Production Specific Guidance (PSG) for applicable security field population values.
ISCLSY	<u>Image Security Classification System</u> This field shall contain valid values indicating the national or multinational security system used to classify the image. Country Codes per FIPS 10-4 shall be used to indicate national security systems; codes found in DIAM 65-19 shall be used to indicate multinational security systems.	2	BCS-A US Note: As an option, this field may contain two space characters when the FSCLAS value is 'U'.	<R> [PSG]	Refer to MIL-STD-2500C for general description of these fields. Consult current security guidelines at the time of production to determine proper markings.

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ISCODE	<u>Image Codewords</u>	11	BCS-A	<R> [PSG]	Consult current security guidelines at the time of production to determine proper markings.
ISCTLH	<u>Image Control and Handling</u>	2	BCS-A	<R> [PSG]	Consult current security guidelines at the time of production to determine proper markings.
ISREL	<u>Image Releasing Instructions</u>	20	BCS-A	<R> [PSG]	Consult current security guidelines at the time of production to determine proper markings.
ISDCTP	<u>Image Declassification Type</u>	2	BCS-A	<R> [PSG]	Consult current security guidelines at the time of production to determine proper markings.
ISDCDT	<u>Image Declassification Date</u>	8	BCS-A CCYYMMDD	<R> [PSG]	Consult current security guidelines at the time of production to determine proper markings.
ISDCXM	<u>Image Declassification Exemption</u>	4	BCS-A	<R> [PSG]	Consult current security guidelines at the time of production to determine proper markings.
ISDG	<u>Image Downgrade</u>	1	BCS-A	<R> [PSG]	Consult current security guidelines at the time of production to determine proper markings.
ISDGD	<u>Image Downgrade Date</u>	8	BCS-A CCYYMMDD	<R> [PSG]	Consult current security guidelines at the time of production to determine proper markings.
ISCLTX	<u>Image Downgrade Text</u>	43	BCS-A	<R> [PSG]	Consult current security guidelines at the time of production to determine proper markings.
ISCATP	<u>Image Classification Authority Type</u>	1	BCS-A	<R> [PSG]	Consult current security guidelines at the time of production to determine proper markings.
ISCAUT	<u>Image Classification Authority</u>	40	BCS-A	<R> [PSG]	Consult current security guidelines at the time of production to determine proper markings.
ISCRSN	<u>Image Classification Reason</u>	1	BCS-A	<R> [PSG]	Consult current security guidelines at the time of production to determine proper markings.
ISCRDT	<u>Image Security Source Date</u>	8	BCS-A CCYYMMDD	<R> [PSG]	Consult current security guidelines at the time of production to determine proper markings.
ISCTLN	<u>Image Security Control Number</u>	15	BCS-A	<R> [PSG]	Consult current security guidelines at the time of production to determine proper markings.
ENCRYP	<u>Encryption</u> This field shall contain the value BCS zero (0x30).	1	BCS-N 0	R	"0" Not encrypted.

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ISORCE	<u>Image Source</u> This field shall contain a description of the source of the image.	42	BCS-A	<R> [PSG]	<i>The source of the matrix data.</i> <i>*When classified, the description shall be preceded by the classification, including codewords.</i>
NROWS	<u>Number of Significant Rows in Image</u> This field shall contain the total number of rows of significant pixels in the in the image.	8	BCS-N 00000001 to 99999999	R	<i>Number of rows in the region data. This will match exactly the number or rows specified in the associated DTEM.</i>
NCOLS	<u>Number of Significant Columns in Image</u> This field shall contain the total number of columns of significant pixels in the image.	8	BCS-N 00000001 to 99999999	R	<i>Number of columns in the region data. This will match exactly the number or columns specified in the associated DTEM.</i>
PVTYPE	<u>Pixel Value Type</u> This field shall contain an indicator of the type of computer representation used for the value for each pixel for each band in the image.	3	BCS-A INT	R	<i>"INT" – indicating integer</i>
IREP	<u>Image Representation</u> This field shall contain a valid indicator of the processing required in order to display an image.	8	BCS-A NODISPLY	R	<i>"NODISPLY" Indicating data not intended for display.</i>
ICAT	<u>Image Category</u> This field shall contain a valid indicator of the specific category of image, raster or grid data.	8	BCS-A MATR	R	<i>"MATR"- indicating Matrix Data</i>
ABPP	<u>Actual Bits-Per-Pixel Per Band</u> This field contains the number of significant bits for the value in each band of each pixel without compression.	2	BCS-N 08	R	<i>08</i>
PJUST	<u>Pixel Justification</u> When ABPP is not equal to NBPP, this field indicates whether the significant bits are left justified or right justified.	1	BCS-A R	R	<i>"R" – indicating Right Justified</i>
ICORDS	<u>Image Coordinate System</u> This field shall contain a valid code indicating the type of coordinate system used for providing an approximate location of the image in the Image Geographic Location field (IGEOL)	1	BCS-A D, N, S	<R>	<i>"D"- indicating geodetic decimal degrees (for HRE level 1) or "N" or "S" indicating UTM North or South (for HRE levels 2-8)</i>

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IGEOL0	<u>Image Geographic Location</u> This field shall contain an approximate geographic location, in terms of corner locations, of the image in the coordinate system specified in the ICORDS field.	60	BCS-N $\pm dd.ddd \pm ddd.ddd$ (four times) or zzeeeeennnnnnn (four times)	C	<i>This value will match the value of the IGEOL0 field in the HRE Post Height Image Subheader (see Table A-3).</i>
NICOM	<u>Number of Image Comments</u> This field shall contain the number of image comment fields to follow.	1	BCS-N 0	R	"0"
IC	<u>Image Compression</u> This field contains a valid code indicating the form of compression used in representing the image data.	2	BCS-A NC	R	"NC" – indicating Not Compressed
NBANDS	<u>Number of Bands</u> This field shall contain the number of data bands within the specified image.	1	BCS-A 1	R	"1" – indicating one band (Post-by-Post region identifier)
IREPBAND1	<u>1st Band Representation</u> This field contains a valid indicator of the interpretation of the nn th band.	2	BCS-A (2 space characters)	<C>	Default – BCS Spaces
ISUBCAT1	<u>1st Band Significance for Image Category</u> This field provides the significance of the nn th band of the image.	6	BCS-A (6 space characters)	<R>	Fill with BCS spaces
IFC1	<u>1st Band Image Filter Condition</u> This field shall contain the value N (to represent none).	1	BCS-A N	R	"N" – indicating no band filter condition
IMFLT1	<u>1st Band Standard Image Filter Code</u> Reserved for future use.	3	BCS-A (3 space characters)	<R>	Default – BCS Spaces
NLUTS1	<u>Number of Look-up Tables for the 1st Band</u> This field shall contain the number of LUTs associated with the nth band of the image.	1	BCS-A 0	<R>	"0" – indicating the number of lookup tables
ISYNC	<u>Image Sync Code</u> This field shall contain BCS zero (0x30)	1	BCS-N 0	R	"0" – no sync code
IMODE	<u>Image Mode</u> This field shall contain an indicator of whether the image bands are stored sequentially, or band interleaved by block, or band interleaved by pixel, or band interleaved by row.	1	BCS-A B	R	"B" – indicating data is stored band interleaved by block.

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NBPR	<u>Number of Blocks per Row</u> This field shall contain the number of image blocks in a row of blocks in the horizontal direction.	4	BCS-N 0001 to 9999	R	<i>Indicates one or more blocks per row</i>
NBPC	<u>Number of Blocks per Column</u> This field shall contain the number of image blocks in a column of blocks in the vertical direction.	4	BCS-N 0001 to 9999	R	<i>Indicates one or more blocks per column</i>
NPPBH	<u>Number of Pixels per Block Horizontal</u> This field shall contain the number of pixels horizontally for each block.	4	BCS-N 0001-8192 Or 0000 When count>8192	R	<i>Number of rows of the data. Use 'large block' option when number of rows is greater than 8192.</i>
NPPBV	<u>Number of Pixels per Block Vertical</u> This field shall contain the number of pixels vertically for each block.	4	BCS-N 0001-8192 Or 0000 When count>8192	R	<i>Number of columns of the data. Use 'large block' option when number of columns is greater than 8192.</i>
NBPP	<u>Number of Bits per Pixel per Band</u> This field shall contain the number of storage bits used for the value from each component of a pixel value.	2	BCS-N 08	R	<i>"08" – Number of bits per pixel per band</i>
IDLVL	<u>Display Level</u> This field shall contain a valid value that indicates the graphic display level of the image relative to the other displayed file components.	3	BCS-N 002	R	<i>"002"</i>
IALVL	<u>Attachment Level</u> This field shall contain a valid value that indicates the attachment level of the image.	3	BCS-N 001	R	<i>"001" – indicating that the region data segment (002) is attached to the HRE DTEM Post Height segment (001)</i>
ILOC	<u>Image Location</u> This field shall contain the location of the first pixel of the first line of the image.	10	BCS-N 0000000000	R	<i>"0000000000"</i>
IMAG	<u>Image Magnification</u> This field shall contain the magnification factor of the image relative to the original source.	4	BCS-A 1.0	R	<i>"1.0 "</i>
UDIDL	<u>User defined image data length</u>	5	BCS-N 00000	R	<i>"00000" No TREs are included.</i>
IXSHDL	<u>Extended subheader data length</u>	5	BCS-N 00000	R	<i>"00000" No TREs are included.</i>

A.7 Rigorous Error Propagation Random Error Scale Factors By Post

A.7.1 Random Error Scale Factors By Post

This image segment is comprised of the standard NITF 2.10 Image Subheader information and random error scale factors by post data. These scale factors are used in conjunction with region by region nominal random error covariance matrices defined in the XML_DATA_CONTENT DES.

A.7.2 Image Subheader

This section describes the fields and contents within the IM subheader. For the random error scale factors by post data, this IM subheader will contain the values designated in Table A-6. Metadata associated with the random error scale factors by post data is contained in the XML_DATA_CONTENT DES.

Table A-6 Random Error Post Scale Factors Image Subheader
(Type "R"=Required, "C" = Conditional, "<>" BCS Spaces allowed for entire field)

FIELD	NAME	SIZE	VALUE RANGE	TYPE	COMMENTS
IM	<u>File Part Type</u> This field shall contain the characters "IM" to identify the subheader as an image subheader.	2	BCS-A IM	R	"IM"
IID1	<u>Image ID1</u> This field shall contain a valid alphanumeric identification code associated with the image	10	BCS-A RE_POST_SF	R	Short name that identifies this segment – "RE_POST_SF"
IDATIM	<u>Image Date & Time</u> This field shall contain the time (UTC) of the image acquisition.	14	BCS-N DDHHMMSSZMONYY	R	Date/Time that the random error scale factor data was created
TGTID	<u>Target ID</u> This field shall contain the identification of the primary target.	17	BCS-A (17 space characters)	<R>	Default – BCS Spaces
IID2	<u>Image IID2</u> This field contains the identification of additional information about the image.	80	BCS-A RSFLlyyyymmdd	<R>	Unique identifier for the Random Error Scale factors Segment. This MUST match the corresponding value found in the PIAPRD TRE field ATEXT of the file header.

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ISCLAS	<u>Image Security Classification</u>	1	BCS-A T, S, C, R, U	R [PSG]	<i>For fields ISCLAS through ISCTLN, consult Production Specific Guidance (PSG) for applicable security field population values.</i>
ISCLSY	<u>Image Security Classification System</u>	2	BCS-A US Note: As an option, this field may contain two space characters when the FSCLAS value is 'U'.	<R> [PSG]	<i>Refer to MIL-STD-2500C for general description of these fields. Consult current security guidelines at the time of production to determine proper markings.</i>
ISCODE	<u>Image Codewords</u>	11	BCS-A	<R> [PSG]	<i>Consult current security guidelines at the time of production to determine proper markings.</i>
ISCTLH	<u>Image Control and Handling</u>	2	BCS-A	<R> [PSG]	<i>Consult current security guidelines at the time of production to determine proper markings.</i>
ISREL	<u>Image Releasing Instructions</u>	20	BCS-A	<R> [PSG]	<i>Consult current security guidelines at the time of production to determine proper markings.</i>
ISDCTP	<u>Image Declassification Type</u>	2	BCS-A	<R> [PSG]	<i>Consult current security guidelines at the time of production to determine proper markings.</i>
ISDCDT	<u>Image Declassification Date</u>	8	BCS-A CCYYMMDD	<R> [PSG]	<i>Consult current security guidelines at the time of production to determine proper markings.</i>
ISDCXM	<u>Image Declassification Exemption</u>	4	BCS-A	<R> [PSG]	<i>Consult current security guidelines at the time of production to determine proper markings.</i>
ISDGG	<u>Image Downgrade</u>	1	BCS-A	<R> [PSG]	<i>Consult current security guidelines at the time of production to determine proper markings.</i>
ISDGGT	<u>Image Downgrade Date</u>	8	BCS-A CCYYMMDD	<R> [PSG]	<i>Consult current security guidelines at the time of production to determine proper markings.</i>
ISCLTX	<u>Image Downgrade Text</u>	43	BCS-A	<R> [PSG]	<i>Consult current security guidelines at the time of production to determine proper markings.</i>
ISCATP	<u>Image Classification Authority Type</u>	1	BCS-A	<R> [PSG]	<i>Consult current security guidelines at the time of production to determine proper markings.</i>
ISCAUT	<u>Image Classification Authority</u>	40	BCS-A	<R> [PSG]	<i>Consult current security guidelines at the time of production to determine proper markings.</i>
ISCRSN	<u>Image Classification Reason</u>	1	BCS-A	<R> [PSG]	<i>Consult current security guidelines at the time of production to determine proper markings.</i>

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ISCRDT	<u>Image Security Source Date</u>	8	BCS-A CCYYMMDD	<R> [PSG]	Consult current security guidelines at the time of production to determine proper markings.
ISCTLN	<u>Image Security Control Number</u>	15	BCS-A	<R> [PSG]	Consult current security guidelines at the time of production to determine proper markings.
ENCRYP	<u>Encryption</u> This field shall contain the value BCS zero (0x30).	1	BCS-N 0	R	"0" Not encrypted.
ISORCE	<u>Image Source</u> This field shall contain a description of the source of the image.	42	BCS-A	<R> [PSG]	The source of the matrix data. *When classified, the description shall be preceded by the classification, including codewords.
NROWS	<u>Number of Significant Rows in Image</u> This field shall contain the total number of rows of significant pixels in the in the image.	8	BCS-N 00000001 to 99999999.	R	Number of rows in the random error scale factor data. This will match exactly the number or rows specified in the associated DTEM.
NCOLS	<u>Number of Significant Columns in Image</u> This field shall contain the total number of columns of significant pixels in the image.	8	BCS-N 00000001 to 99999999	R	Number of columns in the random error scale factor data. This will match exactly the number or columns specified in the associated DTEM.
PVTYPE	<u>Pixel Value Type</u> This field shall contain an indicator of the type of computer representation used for the value for each pixel for each band in the image.	3	BCS-A R	R	"R" – indicating real
IREP	<u>Image Representation</u> This field shall contain a valid indicator of the processing required in order to display an image.	8	BCS-A NODISPLY	R	"NODISPLY" Indicating data not intended for display.
ICAT	<u>Image Category</u> This field shall contain a valid indicator of the specific category of image, raster or grid data.	8	BCS-A MATR	R	"MATR"- indicating Matrix Data
ABPP	<u>Actual Bits-Per-Pixel Per Band</u> This field contains the number of significant bits for the value in each band of each pixel without compression.	2	BCS-N 32	R	32
PJUST	<u>Pixel Justification</u> When ABPP is not equal to NBPP, this field indicates whether the significant bits are left justified or right justified.	1	BCS-A R	R	"R" – indicating Right Justified

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ICORDS	<u>Image Coordinate System</u> This field shall contain a valid code indicating the type of coordinate system used for providing an approximate location of the image in the Image Geographic Location field (IGEOL)	1	BCS-A D, N, S	<R>	"D"- indicating geodetic decimal degrees (for HRE level 1) or "N" or "S" indicating UTM North or South (for HRE levels 2-8)
IGEOL	<u>Image Geographic Location</u> This field shall contain an approximate geographic location, in terms of corner locations, of the image in the coordinate system specified in the ICORDS field.	60	BCS-N $\pm dd.ddd \pm ddd.ddd$ (four times) or zzeeeeennnnnnn (four times)	C	This value will match the value of the IGEOL field in the HRE Post Height Image Subheader (see Table A-3).
NICOM	<u>Number of Image Comments</u> This field shall contain the number of image comment fields to follow.	1	BCS-N 0	R	"0"
IC	<u>Image Compression</u> This field contains a valid code indicating the form of compression used in representing the image data.	2	BCS-A NC, NM	R [PSG]	"NC" – indicating Not Compressed "NM" – indicating use of a pixel mask table.
NBANDS	<u>Number of Bands</u> This field shall contain the number of data bands within the specified image.	1	BCS-A 1	R	"1" – indicating one band (random error scale factor data)
IREPBAND1	<u>1st Band Representation</u> This field contains a valid indicator of the interpretation of the n th band.	2	BCS-A (2 space characters)	<C>	Default – BCS Spaces
ISUBCAT1	<u>1st Band Significance for Image Category</u> This field provides the significance of the n th band of the image.	6	BCS-A (6 space characters)	<R>	Fill with BCS spaces
IFC1	<u>1st Band Image Filter Condition</u> This field shall contain the value N (to represent none).	1	BCS-A N	R	"N" – indicating no band filter condition
IMFLT1	<u>1st Band Standard Image Filter Code</u> Reserved for future use.	3	BCS-A (3 space characters)	<R>	Default – BCS Spaces
NLUTS1	<u>Number of Look-up Tables for the 1st Band</u> This field shall contain the number of LUTs associated with the nth band of the image.	1	BCS-A 0	<R>	"0" – indicating the number of lookup tables
ISYNC	<u>Image Sync Code</u> This field shall contain BCS zero (0x30)	1	BCS-N 0	R	"0" – no sync code

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IMODE	<u>Image Mode</u> This field shall contain an indicator of whether the image bands are stored sequentially, or band interleaved by block, or band interleaved by pixel, or band interleaved by row.	1	BCS-A B	R	"B" – indicating data is stored band interleaved by block.
NBPR	<u>Number of Blocks per Row</u> This field shall contain the number of image blocks in a row of blocks in the horizontal direction.	4	BCS-N 0001 to 9999	R	Indicates one or more blocks per row
NBPC	<u>Number of Blocks per Column</u> This field shall contain the number of image blocks in a column of blocks in the vertical direction.	4	BCS-N 0001 to 9999	R	Indicates one or more blocks per column
NPPBH	<u>Number of Pixels per Block Horizontal</u> This field shall contain the number of pixels horizontally for each block.	4	BCS-N 0001-8192 Or 0000 When count>8192	R	Number of rows of the data. Use 'large block' option when number of rows is greater than 8192.
NPPBV	<u>Number of Pixels per Block Vertical</u> This field shall contain the number of pixels vertically for each block.	4	BCS-N 0001-8192 Or 0000 When count>8192	R	Number of columns of the data. Use 'large block' option when number of columns is greater than 8192.
NBPP	<u>Number of Bits per Pixel per Band</u> This field shall contain the number of storage bits used for the value from each component of a pixel value.	2	BCS-N 32	R	"32" – Number of bits per pixel per band
IDLVL	<u>Display Level</u> This field shall contain a valid value that indicates the graphic display level of the image relative to the other displayed file components.	3	BCS-N 003	R	"003"
IALVL	<u>Attachment Level</u> This field shall contain a valid value that indicates the attachment level of the image.	3	BCS-N 001	R	"001" – indicating that the scale factor segment (003) is attached to the DTEM Post segment (001)
ILOC	<u>Image Location</u> This field shall contain the location of the first pixel of the first line of the image.	10	BCS-N 0000000000	R	"0000000000"
IMAG	<u>Image Magnification</u> This field shall contain the magnification factor of the image relative to the original source.	4	BCS-A 1.0	R	"1.0 "
UDIDL	<u>User defined image data length</u>	5	BCS-N 00000	R	"00000" No TREs are included.
IXSHDL	<u>Extended subheader data length</u>	5	BCS-N 00000	R	"00000" No TREs are included.

A.8 Rigorous Error Propagation Random Error Covariance By Post

A.8.1 Random Error Covariance By Post

This image segment is comprised of the standard NITF 2.10 image subheader information and the random error covariance by post data. The random error covariance data are input as standard deviation terms that when squared, make up the diagonal terms of the random error covariance matrices. The presence of this image segment is defined in the accompanying XML_DATA_CONTENT DES. When this image segment is being used to specify a per-post random error covariance matrix, the random error covariance by post image segment is always accompanied by a random error correlation coefficients by post image segment (Section 9). Dividing the random error covariance matrix terms between two image segments permits different levels of precision to be specified for each in an attempt to minimize file size.

A.8.2 Image Subheader

This section describes the fields and contents within the IM subheader. For the random error covariance by post data, this IM subheader will contain the values designated in Table A-7. Metadata associated with the random error covariance by post data is contained in the XML_DATA_CONTENT DES.

