Conjunction Summary Message Guide

OVERVIEW

The purpose of this document is to provide the Space Situation Awareness (SSA) Sharing satellite operator with details about the Conjunction Summary Message (CSM). The CSM is a fixed-format ASCII formatted message which contains information about a conjunction between a high-interest space object (hereafter referred to as "asset" or "primary satellite") and another resident space object, which will be referred to as the "conjuncting satellite".

BACKGROUND

The CSM is derived from the Orbital Conjunction Message (OCM). The OCM was originally created for the NASA/JSC Human Spaceflight Safety mission.

The CSM is a product generated by the Astrodynamics Support Workstation (ASW) suite of analysis tools. The ASW software provides the capability to generate the Joint Space Operations Center (JSpOC) Special Perturbations (SP) High-Accuracy Catalog (HAC).

SP is the numerical method utilized within ASW for integration of the equations of motion and orbit propagation of the objects in the satellite catalog. This technique accomplishes direct numerical integration of the equations of motion including all necessary perturbing accelerations.

The ASW analysis tool utilized to accomplish the Conjunction Assessment (CA) mission is called "Super COMBO", which stands for Computation of Miss Between Orbits. All Super COMBO screenings are accomplished utilize the SP HAC data for the satellite catalog, which provides for more accurate CA screening results.

CSM NAMING CONVENTION

A separate CSM will be provided for each predicted conjunction that meets the reporting criteria. When the Joint Space Operations Center (JSpOC) generates a CSM the naming convention is provided in the following format: "aaaaa_conj_ccccc_mmm_yyyyddd_n.csm". Where:

"aaaaa"	is the satellite catalog number for the primary satellite,
"ccccc"	is the refers to the satellite catalog number for the conjuncting satellite,
"mmm"	is the three letter abbreviation for the month of the predicted conjunction,
"yyyy"	is the year of the predicted conjunction,
"ddd"	is the Day of the Year of the predicted conjunction, and
"n"	is the sequence number of the conjunction when there are multiple conjunctions predicted to occur on a given day (this will normally be "1", but this sequence number is based upon a time order and not on which predicted conjunction has the closest approach).

