April 11, 2017

Jose P. Albuquerque
Chief, Satellite Division
International Bureau
Federal Communications Commission
445 12th St. SW
Washington, DC 20554

Re: Karousel LLC, IBFS File No. SAT-LOA-20161115-00113 (Call Sign S2980)

Dear Mr. Albuquerque:

Karousel LLC (Karousel) hereby provides responses to the questions contained in your letter dated March 10, 2017.

Question 1: *Karousel seeks to operate its NGSO FSS system in the 29.1-29.25 GHz and 29.25-29.5 GHz bands. The 29.1-29.25 GHz and 29.25-29.5 GHz bands are allocated on a primary basis to the non-Federal fixed, mobile, and fixed-satellite services on the U.S. Table of Frequency Allocations. Under the Commission's Ka-band Plan, the 29.1-29.25 GHz is designated on a primary basis to the operation of NGSO MSS feeder links and to LMDS hub-to-subscriber transmission, and the 29.25-29.5 GHz band is designated on a primary basis to NGSO MSS feeder links and GSO FSS. There is no designation for NGSO FSS in these bands. Accordingly, please clarify whether Karousel seeks a waiver of the Commission's Ka-band Plan in the 29.1-29.25 GHz and 29.25-29.5 GHz bands, and, if so, please provide the appropriate rationale.*

Karousel Response to Question 1:

Karousel seeks a waiver of the Ka-band Plan to operate its proposed NGSO system in the 29.1-29.25 GHz and 29.25-29.5 GHz bands on a non-interference basis. Karousel's use of the 29.1-29.5 GHz frequency range will be limited to a small number of gateway locations (typically one or two per northern or southern service area for each nominal longitudinal location). These locations can be situated to ensure effective coordination with other primary users of these bands.

For terrestrial-based primary users of these bands, spatial separation as well as antenna discrimination of the Karousel uplink antennas in the direction of terrestrial stations will ensure an efficient use of the spectrum, while protecting the co-channel primary services.

For Earth-to-Space MSS users of these bands, Karousel will coordinate with operational systems to ensure that the Karousel uplink signals will provide the necessary protection of the

MSS system satellite uplink signals. This interference protection will be accomplished through a combination of: (1) accurate orbital prediction of both the MSS and Karousel space station locations; (2) precise control of the Karousel uplink antenna pointing; (3) pre-established protection criteria with the active co-frequency MSS operators; (4) transmit power spectral density levels and antenna discrimination of the Karousel uplink antenna signals in the direction of the various co-frequency MSS space stations; (5) antenna discrimination of the MSS space station receive antennas in the direction of Karousel gateway uplink locations; and (6) Karousel muting of co-frequency uplink transmissions whenever all other methods are insufficient to operate on a non-interference basis with the MSS systems.

Karousel is not requesting MSS systems to provide protection to the Karousel satellite uplinks in these bands because Karousel will not experience service disruptions in the event of episodic periods without connectivity between the ground and space segments of its system. For the short durations when both (i) Karousel must mute its own uplink transmissions to protect the MSS systems, and (ii) MSS uplink transmissions interfere with Karousel uplink signals, the Karousel transmissions may be interrupted for very infrequent and short periods of time. These durations are on the order of fractions of a second to a few seconds. The embedded Karousel data error correction methodology is designed to identify and address randomly occurring outages that are much longer in duration than the interference events described here. This data error correction methodology is in addition to the normal forward error correction commonly implemented in DVB-S and other robust transmission schemes, which operate on a much shorter timeframe of error correction.

For Earth-to-Space GEO FSS users of these bands, protection will be provided by the Karousel uplink antenna discrimination and transmit spectral power density levels in the direction of the GEO protected arc out to +/-15 degrees of inclination/latitude. This approach is consistent with the analyses provided with Karousel's initial application, which are designed to protect all GEO system Space-to-Earth and Earth-to-Space operations.

Question 2: *Iridium Constellation LLC (Iridium) is currently licensed to operate its NGSO MSS constellation in the 29.1-29.3 GHz bands. In particular, Iridium is authorized to conduct TT&C operations and to operate feeder uplinks from 29.1-29.3 GHz (Earth-to-space). Karousel's application does not acknowledge the presence of Iridium's operations in these bands. We request that Karousel provide information about how it intends to prevent interference with Iridium's operations in the 29.1-29.3 GHz band.*

Karousel Response to Question 2:

Karousel will operate on a non-interference basis with respect to Iridium's operations. As discussed in Karousel's response to Question 1, Karousel will provide protection to MSS NGSO systems such as Iridium and will operate on a non-interference basis with respect to Iridium's system and similarly situated systems.

Question 3: *Section 25.114(d)(1) of the Commission's rules requires that applicants provide an explanation of how the uplink frequency bands would be connected to the downlink frequency*

bands on their proposed satellite system. In order to better understand the beam and channel connections on the Karousel NGSO FSS system, we request that Karousel supplement its application with a showing (e.g. a strapping table, chart, or spreadsheet) that clearly presents this information.

Karousel Response to Question 3:

Karousel plans to implement a flexible uplink-to-downlink mapping solution to maximize future coordination with other NGSO operators. Solutions with flexible frequency band connectivity will be necessary for successful coordination and operation of NGSO systems in the future because multiple active NGSO systems will likely be documented, licensed, and implemented in the future. Karousel's application therefore does not contain a rigid definition of its mapping solution. Karousel's flexible mapping solution may be implemented either on a discrete/switchable basis using traditional "bent-pipe" satellite design, or alternatively on a much more flexible "digital" satellite design.

To provide the Commission with additional information regarding Karousel's anticipated mapping solutions, Karousel provides two examples of possible uplink-to-downlink mapping schemes below. These examples are not intended to imply limitations to the design at this time, but rather to demonstrate the configuration opportunities that may exist in order to provide both flexibility to the business and flexibility in eventual NGSO operation with other licensees.

ALL BEAMS ACTIVE EXAMPLE

Uplink				Downlink			
Description	Beam ID	Polarization	Sub-Band, GHZ	Description	Beam ID	Polarization	Sub-Band, GHZ
Gateway #1 Uplink Beam	GU5C	RHCP	27.5-28.0	User Prmary Downlink Beam	UD1A	RHCP	10.7-11.2
			28.0-28.5	User Prmary Downlink Beam	UD1A	RHCP	11.2-11.7
			28.5-29.0	User Prmary Downlink Beam	UD1A	RHCP	11.7-12.2
			29.0-29.5	User Spot Beam #1 Downlink	UD2A	RHCP	12.2-12.7
			29.5-30.0				
	GU5D	LHCP	27.5-28.0	User Prmary Downlink Beam	UD1B	LHCP	10.7-11.2
			28.0-28.5	User Prmary Downlink Beam	UD1B	LHCP	11.2-11.7
			28.5-29.0	User Prmary Downlink Beam	UD1B	LHCP	11.7-12.2
			29.0-29.5	User Spot Beam #2 Downlink	UD3B	LHCP	12.2-12.7
			29.5-30.0				
Gateway #2 Uplink Beam	GU6C	RHCP	27.5-28.0	User Prmary Downlink Beam	UD1C	RHCP	17.8-18.3
			28.0-28.5	User Prmary Downlink Beam	UD1C	RHCP	18.3-18.8
			28.5-29.0	User Prmary Downlink Beam	UD1C	RHCP	18.8-19.3
			29.0-29.5	User Global Downlink Beam	UD1E	RHCP	19.7-20.2
			29.5-30.0				
	GU6D	LHCP	27.5-28.0	User Prmary Downlink Beam	UD1D	LHCP	17.8-18.3
			28.0-28.5	User Prmary Downlink Beam	UD1D	LHCP	18.3-18.8
			28.5-29.0	User Prmary Downlink Beam	UD1D	LHCP	18.8-19.3
			29.0-29.5				
			29.5-30.0				
User Primary Uplink Beam	UU1A	RHCP	14.0-14.5	Gateway #1 Downlink Beam	GD5F	LHCP	19.7-20.2
User Spot Beam #1 Uplink	UU2B	LHCP	14.0-14.2	Gateway #2 Downlink Beam	GD6F	LHCP	19.7-19.9
User Spot Beam #2 Uplink	UU3B	LHCP	14.2-14.4	Gateway #2 Downlink Beam		LHCP	19.9-20.1
User Global Uplink Beam	UU4B	LHCP	14.4-14.5	Gateway #2 Downlink Beam		LHCP	20.1-20.2

ALL BROADCAST TO PRMARY BEAM EXAMPLE

Uplink				Downlink			
Description	Beam ID	Polarization	Sub-Band	Description	Beam ID	Polarization	Sub-Band
Gateway #1 Uplink Beam	GU5C	RHCP	27.5-28.0	User Prmary Downlink Beam	UD1A	RHCP	10.7-11.2
			28.0-28.5	User Prmary Downlink Beam	UD1A	RHCP	11.2-11.7
			28.5-29.0	User Prmary Downlink Beam	UD1A	RHCP	11.7-12.2
			29.0-29.5	User Prmary Downlink Beam	UD1A	RHCP	12.2-12.7
			29.5-30.0				
	GU5D	LHCP	27.5-28.0	User Prmary Downlink Beam	UD1B	LHCP	10.7-11.2
			28.0-28.5	User Prmary Downlink Beam	UD1B	LHCP	11.2-11.7
			28.5-29.0	User Prmary Downlink Beam	UD1B	LHCP	11.7-12.2
			29.0-29.5	User Prmary Downlink Beam	UD1B	LHCP	12.2-12.7
			29.5-30.0				
Gateway #2 Uplink Beam	GU6C	RHCP	27.5-28.0	User Prmary Downlink Beam	UD1C	RHCP	17.8-18.3
			28.0-28.5	User Prmary Downlink Beam	UD1C	RHCP	18.3-18.8
			28.5-29.0	User Prmary Downlink Beam	UD1C	RHCP	18.8-19.3
			29.0-29.5				
			29.5-30.0	User Prmary Downlink Beam	UD1E	RHCP	19.7-20.2
	GU6D	LHCP	27.5-28.0	User Prmary Downlink Beam	UD1D	LHCP	17.8-18.3
			28.0-28.5	User Prmary Downlink Beam	UD1D	LHCP	18.3-18.8
			28.5-29.0	User Prmary Downlink Beam	UD1D	LHCP	18.8-19.3
			29.0-29.5				
			29.5-30.0	User Prmary Downlink Beam	UD1F	LHCP	19.7-20.2

Question 4: *Section 25.114(d)(14) of the Commission's rules requires that the applicant provide a description of the design and operational strategies that will be used to mitigate orbital debris. Please provide the following additional information and clarifications:*

a. *A statement as to whether Karousel satellites will release any debris of less than five millimeters in size.*

b. *Information regarding the accuracy with which the parameters of satellite orbits will be maintained, including apogee, perigee, inclination, and the right ascension of the ascending node(s).*

c. *A statement concerning the assessment of the risk of collision with other satellites and large debris, particularly the possibility of collision with satellites operating in the geostationary orbit or in orbits similar to that of the Karousel system, together with the methods used to calculate such risks.*

d. *A statement as to the methods by which Karousel intends to maintain safe flight profiles throughout the life of its satellites.*

e. *Additional information concerning the post-mission disposal plans for Karousel's satellites, including estimated fuel reserves to be maintained for disposal procedures, orbital parameters of the intended disposal orbit, whether Karousel intends to circularize the orbit of its satellites at end of life, and other details pertinent to the disposal of the satellites. Please address, for NGSO operations in an orbit inclined at 63.4 degrees, whether the formula for calculating minimum initial perigee for a GSO disposal, as found at 47 C.F.R. § 25.283(a), is suitable, bearing in mind possible differences in solar lunar perturbations and effects of solar radiation pressure. In particular, please provide a statement and/or analysis with respect to the long-term stability or instability of the proposed post-mission storage orbit. Such analysis should address any measures, such as selection of orbital parameters, that may affect the long-term evolution of orbital parameters, with particular attention to addressing any such evolution that would result in the*

satellites entering the geostationary protected region, i.e., the area defined by the geosynchronous altitude, plus or minus 200 kilometers, and plus or minus 15 degrees from the equatorial plane, or the LEO protected region, i.e., the area below 2000 km.

Karousel Response to Question 4:

Karousel intends to use industry standards and best practices to comply with all U.S. and international regulations with respect to mitigating orbital debris. Karousel commissioned Dr. Darren Garber, President of NXTRAC, to assist in providing detailed responses to each of the Commission's inquiries on orbital debris mitigation. Dr. Garber's full report is attached as Exhibit A to this letter, and key elements of his findings are summarized below.

Karousel Response to Question 4(a):

A statement as to whether Karousel satellites will release any debris of less than five millimeters in size.

Karousel has assessed and limited the amount of debris released in a planned manner during normal operations. Karousel satellites, by design, will not intentionally release any debris, including debris of less than five millimeters in size. In addition, common design practices using closeout structures such as thermal blankets, and protection of sensitive pressurized systems such as batteries and fuel tanks, will minimize the risk of collision with any other small low-mass space objects that might initiate a secondary release of debris from a Karousel satellite.

The Karousel satellites will be manufactured in clean-room environments and consistent with industry recommendations and guidelines. Supplemental information responsive to this question appears in the NXTRAC report.

Karousel Response to Question 4(b):

Information regarding the accuracy with which the parameters of satellite orbits will be maintained, including apogee, perigee, inclination, and the right ascension of the ascending node(s).