Table A-7 Random Error Covariance Image Subheader

(Type "R"=Required, "C" = Conditional, "<>" BCS Spaces allowed for entire field)

FIELD	NAME	SIZE	VALUE RANGE	TYPE	COMMENTS
IM	<u>File Part Type</u> This field shall contain the characters "IM" to identify the subheader as an image subheader.	2	BCS-A IM	R	"IM"
IID1	<u>Image ID1</u> This field shall contain a valid alphanumeric identification code associated with the image	10	BCS-A COVARIANCE	R	Short name that identifies this segment – "COVARIANCE"
IDATIM	<u>Image Date & Time</u> This field shall contain the time (UTC) of the image acquisition.	14	BCS-N DDHHMMSSZMONYY	R	Date/Time that the random error covariance data was created
TGTID	<u>Target ID</u> This field shall contain the identification of the primary target.	17	BCS-A (17 space characters)	<R>	Default – BCS Spaces

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IID2	<u>Image IID2</u> This field contains the identification of additional information about the image.	80	BCS-A COVLLyyyyymmdd	<R>	<i>Unique identifier for the Random Error Covariance Segment. This MUST match the corresponding value found in the PIAPRD TRE field ATEXT of the file header.</i>
ISCLAS	<u>Image Security Classification</u>	1	BCS-A T, S, C, R, U	R [PSG]	<i>For fields ISCLAS through ISCTLN, consult Production Specific Guidance (PSG) for applicable security field population values.</i>
ISCLSY	<u>Image Security Classification System</u>	2	BCS-A US Note: As an option, this field may contain two space characters when the FSCLAS value is 'U'.	<R> [PSG]	<i>Refer to MIL-STD-2500C for general description of these fields. Consult current security guidelines at the time of production to determine proper markings.</i>
ISCODE	<u>Image Codewords</u>	11	BCS-A	<R> [PSG]	<i>Consult current security guidelines at the time of production to determine proper markings.</i>
ISCTLH	<u>Image Control and Handling</u>	2	BCS-A	<R> [PSG]	<i>Consult current security guidelines at the time of production to determine proper markings.</i>
ISREL	<u>Image Releasing Instructions</u>	20	BCS-A	<R> [PSG]	<i>Consult current security guidelines at the time of production to determine proper markings.</i>
ISDCTP	<u>Image Declassification Type</u>	2	BCS-A	<R> [PSG]	<i>Consult current security guidelines at the time of production to determine proper markings.</i>
ISDCDT	<u>Image Declassification Date</u>	8	BCS-A CCYYMMDD	<R> [PSG]	<i>Consult current security guidelines at the time of production to determine proper markings.</i>
ISDCXM	<u>Image Declassification Exemption</u>	4	BCS-A	<R> [PSG]	<i>Consult current security guidelines at the time of production to determine proper markings.</i>
ISDGG	<u>Image Downgrade</u>	1	BCS-A	<R> [PSG]	<i>Consult current security guidelines at the time of production to determine proper markings.</i>
ISDGGT	<u>Image Downgrade Date</u>	8	BCS-A CCYYMMDD	<R> [PSG]	<i>Consult current security guidelines at the time of production to determine proper markings.</i>
ISCLTX	<u>Image Downgrade Text</u>	43	BCS-A	<R> [PSG]	<i>Consult current security guidelines at the time of production to determine proper markings.</i>
ISCATP	<u>Image Classification Authority Type</u>	1	BCS-A	<R> [PSG]	<i>Consult current security guidelines at the time of production to determine proper markings.</i>
ISCAUT	<u>Image Classification Authority</u>	40	BCS-A	<R> [PSG]	<i>Consult current security guidelines at the time of production to determine proper markings.</i>

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ISCRSN	<u>Image Classification Reason</u>	1	BCS-A	<R> [PSG]	Consult current security guidelines at the time of production to determine proper markings.
ISCRDT	<u>Image Security Source Date</u>	8	BCS-A	<R> [PSG]	Consult current security guidelines at the time of production to determine proper markings.
ISCTLN	<u>Image Security Control Number</u>	15	BCS-A	<R> [PSG]	Consult current security guidelines at the time of production to determine proper markings.
ENCRYPT	<u>Encryption</u> This field shall contain the value BCS zero (0x30).	1	BCS-N 0	R	"0" Not encrypted.
ISORCE	<u>Image Source</u> This field shall contain a description of the source of the image.	42	BCS-A	<R> [PSG]	The source of the matrix data. *When classified, the description shall be preceded by the classification, including codewords.
NROWS	<u>Number of Significant Rows in Image</u> This field shall contain the total number of rows of significant pixels in the in the image.	8	BCS-N 00000001 to 99999999	R	Number of rows in the random error covariance data. This will match exactly the number or rows specified in the associated DTEM.
NCOLS	<u>Number of Significant Columns in Image</u> This field shall contain the total number of columns of significant pixels in the image.	8	BCS-N 00000001 to 99999999	R	Number of columns in the random error covariance data. This will match exactly the number or columns specified in the associated DTEM.
PVTYPE	<u>Pixel Value Type</u> This field shall contain an indicator of the type of computer representation used for the value for each pixel for each band in the image.	3	BCS-A R	R	"R" – indicating real
IREF	<u>Image Representation</u> This field shall contain a valid indicator of the processing required in order to display an image.	8	BCS-A NODISPLY	R	"NODISPLY" Indicating data not intended for display.
ICAT	<u>Image Category</u> This field shall contain a valid indicator of the specific category of image, raster or grid data.	8	BCS-A MATR	R	"MATR"- indicating Matrix Data
ABPP	<u>Actual Bits-Per-Pixel Per Band</u> This field contains the number of significant bits for the value in each band of each pixel without compression.	2	BCS-N 32	R	32

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PJUST	<u>Pixel Justification</u> When ABPP is not equal to NBPP, this field indicates whether the significant bits are left justified or right justified.	1	BCS-A R	R	"R" – indicating Right Justified
ICORDS	<u>Image Coordinate System</u> This field shall contain a valid code indicating the type of coordinate system used for providing an approximate location of the image in the Image Geographic Location field (IGEOL).	1	BCS-A D, N, S	<R>	"D" – indicating geodetic decimal degrees (for HRE level 1) or "N" or "S" indicating UTM North or South (for HRE levels 2-8)
IGEOL	<u>Image Geographic Location</u> This field shall contain an approximate geographic location, in terms of corner locations, of the image in the coordinate system specified in the ICORDS field.	60	BCS-N $\pm dd.ddd\pm ddd.ddd$ (four times) or zzeeeeennnnnnn (four times)	C	This value will match the value of the IGEOL field in the HRE Post Height Image Subheader (see Table A-3).
NICOM	<u>Number of Image Comments</u> This field shall contain the number of image comment fields to follow.	1	BCS-N 0	R	"0"
IC	<u>Image Compression</u> This field contains a valid code indicating the form of compression used in representing the image data.	2	BCS-A NC, NM	R [PSG]	"NC" – indicating Not Compressed "NM" – indicating use of a pixel mask table.
NBANDS	<u>Number of Bands</u> This field shall contain the number of data bands within the specified image.	1	BCS-A 3	R	"3" – indicating three bands (random error covariance data)
IREPBANDn	<u>nth Band Representation</u> This field contains a valid indicator of the interpretation of the n th band.	2	BCS-A (2 space characters)	<C>	Default – BCS Spaces
ISUBCATn	<u>nth Band Significance for Image Category</u> This field provides the significance of the n th band of the image.	6	BCS-A (6 space characters)	<R>	Fill with BCS spaces
IFCn	<u>nth Band Image Filter Condition</u> This field shall contain the value N (to represent none).	1	BCS-A N	R	"N" – indicating no band filter condition
IMFLTn	<u>nth Band Standard Image Filter Code</u> Reserved for future use.	3	BCS-A (3 space characters)	<R>	Default – BCS Spaces
NLUTSn	<u>Number of Look-up Tables for the nth Band</u> This field shall contain the number of LUTs associated with the nth band of the image.	1	BCS-A 0	<R>	"0" – indicating the number of lookup tables
ISYNC	<u>Image Sync Code</u> This field shall contain BCS zero (0x30)	1	BCS-N 0	R	"0" – no sync code

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IMODE	<u>Image Mode</u> This field shall contain an indicator of whether the image bands are stored sequentially, or band interleaved by block, or band interleaved by pixel, or band interleaved by row.	1	BCS-A P	R	"P" – indicating data is stored band interleaved by pixel.
NBPR	<u>Number of Blocks per Row</u> This field shall contain the number of image blocks in a row of blocks in the horizontal direction.	4	BCS-N 0001 to 9999	R	Indicates one or more blocks per row
NBPC	<u>Number of Blocks per Column</u> This field shall contain the number of image blocks in a column of blocks in the vertical direction.	4	BCS-N 0001 to 9999	R	Indicates one or more blocks per column
NPPBH	<u>Number of Pixels per Block Horizontal</u> This field shall contain the number of pixels horizontally for each block.	4	BCS-N 0001-8192 Or 0000 When count>8192	R	Number of rows of the data. Use 'large block' option when number of rows is greater than 8192.
NPPBV	<u>Number of Pixels per Block Vertical</u> This field shall contain the number of pixels vertically for each block.	4	BCS-N 0001-8192 Or 0000 When count>8192	R	Number of columns of the data. Use 'large block' option when number of columns is greater than 8192.
NBPP	<u>Number of Bits per Pixel per Band</u> This field shall contain the number of storage bits used for the value from each component of a pixel value.	2	BCS-N 32	R	"32" – Number of bits per pixel per band
IDLVL	<u>Display Level</u> This field shall contain a valid value that indicates the graphic display level of the image relative to the other displayed file components.	3	BCS-N 004	R	"004"
IALVL	<u>Attachment Level</u> This field shall contain a valid value that indicates the attachment level of the image.	3	BCS-N 001	R	"001" – indicating that the random error covariance segment (004) is attached to the DTEM Post segment (001)
ILOC	<u>Image Location</u> This field shall contain the location of the first pixel of the first line of the image.	10	BCS-N 0000000000	R	"0000000000"
IMAG	<u>Image Magnification</u> This field shall contain the magnification factor of the image relative to the original source.	4	BCS-A 1.0	R	"1.0 "
UDIDL	<u>User defined image data length</u>	5	BCS-N 00000	R	"00000" No TREs are included.
IXSHDL	<u>Extended subheader data length</u>	5	BCS-N 00000	R	"00000" No TREs are included.

A.9 Rigorous Error Propagation Random Error Correlation Coefficients By Post

A.9.1 Random Error Correlation Coefficients By Post

This image segment is comprised of the standard NITF 2.10 Image Subheader information and random error correlation coefficients by post data. The random error correlation coefficient data (when multiplied by the corresponding diagonal term standard deviations) make up the off-diagonal terms of the random error covariance matrices. The presence of this image segment is defined in the accompanying XML_DATA_CONTENT DES. When this image segment is being used to specify a per-post random error covariance matrix, the random error correlation coefficients by post image segment is always accompanied with a random error covariance by post image segment (Section 8). Dividing the random error covariance matrix terms between two image segments permits different levels of precision to be specified for each in an attempt to minimize file size.

A.9.2 Image Subheader

This section describes the fields and contents within the IM subheader. For the random error correlation coefficients by post data, this IM subheader will contain the values designated in Table A-8.

Table A-8 Random Error Correlation Coefficient Image Subheader

(Type "R"=Required, "C" = Conditional, "<>" BCS Spaces allowed for entire field)

FIELD	NAME	SIZE	VALUE RANGE	TYPE	COMMENTS
IM	<u>File Part Type</u> This field shall contain the characters "IM" to identify the subheader as an image subheader.	2	BCS-A IM	R	"IM"
IID1	<u>Image ID1</u> This field shall contain a valid alphanumeric identification code associated with the image	10	BCS-A COREL_COEF	R	Short name that identifies this segment – "COREL_COEF"
IDATIM	<u>Image Date & Time</u> This field shall contain the time (UTC) of the image acquisition.	14	BCS-N DDHHMMSSZMONYY	R	Date/Time that the random error correlation coefficient data was created
TGTID	<u>Target ID</u> This field shall contain the identification of the primary target.	17	BCS-A (17 space characters)	<R>	Default – BCS Spaces

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IID2	<u>Image IID2</u> This field contains the identification of additional information about the image.	80	BCS-A CORLLyyyyymmdd	<R>	<i>Unique identifier for the Random Error Correlation Coefficient Segment. This MUST match the corresponding value found in the PIAPRD TRE field ATEXT of the file header.</i>
ISCLAS	<u>Image Security Classification</u>	1	BCS-A T, S, C, R, U	R [PSG]	<i>For fields ISCLAS through ISCTLN, consult Production Specific Guidance (PSG) for applicable security field population values.</i>
ISCLSY	<u>Image Security Classification System</u>	2	BCS-A US Note: As an option, this field may contain two space characters when the FSCLAS value is 'U'.	<R> [PSG]	<i>Refer to MIL-STD-2500C for general description of these fields. Consult current security guidelines at the time of production to determine proper markings..</i>
ISCODE	<u>Image Codewords</u>	11	BCS-A	<R> [PSG]	<i>Consult current security guidelines at the time of production to determine proper markings.</i>
ISCTLH	<u>Image Control and Handling</u>	2	BCS-A	<R> [PSG]	<i>Consult current security guidelines at the time of production to determine proper markings.</i>
ISREL	<u>Image Releasing Instructions</u>	20	BCS-A	<R> [PSG]	<i>Consult current security guidelines at the time of production to determine proper markings.</i>
ISDCTP	<u>Image Declassification Type</u>	2	BCS-A	<R> [PSG]	<i>Consult current security guidelines at the time of production to determine proper markings.</i>
ISDCDT	<u>Image Declassification Date</u>	8	BCS-A CCYYMMDD	<R> [PSG]	<i>Consult current security guidelines at the time of production to determine proper markings.</i>
ISDCXM	<u>Image Declassification Exemption</u>	4	BCS-A	<R> [PSG]	<i>Consult current security guidelines at the time of production to determine proper markings.</i>
ISDG	<u>Image Downgrade</u>	1	BCS-A	<R> [PSG]	<i>Consult current security guidelines at the time of production to determine proper markings.</i>
ISDGDT	<u>Image Downgrade Date</u>	8	BCS-A	<R> [PSG]	<i>Consult current security guidelines at the time of production to determine proper markings.</i>
ISCLTX	<u>Image Downgrade Text</u>	43	BCS-A	<R> [PSG]	<i>Consult current security guidelines at the time of production to determine proper markings.</i>
ISCATP	<u>Image Classification Authority Type</u>	1	BCS-A	<R> [PSG]	<i>Consult current security guidelines at the time of production to determine proper markings.</i>

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ISCAUT	<u>Image Classification Authority</u>	40	BCS-A	<R> [PSG]	Consult current security guidelines at the time of production to determine proper markings.
ISCRSN	<u>Image Classification Reason</u>	1	BCS-A	<R> [PSG]	Consult current security guidelines at the time of production to determine proper markings.
ISCRDT	<u>Image Security Source Date</u>	8	BCS-A CCYYMMDD.	<R> [PSG]	Consult current security guidelines at the time of production to determine proper markings.
ISCTLN	<u>Image Security Control Number</u>	15	BCS-A	<R> [PSG]	Consult current security guidelines at the time of production to determine proper markings.
ENCRYP	<u>Encryption</u> This field shall contain the value BCS zero (0x30).	1	BCS-N 0	R	"0" Not encrypted.
ISORCE	<u>Image Source</u> This field shall contain a description of the source of the image.	42	BCS-A	<R> [PSG]	The source of the matrix data. *When classified, the description shall be preceded by the classification, including codewords.
NROWS	<u>Number of Significant Rows in Image</u> This field shall contain the total number of rows of significant pixels in the in the image.	8	BCS-N 00000001 to 99999999	R	Number of rows in the random error correlation coefficient data. This will match exactly the number or rows specified in the associated DTEM.
NCOLS	<u>Number of Significant Columns in Image</u> This field shall contain the total number of columns of significant pixels in the image.	8	BCS-N 00000001 to 99999999	R	Number of columns in the random error correlation coefficient data. This will match exactly the number or columns specified in the associated DTEM.
PVTYPE	<u>Pixel Value Type</u> This field shall contain an indicator of the type of computer representation used for the value for each pixel for each band in the image.	3	BCS-A SI	R	"SI" – indicating signed integers. The integer values are within the range of -100 to 100 and represent percentage from -100% to 100%.
IREF	<u>Image Representation</u> This field shall contain a valid indicator of the processing required in order to display an image.	8	BCS-A NODISPLY	R	"NODISPLY" Indicating data not intended for display.
ICAT	<u>Image Category</u> This field shall contain a valid indicator of the specific category of image, raster or grid data.	8	BCS-A MATR	R	"MATR"- indicating Matrix Data

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ABPP	<u>Actual Bits-Per-Pixel Per Band</u> This field contains the number of significant bits for the value in each band of each pixel without compression.	2	BCS-N 8	R	8
PJUST	<u>Pixel Justification</u> When ABPP is not equal to NBPP, this field indicates whether the significant bits are left justified or right justified.	1	BCS-A R	R	"R" – indicating Right Justified
ICORDS	<u>Image Coordinate System</u> This field shall contain a valid code indicating the type of coordinate system used for providing an approximate location of the image in the Image Geographic Location field (IGEOL)	1	BCS-A D, N, S	<R>	"D"- indicating geodetic decimal degrees (for HRE level 1) or "N" or "S" indicating UTM North or South (for HRE levels 2-8)
IGEOL	<u>Image Geographic Location</u> This field shall contain an approximate geographic location, in terms of corner locations, of the image in the coordinate system specified in the ICORDS field.	60	BCS-N $\pm dd.ddd\pm ddd.ddd$ (four times) or zzeeeeennnnnnnn (four times)	C	This value will match the value of the IGEOL field in the HRE Post Height Image Subheader (see Table A-3).
NICOM	<u>Number of Image Comments</u> This field shall contain the number of image comment fields to follow.	1	BCS-N 0	R	"0"
IC	<u>Image Compression</u> This field contains a valid code indicating the form of compression used in representing the image data.	2	BCS-A NC, NM	R [PSG]	"NC" – indicating Not Compressed "NM" – indicating use of a pixel mask table.
NBANDS	<u>Number of Bands</u> This field shall contain the number of data bands within the specified image.	1	BCS-A 3	R	"3" – indicating three bands (random error correlation coefficient data)
IREFBANDn	<u>nth Band Representation</u> This field contains a valid indicator of the interpretation of the n th band.	2	BCS-A (2 space characters)	<C>	Default – BCS Spaces
ISUBCATn	<u>nth Band Significance for Image Category</u> This field provides the significance of the n th band of the image.	6	BCS-A (6 space characters)	<R>	Fill with BCS spaces
IFCn	<u>nth Band Image Filter Condition</u> This field shall contain the value N (to represent none).	1	BCS-A N	R	"N" – indicating no band filter condition
IMFLTn	<u>nth Band Standard Image Filter Code</u> Reserved for future use.	3	BCS-A (3 space characters)	<R>	Default – BCS Spaces

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NLUTSn	<u>Number of Look-up Tables for the nth Band</u> This field shall contain the number of LUTs associated with the nth band of the image.	1	BCS-A 0	<R>	"0" – indicating the number of lookup tables
ISYNC	<u>Image Sync Code</u> This field shall contain BCS zero (0x30)	1	BCS-N 0	R	"0" – no sync code
IMODE	<u>Image Mode</u> This field shall contain an indicator of whether the image bands are stored sequentially, or band interleaved by block, or band interleaved by pixel, or band interleaved by row.	1	BCS-A P	R	"P" – indicating data is stored band interleaved by pixel.
NBPR	<u>Number of Blocks per Row</u> This field shall contain the number of image blocks in a row of blocks in the horizontal direction.	4	BCS-N 0001 to 9999	R	Indicates one or more blocks per row
NBPC	<u>Number of Blocks per Column</u> This field shall contain the number of image blocks in a column of blocks in the vertical direction.	4	BCS-N 0001 to 9999	R	Indicates one or more blocks per column
NPPBH	<u>Number of Pixels per Block Horizontal</u> This field shall contain the number of pixels horizontally for each block.	4	BCS-N 0001-8192 Or 0000 When count>8192	R	Number of rows of the data. Use 'large block' option when number of rows is greater than 8192.
NPPBV	<u>Number of Pixels per Block Vertical</u> This field shall contain the number of pixels vertically for each block.	4	BCS-N 0001-8192 Or 0000 When count>8192	R	Number of columns of the data. Use 'large block' option when number of columns is greater than 8192.
NBPP	<u>Number of Bits per Pixel per Band</u> This field shall contain the number of storage bits used for the value from each component of a pixel value.	2	BCS-N 08	R	"8" – Number of bits per pixel per band
IDLVL	<u>Display Level</u> This field shall contain a valid value that indicates the graphic display level of the image relative to the other displayed file components.	3	BCS-N 005	R	"005"
IALVL	<u>Attachment Level</u> This field shall contain a valid value that indicates the attachment level of the image.	3	BCS-N 004	R	"004" – indicating that the random error correlation coefficient segment (004) is attached to the random error covariance segment (002)
ILOC	<u>Image Location</u> This field shall contain the location of the first pixel of the first line of the image.	10	BCS-N 0000000000	R	"0000000000"

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IMAG	<u>Image Magnification</u> This field shall contain the magnification factor of the image relative to the original source.	4	BCS-A 1.0	R	"1.0 "
UDIDL	<u>User defined image data length</u>	5	BCS-N 00000	R	"00000" No TREs are included.
IXSHDL	<u>Extended subheader data length</u>	5	BCS-N 00000	R	"00000" No TREs are included.

A.10 HRE Metadata

A.10.1 XML_Data_Content Data Extension Segment (DES)

Metadata associated with the DTEM data is contained in the XML_DATA_CONTENT DES. A single XML_DATA_CONTENT DES shall be included in every NITF-formatted HRE data file. This data extension segment is comprised of subheader information and XML-formatted metadata.

A.10.2 DES Subheader

This section describes the fields and contents within the DES subheader. For the HRE Metadata, this DES subheader will contain the values designated in Table A-9.

Note: For the security/classification marking fields, DECLAS through DESCTLN, the field descriptions have been removed from this table since they are shown in Table 1, and defined in Mil-Std-2500C.

Table A-9 XML_Data_Content DES Subheader

R = Required, A = Alphanumeric, N = Numeric,
<> = Designated Default Value Allowed

Field	Name/Description	Size	Value Range	Type
DE	<u>File Part Type</u> . This field shall contain the characters DE to identify the subheader as a data extension.	2	BCS-A DE	R
DESID	<u>Unique DES type identifier</u> . This field shall contain XML_DATA_CONTENT	25	BCS-A XML_DATA_CONTENT	R
DESVER	<u>Version of the data definition</u> . This field shall contain the alphanumeric version number of the use of the Tag. The version number is assigned as part of the registration process.	2	BCS-N positive integer 01	R
DECLAS through DESCTLN	Security classification fields are defined in Mil-Std-2500C	167	<i>For fields DECLAS through DESCCTLN, consult Production Specific Guidance (PSG) for applicable security field population values.</i>	R [PSG]

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Field	Name/Description	Size	Value Range	Type
DESSHL	<u>DES User-defined Subheader Length</u> This field shall contain the number of bytes in the field DESSHf. The field, DESSHf (DES User-defined Subheader Field), is comprised of the sub-fields DESCRC through DESSHABS specified below	4	BCS-N positive integer 0773	R
DESCRC	<u>Cyclic Redundancy Check</u> . This field contains the calculated CRC value for the content of the DESDATA field. A value of 99999 shall be used when CRC is not calculated.	5	BCS-N positive integer 999999	R
DESSHFT	<u>XML File Type</u> . Data in this field shall be representative of the XML File Type	8	BCS-A XML	R
DESSHDT	<u>Date and Time</u> . This field shall contain the time (UTC) (Zulu) of the XML file's origination in the format: YYYY-MM-DDThh:mm:ssZ, where YYYY is the year (0000-9999), MM is the month (01 to 12), DD is the day (01 to 31), T is the separator between date and time, hh is the hour (00 to 23), mm is the minute (00 to 59), and ss is the second (00 to 59). Z is the UTC time zone designator to express the time of day. The precision for recording the date and time is dictated by the user application and the field size constraint. Examples: 2007-04-12T11:45:20Z 2007-04-12T11:45Z 2007-04-12	20	BCS-A YYYY-MM-DDThh:mm:ssZ	R
DESSHRP	<u>Responsible Party – Organization Identifier</u> . Identification of the organization responsible for the content of the DES.	40	BCS-A National Geospatial-Intelligence Agency	R
DESSHSI	<u>Specification Identifier</u> . Name of the specification used for the XML data content.	60	BCS-A Implementation Profile for High Resolution Elevation (HRE) Products	R
DESSHSV	<u>Specification Version</u> . Version or edition of the specification.	10	BCS-A 1.0	R
DESSHSD	<u>Specification Date</u> . Version or edition date for the specification. See Date and Time description above.	20	BCS-A YYYY-MM-DDThh:mm:ssZ	R
DESSHTN	<u>Target Namespace</u> . Identification of the <i>target namespace</i> , if any, designated within the XML data content. Example: http://www.w3.org/2001/XMLSchema	120	BCS-A http://www.isotc211.org/2005/gmd	R
When the content of the DES is applicable to a geographic location, at least one of the three Location elements (Polygon, Point, Identifier) shall be recorded.				