CSM EXAMPLE

The following is an example of a CSM. Each part of the CSM will be explained further in the sections following the example.

```
UNCLAS
QQQQ
<> CONJUNCTION SUMMARY MESSAGE FOR: SATELLITE A
<> REAL
<> MESSAGE CREATION TIME: 2010 071 (12 MAR) 22:31:12.000 CENTER: JSpOC
<> MESSAGE VERSION: V2.0
<>
<> *****************************************************************
<> RELATIVE DATA:
<> TIME OF CLOSEST APPROACH (UTC): 2010 072 (13 MAR) 22:37:52.618
<> MISS DISTANCE (M):      715
<> RELATIVE SPEED (M/S): 14762
<> CLOSEST APP. REL. POSITION (M):         27.4      -70.2      711.8
<> CLOSEST APP. REL. VELOCITY (M/S):       -7.2   -14692.0    -1437.2
<>
<> *****************************************************************
<> ASSET: 12345                               INT. DES.: 1997-030E
<> COMMON NAME: SATELLITE A
<> TIME OF LAST ACCEPTED OB: <6 HOURS FROM MESSAGE CREATION TIME
<> LUPI/DC SPAN USED (DAYS):   7.88/  5.50  RESIDUAL ACCPT:  97.8 %
<> NUM OBS AVAIL/USED: 592/ 418
<> APOGEE (KM):   779  PERIGEE (KM):   765  INCLINATION (DEG):  86.4
<> RADAR CROSS SECTION (SCALED): LARGE (>1m sq)  WEIGHTED RMS: 0.864
<> BALLISTIC COEFFICIENT (M2/KG):   0.045663
<> SOLAR RADIATION PRESSURE COEFFICIENT (M2/KG):   0.000000
<> ENERGY DISSIPATION RATE (W/KG):  4.54570E-05
<> GEOPOTENTIAL: EGM-96 36Z,36T  DRAG: JACCHIA70DCA  LUNAR/SOLAR:  ON
<> SOLAR RAD PRESS: OFF  SOLID EARTH TIDES: OFF  IN-TRACK THRUST: OFF
<> -----------------------------------------------------------------
<> ASSET TDR POSITION (M):    2570098.594   2244663.456   6281494.300
<> ASSET TDR VELOCITY (M/S):  4418.768701   4833.542969  -3526.781960
<> -----------------------------------------------------------------
<>
<> *****************************************************************
<> CONJUNCTING SATELLITE: 30337               INT. DES.: 1999-025AA
<> COMMON NAME: FENGYUN 1C DEB
<> TIME OF LAST ACCEPTED OB: 6-12 HOURS FROM MESSAGE CREATION TIME
<> LUPI/DC SPAN USED (DAYS):   2.63/  2.63  RESIDUAL ACCPT:  97.8 %
<> NUM OBS AVAIL/USED: 59/ 58
<> APOGEE (KM):   786  PERIGEE (KM):   414  INCLINATION (DEG):  98.8
<> RADAR CROSS SECTION (SCALED): SMALL (<0.1m sq)  WEIGHTED RMS: 0.864
<> BALLISTIC COEFFICIENT (M2/KG):   0.118668
<> SOLAR RADIATION PRESSURE COEFFICIENT (M2/KG):   0.075204
<> ENERGY DISSIPATION RATE (W/KG):  5.40900E-03
<> GEOPOTENTIAL: EGM-96 36Z,36T  DRAG: JACCHIA70DCA  LUNAR/SOLAR:  ON
<> SOLAR RAD PRESS:  ON  SOLID EARTH TIDES: OFF  IN-TRACK THRUST: OFF
<> -----------------------------------------------------------------
<> SAT. TDR POSITION (M):     2569542.299   2245102.187   6281596.315
<> SAT. TDR VELOCITY (M/S):  -2888.611701  -6007.242986   3328.778993
<> -----------------------------------------------------------------
<>
<> *****************************************************************
<> ASSET COVARIANCE: (1,1) TO (6,6)  (M^2, M^2/S, M^2/S^2)
<>      U          V          W         UD         VD         WD
<>  4.142E+01 -8.579E+00 -2.312E+01  0.000E+00  0.000E+00  0.000E+00
<> -8.579E+00  2.533E+03  1.336E+01  0.000E+00  0.000E+00  0.000E+00
```

```
<> -2.312E+01  1.336E+01  7.098E+01  0.000E+00  0.000E+00  0.000E+00
<>  0.000E+00  0.000E+00  0.000E+00  0.000E+00  0.000E+00  0.000E+00
<>  0.000E+00  0.000E+00  0.000E+00  0.000E+00  0.000E+00  0.000E+00
<>  0.000E+00  0.000E+00  0.000E+00  0.000E+00  0.000E+00  0.000E+00
<>
<> SAT. COVARIANCE: (1,1) TO (6,6)  (M^2, M^2/S, M^2/S^2)
<>      U          V          W         UD         VD         WD
<>  1.337E+03 -4.806E+04 -3.298E+01  0.000E+00  0.000E+00  0.000E+00
<> -4.806E+04  2.492E+06 -7.588E+02  0.000E+00  0.000E+00  0.000E+00
<> -3.298E+01 -7.588E+02  7.105E+01  0.000E+00  0.000E+00  0.000E+00
<>  0.000E+00  0.000E+00  0.000E+00  0.000E+00  0.000E+00  0.000E+00
<>  0.000E+00  0.000E+00  0.000E+00  0.000E+00  0.000E+00  0.000E+00
<>  0.000E+00  0.000E+00  0.000E+00  0.000E+00  0.000E+00  0.000E+00
<>
<> ******************************************************************
<> ASSET COVARIANCE (7,1) TO (8,8)  (M^3/KG, M^3/KG-S, M^4/KG^2)
<>
<>    (7,1)      (7,2)      (7,3)      (7,4)      (7,5)      (7,6)
<>  0.000E+00  0.000E+00  0.000E+00  0.000E+00  0.000E+00  0.000E+00
<>    (7,7)      (7,8)
<>  0.000E+00  0.000E+00
<>
<>    (8,1)      (8,2)      (8,3)      (8,4)      (8,5)      (8,6)
<>  0.000E+00  0.000E+00  0.000E+00  0.000E+00  0.000E+00  0.000E+00
<>    (8,7)      (8,8)
<>  0.000E+00  0.000E+00
<>
<> SAT. COVARIANCE (7,1) TO (8,8)   (M^3/KG, M^3/KG-S, M^4/KG^2)
<>
<>    (7,1)      (7,2)      (7,3)      (7,4)      (7,5)      (7,6)
<>  0.000E+00  0.000E+00  0.000E+00  0.000E+00  0.000E+00  0.000E+00
<>    (7,7)      (7,8)
<>  0.000E+00  0.000E+00
<>
<>    (8,1)      (8,2)      (8,3)      (8,4)      (8,5)      (8,6)
<>  0.000E+00  0.000E+00  0.000E+00  0.000E+00  0.000E+00  0.000E+00
<>    (8,7)      (8,8)
<>  0.000E+00  0.000E+00
<>
<> ******************************************************************
<> ******************************************************************
<> NOTES:
<>
<> -- TIME OF CLOSEST APPROACH IS THE VECTOR AND COVARIANCE TIME TAG
<> -- TDR (EFG) STATE VECTORS ARE EARTH-FIXED ROTATING VECTORS
<>    REFERENCED TO THE TRUE EQUATOR OF DATE.
<> -- RELATIVE VECTORS ARE IN ASSET-CENTERED INERTIAL UVW
<>    (RADIAL, IN-TRACK, CROSS-TRACK) COORDINATES
<> -- COVARIANCE MATRICES ARE IN THEIR RESPECTIVE INERTIAL UVW
<>    (RADIAL, IN-TRACK, CROSS-TRACK) COORDINATES
<> -- THE (7,X),(X,7) COMPONENTS OF THE COVARIANCE MATRICES ARE FOR
<>    ATMOSPHERIC DRAG EFFECTS
<> -- THE (8,X),(X,8) COMPONENTS OF THE COVARIANCE MATRICES ARE FOR
<>    SOLAR RADIATION PRESSURE EFFECTS
```