Karousel satellite orbital parameters will be maintained in accordance with industry practice for other similar satellites using the geostationary arc in addition to any further requirements that may be mutually agreed upon by operators of space stations in similar altitude and inclination orbits to that of Karousel.

Inclination and Right Ascension of the Ascending Node (RAAN) of the Karousel space stations will be held to better than +/-1.0 degrees.[1] Final accuracy will depend on mission optimization and coordination. Karousel intends to retain some measure of flexibility regarding the precise values of apogee and perigee (amount of eccentricity) to allow for coordination with other non-geostationary space stations and ensure sufficient protection for space stations in the geostationary arc. The accuracy in which the apogee and perigee will be maintained is subject to coordination and optimization of the Karousel satellite manufacturer's recommended mission profile; however, Karousel will maintain a worst-case window of accuracy of +/-450 km.

Orbit determination will be made by a combination of RF ranging from at least one ground station before and after every spacecraft maneuver. All resulting orbital parameters will be communicated and published according to industry and regulatory practices. The 72-hour three-sigma uncertainty following the most recent orbit determination solution is less than 100 meters. Further details on the orbit determination precision and uncertainty are provided in the NXTRAC report addressing Question 4(b).

Karousel Response to Question 4(c):

A statement concerning the assessment of the risk of collision with other satellites and large debris, particularly the possibility of collision with satellites operating in the geostationary orbit or in orbits similar to that of the Karousel system, together with the methods used to calculate such risks.

Karousel has assessed and limited the probability of Karousel satellites becoming a source of debris by collision with other satellites or large debris. The nominal Karousel apogee and perigees are approximately 4,200 km away from the nominal geostationary orbit altitude. At this distance, and given that apogee and perigee are oriented to occur approximately at equatorial crossings, there are no opportunities for collision with geostationary satellites. There is also no opportunity for collision with the lower LEO and MEO satellites from this orbit. Any other non-standard objects (and other space stations in similar orbits) will require specific analysis and coordination when appropriate.

NXTRAC analyzed the likelihood of collision with other satellites. NXTRAC also modeled and assessed the ability of Karousel to anticipate and avoid collisions. NXTRAC conducted a risk calculation using the NASA Debris Analysis Software v2.0.2, NASA GSFC General Mission Analysis Tool (GMAT), and NXTRAC Rapid Analytical Dynamics Integrated Navigation Toolkit (RADIANT), using assumptions consistent with enveloping a large class geostationary satellite from any of the major satellite manufacturers. The results of the analysis, including probability determination and miss distance calculations, are provided in the NXTRAC report. NXTRAC's analysis, which included a full Orbit Debris Analysis Report (ODAR) of the

[1] Karousel is not subject to the longitudinal requirements of 47 C.F.R. § 25.210(j) because it is not in a geostationary satellite orbit.

Karousel constellation, shows Karousel's planned system meets all applicable requirements of NS 8719.4.

Karousel Response to Question 4(d):

A statement as to the methods by which Karousel intends to maintain safe flight profiles throughout the life of its satellites.

Karousel intends to maintain safe flight profiles throughout the active orbit raising, service mission station-keeping, as well as post-mission disposal, in accordance with industry standards and best practices, and international regulations. Karousel will incorporate redundant system for all critical communications and controls. Karousel will also conduct ongoing analysis of all orbital parameters and flight profiles and will coordinate with other operators when required to minimize potential collision risk.

Karousel orbit determinations will be made with accuracy better than 100m. All resulting orbital parameters will be communicated and published according to industry and regulatory practices. In addition, Karousel commits to unilaterally making adjustments and performing collision avoidance maneuvers if no coordination is possible.

Further details are provided in the NXTRAC report for Question 4(d).

Karousel Response to Question 4(e):

Additional information concerning the post-mission disposal plans for Karousel's satellites, including estimated fuel reserves to be maintained for disposal procedures, orbital parameters of the intended disposal orbit, whether Karousel intends to circularize the orbit of its satellites at end of life, and other details pertinent to the disposal of the satellites. Please address, for NGSO operations in an orbit inclined at 63.4 degrees, whether the formula for calculating minimum initial perigee for a GSO disposal, as found at 47 C.F.R. § 25.283(a), is suitable, bearing in mind possible differences in solar lunar perturbations and effects of solar radiation pressure. In particular, please provide a statement and/or analysis with respect to the long-term stability or instability of the proposed post-mission storage orbit. Such analysis should address any measures, such as selection of orbital parameters, that may affect the long-term evolution of orbital parameters, with particular attention to addressing any such evolution that would result in the satellites entering the geostationary protected region, i.e., the area defined by the geosynchronous altitude, plus or minus 200 kilometers, and plus or minus 15 degrees from the equatorial plane, or the LEO protected region, i.e., the area below 2000 km.

Karousel commissioned NXTRAC to assess the long term precision propagation of Karousel orbits and demonstrate how these orbits will not cross or decay into the GSO orbital volume. As explained in the NXTRAC report, Karousel will allocate sufficient propellant for end-of-life orbit modification, which typically consists of at least two component orbital adjustments to circularize the orbit at an altitude that will not intersect commonly active space

station orbits. Karousel's orbits are similar in nature to at least one other NGSO applicant orbits, as well as space stations in similar orbits such as SiriusXM and Molnya orbit objects, and accordingly Karousel plans to work with these space station operators and international regulators in order to define acceptable post-mission orbit criteria, similar to those developed for geostationary objects.

The formula for calculating an initial perigee for a GSO disposal as found at 47 C.F.R. § 25.283(a) is not suitable for the Karousel system given the differences in orbits of the NGSO space stations mentioned in comparison to the uniformity of the geostationary orbit characteristics (e.g., the minimum GSO perigee for disposal is well below the Karousel apogee). Given the relatively small number of objects in these orbits, Karousel anticipates that industry cooperation will result in reasonable technical solutions to ensure there are no greater risks of collision than that already calculated for the industry and regulatory agreed upon geostationary disposal methodology. The resulting acceptable disposal orbits for these satellites will not only be intended to protect operational NGSO space stations, but will also be designed to ensure that objects do not drift in to either the geostationary protected region within 200 km and 15 degrees of the nominal geostationary orbit, or the LEO protected region below 2000 km in altitude. Objects at the Karousel altitudes will not de-orbit, or pose risks to those objects at lower altitudes.

Karousel does not expect that the fuel required to comply with this process will detract from the ability of Karousel satellites to fulfill their intended mission. The specifics of the fuel requirements will depend on the design of the satellite manufacturers that provide the Karousel satellites, and the eventual agreements reached with the parties described above.

Further details using worst case longitudes and spacecraft area-to-mass ratios are provided in the NXTRAC report for Question 4(e).

* * * * *

Please contact the undersigned with any questions.

Sincerely,

/s/ Monish Kundra

Monish Kundra
Karousel LLC

EXHIBIT A

NXTRAC REPORT

9 April 2017

TO: Karousel LLC
FROM: Dr. Darren D. Garber, NXTRAC
RE: FCC Response Debris Analysis

4(a) A statement as to whether Karousel satellites will release any debris of less than five millimeters in size.

Response: The proposed 12 vehicle Karousel NGO FSS constellation will not release debris less than 5 millimeters in size. The Karousel vehicles are comprised of commercially available components and will be manufactured to meet Class 10,000 clean room requirements. This cleanliness requirement, which will apply during assembly, integration and testing, is equivalent to ISO 7 standards, which require no particulates above 10 micrometers and therefore precludes any particulate material above 5 mm. Specifically, each Karousel spacecraft will comply with the following recommendations and guidelines:

NASA Procedural Requirements for Limiting Orbital Debris - NPR 8715_006A
These NASA requirements became effective in August 2007 and reflect NASA's policy to limit future orbital debris generation. The applicability, authority, and references of the requirements and the responsibility within NASA organizations are all clearly stated in the document.

NASA Technical Standard 8719.14
NASA has adopted a policy to control the generation of orbital debris in NASA Procedural Requirements 8715.6A and has implemented this policy in NASA Technical Standard 8719.14. All NASA flight projects are now required to provide debris assessments and end-of-mission planning as a normal part of the project development.

Debris Assessment Software & User's Guide
The Debris Assessment Software (DAS) has been developed to assist NASA programs in performing orbital debris assessments as described in NASA Technical Standard 8719.14, Process for Limiting Orbital Debris. The software follows the structure of the standard and provides the user with tools to ensure compliance with the requirements or to assess debris mitigation options to bring a program within requirements.

U.S. Government Orbital Debris Mitigation Standard Practices
A U.S. interagency working group led by NASA and the Department of Defense developed a work plan to study the debris environment and to work with U.S. government agencies and other space faring nations and international organizations to design and adopt guidelines to minimize orbital debris. In 1997, the working group created a set of U.S. Government Orbital Debris Mitigation Standard Practices. Based on a NASA standard of procedures for limiting debris, the Standard Practices are intended for government-operated or -procured space systems, including satellites as well as launch vehicles. The Standard Practices were approved by

all US Government agencies by February 2001. The interagency group has shared the guidelines with the aerospace industry to encourage voluntary compliance.

4(b) Information regarding the accuracy with which the parameters of satellite orbits will be maintained, including apogee, perigee, inclination, and the right ascension of the ascending node(s).

Response: Each Karousel vehicle's predicted root-sum-squared (RSS) position knowledge will be known to better than 100m (3-sigma) for up to 72 hours after each orbit determination solution based upon single station cooperative ranging of the target. The ability to generate comprehensive orbit determination solutions and predicted ephemeris for each vehicle in the Karousel constellation from a single site is due to the significant relative motion between the vehicle and the ground station over a 24-hour period. Over a day, each Karousel spacecraft traces out a unique geometry with respect to a ground observer in altitude, inclination, eccentricity and orbital plane which clearly resolves the trajectory in all 3 axes. Because Karousel is a communications constellation, each satellite will be in contact with the ground during a majority of its orbit providing a near real-time assessment of the vehicle's health and trajectory for safety of flight.

Analysis of Karousel's propagated position knowledge 3 days after the last measurement is detailed in

Table 1:

Table 1: Karousel Predicted 3-Day RSS Position Knowledge

Tracking Scenario	1 Day Tracking Rate	3 Day Predicted RSS Position Knowledge (m) 3-sigma
Single station tracking	1 measurement per second	58m
Single station tracking	1 measurement per minute	60m
Single station tracking	5 minutes of 1Hz data at the top of every hour	73m

Table 1 was constructed by assessing the tracking performance from a single ground site more than 20 degrees in latitude and longitude from the Karousel satellite's ground track covariance. Nominal metric observation quality, quantity, and data rates were assumed using conservative values of current commercial capabilities per the following listed in Table 2.

Table 2: Ground Station Metric Observation Parameters

Metric Observation Type	Sigma	Bias
Azimuth	0.01 deg	0.005 deg
Elevation	0.01 deg	0.005 deg
Range	10 m	5m

Range Rate	0.5 m/s	0.1 m/s

A batch sequential least squares filter was used to process the observations of the Karousel vehicle over the 24 period for each of the above listed cases with no *a priori* information (i.e., the initial state was unknown). After 24 hours from the first measurement, the solution was then propagated forward for 3 days. Additional systematic errors and biases were included to ensure realism in the resulting propagated solution. These additional considered parameters included 1m 1 sigma uncertainty in the site's latitude, longitude and altitude along with a 10e-9 s timing bias.

Similarly, uncooperative tracking by radar assets (LeoLABS and US Space Surveillance Network) and optical telescopes (ExoAnalytics and US Space Surveillance Network) will each provide solutions better than 200m one sigma with respect to cooperative ranging.

4(c) A statement concerning the assessment of the risk of collision with other satellites and large debris, particularly the possibility of collision with satellites operating in the geostationary orbit or in orbits similar to that of the Karousel system, together with the methods used to calculate such risks

Response: NASA DAS 2.0.2 is used to determine the risk of collision with objects in and around GEO as well as all NS 8719.4 requirements with the exception of Requirements 4.4-X: Limiting Probability of Accidental Explosions and 4.5-1 Probability of Collision with Large Objects. See Table 4 for the full Orbit Debris Analysis Report (ODAR) of the Karousel NGSO FSS Constellation. Please note there is no difference in functionality between v2.0.2 and the current version 2.1.1 – updates were made to the materials database and the user interface which do not affect the results. All NASA DAS input parameters are listed in Appendix A along with the full DAS report in Appendix B.

Requirements 4.4-X are met by design and compliance with all standards and guidelines listed in Response (a). For objects with large mass ratios, the confidence with which NASA DAS is able to calculate the probability of collision in GEO deteriorates. We illustrate this in the table below by keeping all things equal except for mission lifetime. One would assume that, if the mission lifetime is longer, then the probability of collision would increase, but looking at the NASA DAS output in Table 3 below and in Appendix C, we see that this is not the case. We also compare the NASA DAS output for probability collision for of for circular orbit GEO + 4000km inclined 63.4deg, circular GEO – 4000km 63.4deg and Geosynchronous orbit. It is expected that over the mission lifetime the GEO spacecraft would have a significantly larger probability of collision, and that spacecraft with longer mission lifetimes would have a larger probability of collision, but this is also not the always case (Table 3 and Appendix C).