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Field	Name/Description	Size	Value Range	Type
DESSLPG	<p><u>Location – Polygon.</u></p> <p>Five-point boundary enclosing the area applicable to the DES, expressed as the closed set of coordinates of the polygon (last point replicates first point). NOTE: This is only an approximate reference so specifying the coordinate reference system is unnecessary.</p> <p>Recorded as paired latitude and longitude values in decimal degrees with no separator. Each latitude and longitude value includes an explicit 'plus' or 'minus sign'.</p> <p>The precision for recording the values in the subheader is dictated by the field size constraint.</p>	125	<p>BCS-A</p> <p>Five pairs of longitude and latitude values.</p> <p>-90 to +90 latitude</p> <p>-180 to +360 longitude</p> <p>±dd.ddd±ddd.ddd d</p> <p>±dd.ddd±ddd.ddd d</p> <p>±dd.ddd±ddd.ddd d</p> <p>±dd.ddd±ddd.ddd d</p> <p>±dd.ddd±ddd.ddd d</p>	R
DESSLPT	<p><u>Location – Point.</u></p> <p>Single geographic point applicable to the DES. NOTE: This is only an approximate reference so specifying the coordinate reference system is unnecessary.</p> <p>Recorded as paired latitude and longitude values in decimal degrees.</p> <p>The precision for recording the values in the subheader is dictated by the field size constraint.</p>	25	<p>BCS-A</p> <p>-90 to +90 latitude</p> <p>-180 to +360 longitude</p> <p>±dd.ddd±ddd.ddd d</p> <p>Default is ECS spaces (0x20)</p> <p><i>HRE shall default to all spaces.</i></p>	<R>
DESSLHI	<p><u>Location – Identifier.</u></p> <p>Identifier used to represent a geographic area. An alphanumeric value identifying an instance in the designated namespace. When this field is recorded with other than the default value, the Location Identifier Namespace URI shall also be recorded.</p> <p>Examples: US USA</p>	20	<p>BCS-A</p> <p>Default is ECS spaces (0x20)</p> <p><i>HRE shall default to all spaces.</i></p>	<R>
DESSLIN	<p><u>Location Identifier Namespace URI.</u></p> <p>URI for the Namespace where the Location Identifier is described.</p> <p>Example: http://metadata.dod.mil/mdr/ns/GPAS/codelist/fips10-4/digraph http://metadata.dod.mil/mdr/ns/GPAS/codelist/iso3166-1/trigraph</p>	120	<p>BCS-A</p> <p>Default is ECS spaces (0x20)</p> <p><i>HRE shall default to all spaces.</i></p>	<R>

Field	Name/Description	Size	Value Range	Type
DESSHABS	<u>Abstract.</u> Brief narrative summary of the content of the DES.	200	BCS-A High Resolution Elevation (HRE) Data consisting of a fixed resolution grid of elevation values at [m] post spacing representing a geospatial surface. <i>Where [m] is the applicable post spacing.</i> Default is ECS spaces (0x20)	<R> [PSG]
DESDATA	<u>User-defined data field.</u> This field shall contain the XML data. The length of this field shall not cause any other NITF field length limits to be exceeded, but is otherwise fully user-defined.	**	Metadata formatted in XML conforming to ISO/TS 19139:2007 with content as described in Annex B	R

A.11 HRE SHAPE Data

A.11.1 CSSHPA Data Extension Segment (DES)

The Shapefile DES (CSSHPA) is a general wrapper structure for an ESRI Shapefile. Inclusion of the CSSHPA DES is optional; see production specific guidance for when to include one or more instances of this DES. This data extension segment is comprised of subheader information and the three files that together constitute a Shapefile.

A.11.2 DES Subheader

The DES shall include a DES subheader (compliant with MIL-STD-2500C Section 5.8.2 and Appendix A, Table A-8) and user-defined data.

1. The format and content of this DES shall be as detailed in Table A-10. This table does not include the /security/classification fields: Fields DECLAS through DESCTLN are required and are detailed in Mil-Std-2500C.
2. User-defined data shall consist of an ESRI Shapefile complying with the ESRI Shapefile Technical Description.
3. Nodes of shapes described in a Shapefile DES shall be expressed as latitude and longitude coordinates referenced to the WGS-84 datum only. It is acceptable to use the WGS-84 datum for Shapefiles even if the elevation or error data files are expressed in a different datum. Shapes within a Shapefile shall be composed of a minimum of three nodes (four is preferable).

4. The datasets may contain multiple instances of the CSSHPA DES, as described below. The SHAPE_USE field of the user-defined DES subheader fields distinguishes the instances.

When accompanying HRE data, shapefiles encapsulated in the DES would typically be used to define water bodies, void areas, alternate source fill, known anomalous data or regions for error/accuracy information.

The following table defines the format of CSSHPA DES as used for HRE data.

Note: For fields DECLAS through DESCTLN, the field descriptions have been removed from this table since they are defined in Mil-Std-2500C.

Table A-10 CSSHPA Data Extension Segment

R = Required, A = Alphanumeric, N = Numeric,
<> = Designated Default Value Allowed

Field	Name/Description	Size	Value Range	Type
DE	<u>File Part Type.</u> This field shall contain the characters "DE" to identify the subheader as a data extension.	2	BCS-A DE	R
DESID	<u>Unique DES type identifier.</u> This field shall contain the value "HRSHPA".	25	BCS-A CSSHPA	R
DESVR	<u>Version of the data definition.</u> This field shall contain the alphanumeric version number of the use of the tag. The version number is assigned as part of the registration process.	2	BCS-N positive integer 01	R
DECLAS through DESCTLN	Security classification fields are defined in Mil-Std-2500C	167	<i>For fields DECLAS through DESCCTLN, consult Production Specific Guidance (PSG) for applicable security field population values.</i>	R [PSG]
DESSHL	DES User-defined Subheader Length. This field shall contain the number of bytes in the field DESSHF.	4	BCS-N positive integer 0062	R
The following eight sub-fields constitute the DESSHF user-defined fields for this DES.				
SHAPE_USE	<u>Shapefile Use.</u> This field shall contain a value descriptive of the purpose for the Shapefile. Typical values include: WATER_BODY_SHAPE VOID_SHAPE ALTERNATE_FILL_SHAPE ANOMALOUS_SHAPE ERROR_REGION_SHAPE LAND_COVER_CLASS VERTICAL_OBSTRUCTION SURFACE_TYPE GROUND_CONTROL_POINT	25	BCS-A	R [PSG]

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Field	Name/Description	Size	Value Range	Type
SHAPE_CLASS	<u>Shapefile Class.</u> Type of shapes contained within this Shapefile. E.g. POLYGON	10	BCS-A	R
SHAPE1_NAME	<u>Shapefile1 Name.</u> Name of first file in the Shapefile. One of three allowed values: SHP, SHX, or DBF.	3	BCS-A SHP SHX DBF	R
SHAPE1_START	<u>Shapefile1 Start Location.</u> Start location in bytes of the first file, expressed as an offset in the DES User-Defined Data.	6	BCS-N positive integer Generated by DES content provider.	R
SHAPE2_NAME	<u>Shapefile2 Name.</u> Name of second file in the Shapefile. One of three allowed values: SHP, SHX, or DBF.	3	BCS-A SHP SHX DBF	R
SHAPE2_START	<u>Shapefile2 Start Location.</u> Start location in bytes of the second file, expressed as an offset in the DES User-Defined Data.	6	BCS-N positive integer Generated by DES content provider.	R
SHAPE3_NAME	<u>Shapefile3 Name.</u> Name of third file in the Shapefile. One of three allowed values: SHP, SHX, or DBF.	3	BCS-A SHP SHX DBF	R
SHAPE3_START	<u>Shapefile3 Start Location.</u> Start location in bytes of the third file, expressed as an offset in the DES User-Defined Data.	6	BCS-N positive integer Generated by DES content provider.	R
DESDATA	<u>User-defined data field.</u> The user-defined data field shall consist of the three files which together comprise the description of an ESRI Shapefile (described in the ESRI Shapefile Technical Description). **The length of this field shall not cause any other NITF field length limits to be exceeded.	**	User defined extension with no intervening octets.	R

A.12 Image Complexity / Compliance Level

The following table lists the derived complexity levels for HRE data contained within the NITFS file structure. Implementations of the NITFS are tested according to their ability to pack and/or unpack various CLEVELs of NITFS formatted files. This concept allows NITFS to be implemented on a wide range of hardware platforms with various levels of internal resources while maintaining a baseline level of interoperability between all compliance tested systems. Five CLEVELs have been defined, CL03, CL05, CL06, CL07 and CL09 (see note at end of the table). A summary of the attributes of each CLEVEL is listed in table A-11. Files shall be marked at the lowest CLEVEL for which they qualify (Adapted from Table A-10 in the MIL-STD-2500C). Note that whenever the HRE elevation post height data

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exceeds 8192 posting in either the row or column direction, the NITF 'large block option' is applied for which the CLEVEL is always CL09.

Table A-11 - Image Complexity / Compliance Level

NITF File Features	Complexity Level (CLEVEL)			
	3	5	6	7
Common Coordinate System Extent (Pixels)	(00000000, 00000000) to (00002047, 00002047)	(00000000, 00000000) to (00008191, 00008191)	(00000000, 00000000) to (00065535, 00065535)	(00000000, 00000000) to (99999999, 99999999)
Maximum File Size	50 MByte – 1byte (52,248,799 bytes)	1 GByte – 1byte (1,073,741,823 bytes)	2 GByte – 2byte (2,147,483,647 bytes)	10 GByte – 1byte (10,737,418,239 bytes)
Image Size (Image(s) placed within CCS extent)	00000001 to 00002048 Rows X 00000001 to 00002048 Columns (R & C ≤ 2048)	00000001 to 00008192 Rows X 00000001 to 00008192 Columns (R or C > 2048)	00000001 to 00065536 Rows X 00000001 to 00065536 Columns (R or C > 8192)	00000001 to 99999999 Rows X 00000001 to 99999999 Columns (R or C > 65536)
Image Blocking (Rectangular Blocks allowed)	Single and Multiple Blocks 0001 to 2048 Rows X 0001 to 2048 Columns	Single and Multiple Blocks 0001 to 8192 Rows X 0001 to 8192 Columns	Multiple blocking is mandatory for images that exceed 8192 Pixels per Row or Column 0001 to 8192 Rows X 0001 to 8192 Columns	
Elevation Data (NODISPLY)	Single Band 8, 12, 16, 32, and 64-Bits per Pixel (NBPP) No LUT IC = NC, NM IMODE = B ICAT = DTEM, ISUBCATn code from DIGEST, Part 3, Annex B (or BCS Spaces (0x20))			
Matrix Data (NODISPLY)	1 to 9 Bands 8, 16, 32, and 64-Bits per Pixel per Band No LUT in any Band IMODE = B, P, R, S	1 to 255 Bands 8, 16, 32, and 64-Bits per Pixel per Band No LUT in any Band IMODE = B, P, R, S		1 to 999 Bands 8, 16, 32, and 64-Bits per Pixel per Band No LUT in any Band IMODE = B, P, R, S
Number of Image Segments per File	0 to 20	0 to 100		
Number of CGM Graphic Segments per File	0 to 100			
Aggregate Size of Graphic Segments	1 MByte maximum	2 MByte maximum		
CGM Graphic Profile	MIL-STD-2301A			
Number of Text Segments per File	0 to 32 Segments			
Text Format Codes Supported	STA, MTF, UT1, U8S			

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Text Data per Segment	00001 to 99999 Characters		
Number of Data Extension Segments (DES) per File	0 to 10	0 to 50	0 to 100
HRE Allowed DES	XML_DATA_CONTENT CSSHPA		

Note: CLEVEL 09 is used to designate NITF 2.1 files that exceed the CLEVEL 07 constraints in Table A-11 but remain within the bounds of the standard. CLEVEL 09 designates that the file exceeds at least one of the CLEVEL 07 constraints:

1. Maximum File Size (10 Gbyte or greater),
2. Image segments with the block size exceeding 8192 pixels per row or column (large block option),
3. More than 999 Bands,
4. More than 100 images,
5. More than 100 graphics segments,
6. Graphic aggregate size exceeds 2 Mbytes,
7. Number of Text Segments exceeds 32, or
8. The number of DES exceeds 100.

Annex B HRE XML Metadata Specification (Normative)

This annex describes the XML schemas for metadata associated with HRE data in the NITF file. The following metadata modules are primarily based upon ISO 19115, drawing from other TC211 19100-series standards to the degree that 19115 makes use of those standards. The elements that have related sub-elements are shaded gray. Additional ISO info (element numbers and XML encoding for specific required values) is included to support mapping of HRE metadata requirements to the ISO model. Italicized text in the domain field represents text that is required in XML instance documents.

B.1 Identification Modules

B.1.1: Metadata Identification

Table B.1 describes the metadata entities and elements that describe the metadata associated with HRE data. This is not information about the content of the elevation data itself, but rather information about the metadata that identifies the content of the elevation data. The elements identify the metadata, the party responsible for the metadata, and security constraints on the metadata.

Table B.1: Metadata Identification

Row	Name (ISO 19115 #)	Definition	Data Type	Domain	Obligation	Max. Occur.
1	MD_Metadata.fileIdentifier (2)	unique identifier for this metadata file	CharacterString	File name of the NITF file (or separate metadata file) that contains the metadata.	R	1
2	MD_Metadata.language (3)	language used for documenting metadata	CharacterString	<i>codeList="http://metadata.dod.mil/mdr/ns/GPAS/codelist/iso639-2"</i> <i>codeListValue="eng"</i>	R	1
3	MD_Metadata.characterSet (4)	full name of the character coding standard used for the metadata set	MD_CharacterSetCode	<i>codeList="http://metadata.dod.mil/mdr/ns/GPAS/codelist/ietf_rfc2130"</i> <i>codeListValue="utf8"</i>	R	1

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Row	Name (ISO 19115 #)	Definition	Data Type	Domain	Obligation	Max. Occur.
4	MD_Metadata.contact (8)	party responsible for the metadata information	Class	CI_ResponsibleParty	R	1
5	CI_ResponsibleParty.organizationName (376)	name of the responsible organization	CharacterString	"US National Geospatial-Intelligence Agency"	R	1
6	CI_ResponsibleParty.role (379)	function performed by the responsible party	CI_RoleCode	codeList="http://metadata.dod.mil/mdr/ns/GSIP/codelist/RoleCode" codeListValue="pointOfContact"	R	1
7	MD_Metadata.dateStamp (9)	date that the metadata was created	Date	YYYY-MM-DD	R	1
8	MD_Metadata.metadataStandardName (10)	name of the metadata standard (including profile name) used	CharacterString	"ISO 19115 Geographic Information – Metadata"	R	1
9	MD_Metadata.metadataStandardVersion (11.1)	version of the metadata standard (version of the profile) used	CharacterString	"First edition, 2003-05-01"	R	1
10	MD_Metadata>MD_Constraints>MD_SecurityConstraints (73)	handling restrictions imposed on the resource for national security or similar security concerns	Class	Lines 11-13	R	1
11	MD_SecurityConstraints.classification (74)	name of the handling restrictions on the metadata	MD_ClassificationCode	codeList="https://www.dnidata.org/standards/ic_ism/current/v2.0.3.1/documents/IC-ISM-DED-v2.0.3.1.html" codeListValue="U" or "C" or "S" or "TS"	R	1
12	MD_SecurityConstraints.classificationSystem (76)	name of the classification system	CharacterString	http://metadata.dod.mil/mdr/ns/GPAS/codelist/iso3166-1_trigraph/USA	R	1
13	MD_SecurityConstraints.handlingDescription (77)	additional information about the restrictions on handling the metadata	CharacterString	See production-specific guidance	C Metadata classified?	1
14	MD_Metadata.dataSetURI (11.1)	uniform Resource Identifier (URI) of the dataset to which the metadata applies	CharacterString	of the form "urn:nga-hre: filename" See production specific guidance	R	1

B.1.2: Resource Identification

Table B.2 describes the metadata entities and elements that describe the HRE data (the resource). These elements identify the resource, the party responsible for the resource, and legal and security constraints on the resource. Additionally, elements are included that allow the geographic extents and the intended use of the resource to be defined, as well as elements that allow the identification of an larger dataset to which the resource belongs.

Table B.2: Resource Identification

Row	Name	Definition	Data Type	Domain	Obligation	Max. Occur.
1	MD_DataIdentification.citation (24)	citation data for the resource	CI_Citation	Lines 2-7	R	1
2	CI_Citation.title (360)	name by which the cited resource is known	CharacterString	File name of the NITF file that contains the elevation data. See text describing file name conventions. Use HRE naming scheme here.	R	1
3	CI_Citation.edition (363)	version of the cited resource	CharacterString	Sequentially increment editions starting with 001. 000 = edition tracking not maintained or unknown	R	1
4	CI_Citation.date (362)	date of the edition	Class	Lines 5 - 6	R	N
5	CI_Date.date (394)	reference date for the cited resource	Date	YYYY-MM-DD Use date that best reflects the currency of the HRE data.	R	1
6	CI_Date.dateType (395)	event used for reference date	CI_DateTypeCode	<i>CI_DateTypeCode codeList= "http://metadata.dod.mil/mdr/ns/GSIP/codelist/DateTypeCode " codeListValue= "creation" or "revision"</i>	R	1

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Row	Name	Definition	Data Type	Domain	Obligation	Max. Occur.
7	CI_Citation.presentationForm (368)	mode in which the resource is represented	CI_PresentationFormCode	<i>CI_PresentationForm codeList= "</i> <i>http://www.isotc211.org/2005/resources/CodeList/gmxCodeLists.xml#CI_PresentationFormCode"</i> <i>codeListValue= "modelDigital"</i>	O	1
8	MD_DataIdentification.abstract (25)	brief narrative summary of the content of the resource(s)	CharacterString	<i>"High Resolution Elevation (HRE) Data consisting of a fixed resolution grid of elevation values representing a geospatial surface."</i> Note: additional information may be included here when deemed necessary by the producer.	R	1
9	MD_DataIdentification.pointOfContact (29)	identification of, and means of communication with, organizations associated with the dataset	Class	Lines 10-11	R	N
10	CI_ResponsibleParty.organisationName (376)	name of the responsible organization	CharacterString	<i>"US National Geospatial-Intelligence Agency"</i>	R	1
11	CI_ResponsibleParty.role (379)	function performed by the responsible party	CI_RoleCode	<i>codeList= "</i> <i>http://metadata.dod.mil/mdr/ns/GSIP/codelist/RoleCode "</i> <i>codeListValue= "pointOfContact"</i>	R	1
12	MD_AggregationInformation.aggregateDataSetIdentifier (66.3)	identification information about aggregate dataset	MD_Identifier	Line 13	C	1
13	MD_Identifier.code (207)	alphanumeric value that identifies a larger data set of which this dataset is a member	CharacterString	Use this element when the dataset is one of many in a named series of datasets Note: see production-specific guidance	C	1
14	MD_AggregationInformation.associationType (66.4)	association type of the aggregate dataset	DS_AssociationTypeCode	<i>DS_AssociationTypeCode codeList= "</i> <i>http://metadata.dod.mil/mdr/ns/GSIP/codelist/ResourceAssociationTypeCode"</i> See production –specific guidance for codelist value, e.g. <i>"largerWorkCitation"</i>	R	1
15	MD_DataIdentification.language (39)	language(s) used within the dataset	CharacterString	<i>codeList= "</i> <i>http://metadata.dod.mil/mdr/ns/GPAS/codelist/is0639-2"</i> <i>codeListValue= "eng"</i>	R	N
16	MD_DataIdentification.topicCategory (41)	main theme(s) of the dataset	MD_TopicCategoryCode	<i>"elevation"</i>	R	1

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Row	Name	Definition	Data Type	Domain	Obligation	Max. Occur.
17	MD_DataIdentification.spatialRepresentation Type (37)	method used to spatially represent geographic information	MD_SpatialRepresentation TypeCode	<i>MD_SpatialRepresentationTypeCode codeList=</i> " <i>http://metadata.dod.mil/mdr/ns/GSIP/codelist/SpatialRepresentationTypeCode</i> " <i>codeListValue=</i> "grid"	O	1
18	MD_DataIdentification.spatialResolution (38)	factor which provides a general understanding of the density of spatial data in the dataset. Distance between consistent parts of adjacent pixels in the object space.	Distance (unit of measure + value)	<i>gco:Distance uom=</i> "meter" or <i>uom=</i> "arc-second" distance value is expressed as a real number. Note: see production-specific guidance for required precision.	R	1
19	MD_DataIdentification.extent (45)	geographic extent of the dataset	EX_Extent	Lines 20-25	R	1
20	EX_GeographicBoundingBox.southBoundLatitude (346)	southern-most coordinate of the limit of the dataset extent, expressed in latitude in decimal degrees (positive north)	Angle (ISO 19103)	-90.00000000° to +90.00000000° (Use 8 decimal places, zero filled as necessary)	R	1
21	EX_GeographicBoundingBox.westBoundLongitude (344)	western-most coordinate of the limit of the dataset extent, expressed in longitude in decimal degrees (positive east)	Angle	-180.00000000° to +180.00000000° (Use 8 decimal places, zero filled as necessary)	R	1
22	EX_GeographicBoundingBox.northBoundLatitude (347)	northern-most coordinate of the limit of the dataset extent expressed in latitude in decimal degrees (positive north)	Angle	-90.00000000° to +90.00000000° (Use 8 decimal places, zero filled as necessary)	R	1
23	EX_GeographicBoundingBox.eastBoundLongitude (345)	eastern-most coordinate of the limit of the dataset extent, expressed in longitude in decimal degrees (positive east)	Angle	-180.00000000° to +180.00000000° (Use 8 decimal places, zero filled as necessary)	R	1
24	EX_BoundingPolygon.polygon (342)	boundary enclosing the dataset, expressed as the closed set of (x,y) coordinates of the polygon (last point replicates first point)	GM_Polygon (ISO 19107)	<i>gml:Polygon gml:id=</i> "datasetExtents" Line 25	O	1