CSM INFORMATION BREAKDOWN

In the following sections the CSM is separated into individual parts for the purpose of providing additional information about each of those sections. The information will be provided based upon the CSM example from above.

CSM CREATION DATA

This section of the CSM identifies the common name (from the satellite catalog) of the asset screened and for which the CSM was generated, as well as the date/time that the message was generated. The time of the generated message is important as it also functions as the reference time that is utilized to determine and populate the "Time of Last Accepted Ob" field for each object identified in the predicted conjunction. This time is provided in Universal Time Coordinated (UTC).

```
UNCLAS
QQQQ
<> CONJUNCTION SUMMARY MESSAGE FOR: SATELLITE A
<> REAL
<> MESSAGE CREATION TIME: 2010 071 (12 MAR) 22:31:12.000 CENTER: JSpOC
<> MESSAGE VERSION: V2.0
<>
<> ******************************************************************
```

CONJUNCTION DETAILS

This section contains information about the predicted conjunction.

```
<> RELATIVE DATA:
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<> RELATIVE SPEED (M/S): 14762
<> CLOSEST APP. REL. POSITION (M):         27.4      -70.2      711.8
<> CLOSEST APP. REL. VELOCITY (M/S):       -7.2   -14692.0    -1437.2
<>
<> ******************************************************************
```

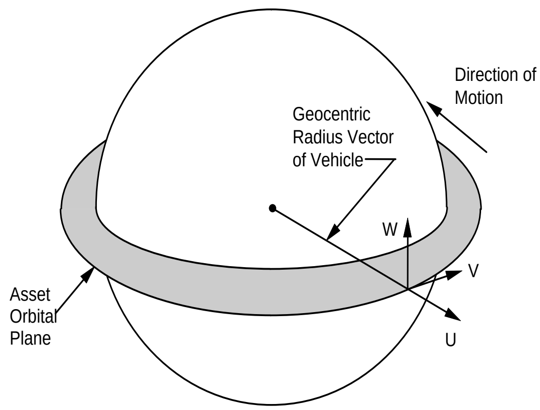
Time of Closest Approach. This is the date and time of the predicted conjunction. This time tag is also serves as the epoch of the vectors in the Satellite Information section, as well as the effective time of the covariance matrixes in the Covariance section of the CSM. This time is also provided in Universal Time Coordinated (UTC).