Table 3: NASA DAS Output Scenarios

Spacecraft Altitude	Inclination (deg)	RAAN (deg)	5 year Mission Life Collision Probability	15 year Mission Life Collision Probability
GEO + 4000km	63.4	40	0.01168	0.01451
GEO + 4000km	63.4	310	0.01196	0.01229
GEO - 4000km	63.4	40	0.01352	0.01164
GEO - 4000km	63.4	310	0.01270	0.01486
GEO	0	40	0.01442	0.01130
GEO	0	310	0.01285	0.01250

Additional detailed analysis has been performed beyond the NASA DAS Tool to prove that the Karousel Constellation poses no threat to GEO and near-GEO assets. To generate results for the worst case Karousel scenarios with confidence we use RADIANT and GMAT software tools, both operational high-fidelity orbit propagation tools used on US Government Programs. In Response e) we show that the long-term propagation of the Karousel orbits over a range of scenarios (solar radiation pressure, area-to-mass ratio, time of year and node location) spanning the mission lifetime yields a minimum range to GEO orbit greater than 2000km.

Additionally, to mitigate collision risk during on-orbit operations, Karousel operators assess potential hazards from spacecraft as well as objects/debris and perform regular collision avoidance calculations to ensure safety of flight. Each Karousel vehicle maintains significant delta-v reserves for collision avoidance maneuvers if necessary.

Table 4: Karousel NASA 8719.14 Requirements Compliance Table

	NS 8719.14 Requirement	Compliant	Not Compliant	N/A	Comments
4.3-1	Mission-Related Debris Passing Through LEO			X	No mission debris is expected (see Response a)
4.3-2	Mission-Related Debris Passing Through GEO	X			No mission debris is expected (see Response a)
4.4-1	Limit Probability of Accidental Explosions	X			By design Karousel spacecraft will meet ISO-9000 and range safety standards
4.4-2	Passivate to Limit Accidental Explosion	X			By design Karousel spacecraft will meet ISO-9000 and range safety standards
4.4-3	Long-Term Risk from Planned Break-ups	X			There are no planned break-ups
4.4-4	Limit Debris Could for Planned Break-ups			X	N/A: there are no planned break-ups
4.5-1	Probability of Damage from Large Objects	X			NASA DAS Tool does not scale for large GEO vehicles; Further analysis shows that we mitigate risk of damage from Large Objects
4.5-2	Probability of Damage from Small Objects			X	By design Karousel spacecraft will meet ISO-9000 and provide micrometeorite shielding around critical and pressurized surfaces; Further analysis will be performed for the Preliminary Design Review to ensure requirements are met
4.6-1	Post-mission Disposal for Structures Passing Through LEO			X	N/A: Karousel performs a Post Mission Disposal for GEO-like orbits
4.6-2	Post-mission Disposal for Structures Passing Near GEO	X			All Karousel vehicles meet requirements via NASA DAS Tool
4.6-3	Post-mission Disposal for Structures Passing Between LEO & GEO	X			All Karousel vehicles meet requirements via NASA DAS Tool and high-fidelity long-term analysis
4.6-4	Reliability of Post-mission Disposal Operations	X			Plan to circularize 300km above mission orbit – see response 4(e)
4.7-1	Casualty Risk of Human Casualty from Reentry Debris			X	N/A: Karousel Spacecraft are in near-GEO and will not re-enter Earth's atmosphere
4.8-1	Collision Hazards of Space Tethers			X	N/A: Karousel spacecraft do not have tethers

The following software was used to demonstrate the safety and robustness of the Karousel constellation:

NASA Debris Analysis Software (DAS) v. 2.0.2

The NASA Debris Analysis Software an industry-standard tool used to determine probability of on-orbit collision from orbit regimes from LEO to GEO. Is the premier tool to verify that spacecraft, rocket bodies and small debris meet NASA Spec Standard 8719.14. It uses Orbital Debris Environment Model (ORDEM) 2000 with a GEO-specific orbit propagator which includes 4x4 zonal harmonics and solar radiation pressure.

NASA GSFC General Mission Analysis Tool (GMAT)

The NASA Goddard Space Flight Center GMAT tool is an orbit propagation tool used for design and approved for use on operational spacecraft missions. It allows for high fidelity dynamics models including harmonic gravity, drag, tides, and relativistic corrections. The user is able to include spacecraft-specific parameters such as propulsive parameters, drag and radiation pressure coefficients as well as attitude data. For this analysis GMAT was primarily used for verifying results and visualization.

NXTRAC Rapid Analytical Dynamics Integrated Navigation Toolkit (RADIANT)

RADIANT performs high-fidelity orbit propagation as well as orbit determination and covariance analysis. The tool uses and Cowell-Adams-Moulton 8th order integrator/predictor with back difference table that restarts when changes in force model (e.g. eclipse entry/exit) are detected. RADIANT accounts for N-Body effects including solar and lunar perturbations per the JPL DE405 planetary ephemeris. The Earth is modeled using a default 41x41 EGM geopotential model, but can be modified up to degree and order 80 and includes solid earth tides. RADIANT also includes spherical and attitude dependent solar radiation pressure models. RADIANT has supported multiple commercial, NASA, DoD, and US government programs for both operations and as an independent reference for advanced analyses and studies.

4(d) A statement as to the methods by which Karousel intends to maintain safe flight profiles throughout the life of its satellites

Response: Karousel's constellation is passively safe via ephemeris sharing with commercial operators within 10 degrees longitude of each vehicle in the constellation's node and publishing precision ephemerides to the Internet for commercial and government agencies (e.g. Joint Space Operations Center) to subscribe to. Safety-of-flight concerns are mitigated by the fact that the constellation is in a

unique orbit relative to GEO and there are currently no other spacecraft in this orbit regime. Additionally, the benefit of the Karousel's changing geometry relative to ground sites, position knowledge measurements (see Response b) are much less than 100m even after 72 hours of propagation.

Long-term safety-of-flight concerns are allayed by performing a Post-Mission Disposal (PMD) maneuver into a graveyard-like orbit. The Karousel spacecraft do not have planned break-ups or debris being created or jettisoned from the spacecraft, thus eliminating safety-of-flight concerns due to small object debris (See Response a) and Karousel's Orbit Debris Assessment Report (ODAR) compliance in Table 4.

4(e) Additional information concerning the post-mission disposal plans for Karousel's satellites, including estimated fuel reserves to be maintained for disposal procedures, orbital parameters of the intended disposal orbit, whether Karousel intends to circularize the orbit of its satellites at end of life, and other details pertinent to the disposal of the satellites. [10] Please address, for NGSO operations in an orbit inclined at 63.4 degrees, whether the formula for calculating minimum initial perigee for a GSO disposal, as found at 47 C.F.R. 25.283(a), is suitable, bearing in mind possible differences in solar lunar perturbations and effects of solar radiation pressure. In particular, please provide a statement and/or analysis with respect to the long-term stability or instability of the proposed post-mission storage orbit. Such analysis should address any measures, such as selection of orbital parameters, that may affect the long-term evolution of orbital parameters, with particular attention to addressing any such evolution that would result in the satellites entering the geostationary protected region, i.e., the area defined by the geosynchronous altitude, plus or minus 200 kilometers, and plus or minus 15 degrees from the equatorial plane, or the LEO protected region, i.e., the area below 2000 km.

Response: Long term precision propagation of Karousel orbits using RADIANT and GMAT show that Karousel orbits, even located between the largest Earth gravity wells, are not perturbed nor cross or decay into the operational GEO volume. The long term propagation analysis assumed initial dates in 2020 thru 2023 with a sample start every 5 days from 1 Jan 2020 thru 31 Dec 2023 to account for solar and lunar variations with above models for 20 years, to determine statistics on closest approach to GEO. Over more than 10,000 cases and for each date, the minimum range to GEO was calculated for three specific longitude cases: Eastern well (Longitude = 75°), Western well (Longitude = 255°) and half way between (Longitude = 165°) and two different spacecraft surface areas: 30m^2 and 400m^2 to envelope and capture the possible constraints.

As the dominant perturbation at GEO, the nominal Solar Radiation Pressure (SRP) +/-50% was also evaluated for each case to account for varying level of solar activities and spacecraft parameter (e.g. mass, area, material reflectivity coefficients, and attitude) uncertainties. Table 5 and Figure 1 illustrate that for an operational lifetime of 20 years, even the minimum range is greater than 2000km from GEO orbit.

Table 5: Karousel minimum range to GEO over 20 years on-orbit is greater than 2000km and account for uncertainties in solar activity, spacecraft design and attitude

Scenario	**Minimum Range to GEO (Nominal SRP)**		**Minimum Range to GEO (Nominal SRP -50%)**		**Minimum Range to GEO (Nominal SRP +50%)**	
	Vehicle Area: $30m^2$	Vehicle Area: $400m^2$	Vehicle Area: $30m^2$	Vehicle Area: $400m^2$	Vehicle Area: $30m^2$	Vehicle Area: $400m^2$
Nominal Location (Longitude = 165°)	2591 km	2480 km	2546 km	2462km	2580 km	2551 km
Eastern Gravity Well (Longitude = 75°)	2563 km	2487 km	2559 km	2522 km	2567 km	2494 km
Western Gravity Well (Longitude = 255°)	2500 km	2456 km	2502 km	2439 km	2497 km	2435 km

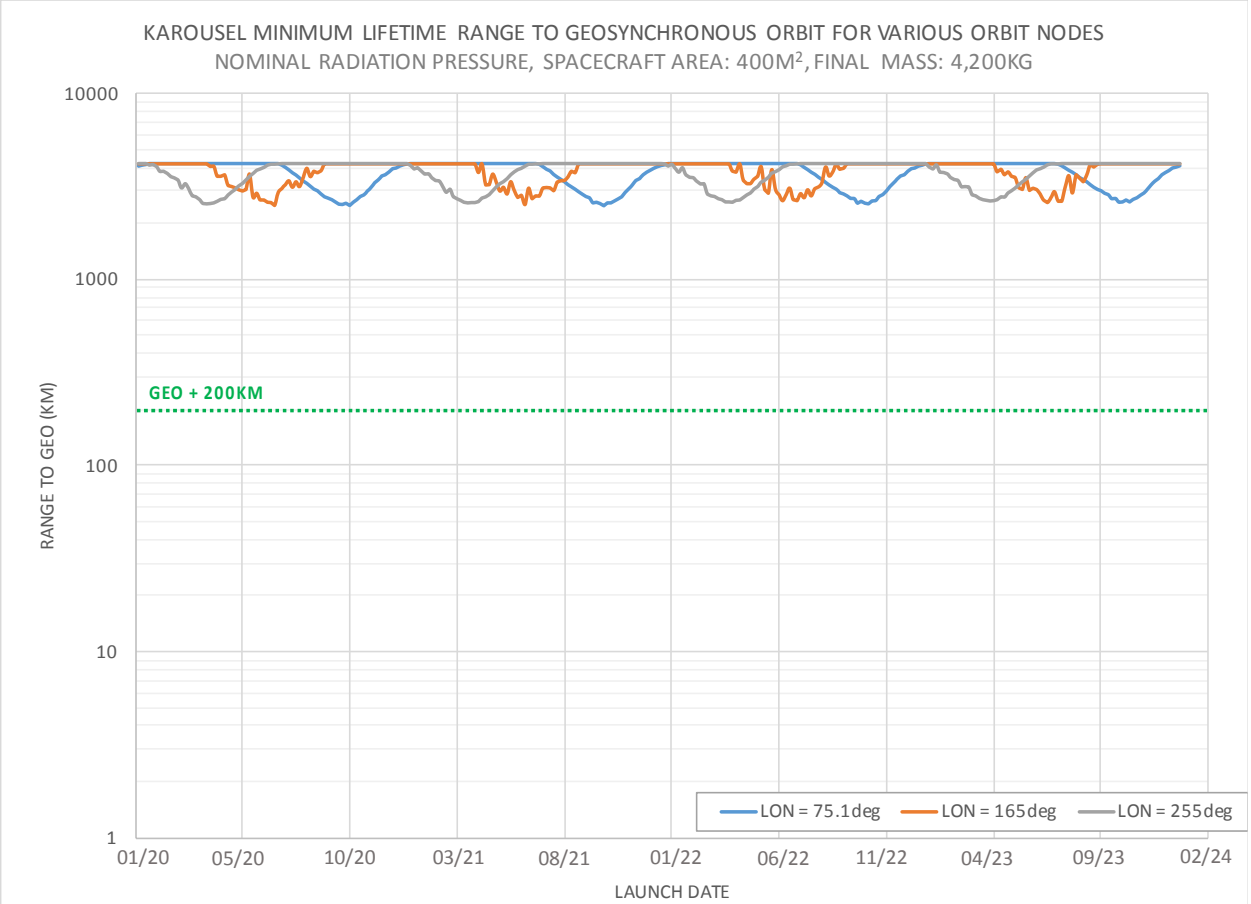

Figure 1: Karousel's minimum range to GEO during a 20 year operational lifetime is much greater than 2000km

Figure 2 provides a plot of the lifetime range to GEO for the closest approach case (Western gravity well assuming nominal solar radiation pressure conditions) listed above in Table 5. In many cases, the minimum range to GEO occurs at the beginning of the scenario, and the range to GEO drifts further away with time primarily due to N-body effects as can be seen in the cyclical nature of the plot. The minimum range to GEO for the 20-year operational mission lifetime is above 2000km and does not pose a threat to GEO objects as illustrated in Figure 2.