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Row	Name	Definition	Data Type	Domain	Obligation	Max. Occur.
25	GM_Polygon.exterior.linearring	set(s) of points defining the bounding polygon.	Sequence<GM_Position>	The vertices of the polygon are limited to a single two-dimensional spatial reference system. Use geographic coordinates, with (latitude, longitude) coordinate ordering. A rectangle will have 5 coordinate pairs, with the first being identical to the last. For example: 39.10333000 -74.92250000 39.19386000 -74.92269000 39.19414000 -74.66167000 39.10306000 -74.66142000 39.10333000 -74.92250000	R	1
26	MD_DataIdentification.extent (45)	extent information including the bounding box, bounding polygon, vertical, and temporal extent of the dataset	EX_Extent	Lines 27-29	R	N
27	EX_VerticalExtent.minimumValue (355)	lowest vertical extent contained in the dataset	Real	Populate with lowest elevation value in the dataset.	R	1
28	EX_VerticalExtent.maximumValue (356)	highest vertical extent contained in the dataset	Real	Populate with highest elevation value in the dataset.	R	1
29	EX_VerticalExtent.verticalCRS	1-dimension coordinate reference system used for recording heights or depths. Vertical CRSs make use of the direction of gravity to define the concept of height or depth, but the relationship with gravity may not be straightforward.	SC_VerticalCRS	<i>href="http://metadata.dod.mil/mdr/ns/GSIP/crs/WGS84E"</i>	R	1
30	MD_Identification>MD_Constraints>MD_SecurityConstraints (73)	handling restrictions imposed on the resource for national security or similar security concerns	Class	Lines 31-33	R	1
31	MD_SecurityConstraints.classification (74)	name of the handling restrictions on the resource	MD_ClassificationCode	<i>codelist="https://www.dnidata.org/standards/ic_ism/current/v2.0.3.1/documents/IC-ISM-DED-v2.0.3.1.html"</i> <i>codeListValue="U" or "C" or "S" or "TS"</i>	R	1

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Row	Name	Definition	Data Type	Domain	Obligation	Max. Occur.
32	MD_SecurityConstraints.classificationSystem (76)	name of the classification system	CharacterString	http://metadata.dod.mil/mdr/ns/GPAS/codelist/is-o3166-1-trigraph/USA	R	1
33	MD_SecurityConstraints.handlingDescription (77)	additional information about the restrictions on handling the resource	CharacterString	See production-specific guidance	C Metadata classified?	1
34	MD_LegalConstraints (69)	restrictions and legal prerequisites for accessing and using the resource	Class	Lines 35-37 See production-specific guidance	C (Use constraints exist?)	N
35	MD_LegalConstraints.accessConstraints (70)	access constraints applied to assure the protection of privacy or intellectual property, and any special restrictions or limitations on obtaining the resource	MD_RestrictionCode	<code>codeList="</code> http://metadata.dod.mil/mdr/ns/GSIP/codelist/RestrictionCode <code>CodeListValue=</code> Choose a value: copyright patent patentPending trademark license intellectualPropertyRights restricted otherRestrictions	C	N
36	MD_LegalConstraints.useConstraints (71)	constraints applied to assure the protection of privacy or intellectual property, and any special restrictions or limitations or warnings on using the resource	MD_RestrictionCode	<code>codeList="</code> http://metadata.dod.mil/mdr/ns/GSIP/codelist/RestrictionCode <code>CodeListValue=</code> Choose a value: copyright patent patentPending trademark license intellectualPropertyRights restricted otherRestrictions	C	N
37	MD_Usage.specificUsage (63)	brief description of the resource and/or resource series usage	CharacterString	See production-specific guidance	O	1

B.1.3: Horizontal Reference System Identification

Table B.3 describes the metadata entities and elements of the allowable horizontal reference systems for HRE data.

Table B.3: Horizontal Reference System Identification

Row	Name	Definition	Data Type	Domain	Obligation	Max. Occur.
1	MD_ReferenceSystem. referenceSystemIdentifier (187)	name of reference system	RS_Identifier	Lines 2-8	R	1
2	RS_Identifier.code (207)	alphanumeric value identifying one of the horizontal reference systems specified in this implementation profile	CharacterString	<i>RS_Identifier id= "horizontal"</i> choose a value: <i>"WGS84E_2D"</i> <i>"WGS84_UTM_zone_zzH" (zone 1-60 + hemisphere, N or S)</i> Note: HRE Level 2-8 shall also include epoch of observation (in decimal years, e.g. '2009.0').	R	1
3	RS_Identifier.codeSpace (208.1)	name or identifier of the person or organization responsible for the namespace	CharacterString	<i>"http://metadata.dod.mil/mdr/ns/GSIP/crs/"</i> Note: actual URL is subject to update prior to publication.	R	1

B.1.4: Vertical Reference System Identification

Table B.4 describes the metadata entities and elements of the allowable vertical reference systems for HRE data.

Table B.4: Vertical Reference System Identification

Row	Name	Definition	Data Type	Domain	Obligation	Max. Occur.
1	MD_ReferenceSystem. referenceSystemIdentifier (187)	name of horizontal reference system	RS_Identifier (Class)	Lines 2-3	R	1

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Row	Name	Definition	Data Type	Domain	Obligation	Max. Occur.
2	RS_Identifier.code (207)	alphanumeric value identifying one of the vertical reference systems specified in this implementation profile	CharacterString	<i>RS_Identifier id= "vertical"</i> choose a value: <i>WGS 84 Ellipsoid</i> <i>WGS 84 Geoid EGM96</i> <i>WGS 84 Geoid EGM08</i>	R	1
3	RS_Identifier.codeSpace (208.1)	name or identifier of the person or organization responsible for the namespace	CharacterString	<i>"http://metadata.dod.mil/mdr/ns/GSIP/crs/"</i> Note: actual URL is subject to update prior to publication	R	1

B.1.1 Content Information

Table B.5 describes the metadata entities and elements of a feature catalog that defines bare earth and reflective surface elevation datasets as feature types.

Table B.5: Content Information

Row	Name	Definition	Data Type	Domain	Obligation	Max. Occur.
1	MD_FeatureCatalogueDescription.featureCatalogueCitation (238)	complete bibliographic reference to one or more external feature catalogues	CI_Citation	Lines 2-5	R	1
2	CI_Citation.title (360)	name by which feature catalog is known	Character String	<i>NSG Entity Catalog</i>	R	1
3	CI_Citation.date (362)	reference date and event used to describe it	CI_Date	Lines 4-5	R	1
4	CI_Date.date (394)	reference date for the feature catalog	Date	YYYY-MM-DD	R	1
5	CI_Date.dateType (395)	event used for reference date	CI_DateTypeCode	<i>003 ('revision')</i>	R	1

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Row	Name	Definition	Data Type	Domain	Obligation	Max. Occur.
6	MD_FeatureCatalogueDescription.includedWithDataset (236)	indicator that Feature Catalogue is/is not included with dataset	Boolean	0=no, 1=yes For HRE: 0	R	1

B.1.2 Feature Catalog

A detailed citation of the catalog that was declared in Table B.5 must be made using the elements in Table B.6 when the hierarchy level of the data being described is a dataset series. A dataset series is a collection of spatial data that shares similar characteristics of theme, source date, resolution, and methodology. The exact definition of what constitutes a dataset series will be determined by the data provider. The creation of a dataset series metadata level is an optional feature that allows users to consult higher-level characteristics for data search.

Also included in this table are elements relating specific catalog feature types and their property types to the HRE resource.

Table B.6: Feature Catalog Module

Row	Name	Definition	Data Type	Domain	Obligation	Max. Occur.
1	FC_FeatureCatalogue	a feature catalogue contains its identification and contact information, and definition of some number of feature types with other information necessary for those definitions.	Class	2-24	C/hierarchy level = series	1
2	FC_FeatureCatalogue.name	name of this feature catalogue	CharacterString	<i>NSG Entity Catalog</i>	R	1

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Row	Name	Definition	Data Type	Domain	Obligation	Max. Occur.
3	FC_FeatureCatalogue.scope	subject domain(s) of feature types defined in this feature catalogue.	CharacterString	TBD	R	1
4	FC_FeatureCatalogue.versionNumber	version number of this feature catalogue, which may include both a major version number or letter and a sequence of minor release numbers or letters, such as "3.2.4a." The format of this attribute may differ between cataloguing authorities.	CharacterString	TBD	R	1
5	FC_FeatureCatalogue.versionDate	effective date of this feature catalogue	Date	TBD	R	1
6	FC_FeatureCatalogue.producer	name, address, country, and telecommunications address of organization having primary responsibility for the intellectual content of this feature catalogue.	CI_ResponsibleParty (Class)	Lines 7-15	R	1
7	CI_ResponsibleParty.organizationName	name of the responsible organization	CharacterString	<i>US National Geospatial-Intelligence Agency</i>	R	1
8	CI_Contact.address	physical and email address at which the organization may be contacted	CI_Address (Class)	Lines 9-15	R	1
9	CI_Address.deliveryPoint	address line for the location (as described in ISO 11180, Annex A)	CharacterString	<i>4600 Sangamore Rd.</i>	R	1
10	CI_Address.city	city of the location	CharacterString	<i>Bethesda</i>	R	1

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Row	Name	Definition	Data Type	Domain	Obligation	Max. Occur.
11	CI_Address.administrativeArea	state, province of the location	CharacterString	<i>Maryland</i>	R	1
12	CI_Address.postalCode	ZIP or other postal code	CharacterString	<i>20816</i>	R	1
13	CI_Address.country	country of the physical address	CharacterString	<i>http://metadata.dod.mil/mdr/ns/GPAS/codelist/iso3166-1_trigraph/USA</i>	R	1
14	CI_Address.electronicMailAddress	address of the electronic mailbox of the responsible party	CharacterString	<i>ncgis-mail@nga.mil</i>	R	1
15	CI_ResponsibleParty.role	function performed by the responsible party	CI_RoleCode	<i>codeList="http://metadata.dod.mil/mdr/ns/GSIP/codelist/RoleCode"</i> <i>codeListValue="pointOfContact"</i>	R	1
16	FC_FeatureCatalogue.featureType	link to a feature type contained in the feature catalogue.	FC_FeatureType (Class)	Lines 17-24	R	N
17	FC_FeatureType.name		CharacterString	TBD	R	
18	FC_FeatureType.isAbstract		Boolean	TBD	R	
19	FC_FeatureType.featureCatalogue	link from this feature type to the feature catalogue that contains it	FC_FeatureCatalogue (Class)	TBD	R	

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Row	Name	Definition	Data Type	Domain	Obligation	Max. Occur.
20	FC_FeatureType.carrierOfCharacteristics	link from this feature type to the property types that it contains. The association class FC_Binding describes particular information regarding the use of this property type within this feature type.	FC_Binding	Lines 21-24	R	N
21	FC_PropertyType.memberName	member name that locates this member within a feature type	LocalName	TBD	R	1
22	FC_PropertyType.definition	definition of the member in a natural language	CharacterString	TBD	R	1
23	FC_PropertyType.cardinality	cardinality of the member in the feature class	Multiplicity	TBD	R	1
24	FC_Binding.description	description of how a property type is bound to a particular feature type	CharacterString	TBD	O	1

B.1.3 Coverage Description

Table B.7 describes the metadata entities and elements of the HRE data values to be defined by elevation model type (bare earth or reflective surface), data type (real number), and content type (physical measurement).

Table B.7: Coverage Description Module

Row	Name	Definition	Data Type	Domain	Obligation	Max. Occur.
1	MD_CoverageDescription.attributeDescription (240)	description of the attribute described by the measurement value	RecordType	A paired value (name, datatype) For bare earth: <i>digitalElevationModel,(real or signed integer)</i> For reflective surface: <i>digitalSurfaceModel,(real or signed integer)</i>	R	1
2	MD_CoverageDescription.contentType (241)	type of information represented by the cell value	MD_CoverageContentType Code	003 (' <i>physicalMeasurement</i> ')	R	1

B.1.4 Elevation Grid Coverage

Table B.1.8 describes the metadata entities and elements of the elevation value array storage sequence and organization. This metadata corresponds with the NITF Image segment structure. HRE elevation values are arranged using the traditional raster pattern where the array origin is notionally in the 'upper left' corner and the recording sequence is in row-major order. The first row of recorded values is the northern-most, and the sequence of values is in west-to-east order. When indexing a value storage cell using array coordinates, the NITF convention is to express the index in (row, col) sequence. This implies that the first axis is the row axis, and the second axis is the column axis.

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Table B.8: Elevation Grid Coverage Module

Row	Name	Definition	Data Type	Domain	Obligation	Max. Occur.
1	ElevationCoverage.domainExtent	spatial extent of the elevation coverage.	EX_GeographicExtent	Line 2	R	N
2	GM_Polygon.exterior.linearring	the set(s) of points defining the bounding polygon.	Sequence<GM_Position>	<p><i>gml:Polygon gml:id="detailedExtent"</i></p> <p>The vertices of the polygon are limited to a single two-dimensional spatial reference system. Use geographic (for HREGP) or UTM coordinates, with (latitude, longitude) or (easting, northing) coordinate ordering. A rectangle will have 5 coordinate pairs, with the first being identical to the last.</p> <p>For example: 39.10333000 -74.92250000 39.19386000 -74.92269000 39.19414000 -74.66167000 39.10306000 -74.66142000 39.10333000 -74.92250000</p>	R	1
3	ElevationCoverage.rangeType	description of the elevation values provided by the elevation coverage	RecordType	<p>A paired value (name, datatype)</p> <p>For bare earth: <i>digitalElevationModel, (real or signed integer)</i></p> <p>For reflective surface: <i>digitalSurfaceModel, (real or signed integer)</i></p>	R	1
4	ElevationCoverage.commonPointRule	rule to follow in interpolating a value at a point that falls on the boundary between two domain objects.	CV_CommonPointRule	<i>Average</i>	R	1
5	ElevationCoverage.metadata	metadata associated with the elevation grid or reference to the location of the metadata	CharacterString	<p>NITF://Segment_Type/Segment_Id/[#Fragment_ID]</p> <p>(NITF segment containing xml metadata)</p> <p>Example: <i>NITF://DE001/XML_DATA_CONTENT</i></p>	R	1

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Row	Name	Definition	Data Type	Domain	Obligation	Max. Occur.
6	ElevationGridCoverage.interpolationType	recommended method for interpolating elevation values at positions between grid points.	CV_InterpolationType	<i>Bilinear</i>	R	1
7	ElevationGrid.dimension	dimension of the elevation grid.	Integer	2	R	1
8	ElevationGrid.axisNames	names of the axes of the elevation grid.	CharacterString	<i>South East</i> (Note: this element occurs twice, once for each axis, South and East.)	R	2
9	ElevationGrid.origin	coordinates, in an external coordinate system, that map to grid coordinates 0, 0.	DirectPosition	Line 10	R	1
10	DirectPosition.coordinate	numerical description of the spatial position	<Sequence> Number	Express as a geographic (HREGP) or UTM coordinate pair to production-specific precision in the order (latitude, longitude) or (easting, northing).	R	1
11	ElevationGrid.offsetVectors	vectors that specify the orientation of the grid axes and the dimensions of the grid cells in directions parallel to the axes. The cell size ground sample distance.	Vector	Lines 12-13 (Note: This element occurs twice, once for the 'South' axis and once for the 'East' axis, in that order.	R	2
12	Vector.dimension	dimension of the coordinate space in which the vector is specified	Integer	1 or 2	R	1

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Row	Name	Definition	Data Type	Domain	Obligation	Max. Occur.
13	Vector.ordinates	coordinates of an end point of the vector, the other end being at the origin of the coordinate system.	Sequence<Number>	<p>Express as a decimal number (real) to (PSG) precision.</p> <p>HRE Level 1: length of a grid cell along the axis specified by Vector.dimension (uom=arc seconds)</p> <p>HRE Level 2-8: length of a grid cell along the axis specified by Vector.dimension (uom=meters).</p> <p>The order shall be</p> <p>HRE Level 1 (0.4, 0.0) to (0.0, 0.4)</p> <p>HRE Level 2 (8.0, 0.0) to (0.0, 8.0)</p> <p>HRE Level 3 (4.0, 0.0) to (0.0, 4.0)</p> <p>HRE Level 4 (2.0, 0.0) to (0.0, 2.0)</p> <p>HRE Level 5 (1.0, 0.0) to (0.0, 1.0)</p> <p>HRE Level 6 (0.5, 0.0) to (0.0, 0.5)</p> <p>HRE Level 7 (0.25, 0.0) to (0.0, 0.25)</p> <p>HRE Level 8 (0.125, 0.0) to (0.0, 0.125)</p>	R	1
14	ElevationGrid.extent	limits of the set of grid points included in the elevation grid.	CV_GridEnvelope	<p>Lines 15-18</p> <p>(Note: Corresponds to NITF array dimensions for Number of Columns (NCOLS) and Number of Rows (NROWS).</p>	R	1
15	CV_GridEnvelope.low	minimal grid coordinate values of the part of the grid that contains elevation values.	CV_GridCoordinate	Line 16	R	1
16	CV_GridCoordinate.coordValues	number of grid cell offsets from the origin of the grid parallel to each axis.	Sequence<Integer>	0,0	R	1
17	CV_GridEnvelope.high	maximal grid coordinate values of the part of the grid that contains elevation values.	CV_GridCoordinate	Line 18	R	1

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Row	Name	Definition	Data Type	Domain	Obligation	Max. Occur.
18	CV_GridCoordinate.coordValues	number of grid cell offsets from the origin of the grid parallel to each axis.	Sequence<Integer>	<i>NROWS-1,NCOLS-1</i>	R	1
19	ElevationGrid.sequencingRule	rule for assigning values to grid points.	CV_SequenceRule	Lines 20-21	R	1
20	CV_SequenceRule.type	identifier of the type of sequencing method.	CV_SequenceType	<i>linear</i>	R	1
21	CV_SequenceRule.scanDirection	list of signed axisNames that indicates the order in which grid points shall be mapped to position within the sequence of values.	Sequence<CharacterString>	<i>+East +South</i>	R	1
22	ElevationGrid.startSequence	grid point associated with the first record in the values sequence.	CV_GridCoordinate	<i>0,0</i>	R	1
23	ElevationGrid.values	recorded elevation values.	Sequence<Record>	NITF://Segment_Type/Segment_Id/[#Fragment_ID] (Reference to NITF segment containing values) Example: <i>NITF://IM001/HRE1020081201</i>	R	1

B.1.5 Maintenance Information

Table B.9 describes the metadata entities and elements for the maintenance requirements of the HRE data to be specified, as well as identification of the party responsible for the maintenance.

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Table B.9: Maintenance Information Module

Row	Name	Definition	Data Type	Domain	Obligation	Max. Occur.
1	MD_MaintenanceInformation.maintenanceAndUpdateFrequency (143)	frequency with which changes and additions are made to the resource after the initial resource is completed	MD_MaintenanceFrequencyCode	<i>codeList</i> -“ http://metadata.dod.mil/mdr/ns/GSIP/codelist/MaintenanceFrequencyCode ” See production-specific guidance for codelist value	R	1
2	MD_MaintenanceInformation.dateOfNextUpdate (144)	scheduled revision date for resource	Date	See production-specific guidance	O	1
3	MD_MaintenanceInformation.maintenanceNote (148)	information regarding specific requirements for maintaining the resource	CharacterString	See production-specific guidance	O	N
4	MD_MaintenanceInformation.contact (148.1)	identification of, and means of communicating with, person(s) and organization(s) with responsibility for maintaining the metadata	CI_ResponsibleParty	See production-specific guidance	O	1

B.1.6 Resource Lineage

Table B.10 describes the metadata entities and elements for describing the sensor and source data used in the creation of the HRE data, and a means to declare a processing event that was performed during the life of the data.

Table B.10: Resource Lineage Module

Row	Name	Definition	Data Type	Domain	Obligation	Max. Occur.
1	LI_Lineage.statement (83)	general explanation of the data producer's knowledge about the lineage of a dataset	CharacterString	Populate with a general description about the lineage of the source data used in the production of the HRE dataset. Include type of sensor used to collect source data.	R	1

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Row	Name	Definition	Data Type	Domain	Obligation	Max. Occur.
2	LI_Lineage.processStep (84)	information about events in the life of a dataset specified by the scope	LI_ProcessStep	Use structure from Processing Steps Module (LI_PocessStep) Include at least one instance of the Processing Steps Module (LI_ProcessStep)	R	N
3	LI_Lineage.source (85)	information about the source data used in creating the data specified by the scope	LI_Source	Lines 4-14	R	N
4	LI_Source.sourceCitation (96)	recommended reference to be used for the source data	CI_Citation	Lines 5-13	R	1
5	CI_Citation (359)	standardized resource reference	Class	Lines 6-13	R	1
6	CI_Citation.title (360)	name by which the cited resource is known	CharacterString	Name of the source data	R	1
7	CI_Citation.date (362)	date of the source	Class	CI_Date	R	1
8	CI_Date.date (394)	reference date for the cited resource	Date	YYYY-MM-DD	R	1
9	CI_Date.dateType (395)	event used for reference date	CI_DateTypeCode	<i>CI_DateTypeCode codeList= "http://metadata.dod.mil/mdr/ns/GSIP/codelist/DateTypeCode " codeListValue= "creation" or "revision"</i>	R	1
10	CI_Citation.citedResponsibleParty (367)	name and position information for an individual or organization that is responsible for the resource	Class	CI_ResponsibleParty	O	1
11	CI_ResponsibleParty (374)	identification of organization associated with the dataset	Class	Lines 12-13	O	N
12	organizationName (376)	name of the responsible organization	CharacterString	Organization that serves as the point of contact for the source data	R	1
13	role (379)	function performed by the responsible party	CI_RoleCode	<i>codeList= "http://metadata.dod.mil/mdr/ns/GSIP/codelist/RoleCode " codeListValue= "pointOfContact"</i>	R	1
14	LI_Source.description (93)	detailed description of the level of the source data	CharacterString	Populate with a detailed description of the source data.	R	1

B.1.7 Processing Steps

If a processing event is declared in Table B.10, the elements in Table B.11 will provide a description and date of the event.