Miss Distance/Relative Speed. The miss distance tells how close the two objects are going to be based upon the conjunction assessment screening results. The relative speed gives an indication of how fast the two objects are moving relative to each other at the time of the predicted encounter.

Closest Approach Relative Position/Velocity. The components of the relative position and velocity are displayed in the order of Radial (U), In-track (V), and Cross-track (W).

The relative position and velocity are in the asset-centered UVW coordinate system, in which U ("Radial") is the unit vector in the radial direction, W ("Cross-track") is the unit vector normal to the satellite's orbit plane (in the direction of the satellite's angular momentum), and V ("In-track") is the unit vector that completes the right-handed coordinate system.

In the UVW coordinate system the spacecraft velocity vector is always along V when the orbit is circular. But when the orbit is eccentric (non-circular) the vehicle's velocity vector is coincident with the V vector only at perigee and again at apogee.



- UVW coordinate system is centered upon the asset.
- The U component (Radial) is positive when the conjuncting object is above the asset.
- The V component (In-track) is positive when the conjuncting object is in front of the asset relative to its direction of motion.
- When the W component (Cross-track) is positive, it means that at TCA the secondary is to the left of the primary (as viewed from the primary looking forward along the V direction in the general direction of motion.

SATELLITE INFORMATION

This section details the information provided for both the asset satellite as well as the conjuncting object. Since the data provided within the CSM is the same for both objects, we will only discuss the specific details once.

```
<> ASSET: 12345                               INT. DES.: YYYY-NNNS
<> COMMON NAME: SATELLITE A
<> TIME OF LAST ACCEPTED OB: <6 HOURS FROM MESSAGE CREATION TIME
<> LUPI/DC SPAN USED (DAYS):   7.88/  5.50  RESIDUAL ACCPT:  97.8 %
<> NUM OBS AVAIL/USED: 592/ 418
<> APOGEE (KM):   779  PERIGEE (KM):   765  INCLINATION (DEG):  86.4
<> RADAR CROSS SECTION (SCALED): LARGE (>1m sq)  WEIGHTED RMS: 0.864
<> BALLISTIC COEFFICIENT (M2/KG):   0.045663
<> SOLAR RADIATION PRESSURE COEFFICIENT (M2/KG):   0.000000
<> ENERGY DISSIPATION RATE (W/KG):  4.54570E-05
<> GEOPOTENTIAL: EGM-96 36Z,36T  DRAG: JACCHIA70DCA  LUNAR/SOLAR:  ON
<> SOLAR RAD PRESS: OFF  SOLID EARTH TIDES: OFF  IN-TRACK THRUST: OFF
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<> ASSET TDR POSITION (M):    2570098.594   2244663.456   6281494.300
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<> CONJUNCTING SATELLITE: 30337               INT. DES.: 1999-025AA
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<> SOLAR RAD PRESS:  ON  SOLID EARTH TIDES: OFF  IN-TRACK THRUST: OFF
<> -----------------------------------------------------------------
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<> SAT. TDR VELOCITY (M/S):  -2888.611701  -6007.242986   3328.778993
<> -----------------------------------------------------------------
<>
<> *****************************************************************
```

Object Identifiers

Asset/Conjuncting Satellite. This is the satellite catalog number for the respective object. On some of the CSMs you will see an 8XXXX or 9XXXX series number instead of a cataloged satellite number (1-69999).