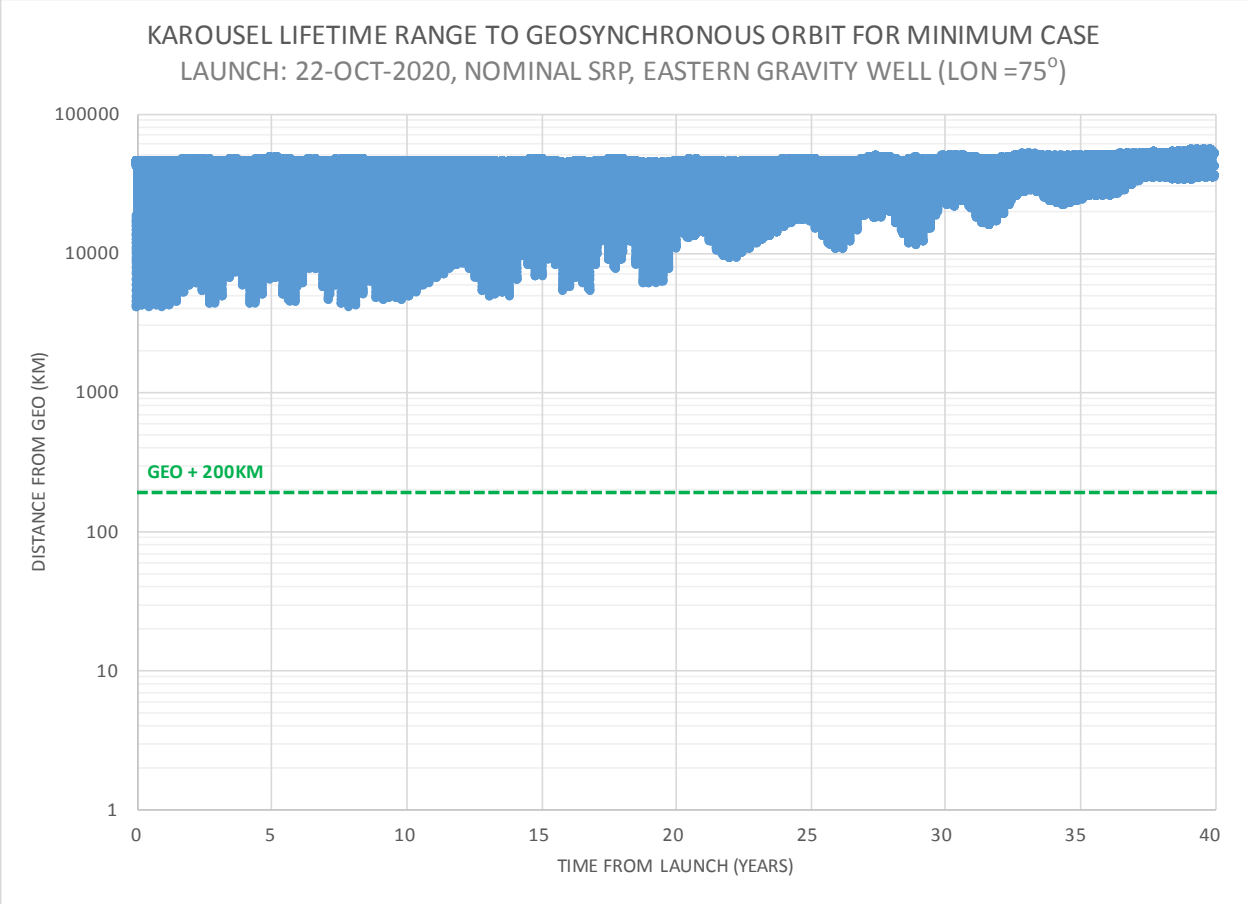

Figure 2: Lifetime range to GEO for minimum range case

Once the Karousel operational mission is complete, a Post-Mission Disposal (PMD) maneuver is performed to raise Perigee and Apogee to 40,302km, thus producing an inclined, circular graveyard orbit 300km above the operational Karousel mission apogee. While the unique Karousel graveyard orbit requires more delta-v than typical GEO spacecraft, approximately 500m/s, the spacecraft can easily meet this requirement as the large GEO Karousel platform, can carry nearly 5000m/s of delta-v capability. Using Karousel's operational mission and disposal orbit parameters (See Appendix A), the NASA Debris Analysis Software (DAS) is used to calculate the probability of collision with other large objects in or near GEO orbit. Table 3 provides the output of this analysis and shows that each proposed Karousel vehicle meets Requirement 4.6-2 of NASA Standard 8719.14.

Since GEO and near-GEO graveyard orbits are a function of area-to-mass ratio (e.g. the higher the area-to-mass ratio, the farther the object's graveyard orbit). The expected Karousel vehicle will likely have at most a 0.09 area-to-mass ratio, which is very large for what NASA DAS expects to be put into a graveyard orbit.

Requirement 4.6-3 requires that the minimum increase in perigee altitude at the end of re-orbiting does not come within GEO + 200 km for the next 100 years. A selected perigee of GEO +235 km + (1000*CR*A/m) and an eccentricity of less than 0.003 (e<0.003) ensures that the space structure does

not come within 200 km of GEO altitude (35,786 km) for at least 100 years. Where CR is the solar radiation pressure coefficient (typical values: 1.2-1.5), A is spacecraft surface area in m^2, and m is the spacecraft mass in kg; Note that the factors 1000 and CR have hidden units to ensure that the second term yields a value in km. For the Karousel Graveyard orbit, the minimum required altitude using this methodology is GEO + 378km, while the Karousel graveyard orbit is planned to be greater than 4500km above GEO.

Please feel free to contact me directly with any questions or requests for ancillary data. Many thanks to Jackie Eanes of Blue Marble Space LLC and Dr. Darren McKnight for their support in producing this memo.

Dr. Darren D. Garber

NXTRAC President

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APPENDIX A: NASA DAS Input Parameters

Operational Mission Orbit Parameters:

Spacecraft Name	Mission Duration	Operational Perigee Alt (km)	Operational Apogee Alt (km)	Operational Inclination (deg)	RAAN (deg)	Argument of Perigee (deg)	Mean Anomaly (deg)
Karousel-1	15 yrs	31569.5	40002.3	63.4	39.984	180	0
Karousel-2	15 yrs	31569.5	40002.3	63.4	309.894	180	90
Karousel-3	15 yrs	31569.5	40002.3	63.4	219.894	180	180
Karousel-4	15 yrs	31569.5	40002.3	63.4	259.894	180	0
Karousel-5	15 yrs	31569.5	40002.3	63.4	169.894	180	90
Karousel-6	15 yrs	31569.5	40002.3	63.4	79.894	180	180
Karousel-7	15 yrs	31569.5	40002.3	63.4	149.894	180	0
Karousel-8	15 yrs	31569.5	40002.3	63.4	59.894	180	90
Karousel-9	15 yrs	31569.5	40002.3	63.4	329.894	180	180
Karousel-10	15 yrs	31569.5	40002.3	63.4	129.894	180	270
Karousel-11	15 yrs	31569.5	40002.3	63.4	349.894	180	270
Karousel-12	15 yrs	31569.5	40002.3	63.4	239.894	180	270

Post-Mission Disposal Parameters:

Spacecraft Name	PMD Maneuver	Disposal Perigee Alt (km)	Disposal Apogee Alt (km)	Disposal Inclination (deg)	Disposal RAAN (deg)	Disposal Mean Anomaly (deg)	Initial Mass (kg)	Final Mass (kg)	Final Area to Mass Ratio (m^2/kg)	Station Kept	Panned Breakup
Karousel-1	YES	31569.5	40002.3	63.4	39.984	0	6000	4200	0.09	YES	NO
Karousel-2	YES	31569.5	40002.3	63.4	309.894	90	6000	4200	0.09	YES	NO
Karousel-3	YES	31569.5	40002.3	63.4	219.894	180	6000	4200	0.09	YES	NO
Karousel-4	YES	31569.5	40002.3	63.4	259.894	0	6000	4200	0.09	YES	NO
Karousel-5	YES	31569.5	40002.3	63.4	169.894	90	6000	4200	0.09	YES	NO
Karousel-6	YES	31569.5	40002.3	63.4	79.894	180	6000	4200	0.09	YES	NO
Karousel-7	YES	31569.5	40002.3	63.4	149.894	0	6000	4200	0.09	YES	NO
Karousel-8	YES	31569.5	40002.3	63.4	59.894	90	6000	4200	0.09	YES	NO
Karousel-9	YES	31569.5	40002.3	63.4	329.894	180	6000	4200	0.09	YES	NO
Karousel-10	YES	31569.5	40002.3	63.4	129.894	270	6000	4200	0.09	YES	NO
Karousel-11	YES	31569.5	40002.3	63.4	349.894	270	6000	4200	0.09	YES	NO
Karousel-12	YES	31569.5	40002.3	63.4	239.894	270	6000	4200	0.09	YES	NO

APPENDIX B: NASA DAS Console Output

```
04 08 2017; 02:44:33AM     DAS Application Started
04 08 2017; 02:44:49AM     Processing Requirement 4.3-1:     Return Status :  Not Run  (LEO Requirement)

====================
No Project Data Available
====================

=============== End of Requirement 4.3-1 ===============
04 08 2017; 02:44:52AM     Processing Requirement 4.3-2: Return Status : Passed

====================
No Project Data Available
====================

=============== End of Requirement 4.3-2 ===============
04 08 2017; 02:44:59AM     Requirement 4.4-3:  Compliant

=============== End of Requirement 4.4-3 ===============
04 08 2017; 02:45:04AM     Requirement 4.5-2:  Compliant

====================
No Project Data Available
====================

====================
No Project Data Available
====================

=============== End of Requirement 4.3-2 ===============
04 08 2017; 02:45:33AM     Requirement 4.4-3:  Compliant

=============== End of Requirement 4.4-3 ===============
04 08 2017; 02:45:38AM     Processing Requirement 4.6 Return Status :  Passed

==============
Project Data
==============

**INPUT**

       Space Structure Name = Karousel-1
       Space Structure Type = Payload

       Perigee Altitude = 31569.500000 (km)
       Apogee Altitude = 40002.300000 (km)
       Inclination = 63.400000 (deg)
       RAAN = 39.894000 (deg)
       Argument of Perigee = 180.000000 (deg)
       Mean Anomaly = 0.000000 (deg)
       Area-To-Mass Ratio = 0.090000 (m^2/kg)
       Start Year = 2010.000000 (yr)
       Initial Mass = 6000.000000 (kg)
       Final Mass = 4200.000000 (kg)
       Duration = 5.000000 (yr)
       Station Kept = True
       Abandoned = False
       PMD Perigee Altitude = 40302.300000 (km)
       PMD Apogee Altitude = 40302.300000 (km)
       PMD Inclination = 63.400000 (deg)
       PMD RAAN = 39.984000 (deg)
```

```
       PMD Argument of Perigee = 180.000000 (deg)
       PMD Mean Anomaly = 0.000000 (deg)

**OUTPUT**

       Suggested Perigee Altitude = 40302.300000 (km)
       Suggested Apogee Altitude = 40302.300000 (km)
       Returned Error Message = Passes super-GEO storage orbit criteria.

       Released Year = -1 (yr)
       Requirement = 63
       Compliance Status = Pass

==============

**INPUT**

       Space Structure Name = Karousel-2
       Space Structure Type = Payload

       Perigee Altitude = 31569.500000 (km)
       Apogee Altitude = 40002.300000 (km)
       Inclination = 63.400000 (deg)
       RAAN = 309.894000 (deg)
       Argument of Perigee = 180.000000 (deg)
       Mean Anomaly = 90.000000 (deg)
       Area-To-Mass Ratio = 0.090000 (m^2/kg)
       Start Year = 2010.000000 (yr)
       Initial Mass = 6000.000000 (kg)
       Final Mass = 4200.000000 (kg)
       Duration = 5.000000 (yr)
       Station Kept = True
       Abandoned = False
       PMD Perigee Altitude = 40302.300000 (km)
       PMD Apogee Altitude = 40302.300000 (km)
       PMD Inclination = 63.400000 (deg)
       PMD RAAN = 309.894000 (deg)
       PMD Argument of Perigee = 180.000000 (deg)
       PMD Mean Anomaly = 90.000000 (deg)

**OUTPUT**

       Suggested Perigee Altitude = 40302.300000 (km)
       Suggested Apogee Altitude = 40302.300000 (km)
       Returned Error Message = Passes super-GEO storage orbit criteria.

       Released Year = -1 (yr)
       Requirement = 63
       Compliance Status = Pass

==============

**INPUT**

       Space Structure Name = Karousel-3
       Space Structure Type = Payload

       Perigee Altitude = 31569.500000 (km)
       Apogee Altitude = 40002.300000 (km)
       Inclination = 63.400000 (deg)
       RAAN = 219.894000 (deg)
       Argument of Perigee = 180.000000 (deg)
       Mean Anomaly = 180.000000 (deg)
```

```
       Area-To-Mass Ratio = 0.090000 (m^2/kg)
       Start Year = 2010.000000 (yr)
       Initial Mass = 6000.000000 (kg)
       Final Mass = 4200.000000 (kg)
       Duration = 15.000000 (yr)
       Station Kept = True
       Abandoned = False
       PMD Perigee Altitude = 40302.300000 (km)
       PMD Apogee Altitude = 40302.300000 (km)
       PMD Inclination = 63.400000 (deg)
       PMD RAAN = 219.894000 (deg)
       PMD Argument of Perigee = 180.000000 (deg)
       PMD Mean Anomaly = 180.000000 (deg)

**OUTPUT**

       Suggested Perigee Altitude = 40302.300000 (km)
       Suggested Apogee Altitude = 40302.300000 (km)
       Returned Error Message = Passes super-GEO storage orbit criteria.

       Released Year = -1 (yr)
       Requirement = 63
       Compliance Status = Pass

==============

**INPUT**

       Space Structure Name = Karousel-4
       Space Structure Type = Payload

       Perigee Altitude = 31569.500000 (km)
       Apogee Altitude = 40002.300000 (km)
       Inclination = 63.400000 (deg)
       RAAN = 259.894000 (deg)
       Argument of Perigee = 180.000000 (deg)
       Mean Anomaly = 0.000000 (deg)
       Area-To-Mass Ratio = 0.090000 (m^2/kg)
       Start Year = 2010.000000 (yr)
       Initial Mass = 6000.000000 (kg)
       Final Mass = 4200.000000 (kg)
       Duration = 15.000000 (yr)
       Station Kept = True
       Abandoned = False
       PMD Perigee Altitude = 40302.300000 (km)
       PMD Apogee Altitude = 40302.300000 (km)
       PMD Inclination = 63.400000 (deg)
       PMD RAAN = 259.894000 (deg)
       PMD Argument of Perigee = 180.000000 (deg)
       PMD Mean Anomaly = 0.000000 (deg)

**OUTPUT**

       Suggested Perigee Altitude = 40302.300000 (km)
       Suggested Apogee Altitude = 40302.300000 (km)
       Returned Error Message = Passes super-GEO storage orbit criteria.

       Released Year = -1 (yr)
       Requirement = 63
       Compliance Status = Pass

==============
```

```
**INPUT**

       Space Structure Name = Karousel-5
       Space Structure Type = Payload

       Perigee Altitude = 31569.500000 (km)
       Apogee Altitude = 40002.300000 (km)
       Inclination = 63.400000 (deg)
       RAAN = 169.894000 (deg)
       Argument of Perigee = 180.000000 (deg)
       Mean Anomaly = 90.000000 (deg)
       Area-To-Mass Ratio = 0.090000 (m^2/kg)
       Start Year = 2010.000000 (yr)
       Initial Mass = 6000.000000 (kg)
       Final Mass = 4200.000000 (kg)
       Duration = 15.000000 (yr)
       Station Kept = True
       Abandoned = False
       PMD Perigee Altitude = 40302.300000 (km)
       PMD Apogee Altitude = 40302.300000 (km)
       PMD Inclination = 63.400000 (deg)
       PMD RAAN = 169.894000 (deg)
       PMD Argument of Perigee = 180.000000 (deg)
       PMD Mean Anomaly = 90.000000 (deg)

**OUTPUT**

       Suggested Perigee Altitude = 40302.300000 (km)
       Suggested Apogee Altitude = 40302.300000 (km)
       Returned Error Message = Passes super-GEO storage orbit criteria.

       Released Year = -1 (yr)
       Requirement = 63
       Compliance Status = Pass

==============

**INPUT**

       Space Structure Name = Karousel-6
       Space Structure Type = Payload

       Perigee Altitude = 31569.500000 (km)
       Apogee Altitude = 40002.300000 (km)
       Inclination = 63.400000 (deg)
       RAAN = 79.894000 (deg)
       Argument of Perigee = 180.000000 (deg)
       Mean Anomaly = 180.000000 (deg)
       Area-To-Mass Ratio = 0.090000 (m^2/kg)
       Start Year = 2010.000000 (yr)
       Initial Mass = 6000.000000 (kg)
       Final Mass = 4200.000000 (kg)
       Duration = 15.000000 (yr)
       Station Kept = True
       Abandoned = False
       PMD Perigee Altitude = 40302.300000 (km)
       PMD Apogee Altitude = 40302.300000 (km)
       PMD Inclination = 63.400000 (deg)
       PMD RAAN = 79.894000 (deg)
       PMD Argument of Perigee = 180.000000 (deg)
       PMD Mean Anomaly = 180.000000 (deg)

**OUTPUT**
```