Table B.11: Processing Steps Module

Row	Name	Definition	Data Type	Domain	Obligation	Max. Occur.
1	LI_ProcessStep.description (87)	description of the event, including related parameters or tolerances	CharacterString	Populate with a brief description of the processing event and related parameters or tolerances that had significance to the processing event. Include a description of the source from which the elevation data was produced.	R	1
2	LI_ProcessStep.dateTime (89)	date and time or range of date and time on or over which the process step occurred	DateTime	Enter date that the source data was processed into elevation data. Note that this date could be much later than the 'currency date' for the information. YYYY-MM-DDThh:mm:ss.sZ	O	1
3	LI_ProcessStep.processor (90)	identification of, and means of communication with, person(s) and organization(s) associated with the process step	Class	CI_ResponsibleParty	O	1
4	CI_ResponsibleParty (374)	identification of, and means of communication with, person(s) and organization(s) associated with the process step	Class	Lines 5-6	R	1
5	organizationName (376)	name of the responsible organization	CharacterString	Organization that serves as the point of contact for the source data	R	1
6	role (379)	function performed by the responsible party	CI_RoleCode	<i>codeList= "http://metadata.dod.mil/mdr/ns/GSIP/codelist/RoleCode " codeListValue= "pointOfContact"</i>	R	1

B.2 Data Quality Modules

The use of high resolution elevation data for tasks that require a specified level of geolocation accuracy necessitates the need for data to estimate these errors anywhere within the elevation data coverage area. This information is to be documented in the XML DES or a combination of the XML DES and one or more NITF image segments. This section specifies how to provide the uncertainty data needed to compute estimated horizontal and vertical errors (both absolute and relative) for each post in the associated high resolution elevation image segment. Various options are defined to specify the rigorous error propagation for each post in the associated HRE DTEM image segment. Options are provided for defining N distinct regions, so that region and cross-region systematic error and relative error covariance data may be specified. Options are also provided for assigning the random error component of covariance data for each post in the DTEM or defining nominal random error component covariance data for each region that can then be scaled to unique covariance matrices for each post in the DTEM via per-post random error scale factors. In general, specifying the covariance data for N regions will result in less metadata being required for rigorous error propagation, at the possible expense of fidelity.

As geolocation accuracy requirements become more stringent, assigning a single value of horizontal and vertical error for an entire DEM becomes an unsatisfactory solution. Therefore, this profile defines a metadata structure that permits rigorous, high fidelity error estimates to be computed on a post-by-post basis. This is accomplished by defining the fields needed to specify the covariance data for an accompanying data set. Standard error propagation techniques (i.e., linear combinations of Gaussian random variables) may then be used to compute a unique 3 by 3 covariance matrix for each post in the data set.

This profile outlines how to define one or more regions and three types of covariance data (systematic, relative and random). The regions are intended to define areas with different error propagation characteristics. With this data a complete set of error propagation covariance data may be specified for each region and for each post. An illustration of regions defined to cover an HRE grid is contained in Figure B.1.

The types of data needed to define the error propagation data is illustrated in Figure B.2. For the systematic error, " σ_x " represents the predicted systematic error per component within a region, and " $\zeta_{r,c}$ " is the correlation coefficient between components, " Σ_{GX} " represents the systematic error for region X, and " Σ_G " is the full cross-region covariance matrix. Relative error between points within a region can be computed given the distance between two points and the matrices, " Φ_U " and " Φ_V " that express the increase in covariance magnitude per meter. For the random error, " σ_x " represents the predicted random error per component at a post and " $\zeta_{r,c}$ " is the correlation coefficient between components. When the random error covariance is defined per region: Random Error Covariance per Post is calculated by:

$$\Sigma_{R(r,c)} = \Sigma_{RX} * SF_{r,c}$$

Where, $\Sigma_{R(r,c)}$ is the random error per post, Σ_{RX} is the random error covariance per region, and $SF_{r,c}$ is a per post scale factor.

DTEM regions may be specified point-by-point. In this case, for each post in the DTEM, a region number is assigned, from 001 to 256. This post-by-post region assignment information is provided in a separate image segment within the same NITF file as the DTEM post data. Indexing into this image segment is identical to indexing into the DTEM post image segment. Every post in the DTEM must be assigned to a region. This option provides the most flexibility for defining region geometries.

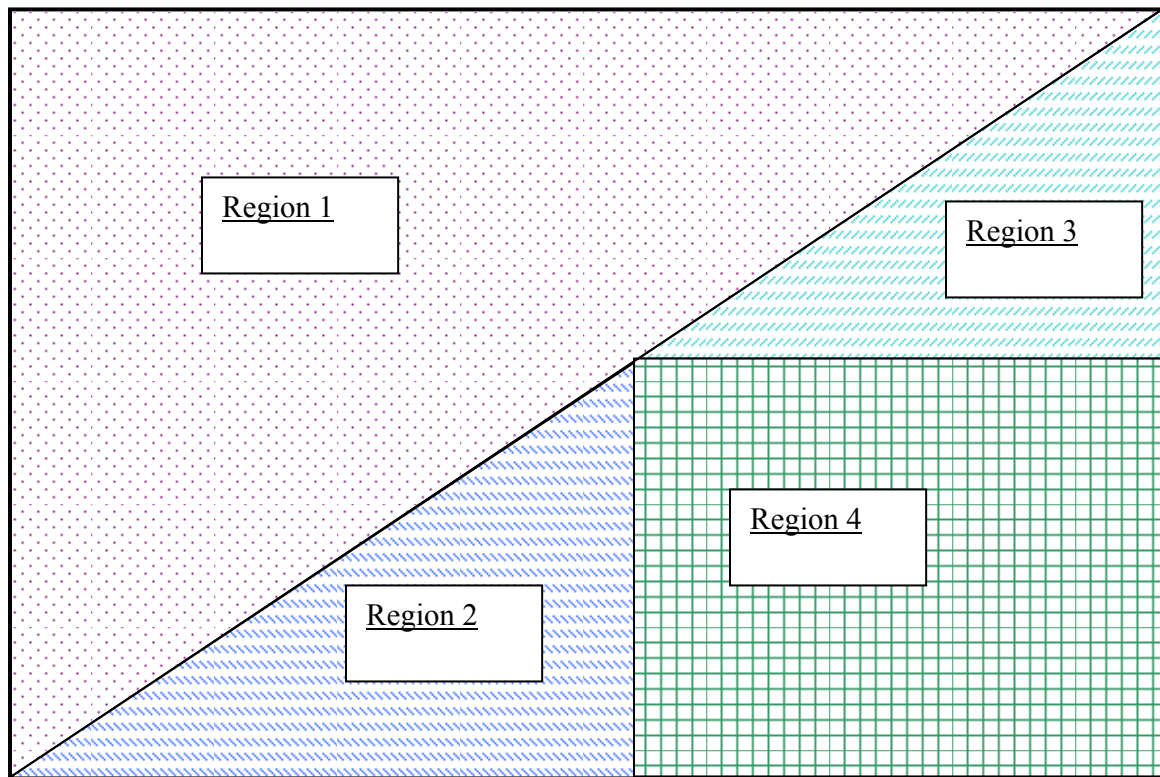


Figure B-1 Example defining regions for a sample DEM area. The regions need not be square, nor all of the same size.

Stored Per Region in XML DES		Stored Per Post in Image Segments
Regions defined by polygon vertices (Table B-12)	<- OR ->	Regions defined per post (Table B-12) (NITF image subheader IID1 field = "EP_REGIONS")
Systematic Error per region (Table B-14): $\Sigma_{GX} = \begin{bmatrix} \sigma_1^2 & \sigma_1\sigma_2\zeta_{12} & \sigma_1\sigma_3\zeta_{13} \\ & \sigma_2^2 & \sigma_2\sigma_3\zeta_{23} \\ & & \sigma_3^2 \end{bmatrix}$ [symmetric]	<- ONLY	

<u>Cross-Region Systematic Error (Table B-15):</u> $\Sigma_G = \begin{bmatrix} \Sigma_{G1} & \Sigma_{G12} & \Sigma_{G13} & \Sigma_{G14} \\ & \Sigma_{G2} & \Sigma_{G23} & \Sigma_{G24} \\ & & \Sigma_{G3} & \Sigma_{G34} \\ \text{symmetric} & & & \Sigma_{G4} \end{bmatrix}$	<- ONLY	
<u>Region Relative Error (Table B-19):</u> $\Phi_U = \begin{bmatrix} \frac{d\sigma^2_x}{du^2} & \frac{d\sigma_{xy}}{du^2} & \frac{d\sigma_{xz}}{du^2} \\ & \frac{d\sigma^2_y}{du^2} & \frac{d\sigma_{yz}}{du^2} \\ \text{Symmetric} & & \frac{d\sigma^2_z}{du^2} \end{bmatrix}$ $\Phi_V = \begin{bmatrix} \frac{d\sigma^2_x}{dv^2} & \frac{d\sigma_{xy}}{dv^2} & \frac{d\sigma_{xz}}{dv^2} \\ & \frac{d\sigma^2_y}{dv^2} & \frac{d\sigma_{yz}}{dv^2} \\ \text{Symmetric} & & \frac{d\sigma^2_z}{dv^2} \end{bmatrix}$ rotationAngle, thresholdDistance	<- ONLY	
<u>Random Error per region (Table B-16)</u> $\Sigma_{RX} = \begin{bmatrix} \sigma_1^2 & \sigma_1\sigma_2\zeta_{12} & \sigma_1\sigma_3\zeta_{13} \\ & \sigma_2^2 & \sigma_2\sigma_3\zeta_{23} \\ \text{symmetric} & & \sigma_3^2 \end{bmatrix}$	AND	<u>Random Error scale factor per post (Table B-18):</u> Scale Factor per post ("RE_POST_SF")
	OR	
	ONLY ->	<u>Random Error per post (Table B-17):</u> $\Sigma_{R(r,c)} = \begin{bmatrix} \sigma_1^2 & \sigma_1\sigma_2\zeta_{12} & \sigma_1\sigma_3\zeta_{13} \\ & \sigma_2^2 & \sigma_2\sigma_3\zeta_{23} \\ \text{symmetric} & & \sigma_3^2 \end{bmatrix}$ (NITF image subheader IID1 field = "COVARIANCE" and "COREL_COEF")

Figure B-2. Examples of the types of covariance matrix data needed for rigorous error propagation. The types of data are organized on the left or right depending on whether the data appears in the XML DES or in an image segment.

As an alternative, DTEM regions may be specified by polygons. This option permits defining regions via polygon vertex coordinate pairs. Each region may consist of from 3 up to 999 coordinate pairs to accurately portray its outline. In addition:

- Coordinate pairs defining a region must be arranged in a clockwise direction.
- Each region coordinate pair must be located on or within the bounding rectangle. The IGEOLO field in the DTEM image sub header defines the bounding rectangle.
- Region areas must not overlap or leave gaps. Region areas must cover the entire HRE DTEM.

- The first and last coordinate pairs of a region shall be the same. Closure of the region is not implied.

Options are defined to place the HRE covariance data wholly within the XML DES, or a mixture of XML DES and NITF image segments that accompany the DTEM image segment in the same NITF file. Two types of covariance data need to be specified. The first, systematic error covariance is always defined within the XML DES. Provision is made to specify the covariance elements for each region, as well as, cross-region covariance elements. The second, random error covariance is specified through a combination of data specified within the XML DES and in one or more image segments. XML DES parameters reference the specific image segments, as needed.

The covariance elements for systematic and random errors are specified via standard deviations for the diagonal terms, and correlation coefficients for the off-diagonal terms. The actual off-diagonal covariance elements are then computed by multiplying the correlation coefficients with the appropriate, diagonal, standard deviation terms. The diagonal variance terms are computed by squaring the corresponding standard deviations. The covariance elements for relative error are specified as changes in variance (see Annex C).

B.2.1 Geographic Region Scope

Table B.12 describes the metadata entities and elements of the scope of the data quality information as either ‘dataset’ or a subset region of the dataset. In the region case, the region is identified by number and its geographic extents are defined.

Table B.12: Geographic Region Scope

Row	Name	Definition	Data Type	Domain	Obligation	Max. Occur.
1	DQ_DataQuality.scope (79)	extent of characteristics of the data for which quality information is reported	Class	<i>id = “Dataset” or “Region***”</i> Lines 2-6	R	N
2	DQ_Scope.level (139)	hierarchical level of the data specified by the scope	MD_ScopeCode	‘collectionSession’ or ‘dataset’ Use collectionSession for quality measure by region. This includes positional accuracy summary if also defined by region. Use dataset for positional accuracy summary data, cross-region covariance, completeness, and per post data. Note: in the context of HRE, ‘collection session’ implies that the data has been divided into regions for some reason	R	1
3	EX_Extent (334)	information about horizontal, vertical, and temporal extent	Class	Lines 4-6	C / level equals collectionSession	1
4	EX_Extent > EX_GeographicExtent > EX_BoundingPolygon.polygon (342)	set of points defining the bounding polygon	GM_Polygon (ISO 19107)	<i>gml:id= “Region***Extents”</i> Line 5	C/level equals collectionSession and Region Mask does not exist	1

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Row	Name	Definition	Data Type	Domain	Obligation	Max. Occur.
5	GM_Polygon.exterior.linearring	set(s) of points defining the bounding polygon.	Sequence<GM_Position>	The vertices of the polygon are limited to a single two-dimensional spatial reference system. Use geographic (for HREGP) or UTM coordinates, with (latitude, longitude) or (easting, northing) coordinate ordering. A rectangle will have 5 coordinate pairs, with the first being identical to the last. For example: 39.10333000 -74.92250000 39.19386000 -74.92269000 39.19414000 -74.66167000 39.10306000 -74.66142000 39.10333000 -74.92250000	R	1
6	EX_Extent.description (335)	spatial extent of the referring object as free text	CharacterString	'Region_xxx'	C/level equals collectionSession	1
7	DQ_Scope.levelDescription > MD_ScopeDescription.other (155)	class of information that does not fall into the other categories to which the information applies	CharacterString	NITF://Segment_Type/Segment_Id/[#Fragment_ID] (Reference to and Image Segment providing the Region Definition per Post (Region Mask)) (Segment_Id = NITF IID2 field value in image subheader) Example: NITF://IM002/REG1020081201	C / level equals collectionSession and Region Mask exists	1

B.2.2 Positional Accuracy

Table B.13 describes the metadata entities and elements that describe summary positional accuracy for the entire dataset. They include a declaration of the type of positional accuracy being measured, the qualitative and quantitative results of the accuracy measurement, and the procedure used to derive the measurement. A citation for the party performing the procedure is also included.

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Table B.13: Positional Accuracy

Row	Name	Definition	Data Type	Domain	Obligation	Max. Occur.
1	DQ_Element (99)	aspect of quantitative quality information	Aggregated Class (DQ_DataQuality) <<Abstract>>	Lines 2-25	R (scope = dataset) O (scope = collectionSession) (see text on Positional Accuracy data requirements)	12
2	nameOfMeasure (100)	name of the test applied to the data	CharacterString	For each occurrence of a data quality element, specify one of the following types of accuracy: Absolute Horizontal Accuracy, vendor-provided (R) Relative Horizontal Accuracy, vendor-provided (O) Random Horizontal Accuracy, vendor-provided (O) Absolute Vertical Accuracy, vendor-provided (R) Relative Vertical Accuracy, vendor-provided (R) Random Vertical Accuracy, vendor-provided (R) Absolute Horizontal Accuracy, validator-provided (O) Relative Horizontal Accuracy, validator-provided (O) Random Horizontal Accuracy, validator-provided (O) Absolute Vertical Accuracy, validator-provided (O) Relative Vertical Accuracy, validator-provided (O) Random Vertical Accuracy, validator-provided (O) Each measure name will include the suffix “for dataset” or “for Region_xxx” depending on scope.	R	1
3	measureDescription (102)	description of the measure	CharacterString	“Stated (absolute, relative, or random) (horizontal or vertical) accuracy based on DMA-TR-8400.1 definition, as provided by the data (provider or validator)”	R	1
4	evaluationMethodType (103)	type of method used to evaluate quality of the dataset	DQ_EvaluationMethodTypeCode	Use ‘Indirect’ for predicted accuracy, ‘DirectExternal’ for comparison to control	R	1
5	evaluationMethodDescription (104)	description of the evaluation method	CharacterString	For Direct External Evaluation method: “Validated using comparison to control” For Indirect evaluation method: “Predicted using rigorous sensor modeling, data adjustment, and error propagation techniques”	R	1
6	evaluationProcedure (105)	reference to the procedure information	CI_Citation	Lines 7-13	R	1
7	CI_Citation.title (360)	name by which the cited resource is known	CharacterString	Identify the document (e.g. manual, handbook, etc.) describing the evaluation procedure used	R	1
8	CI_Citation.date (362)	reference date for the cited resource	CI_Date	Lines 9-10	R	1

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Row	Name	Definition	Data Type	Domain	Obligation	Max. Occur.
9	CI_Date.date (394)	reference date for the cited resource	Date	YYYY-MM-DD Use date that best reflects the currency of the document	R	1
10	CI_Date.dateType (395)	event used for reference date	CI_DateTypeCode	<i>CI_DateTypeCode codeList="http://metadata.dod.mil/mdr/ns/GSIP/codelist/DateTypeCode" codeListValue="creation" or "revision"</i>	R	1
11	CI_Citation.citedResponsibleParty (367)	name and position information for an individual or organization that is responsible for the resource	CI_ResponsibleParty	Lines 12-13	R	1
12	CI_ResponsibleParty.organizationName (376)	name of the responsible organization	CharacterString	entity that used (performed) the evaluation procedure	R	1
13	CI_ResponsibleParty.role (379)	function performed by the responsible party	CI_RoleCode	<i>user</i>	R	1
14	dateTime (106)	date or range of dates on which a data quality measure was applied	DateTime	If evaluation method = direct external, use Date/Time data was evaluated. If evaluation method = indirect, omit this element YYYY-MM-DDThh:mm:ss.sZ	C	1
15	result (107)	value (or set of values) obtained from applying a data quality measure or the outcome of evaluating the obtained value (or set of values) against a specified acceptable conformance quality level	Class	DQ_Result	R	2
16	DQ_Result (128)	generalization of more specific result classes	Class <<Abstract>>	Lines 17-25	R	2
17	DQ_ConformanceResult (129)	information about the outcome of evaluating the obtained value (or set of values) against a specified acceptable conformance quality level	Specified Class (DQ_Result)	Lines 18-20	O	1
18	specification (130)	citation of product specification or user requirement against which data is being evaluated	CI_Citation	Lines 19-22	R	1
19	CI_Citation.title (360)	name by which the cited resource is known	CharacterString	<i>"HRE v1.0"</i>	R	1
20	CI_Citation.date (362)	date of the resource	Class	Lines 21-22	R	N
21	CI_Date.date (394)	reference date for the cited resource	Date	YYYY-MM-DD	R	1

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Row	Name	Definition	Data Type	Domain	Obligation	Max. Occur.
22	CI_Date.dateType (395)	event used for reference date	CI_DateTypeCode	CI_DateTypeCode codeList="http://metadata.dod.mil/mdr/ns/GSIP/codelist/DateTypeCode " codeListValue="creation" or "revision"	R	1
23	explanation (131)	explanation of the meaning of conformance for this result	CharacterString	<p>"Used non-parametric testing making no assumptions of data distribution and using empirical cumulative distribution functions to identify the desired percentile value and determine the conformance to the Implementation Profile for HRE Products. Pass means that the tested value was less than or equal to the value required by the profile"</p> <p>OR</p> <p>"Used parametric testing assuming a Gaussian distribution and using Chi Squared statistic to determine the pass/fail of the hypothesis testing and conformance to the HRE Implementation Profile for HRE Products. Pass means that the test statistic was less than the critical value and the tested value conforms to the profile"</p>	R	1
24	pass (132)	indication of the conformance result where 0= fail and 1 = pass	Boolean	1 (yes) or 0 (no)	R	1
25	DQ_QuantitativeResult (133)	the values or information about the value(s) (or set of values) obtained from applying a data quality measure	Specified Class (DQ_Result)	Lines 26-29	R	1
26	valueType (134)	value type for reporting a data quality result	RecordType	accuracy measure, real	R	1
27	valueUnit (135)	value unit for reporting a data quality result	UnitOfMeasure	href="http://metadata.dod.mil/mdr/ns/GPAS/codelist/uom/metre"	R	1
28	errorStatistic (136)	statistical method used to determine the value	CharacterString	<p>"Non-parametric methods making no assumptions of data distribution and using empirical cumulative distribution functions to calculate the statistic at the 90 percent confidence level."</p> <p>or</p> <p>"Assumed a normal distribution and used the mean, standard deviation and desired confidence interval to determine the statistic at the 90 percent confidence level"</p> <p>See production-specific guidance</p>	R	1
29	value (137)	quantitative value or values, content determined by the evaluation procedure used.	Record	Record id="accuracy measure" The data type is a real number.	R	1

B.2.3 Systematic Error Covariance by Region

In order to calculate rigorous, high fidelity error estimates for each post within a dataset region, standard error propagation techniques shall be used. A 3 x 3 covariance matrix must be defined with correlation coefficients and standard deviations that can be applied to every post in the dataset or region to determine the post's systematic error. Table B.14 describes the metadata entities and elements that describe the procedure for computing the systematic error covariance and allow the 3 x 3 matrix to be defined. Two quantitative results are included, one for providing the standard deviations and one for providing the correlation coefficients of the matrix. The Evaluation Procedure element (row 6) that was required in the Positional Accuracy reports is conditional here and throughout the remaining accuracy modules. That is, it should not be repeated for every accuracy report in the xml metadata unless the citation information it contains is different from the information in the last citation provided in the xml sequence. This will serve to eliminate redundancy in the xml file. Production-specific guidance will determine the requirement for the Systematic Error Covariance module.