An 80000 – 89999 series number will indicate that the object is an analyst satellite. An analyst satellite is currently being maintained by the JSpOC and is being tasked to/tracked by the Space Surveillance Network (SSN) of sensors. In order for an analyst satellite to become a part of the satellite catalog range it must be correlated to a known launch.

A 90000 – 99999 number will reflect that an owner/operator ephemeris was utilized for the asset (and potentially for the conjuncting object as well), and will result in most of the related information fields (which we will describe below) to be empty.

International Designator. This is the full international designator for each respective object. The first part is the year that the object was launched, or the launch to which the object has been correlated. The next three characters define the number of the launch for the year in which this object was launched. The last character(s) are piece designators and give some additional information about the launch itself. If you see a letter other than an A, the launch resulted in several objects that reached space. In general, for multiple objects placed into space by a single launch, the lower the letter, the higher the importance of the object.

Common Name. This is the common name of the respective object, assuming it has one. The name can give an indication if the object is a payload, a rocket body (identified with an “R/B” in the name), or a piece of debris (identified with a “DEB” in the name). For the analyst satellite range the common name will be displayed as “UNKNOWN”. In order for an UNKNOWN object to be cataloged it must be positively correlated to a known launch.

Observation Statistics

This section describes what information was used in creating the vectors utilized for the object identified for this particular predicted conjunction. As with any data of this type, any single parameter should be understood in relation to all available data. These fields can signify whether the applicable object is well tracked or not.

Time of Last Accepted Observation. This parameter provides information about when the last observation was received from the Space Surveillance Network (SSN) that was utilized in the creation of the object’s vector. This field will be populated with a range of time based upon when the last observation was received from the sensor network (and compared with the time that the CSM was generated). The following time ranges will be provided for all objects:

<24 hours from message creation time
24 to 48 hours from message creation time
>48 hours from message creation time

LUPI/DC Span Used. LUPI stands for the "Length of Update Interval", and DC stands for "Differential Correction". These values indicate how many days worth of SSN observations were made available for use and how many days were actually used for the most recent orbit determination.

The Dynamic LUPI Algorithm (DLA) is the default method for determining the optimum ASW DC span (or LUPI). It is computed prior to each DC and is a function of the current tracking received on the object and the object's Energy Dissipation Rate (EDR). It results in the increased accuracy of the satellite catalog and reduces the number of automatic DC failures.

Residual Acceptance. This parameter provides the percentage of the observation residuals that were utilized for the most recent orbit determination.

Number of Observations Available/Used. This parameter provides the number of observations (collected by the SSN) for the time span of the LUPI that were available for…and used in the most recent orbit determination.

Weighted RMS. This is a value that can generally identify the quality of the most recent vector update, but is utilized by the analyst in the orbit determination process. If the model error is small and the weights are accurate, the ideal value is unity (i.e. RMS = 1), indicating a perfect statistical fit.

Orbit Parameters

Apogee, Perigee, and Orbit Inclination. These parameters describe the orbit in general classical terms.

Radar Cross Section. This is the estimated size of the object (m^2), and the field will be populated with the size of the particular object in one of the ranges below.

Large (>1m^2)
Medium (0.1 to 1m^2)
Small (<0.1m^2)

Ballistic Coefficient. The current atmospheric drag model parameter value (m^2/kg) for each object.

Solar Radiation Pressure. The current solar radiation model parameter value for each object.

Energy Dissipation Rate (EDR). The current energy dissipation rate, measured in watts per kilogram of mass (watts/kg) value for each object's orbit. EDR is representative of the amount of energy being removed from an object's orbit by atmospheric drag. It is a very useful metric for characterizing space objects since it takes into account both the drag environment (atmospheric density) and the “area to mass ratio” of the specific object. EDR is computed by the ASW in each differential correction (DC) for those objects experiencing atmospheric drag. Used to characterize the drag portion of the satellite catalog, and is utilized in the calculation of the dynamic LUPI.

Modeling Flags

Geopotential Model. Indicates the geopotential model utilized in the Special Perturbation (SP) vector update, truncated to mm degree zonals, nn degree/order tesserals. Are caused by the aspherical gravity field of the Earth, and are normally applied to all objects in the satellite catalog, but as the altitude of the orbit increases the degree and order of can be relaxed without a loss of accuracy.