Suggested Perigee Altitude = 40302.300000 (km)
Suggested Apogee Altitude = 40302.300000 (km)
Returned Error Message = Passes super-GEO storage orbit criteria.

Released Year = -1 (yr)
Requirement = 63
Compliance Status = Pass

==========

INPUT

Space Structure Name = Karousel-7
Space Structure Type = Payload

Perigee Altitude = 31569.500000 (km)
Apogee Altitude = 40002.300000 (km)
Inclination = 63.400000 (deg)
RAAN = 149.894000 (deg)
Argument of Perigee = 180.000000 (deg)
Mean Anomaly = 0.000000 (deg)
Area-To-Mass Ratio = 0.090000 (m^2/kg)
Start Year = 2010.000000 (yr)
Initial Mass = 6000.000000 (kg)
Final Mass = 4200.000000 (kg)
Duration = 15.000000 (yr)
Station Kept = True
Abandoned = False
PMD Perigee Altitude = 40302.300000 (km)
PMD Apogee Altitude = 40302.300000 (km)
PMD Inclination = 63.400000 (deg)
PMD RAAN = 149.894000 (deg)
PMD Argument of Perigee = 180.000000 (deg)
PMD Mean Anomaly = 0.000000 (deg)

OUTPUT

Suggested Perigee Altitude = 40302.300000 (km)
Suggested Apogee Altitude = 40302.300000 (km)
Returned Error Message = Passes super-GEO storage orbit criteria.

Released Year = -1 (yr)
Requirement = 63
Compliance Status = Pass

==========

INPUT

Space Structure Name = Karousel-8
Space Structure Type = Payload

Perigee Altitude = 31569.500000 (km)
Apogee Altitude = 40002.300000 (km)
Inclination = 63.400000 (deg)
RAAN = 59.894000 (deg)
Argument of Perigee = 180.000000 (deg)
Mean Anomaly = 90.000000 (deg)
Area-To-Mass Ratio = 0.090000 (m^2/kg)
Start Year = 2010.000000 (yr)
Initial Mass = 6000.000000 (kg)
Final Mass = 4200.000000 (kg)

```
       Duration = 15.000000 (yr)
       Station Kept = True
       Abandoned = False
       PMD Perigee Altitude = 40302.300000 (km)
       PMD Apogee Altitude = 40302.300000 (km)
       PMD Inclination = 63.400000 (deg)
       PMD RAAN = 59.894000 (deg)
       PMD Argument of Perigee = 180.000000 (deg)
       PMD Mean Anomaly = 90.000000 (deg)

**OUTPUT**

       Suggested Perigee Altitude = 40302.300000 (km)
       Suggested Apogee Altitude = 40302.300000 (km)
       Returned Error Message = Passes super-GEO storage orbit criteria.

       Released Year = -1 (yr)
       Requirement = 63
       Compliance Status = Pass

==============

**INPUT**

       Space Structure Name = Karousel-9
       Space Structure Type = Payload

       Perigee Altitude = 31569.500000 (km)
       Apogee Altitude = 40002.300000 (km)
       Inclination = 63.400000 (deg)
       RAAN = 329.894000 (deg)
       Argument of Perigee = 180.000000 (deg)
       Mean Anomaly = 180.000000 (deg)
       Area-To-Mass Ratio = 0.090000 (m^2/kg)
       Start Year = 2010.000000 (yr)
       Initial Mass = 6000.000000 (kg)
       Final Mass = 4200.000000 (kg)
       Duration = 15.000000 (yr)
       Station Kept = True
       Abandoned = False
       PMD Perigee Altitude = 40302.300000 (km)
       PMD Apogee Altitude = 40302.300000 (km)
       PMD Inclination = 63.400000 (deg)
       PMD RAAN = 329.894000 (deg)
       PMD Argument of Perigee = 180.000000 (deg)
       PMD Mean Anomaly = 180.000000 (deg)

**OUTPUT**

       Suggested Perigee Altitude = 40302.300000 (km)
       Suggested Apogee Altitude = 40302.300000 (km)
       Returned Error Message = Passes super-GEO storage orbit criteria.

       Released Year = -1 (yr)
       Requirement = 63
       Compliance Status = Pass

==============

**INPUT**

       Space Structure Name = Karousel-10
       Space Structure Type = Payload
```

```
       Perigee Altitude = 31569.500000 (km)
       Apogee Altitude = 40002.300000 (km)
       Inclination = 63.400000 (deg)
       RAAN = 129.894000 (deg)
       Argument of Perigee = 180.000000 (deg)
       Mean Anomaly = 270.000000 (deg)
       Area-To-Mass Ratio = 0.090000 (m^2/kg)
       Start Year = 2010.000000 (yr)
       Initial Mass = 6000.000000 (kg)
       Final Mass = 4200.000000 (kg)
       Duration = 15.000000 (yr)
       Station Kept = True
       Abandoned = False
       PMD Perigee Altitude = 40302.300000 (km)
       PMD Apogee Altitude = 40302.300000 (km)
       PMD Inclination = 63.400000 (deg)
       PMD RAAN = 129.894000 (deg)
       PMD Argument of Perigee = 180.000000 (deg)
       PMD Mean Anomaly = 270.000000 (deg)

**OUTPUT**

       Suggested Perigee Altitude = 40302.300000 (km)
       Suggested Apogee Altitude = 40302.300000 (km)
       Returned Error Message = Passes super-GEO storage orbit criteria.

       Released Year = -1 (yr)
       Requirement = 63
       Compliance Status = Pass

==============

**INPUT**

       Space Structure Name = Karousel-11
       Space Structure Type = Payload

       Perigee Altitude = 31569.500000 (km)
       Apogee Altitude = 40002.300000 (km)
       Inclination = 63.400000 (deg)
       RAAN = 349.894000 (deg)
       Argument of Perigee = 180.000000 (deg)
       Mean Anomaly = 270.000000 (deg)
       Area-To-Mass Ratio = 0.090000 (m^2/kg)
       Start Year = 2010.000000 (yr)
       Initial Mass = 6000.000000 (kg)
       Final Mass = 4200.000000 (kg)
       Duration = 15.000000 (yr)
       Station Kept = True
       Abandoned = False
       PMD Perigee Altitude = 40302.300000 (km)
       PMD Apogee Altitude = 40302.300000 (km)
       PMD Inclination = 63.400000 (deg)
       PMD RAAN = 349.894000 (deg)
       PMD Argument of Perigee = 180.000000 (deg)
       PMD Mean Anomaly = 270.000000 (deg)

**OUTPUT**

       Suggested Perigee Altitude = 40302.300000 (km)
       Suggested Apogee Altitude = 40302.300000 (km)
       Returned Error Message = Passes super-GEO storage orbit criteria.
```

```
       Released Year = -1 (yr)
       Requirement = 63
       Compliance Status = Pass

==============

**INPUT**

       Space Structure Name = Karousel-12
       Space Structure Type = Payload

       Perigee Altitude = 31569.500000 (km)
       Apogee Altitude = 40002.300000 (km)
       Inclination = 63.400000 (deg)
       RAAN = 239.894000 (deg)
       Argument of Perigee = 180.000000 (deg)
       Mean Anomaly = 270.000000 (deg)
       Area-To-Mass Ratio = 0.090000 (m^2/kg)
       Start Year = 2010.000000 (yr)
       Initial Mass = 6000.000000 (kg)
       Final Mass = 4200.000000 (kg)
       Duration = 15.000000 (yr)
       Station Kept = True
       Abandoned = False
       PMD Perigee Altitude = 40302.300000 (km)
       PMD Apogee Altitude = 40302.300000 (km)
       PMD Inclination = 63.400000 (deg)
       PMD RAAN = 239.894000 (deg)
       PMD Argument of Perigee = 180.000000 (deg)
       PMD Mean Anomaly = 270.000000 (deg)

**OUTPUT**

       Suggested Perigee Altitude = 40302.300000 (km)
       Suggested Apogee Altitude = 40302.300000 (km)
       Returned Error Message = Passes super-GEO storage orbit criteria.

       Released Year = -1 (yr)
       Requirement = 63
       Compliance Status = Pass

==============

=============== End of Requirement 4.6 ===============
04 08 2017; 02:45:45AM     Requirement 4.5-2:  Compliant
04 08 2017; 02:48:54AM     Processing Requirement 4.5-1:    Return Status :  Failed

==============
Run Data
==============

**INPUT**

       Space Structure Name = Karousel-1
       Space Structure Type = Payload
       Perigee Altitude = 31569.500000 (km)
       Apogee Altitude = 40002.300000 (km)
       Inclination = 63.400000 (deg)
       RAAN = 39.894000 (deg)
       Argument of Perigee = 180.000000 (deg)
       Mean Anomaly = 0.000000 (deg)
       Final Area-To-Mass Ratio = 0.090000 (m^2/kg)
```

```
       Start Year = 2010.000000 (yr)
       Initial Mass = 6000.000000 (kg)
       Final Mass = 4200.000000 (kg)
       Duration = 5.000000 (yr)
       Station-Kept = True
       Abandoned = False
       PMD Perigee Altitude = 40302.300000 (km)
       PMD Apogee Altitude = 40302.300000 (km)
       PMD Inclination = 63.400000 (deg)
       PMD RAAN = 39.984000 (deg)
       PMD Argument of Perigee = 180.000000 (deg)
       PMD Mean Anomaly = 0.000000 (deg)

**OUTPUT**

       Collision Probability = 0.011679
       Returned Error Message: Failed Assessment.  Probability of Collision too great
       Date Range Error Message: Normal Date Range
       Status = Fail

==============

**INPUT**

       Space Structure Name = Karousel-2
       Space Structure Type = Payload
       Perigee Altitude = 31569.500000 (km)
       Apogee Altitude = 40002.300000 (km)
       Inclination = 63.400000 (deg)
       RAAN = 309.894000 (deg)
       Argument of Perigee = 180.000000 (deg)
       Mean Anomaly = 90.000000 (deg)
       Final Area-To-Mass Ratio = 0.090000 (m^2/kg)
       Start Year = 2010.000000 (yr)
       Initial Mass = 6000.000000 (kg)
       Final Mass = 4200.000000 (kg)
       Duration = 5.000000 (yr)
       Station-Kept = True
       Abandoned = False
       PMD Perigee Altitude = 40302.300000 (km)
       PMD Apogee Altitude = 40302.300000 (km)
       PMD Inclination = 63.400000 (deg)
       PMD RAAN = 309.894000 (deg)
       PMD Argument of Perigee = 180.000000 (deg)
       PMD Mean Anomaly = 90.000000 (deg)

**OUTPUT**

       Collision Probability = 0.011963
       Returned Error Message: Failed Assessment.  Probability of Collision too great
       Date Range Error Message: Normal Date Range
       Status = Fail

==============

**INPUT**

       Space Structure Name = Karousel-3
       Space Structure Type = Payload
       Perigee Altitude = 31569.500000 (km)
       Apogee Altitude = 40002.300000 (km)
       Inclination = 63.400000 (deg)
       RAAN = 219.894000 (deg)
```