Table B.14: Systematic Error Covariance by Region

Row	Name	Definition	Data Type	Domain	Obligation	Max. Occur.
1	DQ_Element (99)	aspect of quantitative quality information	Aggregated Class (DQ_DataQuality) <<Abstract>>	Lines 2-26	C See production-specific guidance	N (one per region)
2	nameOfMeasure (100)	name of the test applied to the data	CharacterString	<i>Systematic Error Covariance Matrix for Region_xxx</i>	R	1
3	measureDescription (102)	description of the measure	CharacterString	<i>Systematic error standard deviations for diagonal elements 1,2, and 3, followed by systematic error correlation coefficients between elements 1 and 2, 1 and 3, and 2 and 3.</i>	R	1
4	evaluationMethodType (103)	type of method used to evaluate quality of the dataset	DQ_EvaluationMethodT ypeCode	<i>Indirect</i>	R	1
5	evaluationMethodDescription (104)	description of the evaluation method	CharacterString	<i>Predicted using rigorous sensor modeling, data adjustment, and error propagation techniques</i>	R	1

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Row	Name	Definition	Data Type	Domain	Obligation	Max. Occur.
6	evaluationProcedure (105)	reference to the procedure information	CI_Citation	Lines 7-13	C/is procedure information different from last reported procedure in the xml sequence?	1
7	CI_Citation.title (360)	name by which the cited resource is known	CharacterString	Identify the document (e.g. manual, handbook, etc.) describing the evaluation procedure used	R	1
8	CI_Citation.date (362)	reference date for the cited resource	Date	Lines 9-10	R	1
9	CI_Date.date (394)	reference date for the cited resource	Date	YYYY-MM-DD Use date that best reflects the currency of the document	R	1
10	CI_Date.dateType (395)	event used for reference date	CI_DateTypeCode	<i>CI_DateTypeCode codeList="http://metadata.dod.mil/mdr/ns/GSIP/codelist/DateTypeCode" codeListValue="creation" or "revision"</i>	R	1
11	CI_Citation.citedResponsibleParty (367)	name and position information for an individual or organization that is responsible for the resource	CI_ResponsibleParty	Lines 12-13	R	1
12	CI_ResponsibleParty.organizationName (376)	name of the responsible organization	CharacterString	entity that used (performed) the evaluation procedure	R	1
13	CI_ResponsibleParty.role (379)	function performed by the responsible party	CI_RoleCode	<i>user</i>	R	1
14	dateTime (106)	date or range of dates on which a data quality measure was applied	DateTime	Date/Time of error derivation. YYYY-MM-DDThh:mm:ss.SZ	R	1

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Row	Name	Definition	Data Type	Domain	Obligation	Max. Occur.
15	result (107)	value (or set of values) obtained from applying a data quality measure or the outcome of evaluating the obtained value (or set of values) against a specified acceptable conformance quality level	Class	DQ_Result	R	2
16	DQ_Result (128)	generalization of more specific result classes	Class <<Abstract>>	DQ_QuantitativeResult	R	2
17	DQ_QuantitativeResult (133)	values or information about the value(s) (or set of values) obtained from applying a data quality measure	Specified Class (DQ_Result)	Lines 18-21	R	1
18	valueType (134)	value type for reporting a data quality result	RecordType	<i>standard deviation, real</i>	R	1
19	valueUnit (135)	value unit for reporting a data quality result	UnitOfMeasure	<i>href= "http://metadata.dod.mil.mdr/ns/GPAS/codelist/uom/metre" (for Standard Deviation, a parameter required in determining systematic error covariance.)</i>	R	1
20	errorStatistic (136)	statistical method used to determine the value	CharacterString	<i>Three values providing standard deviations for diagonal term values of 3-by-3 region systematic error covariance matrix.</i>	R	1
21	value (137)	quantitative value or values, content determined by the evaluation procedure used.	Record	<i>Record id= "standard deviation"</i> The data type is a real number	R	3
22	DQ_QuantitativeResult (133)	values or information about the value(s) (or set of values) obtained from applying a data quality measure	Specified Class (DQ_Result)	Lines 23-26	R	1
23	valueType (134)	value type for reporting a data quality result	RecordType	<i>correlation coefficient, real</i>	R	1
24	valueUnit (135)	value unit for reporting a data quality result	UnitOfMeasure	<i>href= "http://metadata.dod.mil.mdr/ns/GPAS/codelist/uom/unitless" (for Correlation Coefficient, a parameter required in determining systematic error covariance.)</i>	R	1

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Row	Name	Definition	Data Type	Domain	Obligation	Max. Occur.
25	errorStatistic (136)	statistical method used to determine the value	CharacterString	Three values providing correlation coefficients between elements 1 and 2, 1 and 3, and 2 and 3 for off diagonal term values of 3-by-3 region systematic error covariance matrix.	R	1
26	value (137)	quantitative value or values, content determined by the evaluation procedure used.	Record	Record id="correlation coefficient" The data type is a real number	R	3

B.2.4 Systematic Error Cross-Region Covariance

Table B.15 describes the metadata entities and elements for a dataset containing two or more regions, the covariance between each region pair shall be calculated. For each pair of regions, a matrix of nine correlation coefficients must be created. Production-specific guidance will determine the requirement for this module.

Table B.15: Systematic Error Cross-Region Covariance

Row	Name	Definition	Data Type	Domain	Obligation	Max. Occur.
1	DQ_Element (99)	aspect of quantitative quality information	Aggregated Class (DQ_DataQuality) <<Abstract>>	Lines 2-21	C See production-specific guidance	$\frac{1}{2}(R)(R-1)$ Where R = number of regions
2	nameOfMeasure (100)	name of the test applied to the data	CharacterString	Systematic Error Cross-Region Covariance Matrix for Region xxx and Region yyy	R	1
3	measureDescription (102)	description of the measure	CharacterString	When two or more regions are defined, these cross-region covariance matrices define the 9 unique correlation coefficients for each pair of regions. These are the off-diagonal terms of the sigmaG matrix. The number of these matrices required is equal to $\frac{1}{2}(\text{number of regions} - 1)$	R	1
4	evaluationMethodType (103)	type of method used to evaluate quality of the dataset	DQ_EvaluationMethodTypeCode	Indirect	R	1
5	evaluationMethodDescription (104)	description of the evaluation method	CharacterString	Predicted using rigorous sensor modeling, data adjustment, and error propagation techniques	R	1

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Row	Name	Definition	Data Type	Domain	Obligation	Max. Occur.
6	evaluationProcedure (105)	reference to the procedure information	CI_Citation	Lines 7-13	C/is procedure information different from last reported procedure in the xml sequence?	1
7	CI_Citation.title (360)	name by which the cited resource is known	CharacterString	Identify the document (e.g. manual, handbook, etc.) describing the evaluation procedure used	R	1
8	CI_Citation.date (362)	reference date for the cited resource	Date	Lines 9-10	R	1
9	CI_Date.date (394)	reference date for the cited resource	Date	YYYY-MM-DD Use date that best reflects the currency of the document	R	1
10	CI_Date.dateType (395)	event used for reference date	CI_DateTypeCode	<i>CI_DateTypeCode codeList=</i> <i>http://metadata.dod.mil/mdr/ns/GSIP/codelist/DateTypeCode</i> <i>codeListValue=</i> "creation" <i>or</i> "revision"	R	1
11	CI_Citation.citedResponsibleParty (367)	name and position information for an individual or organization that is responsible for the resource	CI_ResponsibleParty	Lines 12-13	R	1
12	CI_ResponsibleParty.organizationName (376)	name of the responsible organization	CharacterString	entity that used the evaluation procedure	R	1
13	CI_ResponsibleParty.role (379)	function performed by the responsible party	CI_RoleCode	User	R	1
14	dateTime (106)	date or range of dates on which a data quality measure was applied	DateTime	DateTime of error derivation. YYYY-MM-DDThh:mm:ss.sZ	R	1
15	Result (107)	value (or set of values) obtained from applying a data quality measure or the outcome of evaluating the obtained value (or set of values) against a specified acceptable conformance quality level	Class	DQ_Result	R	1
16	DQ_Result (128)	generalization of more specific result classes	Class <<Abstract>>	Lines 17-21	R	1
17	DQ_QuantitativeResult (133)	values or information about the value(s) (or set of values) obtained from applying a data quality measure	Specified Class (DQ_Result)	Lines 18-21	R	1
18	valueType (134)	value type for reporting a data quality result	RecordType	correlation coefficient matrix element, real	R	1
19	valueUnit (135)	value unit for reporting a data quality result	UnitOfMeasure	<i>href=</i> "http://metadata.dod.mil/mdr/ns/GPAS/codelist/uom/unitless"	R	1
20	errorStatistic (136)	statistical method used to determine the value	CharacterString	Nine values (in row major order) providing correlation coefficients of 3-by-3 region systematic error for each cross-region covariance matrix.	R	1

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Row	Name	Definition	Data Type	Domain	Obligation	Max. Occur.
21	value (137)	quantitative value or values, content determined by the evaluation procedure used.	Record	<i>Record id="correlation coefficient matrix element"</i> <i>(Sequence of 9 real numbers in row major order)</i>	R	9

B.2.5 Random Error Covariance by Region

Random Error for each post in a dataset can be provided either by a random error covariance matrix per region combined with a per post scale factor (see Section B.2.7), or by image segments in the NITF file that provide the random error covariance for each post (Section B.2.6). Table B.16 describes the metadata entities and elements of the standard deviations and correlation coefficients used in a random error covariance matrix per region are defined. The date of the evaluation is again included. Production-specific guidance will determine the requirement for this module.

Table B.16: Random Error Covariance by Region

Row	Name	Definition	Data Type	Domain	Obligation	Max. Occur.
1	DQ_Element (99)	aspect of quantitative quality information	Aggregated Class (DQ_DataQuality) <<Abstract>>	Lines 2-26	C See production-specific guidance	N
2	nameOfMeasure (100)	name of the test applied to the data	CharacterString	<i>Random Error Covariance Matrix for Region_xxx</i>	R	1
3	measureDescription (102)	description of the measure	CharacterString	<i>Random error standard deviations for diagonal elements 1, 2, and 3, followed by systematic error correlation coefficients between elements 1 and 2, 1 and 3, and 2 and 3.</i>	R	1
4	evaluationMethodType (103)	type of method used to evaluate quality of the dataset	DQ_EvaluationMethodT ypeCode	<i>Indirect</i>	R	1
5	evaluationMethodDescription (104)	description of the evaluation method	CharacterString	<i>Predicted using rigorous sensor modeling, data adjustment, and error propagation techniques</i>	R	1

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Row	Name	Definition	Data Type	Domain	Obligation	Max. Occur.
6	evaluationProcedure (105)	reference to the procedure information	CI_Citation	Lines 7-13	C/is procedure information different from last reported procedure in the xml sequence?	1
7	CI_Citation.title (360)	name by which the cited resource is known	CharacterString	Identify the document (e.g. manual, handbook, etc.) describing the evaluation procedure used	R	1
8	CI_Citation.date (362)	reference date for the cited resource	Date	Lines 9-10	R	1
9	CI_Date.date (394)	reference date for the cited resource	Date	YYYY-MM-DD Use date that best reflects the currency of the document	R	1
10	CI_Date.dateType (395)	event used for reference date	CI_DateTypeCode	<i>CI_DateTypeCode codeList="http://metadata.dod.mil/mdr/ns/GSIP/codelist/DateTypeCode" codeListValue="creation" or "revision"</i>	R	1
11	CI_Citation.citedResponsibleParty (367)	name and position information for an individual or organization that is responsible for the resource	CI_ResponsibleParty	Lines 12-13	R	1
12	CI_ResponsibleParty.organizationName (376)	Name of the responsible organization	CharacterString	entity that used (performed) the evaluation procedure	R	1
13	CI_ResponsibleParty.role (379)	function performed by the responsible party	CI_RoleCode	User	R	1
14	dateTime (106)	date or range of dates on which a data quality measure was applied	DateTime	DateTime of error derivation. YYYY-MM-DDThh:mm:ss.SZ	R	1

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Row	Name	Definition	Data Type	Domain	Obligation	Max. Occur.
15	result (107)	value (or set of values) obtained from applying a data quality measure or the outcome of evaluating the obtained value (or set of values) against a specified acceptable conformance quality level	Class	DQ_Result	R	2
16	DQ_Result (128)	generalization of more specific result classes	Class <<Abstract>>	Lines 17-26	R	2
17	DQ_QuantitativeResult (133)	values or information about the value(s) (or set of values) obtained from applying a data quality measure	Specified Class (DQ_Result)	Lines 18-21	R	1
18	valueType (134)	value type for reporting a data quality result	RecordType	<i>standard deviation, real</i>	R	1
19	valueUnit (135)	value unit for reporting a data quality result	UnitOfMeasure	<i>href= "http://metadata.dod.mil.mdr/ns/GPAS/codelist/uom/ metre" (for Standard Deviation, a parameter required in determining random error covariance.)</i>	R	1
20	errorStatistic (136)	statistical method used to determine the value	CharacterString	<i>Three values providing standard deviations for diagonal term values of 3-by-3 region random error covariance matrix.</i>	R	1
21	value (137)	quantitative value or values, content determined by the evaluation procedure used.	Record	<i>Record id= "standard deviation"</i> The value is a real number	R	3
22	DQ_QuantitativeResult (133)	values or information about the value(s) (or set of values) obtained from applying a data quality measure	Specified Class (DQ_Result)	Lines 23-26	R	1
23	valueType (134)	value type for reporting a data quality result	RecordType	<i>correlation coefficient, real</i>	R	1
24	valueUnit (135)	value unit for reporting a data quality result	UnitOfMeasure	<i>href= "http://metadata.dod.mil.mdr/ns/GPAS/codelist/uom/ unitless" (for Correlation Coefficient, a parameter required in determining random error covariance.)</i>	R	1

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Row	Name	Definition	Data Type	Domain	Obligation	Max. Occur.
25	errorStatistic (136)	statistical method used to determine the value	CharacterString	Three values providing correlation coefficients between elements 1 and 2, 1 and 3, and 2 and 3 for off diagonal term values of 3-by-3 region random error covariance matrix.	R	1
26	value (137)	quantitative value or values, content determined by the evaluation procedure used.	Record	Record id="correlation coefficient" The value is a real number	R	3

B.2.6 Random Error Covariance Per Post

As described in Section B.2.5, random error for each post in a dataset may alternatively be provided through the use of NITF image segments that can be combined to create a 3 x 3 random error covariance matrix for each post in the dataset. Table B.17 describes the metadata entities and elements for describing the procedure for determining the standard deviations and correlation coefficients of the covariance matrix, and specify the location of the image segments (one for standard deviations and one for correlation coefficients). The date and time of the error derivations is also included. Production-specific guidance will determine the requirement for this module.

Table B.17: Random Error Covariance by Post

Row	Name	Definition	Data Type	Domain	Obligation	Max. Occur.
1	DQ_Element (99)	aspect of quantitative quality information	Aggregated Class (DQ_DataQuality) <<Abstract>>	Lines 2-17	C See production-specific guidance	N
2	nameOfMeasure (100)	name of the test applied to the data	CharacterString	Random error covariance matrix	R	1
3	measureDescription (102)	description of the measure	CharacterString	Each post is assigned six unique values that make up its 3-by-3 covariance matrix. These covariance matrix elements are located in two separate image segments contained in the NITF file. One image segment contains the 3 diagonal term standard deviations, the other contains the 3 off-diagonal correlation coefficients.	R	1

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Row	Name	Definition	Data Type	Domain	Obligation	Max. Occur.
4	evaluationMethodDescription (104)	description of the evaluation method	CharacterString	(Method is described by producer)	R	1
5	dateTime (106)	date or range of dates on which a data quality measure was applied	DateTime	Provides Date/Time of error derivation. YYYY-MM-DDThh:mm:ss.SZ	R	1
6	result (107)	value (or set of values) obtained from applying a data quality measure or the outcome of evaluating the obtained value (or set of values) against a specified acceptable conformance quality level	Class	DQ_Result	R	2
7	DQ_Result (128)	generalization of more specific result classes	Class <<Abstract>>	Lines 8-17	R	2
8	DQ_QuantitativeResult (133)	values or information about the value(s) (or set of values) obtained from applying a data quality measure	Specified Class (DQ_Result)	Lines 9-12	R	1
9	valueType (134)	value type for reporting a data quality result	RecordType	<i>standard deviation, character string</i>	R	1
10	valueUnit (135)	value unit for reporting a data quality result	UnitOfMeasure	<i>href= "http://metadata.dod.mil.mdr/ns/GPAS/codelist/uom/metre" (for Standard Deviation, a parameter required in determining random error covariance.)</i>	R	1
11	errorStatistic (136)	statistical method used to determine the value	CharacterString	<i>Three values providing standard deviations for diagonal term values of 3-by-3 region random error covariance matrix.</i>	R	1
12	value (137)	quantitative value or values, content determined by the evaluation procedure used.	Record	<i>Record id = "standard deviation"</i> NITF://Segment_Type/Segment_Id/[#Fragment_ID] (Reference to specific NITF image segment containing random error standard deviation values for the 3 diagonal elements.) Example: NITF://IM003/COV1020081201	R	1

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Row	Name	Definition	Data Type	Domain	Obligation	Max. Occur.
13	DQ_QuantitativeResult (133)	values or information about the value(s) (or set of values) obtained from applying a data quality measure	Specified Class (DQ_Result)	Lines 14-17	R	1
14	valueType (134)	value type for reporting a data quality result	RecordType	<i>correlation coefficient, character string</i>	R	1
15	valueUnit (135)	value unit for reporting a data quality result	UnitOfMeasure	<i>href= "http://metadata.dod.mil.mdr/ns/GPAS/codelist/uom/unitless" (for Correlation Coefficient, a parameter required in determining random error covariance.)</i>	R	1
16	errorStatistic (136)	statistical method used to determine the value	CharacterString	<i>Three values providing correlation coefficients between elements 1 and 2, 1 and 3, and 2 and 3 for off diagonal term values of 3-by-3 region random error covariance matrix.</i>	R	1
17	value (137)	quantitative value or values, content determined by the evaluation procedure used.	Record	<i>Record id = "correlation coefficient"</i> NITF://Segment_Type/Segment_Id/[#Fragment_ID] (Reference to specific NITF image segment containing random error correlation values for the 3 unique off-diagonal matrix elements.) Example: NITF://IM004/COR1020081201	R	1

B.2.7 Random Error Scale Factor Per Post

As described in Section B.2.7, random error for each post in the dataset can be determined by combining a random error per region covariance matrix with a NITF image segment that provides random error scale factor for each post. Table B.18 describes the metadata entities and elements for this procedure and specifies the NITF file location of the scale factor image segment. The date of the scale factor determination is also included. Production-specific guidance will determine the requirement for this module.

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Table B.18: Random Error Scale Factor Per Post

Row	Name	Definition	Data Type	Domain	Obligation	Max. Occur.
1	DQ_Element (99)	aspect of quantitative quality information	Aggregated Class (DQ_DataQuality) <<Abstract>>	Lines 2-21	C See production-specific guidance	N
2	nameOfMeasure (100)	name of the test applied to the data	CharacterString	<i>Random Error Scale Factor</i>	R	1
3	measureDescription (102)	description of the measure	CharacterString	<i>Random error scale factor corresponding to each HRE post. These scale factors are stored in a separate image segment accompanying the HRE data.</i>	R	1
4	evaluationMethodType (103)	type of method used to evaluate quality of the dataset	DQ_EvaluationMethodTypeCode	<i>Indirect</i>	R	1
5	evaluationMethodDescription (104)	description of the evaluation method	CharacterString	<i>Predicted using rigorous sensor modeling, data adjustment, and error propagation techniques</i>	R	1
6	evaluationProcedure (105)	reference to the procedure information	CI_Citation	Lines 7-13	C/is procedure information different from last reported procedure in the xml sequence?	1
7	CI_Citation.title (360)	name by which the cited resource is known	CharacterString	Identify the document (e.g. manual, handbook, etc.) describing the evaluation procedure used	R	1
8	CI_Citation.date (362)	reference date for the cited resource	Date	Lines 9-10	R	1
9	CI_Date.date (394)	reference date for the cited resource	Date	YYYY-MM-DD Use date that best reflects the currency of the document	R	1

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Row	Name	Definition	Data Type	Domain	Obligation	Max. Occur.
10	CI_Date.dateType (395)	event used for reference date	CI_DateTypeCode	CI_DateTypeCode codeList="http://metadata.dod.mil/mdr/ns/GSIP/codelist/DateTypeCode" codeListValue="creation" or "revision"	R	1
11	CI_Citation.citedResponsibleParty (367)	name and position information for an individual or organization that is responsible for the resource	CI_ResponsibleParty	Lines 10-11	R	1
12	CI_ResponsibleParty.organizationName (376)	name of the responsible organization	CharacterString	entity that used the evaluation procedure	R	1
13	CI_ResponsibleParty.role (379)	function performed by the responsible party	CI_RoleCode	User	R	1
14	dateTime (106)	date or range of dates on which a data quality measure was applied	DateTime	DateTime of error derivation. YYYY-MM-DDThh:mm:ss.sZ	R	1
15	result (107)	value (or set of values) obtained from applying a data quality measure or the outcome of evaluating the obtained value (or set of values) against a specified acceptable conformance quality level	Class	DQ_Result	R	1
16	DQ_Result (128)	generalization of more specific result classes	Class <<Abstract>>	Lines 17-21	R	1
17	DQ_QuantitativeResult (133)	the values or information about the value(s) (or set of values) obtained from applying a data quality measure	Specified Class (DQ_Result)	Lines 18-21	R	1
18	valueType (134)	value type for reporting a data quality result	RecordType	scale factor, character string	R	1
19	valueUnit (135)	value unit for reporting a data quality result	UnitOfMeasure	href="http://metadata.dod.mil/mdr/ns/GPAS/codelist/uom/unitless"	R	1

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Row	Name	Definition	Data Type	Domain	Obligation	Max. Occur.
20	errorStatistic (136)	statistical method used to determine the value	CharacterString	<i>Per post scale factor used in conjunction with the regional random error covariance matrix</i>	R	1
21	value (137)	quantitative value or values, content determined by the evaluation procedure used.	Record (value= CharacterString)	<i>Record id = "scale factor"</i> NITF://Segment_Type/Segment_Id/[#Fragment_ID] (Reference to specific NITF image segment containing scale factor data) Example: <i>NITF://IM002/RSF1020081201</i>	R	1

B.2.8 Relative Error Covariance by Region

To calculate the relative error between posts in a specified region of a dataset one must be provided two relative error covariance matrices per region that describes the growth in error as a function of distance between the points in a local coordinate system (with axes U and V, that are rotated with respect to the UTM coordinate system by an angle theta about the UTM up direction. In addition, a maximum distance threshold value is specified for each direction. Table B.19 describes the metadata elements and entities of the variance terms used in a relative error covariance matrix per region. A citation is again included that identifies the party performing the procedure, and the date it was performed. Table B.20 provides the angle and distance threshold. Production-specific guidance will determine the requirement for these modules.