Drag Model. Indicates the drag model utilized in the SP vector update. Are caused by the atmospheric drag perturbations acting on an object, and are normally only applied to relatively low altitude objects (i.e. below 1500km altitude).

The default density model utilized is the Jacchia 70 DCA. This model is calibrated prior to each satellite catalog update by running the Dynamic Calibration Atmosphere (DCA) program, which produces a file of atmospheric temperature corrections that is a required input to Jacchia 70 DCA.

Lunar/Solar. Indicates whether this perturbation is being applied in the SP vector update. This perturbation is caused by the gravitational attraction of the Sun and the Moon. These third-body effects are normally applied to relatively high altitude objects (i.e. those whose orbits exceed 600-800km altitude).

Solar Radiation Pressure. Indicates whether this perturbation is being solved for in the SP vector update. They are caused by electromagnetic radiation from the Sun impinging on an object and acts as an acceleration in a direction away from the Sun. Normally only applied to relatively high altitude objects (i.e. those whose orbits exceed 600-800km altitude).

Solid Earth Tides. Indicates whether this perturbation is being applied in the SP vector update. Solid Earth Tides are gravitational effects caused by the Sun and Moon and are modeled as periodic variations in the standard Geopotential coefficients. Normally Solid Earth Tides are only used for the Sensor Laser Ranging (SLR) tracked sensor calibration satellites for the development of precision reference orbits used in the calibration of the SSN sensors.

In-Track Thrust. Indicates whether this perturbation is being solved for in the SP vector update. Within ASW In-Track Thrust is modeled as a constant thrust in the “v” (in-track) direction. Its use is an operational decision based upon analyst opinion that an object may be “outgassing” or otherwise experiencing un-modeled in-track acceleration.

Satellite State Vector. The positions and velocities of the asset and satellite are provided in NASA’s “TDR” coordinates, and are propagated to the Time of Closest Approach (TCA) of the predicted conjunction. The TDR coordinate system is used interchangeably with the JSpOC’s Earth-Fixed Greenwich (EFG) coordinate system. TDR is an Earth-fixed rotating coordinate system related to the true equator/mean equinox of date Earth-Centered Inertial system by a simple rotation about the Z axis (normal to the true equator of date), using the mean Greenwich hour angle. TDR differs from the more commonly understood crust-fixed Earth-Centered

Rotating (ECR) frame in that TDR does not incorporate polar motion. Differences between the TDR and ECR frames are small, on the order of 15 meters or less. ECR is terminology used within the JSpOC. It is equivalent to the Earth-Centered Earth-Fixed (ECEF) and Earth-Centered Fixed (ECF) frames.