Argument of Perigee = 180.000000 (deg)
Mean Anomaly = 180.000000 (deg)
Final Area-To-Mass Ratio = 0.090000 (m^2/kg)
Start Year = 2010.000000 (yr)
Initial Mass = 6000.000000 (kg)
Final Mass = 4200.000000 (kg)
Duration = 15.000000 (yr)
Station-Kept = True
Abandoned = False
PMD Perigee Altitude = 40302.300000 (km)
PMD Apogee Altitude = 40302.300000 (km)
PMD Inclination = 63.400000 (deg)
PMD RAAN = 219.894000 (deg)
PMD Argument of Perigee = 180.000000 (deg)
PMD Mean Anomaly = 180.000000 (deg)

OUTPUT

Collision Probability = 0.013064
Returned Error Message: Failed Assessment. Probability of Collision too great
Date Range Error Message: Normal Date Range
Status = Fail

==========

INPUT

Space Structure Name = Karousel-4
Space Structure Type = Payload
Perigee Altitude = 31569.500000 (km)
Apogee Altitude = 40002.300000 (km)
Inclination = 63.400000 (deg)
RAAN = 259.894000 (deg)
Argument of Perigee = 180.000000 (deg)
Mean Anomaly = 0.000000 (deg)
Final Area-To-Mass Ratio = 0.090000 (m^2/kg)
Start Year = 2010.000000 (yr)
Initial Mass = 6000.000000 (kg)
Final Mass = 4200.000000 (kg)
Duration = 15.000000 (yr)
Station-Kept = True
Abandoned = False
PMD Perigee Altitude = 40302.300000 (km)
PMD Apogee Altitude = 40302.300000 (km)
PMD Inclination = 63.400000 (deg)
PMD RAAN = 259.894000 (deg)
PMD Argument of Perigee = 180.000000 (deg)
PMD Mean Anomaly = 0.000000 (deg)

OUTPUT

Collision Probability = 0.012443
Returned Error Message: Failed Assessment. Probability of Collision too great
Date Range Error Message: Normal Date Range
Status = Fail

==========

INPUT

Space Structure Name = Karousel-5
Space Structure Type = Payload
Perigee Altitude = 31569.500000 (km)

```
       Apogee Altitude = 40002.300000 (km)
       Inclination = 63.400000 (deg)
       RAAN = 169.894000 (deg)
       Argument of Perigee = 180.000000 (deg)
       Mean Anomaly = 90.000000 (deg)
       Final Area-To-Mass Ratio = 0.090000 (m^2/kg)
       Start Year = 2010.000000 (yr)
       Initial Mass = 6000.000000 (kg)
       Final Mass = 4200.000000 (kg)
       Duration = 15.000000 (yr)
       Station-Kept = True
       Abandoned = False
       PMD Perigee Altitude = 40302.300000 (km)
       PMD Apogee Altitude = 40302.300000 (km)
       PMD Inclination = 63.400000 (deg)
       PMD RAAN = 169.894000 (deg)
       PMD Argument of Perigee = 180.000000 (deg)
       PMD Mean Anomaly = 90.000000 (deg)

**OUTPUT**

       Collision Probability = 0.014246
       Returned Error Message: Failed Assessment.  Probability of Collision too great
       Date Range Error Message: Normal Date Range
       Status = Fail

==============

**INPUT**

       Space Structure Name = Karousel-6
       Space Structure Type = Payload
       Perigee Altitude = 31569.500000 (km)
       Apogee Altitude = 40002.300000 (km)
       Inclination = 63.400000 (deg)
       RAAN = 79.894000 (deg)
       Argument of Perigee = 180.000000 (deg)
       Mean Anomaly = 180.000000 (deg)
       Final Area-To-Mass Ratio = 0.090000 (m^2/kg)
       Start Year = 2010.000000 (yr)
       Initial Mass = 6000.000000 (kg)
       Final Mass = 4200.000000 (kg)
       Duration = 15.000000 (yr)
       Station-Kept = True
       Abandoned = False
       PMD Perigee Altitude = 40302.300000 (km)
       PMD Apogee Altitude = 40302.300000 (km)
       PMD Inclination = 63.400000 (deg)
       PMD RAAN = 79.894000 (deg)
       PMD Argument of Perigee = 180.000000 (deg)
       PMD Mean Anomaly = 180.000000 (deg)

**OUTPUT**

       Collision Probability = 0.013110
       Returned Error Message: Failed Assessment.  Probability of Collision too great
       Date Range Error Message: Normal Date Range
       Status = Fail

==============

**INPUT**
```

```
       Space Structure Name = Karousel-7
       Space Structure Type = Payload
       Perigee Altitude = 31569.500000 (km)
       Apogee Altitude = 40002.300000 (km)
       Inclination = 63.400000 (deg)
       RAAN = 149.894000 (deg)
       Argument of Perigee = 180.000000 (deg)
       Mean Anomaly = 0.000000 (deg)
       Final Area-To-Mass Ratio = 0.090000 (m^2/kg)
       Start Year = 2010.000000 (yr)
       Initial Mass = 6000.000000 (kg)
       Final Mass = 4200.000000 (kg)
       Duration = 15.000000 (yr)
       Station-Kept = True
       Abandoned = False
       PMD Perigee Altitude = 40302.300000 (km)
       PMD Apogee Altitude = 40302.300000 (km)
       PMD Inclination = 63.400000 (deg)
       PMD RAAN = 149.894000 (deg)
       PMD Argument of Perigee = 180.000000 (deg)
       PMD Mean Anomaly = 0.000000 (deg)

**OUTPUT**

       Collision Probability = 0.014524
       Returned Error Message: Failed Assessment.  Probability of Collision too great
       Date Range Error Message: Normal Date Range
       Status = Fail

==============

**INPUT**

       Space Structure Name = Karousel-8
       Space Structure Type = Payload
       Perigee Altitude = 31569.500000 (km)
       Apogee Altitude = 40002.300000 (km)
       Inclination = 63.400000 (deg)
       RAAN = 59.894000 (deg)
       Argument of Perigee = 180.000000 (deg)
       Mean Anomaly = 90.000000 (deg)
       Final Area-To-Mass Ratio = 0.090000 (m^2/kg)
       Start Year = 2010.000000 (yr)
       Initial Mass = 6000.000000 (kg)
       Final Mass = 4200.000000 (kg)
       Duration = 15.000000 (yr)
       Station-Kept = True
       Abandoned = False
       PMD Perigee Altitude = 40302.300000 (km)
       PMD Apogee Altitude = 40302.300000 (km)
       PMD Inclination = 63.400000 (deg)
       PMD RAAN = 59.894000 (deg)
       PMD Argument of Perigee = 180.000000 (deg)
       PMD Mean Anomaly = 90.000000 (deg)

**OUTPUT**

       Collision Probability = 0.012303
       Returned Error Message: Failed Assessment.  Probability of Collision too great
       Date Range Error Message: Normal Date Range
       Status = Fail

==============
```

```
**INPUT**

       Space Structure Name = Karousel-9
       Space Structure Type = Payload
       Perigee Altitude = 31569.500000 (km)
       Apogee Altitude = 40002.300000 (km)
       Inclination = 63.400000 (deg)
       RAAN = 329.894000 (deg)
       Argument of Perigee = 180.000000 (deg)
       Mean Anomaly = 180.000000 (deg)
       Final Area-To-Mass Ratio = 0.090000 (m^2/kg)
       Start Year = 2010.000000 (yr)
       Initial Mass = 6000.000000 (kg)
       Final Mass = 4200.000000 (kg)
       Duration = 15.000000 (yr)
       Station-Kept = True
       Abandoned = False
       PMD Perigee Altitude = 40302.300000 (km)
       PMD Apogee Altitude = 40302.300000 (km)
       PMD Inclination = 63.400000 (deg)
       PMD RAAN = 329.894000 (deg)
       PMD Argument of Perigee = 180.000000 (deg)
       PMD Mean Anomaly = 180.000000 (deg)

**OUTPUT**

       Collision Probability = 0.011653
       Returned Error Message: Failed Assessment.  Probability of Collision too great
       Date Range Error Message: Normal Date Range
       Status = Fail

==============

**INPUT**

       Space Structure Name = Karousel-10
       Space Structure Type = Payload
       Perigee Altitude = 31569.500000 (km)
       Apogee Altitude = 40002.300000 (km)
       Inclination = 63.400000 (deg)
       RAAN = 129.894000 (deg)
       Argument of Perigee = 180.000000 (deg)
       Mean Anomaly = 270.000000 (deg)
       Final Area-To-Mass Ratio = 0.090000 (m^2/kg)
       Start Year = 2010.000000 (yr)
       Initial Mass = 6000.000000 (kg)
       Final Mass = 4200.000000 (kg)
       Duration = 15.000000 (yr)
       Station-Kept = True
       Abandoned = False
       PMD Perigee Altitude = 40302.300000 (km)
       PMD Apogee Altitude = 40302.300000 (km)
       PMD Inclination = 63.400000 (deg)
       PMD RAAN = 129.894000 (deg)
       PMD Argument of Perigee = 180.000000 (deg)
       PMD Mean Anomaly = 270.000000 (deg)

**OUTPUT**

       Collision Probability = 0.014873
       Returned Error Message: Failed Assessment.  Probability of Collision too great
       Date Range Error Message: Normal Date Range
```

```
       Status = Fail

==============

**INPUT**

       Space Structure Name = Karousel-11
       Space Structure Type = Payload
       Perigee Altitude = 31569.500000 (km)
       Apogee Altitude = 40002.300000 (km)
       Inclination = 63.400000 (deg)
       RAAN = 349.894000 (deg)
       Argument of Perigee = 180.000000 (deg)
       Mean Anomaly = 270.000000 (deg)
       Final Area-To-Mass Ratio = 0.090000 (m^2/kg)
       Start Year = 2010.000000 (yr)
       Initial Mass = 6000.000000 (kg)
       Final Mass = 4200.000000 (kg)
       Duration = 15.000000 (yr)
       Station-Kept = True
       Abandoned = False
       PMD Perigee Altitude = 40302.300000 (km)
       PMD Apogee Altitude = 40302.300000 (km)
       PMD Inclination = 63.400000 (deg)
       PMD RAAN = 349.894000 (deg)
       PMD Argument of Perigee = 180.000000 (deg)
       PMD Mean Anomaly = 270.000000 (deg)

**OUTPUT**

       Collision Probability = 0.011540
       Returned Error Message: Failed Assessment.  Probability of Collision too great
       Date Range Error Message: Normal Date Range
       Status = Fail

==============

**INPUT**

       Space Structure Name = Karousel-12
       Space Structure Type = Payload
       Perigee Altitude = 31569.500000 (km)
       Apogee Altitude = 40002.300000 (km)
       Inclination = 63.400000 (deg)
       RAAN = 239.894000 (deg)
       Argument of Perigee = 180.000000 (deg)
       Mean Anomaly = 270.000000 (deg)
       Final Area-To-Mass Ratio = 0.090000 (m^2/kg)
       Start Year = 2010.000000 (yr)
       Initial Mass = 6000.000000 (kg)
       Final Mass = 4200.000000 (kg)
       Duration = 15.000000 (yr)
       Station-Kept = True
       Abandoned = False
       PMD Perigee Altitude = 40302.300000 (km)
       PMD Apogee Altitude = 40302.300000 (km)
       PMD Inclination = 63.400000 (deg)
       PMD RAAN = 239.894000 (deg)
       PMD Argument of Perigee = 180.000000 (deg)
       PMD Mean Anomaly = 270.000000 (deg)

**OUTPUT**
```

```
       Collision Probability = 0.012742
       Returned Error Message: Failed Assessment.  Probability of Collision too great
       Date Range Error Message: Normal Date Range
       Status = Fail

==============

=============== End of Requirement 4.5-1 ===============
```