Table B.19: Relative Error Covariance by Region

Row	Name	Definition	Data Type	Domain	Obligation	Max. Occur.
1	DQ_Element (99)	aspect of quantitative quality information	Aggregated Class (DQ_DataQuality) <<Abstract>>	Lines 2-24	C See production-specific guidance	2
2	nameOfMeasure (100)	name of the test applied to the data	CharacterString	<i>Relative Error Covariance Matrix for Region_xxx in "U" direction</i> Or <i>Relative Error Covariance Matrix for Region_xxx in "V" direction</i>	R	1

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Row	Name	Definition	Data Type	Domain	Obligation	Max. Occur.
3	measureDescription (102)	description of the measure	CharacterString	<i>Relative error variance terms for diagonal elements 1,2, and 3, followed by relative error variance terms between elements 1 and 2, 1 and 3, and 2 and 3.</i>	R	1
4	evaluationMethodType (103)	type of method used to evaluate quality of the dataset	DQ_EvaluationMethodTypeCode	<i>Indirect</i>	R	1
5	evaluationMethodDescription (104)	description of the evaluation method	CharacterString	<i>Predicted using rigorous sensor modeling, data adjustment, and error propagation techniques</i>	R	1
6	evaluationProcedure (105)	reference to the procedure information	CI_Citation	Lines 7-11	C/is procedure information different from last reported procedure in the xml sequence?	1
7	CI_Citation.title (360)	name by which the cited resource is known	CharacterString	Identify the document (e.g. manual, handbook, etc.) describing the evaluation procedure used	R	1
8	CI_Citation.date (362)	reference date for the cited resource	Date	Lines 9-10	R	1
9	CI_Date.date (394)	reference date for the cited resource	Date	YYYY-MM-DD Use date that best reflects the currency of the document	R	1
10	CI_Date.dateType (395)	event used for reference date	CI_DateTypeCode	<i>CI_DateTypeCode codeList="http://metadata.dod.mil/mdr/ns/GSIP/codelist/DateTypeCode" codeListValue="creation" or "revision"</i>	R	1
9	CI_Citation.citedResponsibleParty (367)	name and position information for an individual or organization that is responsible for the resource	CI_ResponsibleParty	Lines 10-11	R	1

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Row	Name	Definition	Data Type	Domain	Obligation	Max. Occur.
10	CI_ResponsibleParty.organization Name (376)	name of the responsible organization	CharacterString	entity that used (performed) the evaluation procedure	R	1
11	CI_ResponsibleParty.role (379)	function performed by the responsible party	CI_RoleCode	User	R	1
12	dateTime (106)	date or range of dates on which a data quality measure was applied	DateTime	DateTime of error derivation. YYYY-MM-DDThh:mm:ss.sZ	R	1
13	result (107)	value (or set of values) obtained from applying a data quality measure or the outcome of evaluating the obtained value (or set of values) against a specified acceptable conformance quality level	Class	DQ_Result	R	2
14	DQ_Result (128)	generalization of more specific result classes	Class <<Abstract>>	Lines 15-24	R	2
15	DQ_QuantitativeResult (133)	values or information about the value(s) (or set of values) obtained from applying a data quality measure	Specified Class (DQ_Result)	Lines 16-19	R	1
16	valueType (134)	value type for reporting a data quality result	RecordType	diagonal term value, real	R	1
17	valueUnit (135)	value unit for reporting a data quality result	UnitOfMeasure	href="http://metadata.dod.mil.mdr/ns/GPAS/codelist/uom/metre" (actually metre squared per metre, for Variance, a parameter required in determining relative error covariance.)	R	1
18	errorStatistic (136)	statistical method used to determine the value	CharacterString	Three values providing change in variance with distance for diagonal term values of 3-by-3 region relative error covariance matrix.	R	1
19	value (137)	quantitative value or values, content determined by the evaluation procedure used.	Record	Record id="diagonal term value" The value is a real number	R	3

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Row	Name	Definition	Data Type	Domain	Obligation	Max. Occur.
20	DQ_QuantitativeResult (133)	values or information about the value(s) (or set of values) obtained from applying a data quality measure	Specified Class (DQ_Result)	Lines 21-24	R	1
21	valueType (134)	value type for reporting a data quality result	RecordType	<i>off diagonal term value, real</i>	R	1
22	valueUnit (135)	value unit for reporting a data quality result	UnitOfMeasure	<i>href= "http://metadata.dod.mil.mdr/ns/GPAS/codelist/uom/metre" (actually meters squared per distance in meters squared, for Variance, a parameter required in determining relative error covariance.)</i>	R	1
23	errorStatistic (136)	statistical method used to determine the value	CharacterString	<i>Three values providing change in variance terms with distance for elements 1 and 2, 1 and 3, and 2 and 3 for off diagonal term values of 3-by-3 region relative error covariance matrix.</i>	R	1
24	value (137)	quantitative value or values, content determined by the evaluation procedure used.	Record	<i>Record id="off diagonal term value"</i> The value is a real number	R	3

Table B.20: Relative Error Angle and Distance

Row	Name	Definition	Data Type	Domain	Obligation	Max. Occur.
1	DQ_Element (99)	aspect of quantitative quality information	Aggregated Class (DQ_DataQuality) <<Abstract>>	Lines 2-14	C Relative Error Covariance by Region specified?	1
2	nameOfMeasure (100)	name of the test applied to the data	CharacterString	<i>Relative Error Angle and Distance</i>	R	1

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Row	Name	Definition	Data Type	Domain	Obligation	Max. Occur.
3	result (107)	value (or set of values) obtained from applying a data quality measure or the outcome of evaluating the obtained value (or set of values) against a specified acceptable conformance quality level	Class	DQ_Result	R	2
4	DQ_Result (128)	generalization of more specific result classes	Class <<Abstract>>	Lines 5-14	R	2
5	DQ_QuantitativeResult (133)	values or information about the value(s) (or set of values) obtained from applying a data quality measure	Specified Class (DQ_Result)	Lines 6-9	R	1
6	valueType (134)	value type for reporting a data quality result	RecordType	<i>angle, real</i>	R	1
7	valueUnit (135)	value unit for reporting a data quality result	UnitOfMeasure	<i>href="http://metadata.dod.mil.mdr/ns/GPAS/codelist/uom/degrees"</i> (for rotationAngle, a parameter required in determining relative error covariance.)	R	1
8	errorStatistic (136)	statistical method used to determine the value	CharacterString	<i>A value providing a counterclockwise rotation angle that rotates the Easting direction about the vertical to align with the U axis. Used for region relative error covariance matrix.</i>	R	1
9	value (137)	quantitative value or values, content determined by the evaluation procedure used.	Record	<i>Record id="angle"</i> The value is a real number	R	1
10	DQ_QuantitativeResult (133)	values or information about the value(s) (or set of values) obtained from applying a data quality measure	Specified Class (DQ_Result)	Lines 11-14	R	1
11	valueType (134)	value type for reporting a data quality result	RecordType	<i>distance, real</i>	R	1
12	valueUnit (135)	value unit for reporting a data quality result	UnitOfMeasure	<i>href="http://metadata.dod.mil.mdr/ns/GPAS/codelist/uom/metre"</i> (for thresholdDistance, a parameter required in determining relative error covariance.)	R	1

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Row	Name	Definition	Data Type	Domain	Obligation	Max. Occur.
13	errorStatistic (136)	statistical method used to determine the value	CharacterString	<i>A value providing a threshold maximum distance for region relative error covariance matrix.</i>	R	1
14	value (137)	quantitative value or values, content determined by the evaluation procedure used.	Record	<i>Record id="distance"</i> The value is a real number	R	1

B.2.9 Completeness of the Dataset

The data quality elements in Table B.21 provide a means to define the rate of missing elevation values in the dataset. The rate is expressed as an integer that represents a percentage.

Table B.21: Completeness of the Dataset (Omission)

Row	Name	Definition	Data Type	Domain	Obligation	Max. Occur.
1	DQ_Element (99)	aspect of quantitative quality information	Aggregated Class (DQ_DataQuality) <<Abstract>>	Lines 2-8	R	N
2	nameOfMeasure (100)	name of the test applied to the data	CharacterString	<i>Rate of missing items</i>	R	1
3	result (107)	value (or set of values) obtained from applying a data quality measure or the outcome of evaluating the obtained value (or set of values) against a specified acceptable conformance quality level	Class	DQ_Result	R	2
4	DQ_Result (128)	generalization of more specific result classes	Class <<Abstract>>	Lines 5-8	R	1

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Row	Name	Definition	Data Type	Domain	Obligation	Max. Occur.
5	DQ_QuantitativeResult (133)	values or information about the value(s) (or set of values) obtained from applying a data quality measure	Specified Class (DQ_Result)	Lines 6-8	R	1
6	valueType (134)	value type for reporting a data quality result	RecordType	<i>omission rate percentage, integer</i>	R	1
7	valueUnit (135)	value unit for reporting a data quality result	UnitOfMeasure	<i>href="http://metadata.dod.mil.mdr/ns/GPAS/codelist/uom/unitless"</i>	R	1
8	value (137)	quantitative value or values, content determined by the evaluation procedure used.	Record	<i>Record id="omission rate percentage"</i> The value is an integer Note: range for Integer is 0-99	R	1

Annex C HRE Metadata in support of Error Propagation

C.1 Overview

This annex provides insight into the metadata architecture that allows rigorous error propagation of HRE data. The first subsection describes how error covariance data is to be stored. The second subsection describes how an exploitation tool would use the HRE metadata. The explanation and examples pertain specifically to lidar; however they can be extended to apply to other systems such as IFSAR and stereo optical. The principles recommended below are described in terms of points (relevant to a future HRE spec) and full covariance matrices, but would apply also to the special case of posts (relevant to the current HRE spec).

C.2 Metadata Contents

C.2.1 Define Regions

The vendor shall partition the entire HRE product into N distinct regions (one or more) based on data error characteristics. HRE provides 2 methods for partitioning into regions; (1) to define a raster grid of positive integers that identify a post as belonging to one of the N regions; or (2) specify the X,Y coordinates of each vertex defining each of the N polygons or regions, assuring that the edges of adjacent polygons are coincident and there are not any gaps or overlaps between regions.

C.2.2 Provide Cross-Region Systematic Error Covariance Data

Consider for example a HRE product requiring the division into four regions (see Figure C.1). Our objective is to specify a full covariance matrix that represents the typical covariance and correlation information associated with multiple ground points appearing across different regions. Then, Equation 1 is the full covariance matrix that shall be provided as metadata:

$$\Sigma_G = \begin{bmatrix} \Sigma_{G1} & \Sigma_{G12} & \Sigma_{G13} & \Sigma_{G14} \\ & \Sigma_{G2} & \Sigma_{G23} & \Sigma_{G24} \\ & & \Sigma_{G3} & \Sigma_{G34} \\ \text{symmetric} & & & \Sigma_{G4} \end{bmatrix} \quad (1)$$

In the lidar example, the full ground points covariance matrix, Σ_G , consisting of 3 by 3 sub-matrices, can be calculated by performing rigorous error propagation on a set of three condition equations per object point in which observations consist of: a pair of direction angles, a range measurement, and all sensor parameters. The vendor should calculate the covariance matrix to correspond to ground points located at the approximate centers of their associated regions (see Figure C.2). The full simultaneous error propagation must take into account the correlation between sensor parameters in different strips. Also, the input covariance information should exclude high-frequency noise, i.e. random error, which will be handled separately. The

availability of a sensor model for the collection system that is compliant with the Community Sensor Model (CSM) standard would allow for such error propagation.

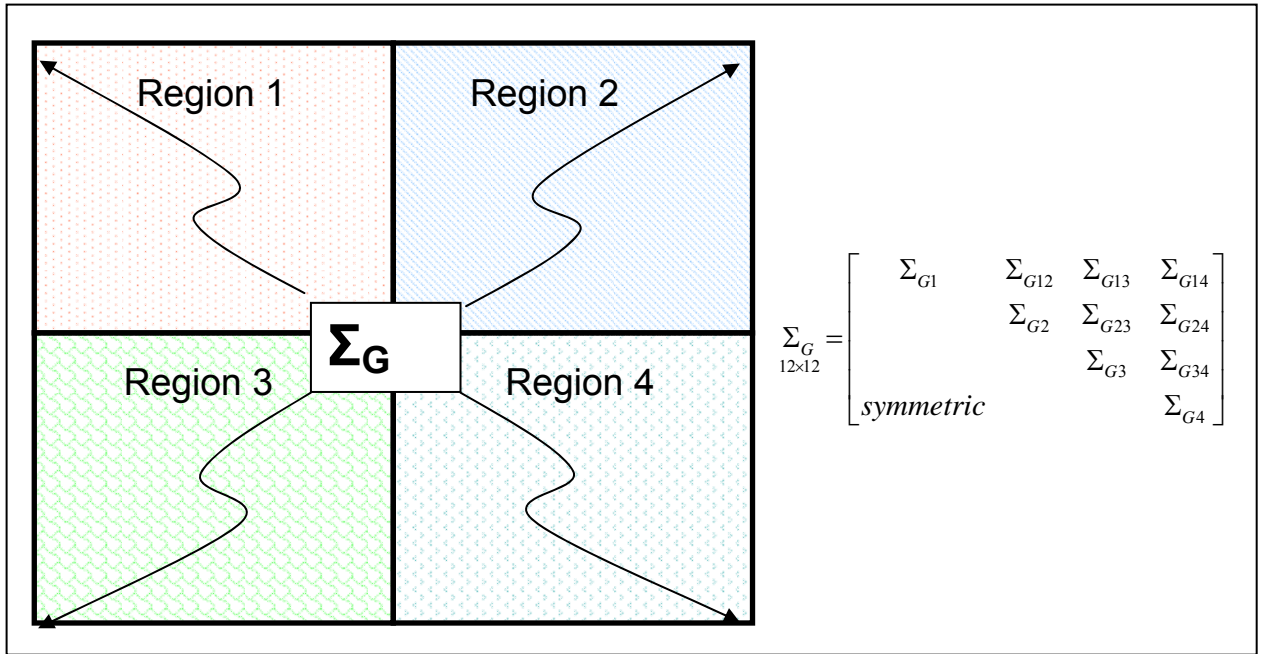


Figure C-1 Full covariance data for the systematic errors of four regions

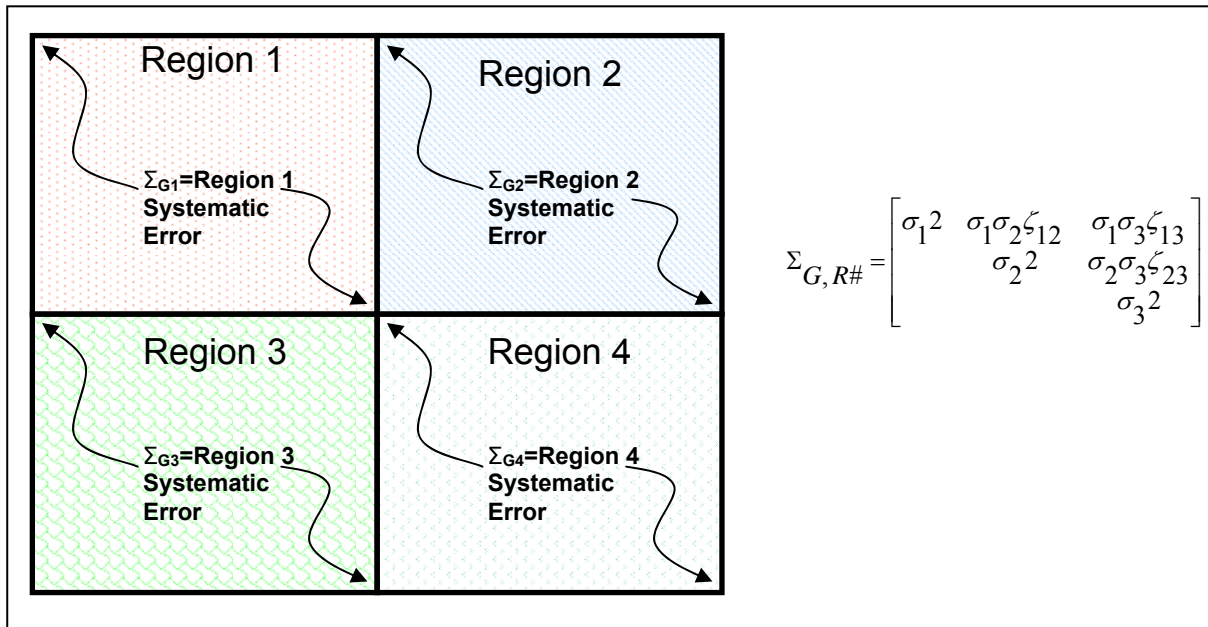


Figure C-2 Systematic Error ($\Sigma_{G,R\#}$) per Region where R# represents a Region Number and the DEM consists of four regions (1-4)

C.2.3 Provide Random Covariance Data

The random component of predicted error shall be handled on a point by point basis. Following are two strategies to consider: 1) for each point store all 6 independent values required to express a 3 by 3 ground covariance matrix; or 2) for each of the N regions specify the 6 independent values required to express a nominal 3 by 3 random-component ground covariance matrix, and then for each point in the dataset store a scalar value necessary to scale the nominal 3 by 3 ground covariance matrix to arrive at the desired per point values (see Figure C.3).

Strategy 1 will take a large amount of storage space. Strategy 2 is an approximation that will only be valid for narrow field-of-view (i.e., except for a scale factor, the characteristics of the 3D error volume are well modeled by the nominal covariance matrix everywhere in the region). Note that the availability of a CSM compliant model would allow for calculation of the 3 by 3 ground covariance matrix at each point.

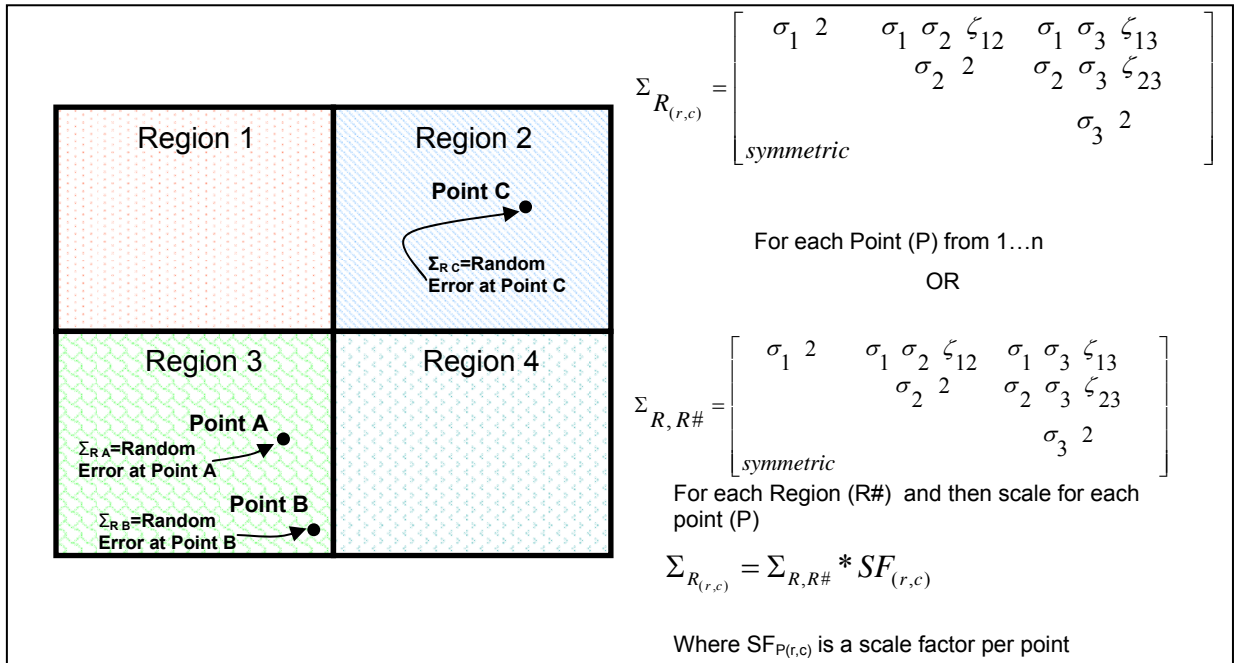


Figure C-3 The random error (Σ_R) at a point (P)

C.2.4 Provide Relative Covariance Data within a Region

The precision of the relative vector between two points, A and B, appearing within the same region should vary as a function of the horizontal vector between the two points:

$$\Sigma_{AB} = \Sigma_{RA} + \Sigma_{RB} + D_U^2 \cdot \Phi_U + D_V^2 \cdot \Phi_V \quad (2)$$

Where $\Sigma_{randomA}, \Sigma_{randomB}$ are the 3 by 3 matrices, as per Section C.2.3, expressing the random error at each point; D_U, D_V represent the horizontal distances in meters between the two points in a local coordinate system that has been rotated from the UTM cartesian coordinate system of

the dataset (see Figure C-4); and Φ_U, Φ_V are 3 by 3 matrices expressing the increase in covariance magnitude per meter point separation along the U and V axes. As illustrated in the example below, the local (U-V) space is necessary to provide the flexibility to account for covariance growth resulting from the data collection / generation that may not occur parallel to the UTM coordinate system. A ceiling can also be defined such that the magnitude of Σ_R does not exceed specified maxima.