SATELLITE COVARIANCE

The asset and satellite covariance matrices are in their respective UVW coordinate systems, computed from the corresponding inertial position and velocity vectors. Both covariance matrices are 1-sigma values, and are also propagated to the Time of Closest Approach (TCA) of the conjunction.

```
<> ASSET COVARIANCE: (1,1) TO (6,6)  (M^2, M^2/S, M^2/S^2)
<>      U          V          W         UD         VD         WD
<>  4.142E+01 -8.579E+00 -2.312E+01  0.000E+00  0.000E+00  0.000E+00
<> -8.579E+00  2.533E+03  1.336E+01  0.000E+00  0.000E+00  0.000E+00
<> -2.312E+01  1.336E+01  7.098E+01  0.000E+00  0.000E+00  0.000E+00
<>  0.000E+00  0.000E+00  0.000E+00  0.000E+00  0.000E+00  0.000E+00
<>  0.000E+00  0.000E+00  0.000E+00  0.000E+00  0.000E+00  0.000E+00
<>  0.000E+00  0.000E+00  0.000E+00  0.000E+00  0.000E+00  0.000E+00
<>
<> SAT. COVARIANCE: (1,1) TO (6,6)  (M^2, M^2/S, M^2/S^2)
<>      U          V          W         UD         VD         WD
<>  1.337E+03 -4.806E+04 -3.298E+01  0.000E+00  0.000E+00  0.000E+00
<> -4.806E+04  2.492E+06 -7.588E+02  0.000E+00  0.000E+00  0.000E+00
<> -3.298E+01 -7.588E+02  7.105E+01  0.000E+00  0.000E+00  0.000E+00
<>  0.000E+00  0.000E+00  0.000E+00  0.000E+00  0.000E+00  0.000E+00
<>  0.000E+00  0.000E+00  0.000E+00  0.000E+00  0.000E+00  0.000E+00
<>  0.000E+00  0.000E+00  0.000E+00  0.000E+00  0.000E+00  0.000E+00
<>
<> *****************************************************************
<> ASSET COVARIANCE (7,1) TO (8,8)  (M^3/KG, M^3/KG-S, M^4/KG^2)
<>
<>    (7,1)      (7,2)      (7,3)      (7,4)      (7,5)      (7,6)
<>  0.000E+00  0.000E+00  0.000E+00  0.000E+00  0.000E+00  0.000E+00
<>    (7,7)      (7,8)
<>  0.000E+00  0.000E+00
<>
<>    (8,1)      (8,2)      (8,3)      (8,4)      (8,5)      (8,6)
<>  0.000E+00  0.000E+00  0.000E+00  0.000E+00  0.000E+00  0.000E+00
<>    (8,7)      (8,8)
<>  0.000E+00  0.000E+00
<>
<> SAT. COVARIANCE (7,1) TO (8,8)   (M^3/KG, M^3/KG-S, M^4/KG^2)
<>
<>    (7,1)      (7,2)      (7,3)      (7,4)      (7,5)      (7,6)
<>  0.000E+00  0.000E+00  0.000E+00  0.000E+00  0.000E+00  0.000E+00
<>    (7,7)      (7,8)
<>  0.000E+00  0.000E+00
<>
<>    (8,1)      (8,2)      (8,3)      (8,4)      (8,5)      (8,6)
<>  0.000E+00  0.000E+00  0.000E+00  0.000E+00  0.000E+00  0.000E+00
<>    (8,7)      (8,8)
<>  0.000E+00  0.000E+00
<>
<> *****************************************************************
```

CSM NOTES

The CSM also provides some notes at the bottom of the message that provide some pre-formatted information which has also been provided within this guide.

```
<> ******************************************************************
<> NOTES:
<>
<> -- TIME OF CLOSEST APPROACH IS THE VECTOR AND COVARIANCE TIME TAG
<> -- TDR (EFG) STATE VECTORS ARE EARTH-FIXED ROTATING VECTORS
<>    REFERENCED TO THE TRUE EQUATOR OF DATE.
<> -- RELATIVE VECTORS ARE IN ASSET-CENTERED INERTIAL UVW
<>    (RADIAL, IN-TRACK, CROSS-TRACK) COORDINATES
<> -- COVARIANCE MATRICES ARE IN THEIR RESPECTIVE INERTIAL UVW
<>    (RADIAL, IN-TRACK, CROSS-TRACK) COORDINATES
<> -- THE (7,X),(X,7) COMPONENTS OF THE COVARIANCE MATRICES ARE FOR
<>    ATMOSPHERIC DRAG EFFECTS
<> -- THE (8,X),(X,8) COMPONENTS OF THE COVARIANCE MATRICES ARE FOR
<>    SOLAR RADIATION PRESSURE EFFECTS
```

MESSAGE FORMATTING INFORMATION

The message consists of 110 or more lines of data about the conjunction. All data lines are preceded by the 2-character sequence “<>“ (less-than, greater-than) to distinguish the message data lines from additional lines that the various communication systems may insert. In the message, all fields must appear within the columns indicated.

In the format, note that:

- “Tabs” and other non-printing characters (except for blanks) are not allowed
- “+” signs may be replaced by blanks
- Leading zeros on numerical fields may be replaced by blanks
- Alphabetic fields may contain blanks
- Numerical data may be omitted, in which case a value of 0 (zero) will be assumed