APPENDIX C: NASA DAS OUTPUT FOR LARGE AREA-TO-MASS RATIOS

```
04 08 2017; 10:29:05AM     DAS Application Started
04 08 2017; 10:29:05AM     Opened Project C:\Program Files (x86)\NASA\DAS
2.0\project\Karousel\ERROR\
04 08 2017; 10:29:14AM     Opened Project C:\Program Files (x86)\NASA\DAS
2.0\project\Karousel\ERROR\
04 08 2017; 10:29:20AM     Processing Requirement 4.3-1:     Return Status :  Not Run

====================
No Project Data Available
====================

=============== End of Requirement 4.3-1 ===============
04 08 2017; 10:29:24AM     Processing Requirement 4.3-2: Return Status : Passed

====================
No Project Data Available
====================

=============== End of Requirement 4.3-2 ===============
04 08 2017; 10:29:30AM     Processing Requirement 4.6 Return Status :  Passed

==============
Project Data
==============

**INPUT**

       Space Structure Name = GEO1+4000-5yr
       Space Structure Type = Payload

       Perigee Altitude = 40002.300000 (km)
       Apogee Altitude = 40002.300000 (km)
       Inclination = 63.400000 (deg)
       RAAN = 39.894000 (deg)
       Argument of Perigee = 180.000000 (deg)
       Mean Anomaly = 180.000000 (deg)
       Area-To-Mass Ratio = 0.090000 (m^2/kg)
       Start Year = 2010.000000 (yr)
       Initial Mass = 6000.000000 (kg)
       Final Mass = 4200.000000 (kg)
       Duration = 5.000000 (yr)
       Station Kept = True
       Abandoned = False
       PMD Perigee Altitude = 40302.300000 (km)
       PMD Apogee Altitude = 40302.300000 (km)
       PMD Inclination = 63.400000 (deg)
       PMD RAAN = 39.984000 (deg)
       PMD Argument of Perigee = 180.000000 (deg)
       PMD Mean Anomaly = 0.000000 (deg)

**OUTPUT**

       Suggested Perigee Altitude = 40302.300000 (km)
       Suggested Apogee Altitude = 40302.300000 (km)
       Returned Error Message = Passes super-GEO storage orbit criteria.

       Released Year = -1 (yr)
       Requirement = 63
       Compliance Status = Pass

==============
```

```
**INPUT**

       Space Structure Name = GEO2+4000-5yr
       Space Structure Type = Payload

       Perigee Altitude = 40002.300000 (km)
       Apogee Altitude = 40002.300000 (km)
       Inclination = 63.400000 (deg)
       RAAN = 309.894000 (deg)
       Argument of Perigee = 180.000000 (deg)
       Mean Anomaly = 180.000000 (deg)
       Area-To-Mass Ratio = 0.090000 (m^2/kg)
       Start Year = 2010.000000 (yr)
       Initial Mass = 6000.000000 (kg)
       Final Mass = 4200.000000 (kg)
       Duration = 5.000000 (yr)
       Station Kept = True
       Abandoned = False
       PMD Perigee Altitude = 40302.300000 (km)
       PMD Apogee Altitude = 40302.300000 (km)
       PMD Inclination = 63.400000 (deg)
       PMD RAAN = 309.894000 (deg)
       PMD Argument of Perigee = 180.000000 (deg)
       PMD Mean Anomaly = 90.000000 (deg)

**OUTPUT**

       Suggested Perigee Altitude = 40302.300000 (km)
       Suggested Apogee Altitude = 40302.300000 (km)
       Returned Error Message = Passes super-GEO storage orbit criteria.

       Released Year = -1 (yr)
       Requirement = 63
       Compliance Status = Pass

==============

**INPUT**

       Space Structure Name = GEO1-4000-5yr
       Space Structure Type = Payload

       Perigee Altitude = 31569.500000 (km)
       Apogee Altitude = 31569.500000 (km)
       Inclination = 63.400000 (deg)
       RAAN = 39.894000 (deg)
       Argument of Perigee = 180.000000 (deg)
       Mean Anomaly = 180.000000 (deg)
       Area-To-Mass Ratio = 0.090000 (m^2/kg)
       Start Year = 2010.000000 (yr)
       Initial Mass = 6000.000000 (kg)
       Final Mass = 4200.000000 (kg)
       Duration = 5.000000 (yr)
       Station Kept = True
       Abandoned = False
       PMD Perigee Altitude = 40302.300000 (km)
       PMD Apogee Altitude = 40302.300000 (km)
       PMD Inclination = 63.400000 (deg)
       PMD RAAN = 219.894000 (deg)
       PMD Argument of Perigee = 180.000000 (deg)
       PMD Mean Anomaly = 180.000000 (deg)
```

```
**OUTPUT**

       Suggested Perigee Altitude = 40302.300000 (km)
       Suggested Apogee Altitude = 40302.300000 (km)
       Returned Error Message = Passes super-GEO storage orbit criteria.

       Released Year = -1 (yr)
       Requirement = 63
       Compliance Status = Pass

==============

**INPUT**

       Space Structure Name = GEO2-4000-5yr
       Space Structure Type = Payload

       Perigee Altitude = 31569.500000 (km)
       Apogee Altitude = 31569.500000 (km)
       Inclination = 63.400000 (deg)
       RAAN = 309.894000 (deg)
       Argument of Perigee = 180.000000 (deg)
       Mean Anomaly = 180.000000 (deg)
       Area-To-Mass Ratio = 0.090000 (m^2/kg)
       Start Year = 2010.000000 (yr)
       Initial Mass = 6000.000000 (kg)
       Final Mass = 4200.000000 (kg)
       Duration = 5.000000 (yr)
       Station Kept = True
       Abandoned = False
       PMD Perigee Altitude = 40302.300000 (km)
       PMD Apogee Altitude = 40302.300000 (km)
       PMD Inclination = 63.400000 (deg)
       PMD RAAN = 259.894000 (deg)
       PMD Argument of Perigee = 180.000000 (deg)
       PMD Mean Anomaly = 0.000000 (deg)

**OUTPUT**

       Suggested Perigee Altitude = 40302.300000 (km)
       Suggested Apogee Altitude = 40302.300000 (km)
       Returned Error Message = Passes super-GEO storage orbit criteria.

       Released Year = -1 (yr)
       Requirement = 63
       Compliance Status = Pass

==============

**INPUT**

       Space Structure Name = GEO1-5yr
       Space Structure Type = Payload

       Perigee Altitude = 35786.000000 (km)
       Apogee Altitude = 35786.000000 (km)
       Inclination = 0.000000 (deg)
       RAAN = 39.894000 (deg)
       Argument of Perigee = 180.000000 (deg)
       Mean Anomaly = 180.000000 (deg)
       Area-To-Mass Ratio = 0.090000 (m^2/kg)
       Start Year = 2010.000000 (yr)
       Initial Mass = 6000.000000 (kg)
```

```
       Final Mass = 4200.000000 (kg)
       Duration = 5.000000 (yr)
       Station Kept = True
       Abandoned = False
       PMD Perigee Altitude = 40302.300000 (km)
       PMD Apogee Altitude = 40302.300000 (km)
       PMD Inclination = 63.400000 (deg)
       PMD RAAN = 169.894000 (deg)
       PMD Argument of Perigee = 180.000000 (deg)
       PMD Mean Anomaly = 90.000000 (deg)

**OUTPUT**

       Suggested Perigee Altitude = 40302.300000 (km)
       Suggested Apogee Altitude = 40302.300000 (km)
       Returned Error Message = Passes GEO storage orbit criteria.

       Released Year = -1 (yr)
       Requirement = 62
       Compliance Status = Pass

==============

**INPUT**

       Space Structure Name = GEO2-5yr
       Space Structure Type = Payload

       Perigee Altitude = 35786.000000 (km)
       Apogee Altitude = 35786.000000 (km)
       Inclination = 0.000000 (deg)
       RAAN = 309.894000 (deg)
       Argument of Perigee = 180.000000 (deg)
       Mean Anomaly = 180.000000 (deg)
       Area-To-Mass Ratio = 0.090000 (m^2/kg)
       Start Year = 2010.000000 (yr)
       Initial Mass = 6000.000000 (kg)
       Final Mass = 4200.000000 (kg)
       Duration = 5.000000 (yr)
       Station Kept = True
       Abandoned = False
       PMD Perigee Altitude = 40302.300000 (km)
       PMD Apogee Altitude = 40302.300000 (km)
       PMD Inclination = 63.400000 (deg)
       PMD RAAN = 79.894000 (deg)
       PMD Argument of Perigee = 180.000000 (deg)
       PMD Mean Anomaly = 180.000000 (deg)

**OUTPUT**

       Suggested Perigee Altitude = 40302.300000 (km)
       Suggested Apogee Altitude = 40302.300000 (km)
       Returned Error Message = Passes GEO storage orbit criteria.

       Released Year = -1 (yr)
       Requirement = 62
       Compliance Status = Pass

==============

**INPUT**

       Space Structure Name = GEO1+4000-15yr
```

```
       Space Structure Type = Payload

       Perigee Altitude = 40002.300000 (km)
       Apogee Altitude = 40002.300000 (km)
       Inclination = 63.400000 (deg)
       RAAN = 39.894000 (deg)
       Argument of Perigee = 180.000000 (deg)
       Mean Anomaly = 180.000000 (deg)
       Area-To-Mass Ratio = 0.090000 (m^2/kg)
       Start Year = 2010.000000 (yr)
       Initial Mass = 6000.000000 (kg)
       Final Mass = 4200.000000 (kg)
       Duration = 15.000000 (yr)
       Station Kept = True
       Abandoned = False
       PMD Perigee Altitude = 40302.300000 (km)
       PMD Apogee Altitude = 40302.300000 (km)
       PMD Inclination = 63.400000 (deg)
       PMD RAAN = 149.894000 (deg)
       PMD Argument of Perigee = 180.000000 (deg)
       PMD Mean Anomaly = 0.000000 (deg)

**OUTPUT**

       Suggested Perigee Altitude = 40302.300000 (km)
       Suggested Apogee Altitude = 40302.300000 (km)
       Returned Error Message = Passes super-GEO storage orbit criteria.

       Released Year = -1 (yr)
       Requirement = 63
       Compliance Status = Pass

==============

**INPUT**

       Space Structure Name = GEO2+4000-15yr
       Space Structure Type = Payload

       Perigee Altitude = 40002.300000 (km)
       Apogee Altitude = 40002.300000 (km)
       Inclination = 63.400000 (deg)
       RAAN = 309.894000 (deg)
       Argument of Perigee = 180.000000 (deg)
       Mean Anomaly = 180.000000 (deg)
       Area-To-Mass Ratio = 0.090000 (m^2/kg)
       Start Year = 2010.000000 (yr)
       Initial Mass = 6000.000000 (kg)
       Final Mass = 4200.000000 (kg)
       Duration = 15.000000 (yr)
       Station Kept = True
       Abandoned = False
       PMD Perigee Altitude = 40302.300000 (km)
       PMD Apogee Altitude = 40302.300000 (km)
       PMD Inclination = 63.400000 (deg)
       PMD RAAN = 59.894000 (deg)
       PMD Argument of Perigee = 180.000000 (deg)
       PMD Mean Anomaly = 90.000000 (deg)

**OUTPUT**

       Suggested Perigee Altitude = 40302.300000 (km)
       Suggested Apogee Altitude = 40302.300000 (km)
```

Returned Error Message = Passes super-GEO storage orbit criteria.

Released Year = -1 (yr)
Requirement = 63
Compliance Status = Pass

==========

INPUT

Space Structure Name = GEO1-4000-15yr
Space Structure Type = Payload

Perigee Altitude = 31569.500000 (km)
Apogee Altitude = 31569.500000 (km)
Inclination = 63.400000 (deg)
RAAN = 39.894000 (deg)
Argument of Perigee = 180.000000 (deg)
Mean Anomaly = 180.000000 (deg)
Area-To-Mass Ratio = 0.090000 (m^2/kg)
Start Year = 2010.000000 (yr)
Initial Mass = 6000.000000 (kg)
Final Mass = 4200.000000 (kg)
Duration = 15.000000 (yr)
Station Kept = True
Abandoned = False
PMD Perigee Altitude = 40302.300000 (km)
PMD Apogee Altitude = 40302.300000 (km)
PMD Inclination = 63.400000 (deg)
PMD RAAN = 329.894000 (deg)
PMD Argument of Perigee = 180.000000 (deg)
PMD Mean Anomaly = 180.000000 (deg)

OUTPUT

Suggested Perigee Altitude = 40302.300000 (km)
Suggested Apogee Altitude = 40302.300000 (km)
Returned Error Message = Passes super-GEO storage orbit criteria.