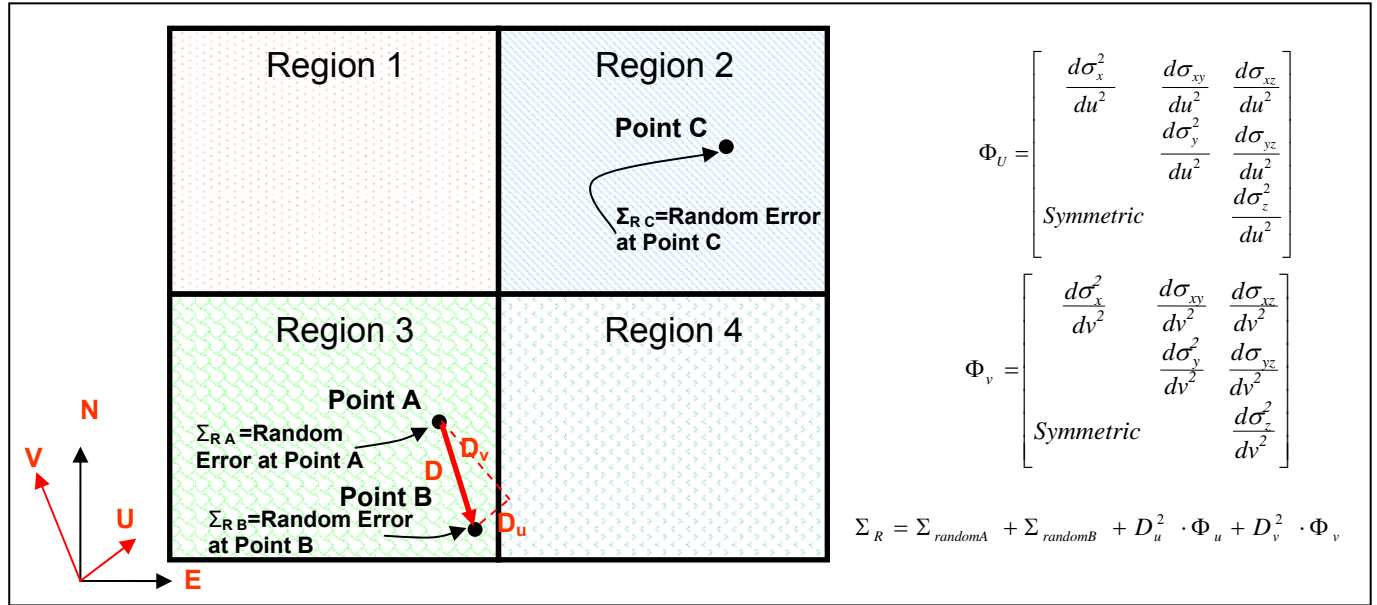


Figure C-4 Relative covariance of vector R within a region (region 3 in this case)

As an example of how a vendor would calculate the Φ_U, Φ_V matrices to provide in the HRE metadata, consider an airborne lidar platform flying along the U axis and scanning perpendicular to the U axis in the V direction. Then, using rigorous error propagation facilitated by CSM function calls, the vendor can calculate the covariance matrices of the vectors between pairs of points as a function of their separation distances in the U and V directions, i.e. D_U, D_V . The vendor would solve for the increase in covariance magnitude per meter, Φ_U, Φ_V , assuming that relative error increases linearly as follows:

$$\Sigma_{AB} = \Sigma_{RA} + \Sigma_{RB} + D_U^2 \cdot \Phi_U + D_V^2 \cdot \Phi_V \quad (3)$$

Given that a counterclockwise rotation angle of θ rotates the X axis (about the Z, or up, axis) to align with the U axis, we can apply the changes associated with Φ_U, Φ_V using the ground distances (D_X, D_Y) and the following equation:

$$\Sigma_{AB} = \Sigma_{RA} + \Sigma_{RB} + \Phi_U (D_X \cos \theta + D_Y \sin \theta)^2 + \Phi_V (-D_X \sin \theta + D_Y \cos \theta)^2 \quad (4)$$

C.2.5 Error data discussion

To help clarify the error data discussed above, consider a derivation of the results just presented. Imagine that data points of interest are segregated into non-overlapping geographic regions. Let each region be designated by the letter 'G' followed by a unique number. Let each point within a region be designated by the same region designation followed by a unique lowercase alphabetic label (e.g. we have point a in region G1, also designated as G1a). We are interested in the errors in spatial position of such data points.

Let \mathbf{P}_{G1a} be a 3D vector specifying the position of point G1a in a suitable reference frame. Express \mathbf{P}_{G1a} as the sum of a vector that specifies the position of region G1 (designated as \mathbf{S}_{G1}) and a 3D vector that gives the position of point G1a relative to \mathbf{S}_{G1} (designate this vector as \mathbf{r}_{G1a}). Then

$$\mathbf{P}_{G1a} = \mathbf{S}_{G1} + \mathbf{r}_{G1a} \quad (5)$$

The quantities in equation (5) are all subject to errors. Designate the deviation from the mean of any quantity i with the symbol (δ) . Then

$$\delta\mathbf{P}_{G1a} = \delta\mathbf{S}_{G1} + \delta\mathbf{r}_{G1a} \quad (6)$$

Now we can identify the errors $\delta\mathbf{S}_{G1}$ with the systematic errors in section C.2.2, and the errors $\delta\mathbf{r}_{G1a}$ with the random errors in section C.2.3.

Three by three covariance matrices between a pair of 3D vectors can be written as,

$$\Sigma_{GIGJ} \equiv \langle \delta\mathbf{S}_{GI} \delta\mathbf{S}_{GJ}^T \rangle \quad (7)$$

Where the brackets denote expectation value and \mathbf{S}^T indicates the transpose (a row vector) of the column vector \mathbf{S} , so that the product in (7) is an outer product. As written, equation (7) gives the covariances for the systematic errors $\delta\mathbf{S}_{GI}$ and $\delta\mathbf{S}_{GJ}$. If the terms for region numbers $I \neq J$ are non-zero, it indicates that the errors in specifying the location of region I are not independent of the errors in locating region J . If the set of covariance matrices for N regions are gathered into a $3N \times 3N$ matrix, the result is equation (1), in section C.2.2.

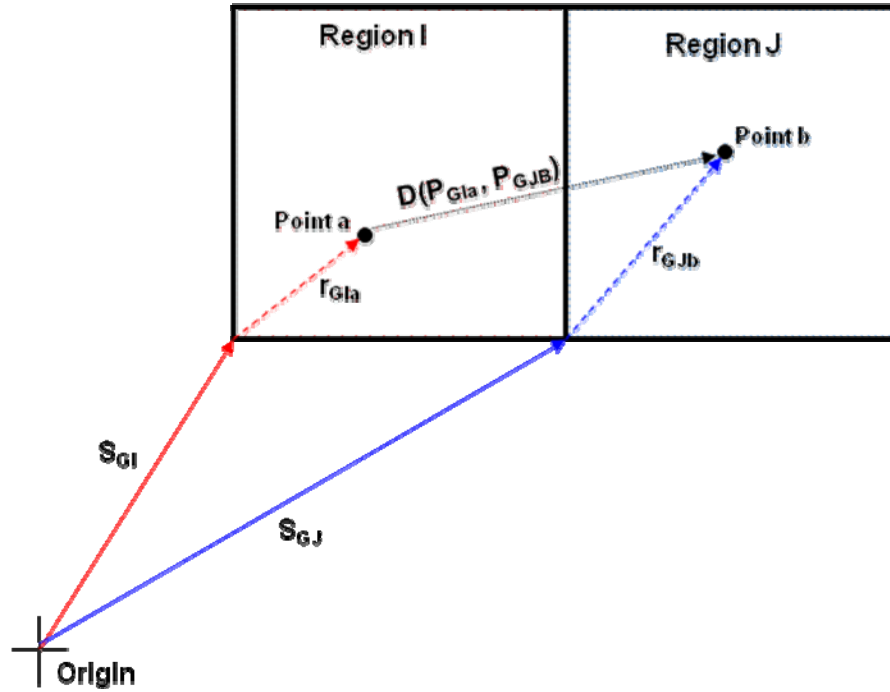


Figure C-5 Systematic and Random Error Vector Representation

Now consider the covariance matrix between a vector locating point GIa, \mathbf{P}_{GIa} , and a vector locating point GJb, \mathbf{P}_{GJb} . This can be written as

$$\Sigma(\mathbf{P}_{GIa}\mathbf{P}_{GJb}) \equiv \langle \delta\mathbf{P}_{GIa} \delta\mathbf{P}_{GJb}^T \rangle \equiv \Sigma_{GIJ} + \Sigma_{GIaGJb} + \Sigma_{GIJGb} + \Sigma_{GIaGJ} \quad (8)$$

The four terms on the right are obtained by using equation (6) in the middle expression in (8), expanding out the product and denoting the individual product terms as covariance matrices using notation to differentiate between systematic and random error terms. The first of the terms on the right is defined by equation (7), the second is a similar expression for covariances between random errors, and the third and fourth terms involve covariances between systematic errors and random errors. Here, the definition of separate regions implies that covariances of random errors across regions are zero ($\Sigma_{GIaGJb} \equiv 0$, $I \neq J$) and that the covariances of random errors with systematic errors are always zero. With these assumptions equation (8) becomes:

$$\Sigma(\mathbf{P}_{GIa}\mathbf{P}_{GJb}) = \Sigma_{GIJ} \quad I \neq J \quad (9)$$

$$\Sigma(\mathbf{P}_{GIa}\mathbf{P}_{GJb}) = \Sigma_{GII} + \Sigma_{GIaGIb} \quad I = J \quad (10)$$

If $a = b$, equation (10) is essentially equation (15) in section C.3.1. Taken together, equations (9) and (10) are used in the formulation of equation (16) in section C.3.1.

Finally, consider the covariances for a vector connecting two points (so that we may arrive at an expression for the relative error between two points). Let the vector from point \mathbf{P}_{GJb} to point \mathbf{P}_{Gla} be denoted as $\mathbf{D}(\mathbf{P}_{\text{Gla}}\mathbf{P}_{\text{GJb}}) \equiv \mathbf{P}_{\text{Gla}} - \mathbf{P}_{\text{GJb}}$. Then the error in \mathbf{D} is

$$\delta \mathbf{D}(\mathbf{P}_{\text{Gla}}\mathbf{P}_{\text{GJb}}) = \delta \mathbf{P}_{\text{Gla}} - \delta \mathbf{P}_{\text{GJb}} \quad (11)$$

And the covariance matrix among the components of \mathbf{D} is

$$\begin{aligned} \Sigma_{\mathbf{D}}(\text{Gla}, \text{GJb}) &= \langle (\delta \mathbf{P}_{\text{Gla}} - \delta \mathbf{P}_{\text{GJb}}) (\delta \mathbf{P}_{\text{Gla}} - \delta \mathbf{P}_{\text{GJb}})^T \rangle \quad (12) \\ &= \langle (\delta \mathbf{S}_{\text{GI}} - \delta \mathbf{S}_{\text{GJ}} + \delta \mathbf{r}_{\text{Gla}} - \delta \mathbf{r}_{\text{GJb}}) (\delta \mathbf{S}_{\text{GI}} - \delta \mathbf{S}_{\text{GJ}} + \delta \mathbf{r}_{\text{Gla}} - \delta \mathbf{r}_{\text{GJb}})^T \rangle \end{aligned}$$

If $I = J$ (the endpoints of \mathbf{D} are both in the same region) then

$$\begin{aligned} \Sigma_{\mathbf{D}}(\text{Gla}, \text{GJb}) &= \langle (\delta \mathbf{r}_{\text{Gla}} - \delta \mathbf{r}_{\text{Glb}}) (\delta \mathbf{r}_{\text{Gla}} - \delta \mathbf{r}_{\text{Glb}})^T \rangle \quad (13) \\ &= \Sigma_{\text{GlaGJa}} + \Sigma_{\text{GlbGlb}} - \Sigma_{\text{GlaGJb}} - \Sigma_{\text{GlbGJa}} \end{aligned}$$

This agrees with equation (2) in section C.2.4 if we identify the last two terms in equation (13) with $D_U^2 \Phi_U + D_V^2 \Phi_V$ in equation (2). Equation (13) is the more general form and equation (2) was chosen as a way to provide a simplified approach to specifying the cross-covariance terms in the HRE metadata.

If $I \neq J$ (the endpoints of \mathbf{D} are in different regions) then the right hand side of equation (12) comprises sixteen terms. If, however, we again assume that covariances of random errors across regions are zero, and that covariances of random errors with systematic errors are zero, (12) becomes

$$\Sigma_{\mathbf{D}}(\text{Gla}, \text{GJb}) = (\Sigma_{\text{GI GI}} + \Sigma_{\text{Gla Gla}}) + (\Sigma_{\text{GJ GJ}} + \Sigma_{\text{GJb GJb}}) - \Sigma_{\text{GI GJ}} - \Sigma_{\text{GJ GI}} \quad (14)$$

This is essentially equation (17) below in section C.3.2.1.

C.3 Exploitation

Figure C-6 illustrates a simple example where two points of interest, A and C, appear in different regions. The first sub-section illustrates how an exploitation tool reconstructs a full covariance matrix containing the covariance matrices for points A and C and the joint cross covariance between points A and C. The second sub-section illustrates how an exploitation tool calculates the precision, expressed as a full covariance matrix, of the relative vector between points A and C.

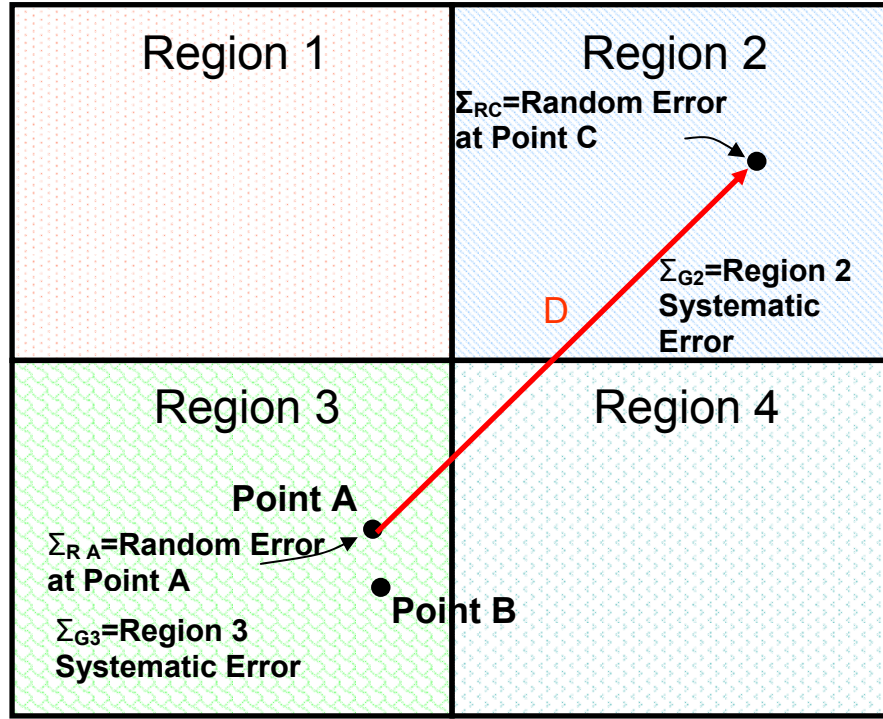


Figure C-6 Sample DEM footprint consisting of four regions with vector crossing regions

C.3.1 Reconstruction of Full Covariance Matrix for a Single Point

Consider point A in region 3. Then, following is the equation for the full 3 by 3 covariance matrix for point A:

$$\Sigma_{AA} = (\Sigma_{G3} + \Sigma_{RA}) \quad (15)$$

C.3.2 Reconstruction of Full Covariance Matrix for Multiple Points

The full 6 by 6 covariance matrix for points A and C is constructed as follows:

$$\Sigma_{AC} = \begin{bmatrix} \Sigma_{G3} + \Sigma_{RA} & \Sigma_{G23} \\ \Sigma_{G23}^T & \Sigma_{G2} + \Sigma_{RC} \end{bmatrix} \quad (16)$$

Where Σ_{RA}, Σ_{RC} are the random components of precision for points A and C.

C.3.2.1 Construct Covariance Matrix for Relative Error

Let D denote the relative vector from A to C. Then, following is the equation for the full 3 by 3 covariance matrix for vector D:

$$\Sigma_{DD} = (\Sigma_{G3} + \Sigma_{RA}) + (\Sigma_{G2} + \Sigma_{RC}) - \Sigma_{G23} - \Sigma_{G23}^T \quad (17)$$

C.3.2.2 Random Error Covariance at a Point

Consider the case where we would like to isolate the random error covariance at a point (point A) without trying to isolate the system observations that contribute solely to random error. We can calculate the full covariance matrix for points A and B, where B is very close to A, and both A and B have the same precision. Then, we can break this full 6 by 6 matrix down to determine the random component of precision at point A, expressed as a full 3 by 3 matrix as follows:

$$\Sigma_{RA} \cong \frac{1}{2} (\Sigma_{AA} + \Sigma_{BB} - \Sigma_{AB} - \Sigma_{AB}^T) \quad (18)$$

C.3.2.3 Computing the Absolute Error at a Point

One of the common applications of the uncertainty data is to predict the absolute error of a point. This could be performed to determine the absolute accuracy of a single point or it may be an operation where the absolute accuracy of every DEM post is determined to develop a grid of uncertainties for additional visualization / exploitation.

The first step to developing the absolute accuracy is to combine the systematic and random uncertainty estimates for the point(s) of interest as shown in Figure C-7 below.

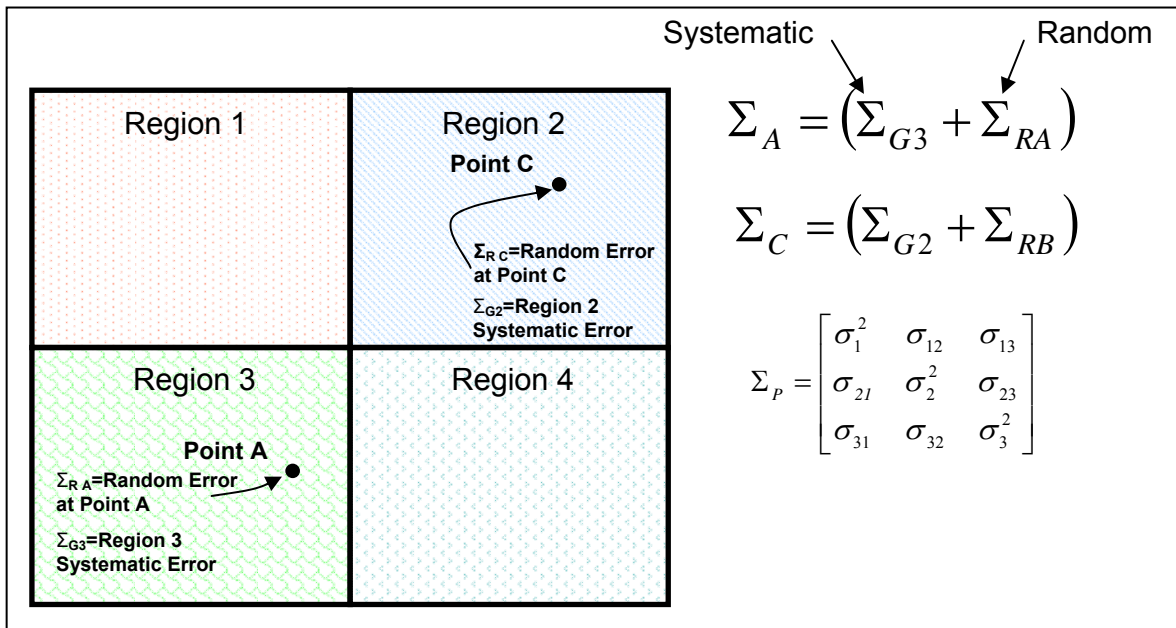


Figure C-7 Covariance data at a point

Once developed the covariance matrix (Σ_P) represents the uncertainty around the point (P). If one were solely interested in the horizontal uncertainty of point P, only the 2x2 covariance

elements related to horizontal uncertainty would be evaluated and these would represent an error ellipse of uncertainty around point P (See Figure C.8).

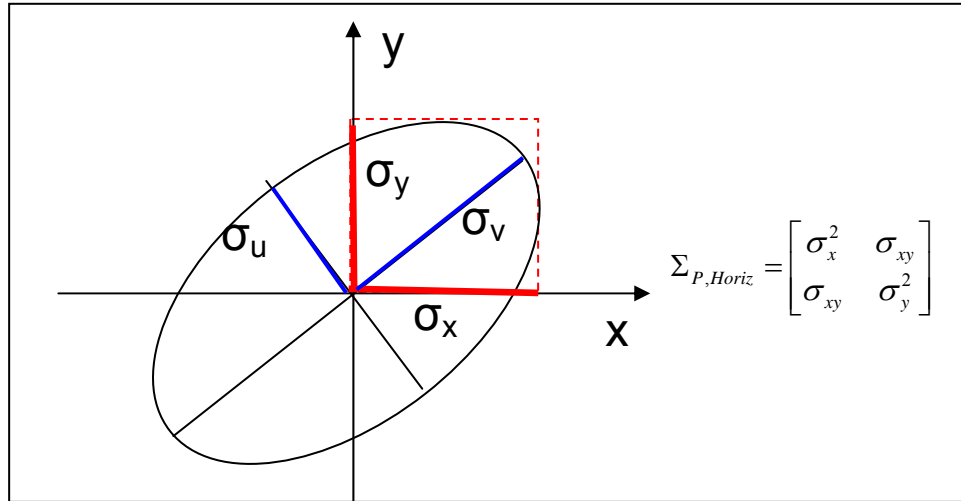


Figure C-8 Horizontal Error ellipse at a point

Using the values of the error ellipse, one can also calculate a circular error for the point (P) at a given confidence interval (see Figure C.9). There are several documented methods to calculate the CE90 using the covariance data. In this case, the method proposed in Department of Defense Standard Practice: Mapping, Charting, and Geodesy Accuracy [MIL-STD-600001] is shown.

First compute the eigenvalues of the ellipse:

$$\sigma_u^2 = \frac{\sigma_x^2 + \sigma_y^2}{2} + \sqrt{\frac{1}{4}(\sigma_x^2 - \sigma_y^2)^2 + (\sigma_{xy})^2}$$

$$\sigma_v^2 = \frac{\sigma_x^2 + \sigma_y^2}{2} - \sqrt{\frac{1}{4}(\sigma_x^2 - \sigma_y^2)^2 + (\sigma_{xy})^2}$$

Then compute the ratio between them:

$$C = \sigma_v / \sigma_u$$

Finally, calculate the CE:

$$CE90 = (1.6545 - 0.13913C + 0.6324C^2)\sigma_u$$

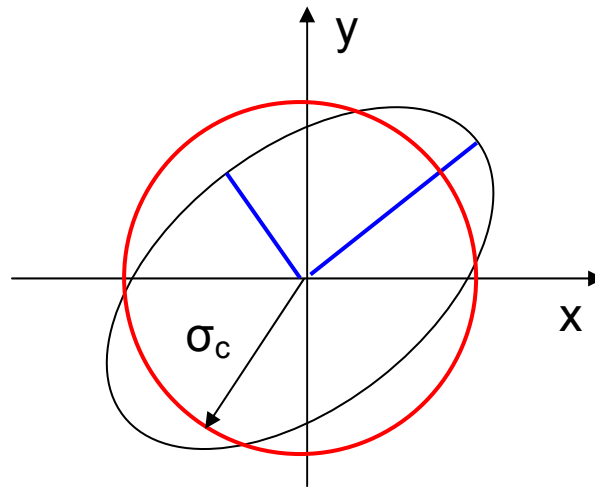


Figure C-9 Circular error from covariance data

In a similar fashion, the covariance data can also be used to calculate the vertical uncertainty of a point at a given confidence interval. To calculate the LE90 of a point (P), one would calculate:

$$LE90_{ABS,P} = 1.6449|\sigma|$$