Released Year = -1 (yr)
Requirement = 63
Compliance Status = Pass

==========

INPUT

Space Structure Name = GEO2-4000-15yr
Space Structure Type = Payload

Perigee Altitude = 31569.500000 (km)
Apogee Altitude = 31569.500000 (km)
Inclination = 63.400000 (deg)
RAAN = 309.894000 (deg)
Argument of Perigee = 180.000000 (deg)
Mean Anomaly = 180.000000 (deg)
Area-To-Mass Ratio = 0.090000 (m^2/kg)
Start Year = 2010.000000 (yr)
Initial Mass = 6000.000000 (kg)
Final Mass = 4200.000000 (kg)
Duration = 15.000000 (yr)
Station Kept = True
Abandoned = False

```
       PMD Perigee Altitude = 40302.300000 (km)
       PMD Apogee Altitude = 40302.300000 (km)
       PMD Inclination = 63.400000 (deg)
       PMD RAAN = 129.894000 (deg)
       PMD Argument of Perigee = 180.000000 (deg)
       PMD Mean Anomaly = 270.000000 (deg)

**OUTPUT**

       Suggested Perigee Altitude = 40302.300000 (km)
       Suggested Apogee Altitude = 40302.300000 (km)
       Returned Error Message = Passes super-GEO storage orbit criteria.

       Released Year = -1 (yr)
       Requirement = 63
       Compliance Status = Pass

==============

**INPUT**

       Space Structure Name = GEO1-15yr
       Space Structure Type = Payload

       Perigee Altitude = 35786.000000 (km)
       Apogee Altitude = 35786.000000 (km)
       Inclination = 0.000000 (deg)
       RAAN = 39.894000 (deg)
       Argument of Perigee = 180.000000 (deg)
       Mean Anomaly = 180.000000 (deg)
       Area-To-Mass Ratio = 0.090000 (m^2/kg)
       Start Year = 2010.000000 (yr)
       Initial Mass = 6000.000000 (kg)
       Final Mass = 4200.000000 (kg)
       Duration = 15.000000 (yr)
       Station Kept = True
       Abandoned = False
       PMD Perigee Altitude = 40302.300000 (km)
       PMD Apogee Altitude = 40302.300000 (km)
       PMD Inclination = 63.400000 (deg)
       PMD RAAN = 349.894000 (deg)
       PMD Argument of Perigee = 180.000000 (deg)
       PMD Mean Anomaly = 270.000000 (deg)

**OUTPUT**

       Suggested Perigee Altitude = 40302.300000 (km)
       Suggested Apogee Altitude = 40302.300000 (km)
       Returned Error Message = Passes GEO storage orbit criteria.

       Released Year = -1 (yr)
       Requirement = 62
       Compliance Status = Pass

==============

**INPUT**

       Space Structure Name = GEO2-15yr
       Space Structure Type = Payload

       Perigee Altitude = 35786.000000 (km)
       Apogee Altitude = 35786.000000 (km)
```

```
       Inclination = 0.000000 (deg)
       RAAN = 309.894000 (deg)
       Argument of Perigee = 180.000000 (deg)
       Mean Anomaly = 180.000000 (deg)
       Area-To-Mass Ratio = 0.090000 (m^2/kg)
       Start Year = 2010.000000 (yr)
       Initial Mass = 6000.000000 (kg)
       Final Mass = 4200.000000 (kg)
       Duration = 15.000000 (yr)
       Station Kept = True
       Abandoned = False
       PMD Perigee Altitude = 40302.300000 (km)
       PMD Apogee Altitude = 40302.300000 (km)
       PMD Inclination = 63.400000 (deg)
       PMD RAAN = 239.894000 (deg)
       PMD Argument of Perigee = 180.000000 (deg)
       PMD Mean Anomaly = 270.000000 (deg)

**OUTPUT**

       Suggested Perigee Altitude = 40302.300000 (km)
       Suggested Apogee Altitude = 40302.300000 (km)
       Returned Error Message = Passes GEO storage orbit criteria.

       Released Year = -1 (yr)
       Requirement = 62
       Compliance Status = Pass

==============

=============== End of Requirement 4.6 ===============
04 08 2017; 10:29:37AM     Requirement 4.5-2:  Compliant
04 08 2017; 10:29:42AM     Requirement 4.4-3:  Compliant

=============== End of Requirement 4.4-3 ===============
04 08 2017; 10:32:50AM     Processing Requirement 4.5-1:    Return Status :  Failed

==============
Run Data
==============

**INPUT**

       Space Structure Name = GEO1+4000-5yr
       Space Structure Type = Payload
       Perigee Altitude = 40002.300000 (km)
       Apogee Altitude = 40002.300000 (km)
       Inclination = 63.400000 (deg)
       RAAN = 39.894000 (deg)
       Argument of Perigee = 180.000000 (deg)
       Mean Anomaly = 180.000000 (deg)
       Final Area-To-Mass Ratio = 0.090000 (m^2/kg)
       Start Year = 2010.000000 (yr)
       Initial Mass = 6000.000000 (kg)
       Final Mass = 4200.000000 (kg)
       Duration = 5.000000 (yr)
       Station-Kept = True
       Abandoned = False
       PMD Perigee Altitude = 40302.300000 (km)
       PMD Apogee Altitude = 40302.300000 (km)
       PMD Inclination = 63.400000 (deg)
       PMD RAAN = 39.984000 (deg)
       PMD Argument of Perigee = 180.000000 (deg)
```

```
       PMD Mean Anomaly = 0.000000 (deg)

**OUTPUT**

       Collision Probability = 0.011676
       Returned Error Message: Failed Assessment.  Probability of Collision too great
       Date Range Error Message: Normal Date Range
       Status = Fail

==============

**INPUT**

       Space Structure Name = GEO2+4000-5yr
       Space Structure Type = Payload
       Perigee Altitude = 40002.300000 (km)
       Apogee Altitude = 40002.300000 (km)
       Inclination = 63.400000 (deg)
       RAAN = 309.894000 (deg)
       Argument of Perigee = 180.000000 (deg)
       Mean Anomaly = 180.000000 (deg)
       Final Area-To-Mass Ratio = 0.090000 (m^2/kg)
       Start Year = 2010.000000 (yr)
       Initial Mass = 6000.000000 (kg)
       Final Mass = 4200.000000 (kg)
       Duration = 5.000000 (yr)
       Station-Kept = True
       Abandoned = False
       PMD Perigee Altitude = 40302.300000 (km)
       PMD Apogee Altitude = 40302.300000 (km)
       PMD Inclination = 63.400000 (deg)
       PMD RAAN = 309.894000 (deg)
       PMD Argument of Perigee = 180.000000 (deg)
       PMD Mean Anomaly = 90.000000 (deg)

**OUTPUT**

       Collision Probability = 0.011959
       Returned Error Message: Failed Assessment.  Probability of Collision too great
       Date Range Error Message: Normal Date Range
       Status = Fail

==============

**INPUT**

       Space Structure Name = GEO1-4000-5yr
       Space Structure Type = Payload
       Perigee Altitude = 31569.500000 (km)
       Apogee Altitude = 31569.500000 (km)
       Inclination = 63.400000 (deg)
       RAAN = 39.894000 (deg)
       Argument of Perigee = 180.000000 (deg)
       Mean Anomaly = 180.000000 (deg)
       Final Area-To-Mass Ratio = 0.090000 (m^2/kg)
       Start Year = 2010.000000 (yr)
       Initial Mass = 6000.000000 (kg)
       Final Mass = 4200.000000 (kg)
       Duration = 5.000000 (yr)
       Station-Kept = True
       Abandoned = False
       PMD Perigee Altitude = 40302.300000 (km)
       PMD Apogee Altitude = 40302.300000 (km)
```

```
       PMD Inclination = 63.400000 (deg)
       PMD RAAN = 219.894000 (deg)
       PMD Argument of Perigee = 180.000000 (deg)
       PMD Mean Anomaly = 180.000000 (deg)

**OUTPUT**

       Collision Probability = 0.013525
       Returned Error Message: Failed Assessment.  Probability of Collision too great
       Date Range Error Message: Normal Date Range
       Status = Fail

==============

**INPUT**

       Space Structure Name = GEO2-4000-5yr
       Space Structure Type = Payload
       Perigee Altitude = 31569.500000 (km)
       Apogee Altitude = 31569.500000 (km)
       Inclination = 63.400000 (deg)
       RAAN = 309.894000 (deg)
       Argument of Perigee = 180.000000 (deg)
       Mean Anomaly = 180.000000 (deg)
       Final Area-To-Mass Ratio = 0.090000 (m^2/kg)
       Start Year = 2010.000000 (yr)
       Initial Mass = 6000.000000 (kg)
       Final Mass = 4200.000000 (kg)
       Duration = 5.000000 (yr)
       Station-Kept = True
       Abandoned = False
       PMD Perigee Altitude = 40302.300000 (km)
       PMD Apogee Altitude = 40302.300000 (km)
       PMD Inclination = 63.400000 (deg)
       PMD RAAN = 259.894000 (deg)
       PMD Argument of Perigee = 180.000000 (deg)
       PMD Mean Anomaly = 0.000000 (deg)

**OUTPUT**

       Collision Probability = 0.012705
       Returned Error Message: Failed Assessment.  Probability of Collision too great
       Date Range Error Message: Normal Date Range
       Status = Fail

==============

**INPUT**

       Space Structure Name = GEO1-5yr
       Space Structure Type = Payload
       Perigee Altitude = 35786.000000 (km)
       Apogee Altitude = 35786.000000 (km)
       Inclination = 0.000000 (deg)
       RAAN = 39.894000 (deg)
       Argument of Perigee = 180.000000 (deg)
       Mean Anomaly = 180.000000 (deg)
       Final Area-To-Mass Ratio = 0.090000 (m^2/kg)
       Start Year = 2010.000000 (yr)
       Initial Mass = 6000.000000 (kg)
       Final Mass = 4200.000000 (kg)
       Duration = 5.000000 (yr)
       Station-Kept = True
```

```
       Abandoned = False
       PMD Perigee Altitude = 40302.300000 (km)
       PMD Apogee Altitude = 40302.300000 (km)
       PMD Inclination = 63.400000 (deg)
       PMD RAAN = 169.894000 (deg)
       PMD Argument of Perigee = 180.000000 (deg)
       PMD Mean Anomaly = 90.000000 (deg)

**OUTPUT**

       Collision Probability = 0.014417
       Returned Error Message: Failed Assessment.  Probability of Collision too great
       Date Range Error Message: Normal Date Range
       Status = Fail

==============

**INPUT**

       Space Structure Name = GEO2-5yr
       Space Structure Type = Payload
       Perigee Altitude = 35786.000000 (km)
       Apogee Altitude = 35786.000000 (km)
       Inclination = 0.000000 (deg)
       RAAN = 309.894000 (deg)
       Argument of Perigee = 180.000000 (deg)
       Mean Anomaly = 180.000000 (deg)
       Final Area-To-Mass Ratio = 0.090000 (m^2/kg)
       Start Year = 2010.000000 (yr)
       Initial Mass = 6000.000000 (kg)
       Final Mass = 4200.000000 (kg)
       Duration = 5.000000 (yr)
       Station-Kept = True
       Abandoned = False
       PMD Perigee Altitude = 40302.300000 (km)
       PMD Apogee Altitude = 40302.300000 (km)
       PMD Inclination = 63.400000 (deg)
       PMD RAAN = 79.894000 (deg)
       PMD Argument of Perigee = 180.000000 (deg)
       PMD Mean Anomaly = 180.000000 (deg)

**OUTPUT**

       Collision Probability = 0.012849
       Returned Error Message: Failed Assessment.  Probability of Collision too great
       Date Range Error Message: Normal Date Range
       Status = Fail

==============

**INPUT**

       Space Structure Name = GEO1+4000-15yr
       Space Structure Type = Payload
       Perigee Altitude = 40002.300000 (km)
       Apogee Altitude = 40002.300000 (km)
       Inclination = 63.400000 (deg)
       RAAN = 39.894000 (deg)
       Argument of Perigee = 180.000000 (deg)
       Mean Anomaly = 180.000000 (deg)
       Final Area-To-Mass Ratio = 0.090000 (m^2/kg)
       Start Year = 2010.000000 (yr)
       Initial Mass = 6000.000000 (kg)
```

```
       Final Mass = 4200.000000 (kg)
       Duration = 15.000000 (yr)
       Station-Kept = True
       Abandoned = False
       PMD Perigee Altitude = 40302.300000 (km)
       PMD Apogee Altitude = 40302.300000 (km)
       PMD Inclination = 63.400000 (deg)
       PMD RAAN = 149.894000 (deg)
       PMD Argument of Perigee = 180.000000 (deg)
       PMD Mean Anomaly = 0.000000 (deg)

**OUTPUT**

       Collision Probability = 0.014512
       Returned Error Message: Failed Assessment.  Probability of Collision too great
       Date Range Error Message: Normal Date Range
       Status = Fail

==============

**INPUT**

       Space Structure Name = GEO2+4000-15yr
       Space Structure Type = Payload
       Perigee Altitude = 40002.300000 (km)
       Apogee Altitude = 40002.300000 (km)
       Inclination = 63.400000 (deg)
       RAAN = 309.894000 (deg)
       Argument of Perigee = 180.000000 (deg)
       Mean Anomaly = 180.000000 (deg)
       Final Area-To-Mass Ratio = 0.090000 (m^2/kg)
       Start Year = 2010.000000 (yr)
       Initial Mass = 6000.000000 (kg)
       Final Mass = 4200.000000 (kg)
       Duration = 15.000000 (yr)
       Station-Kept = True
       Abandoned = False
       PMD Perigee Altitude = 40302.300000 (km)
       PMD Apogee Altitude = 40302.300000 (km)
       PMD Inclination = 63.400000 (deg)
       PMD RAAN = 59.894000 (deg)
       PMD Argument of Perigee = 180.000000 (deg)
       PMD Mean Anomaly = 90.000000 (deg)

**OUTPUT**

       Collision Probability = 0.012291
       Returned Error Message: Failed Assessment.  Probability of Collision too great
       Date Range Error Message: Normal Date Range
       Status = Fail

==============

**INPUT**

       Space Structure Name = GEO1-4000-15yr
       Space Structure Type = Payload
       Perigee Altitude = 31569.500000 (km)
       Apogee Altitude = 31569.500000 (km)
       Inclination = 63.400000 (deg)
       RAAN = 39.894000 (deg)
       Argument of Perigee = 180.000000 (deg)
       Mean Anomaly = 180.000000 (deg)
```

```
       Final Area-To-Mass Ratio = 0.090000 (m^2/kg)
       Start Year = 2010.000000 (yr)
       Initial Mass = 6000.000000 (kg)
       Final Mass = 4200.000000 (kg)
       Duration = 15.000000 (yr)
       Station-Kept = True
       Abandoned = False
       PMD Perigee Altitude = 40302.300000 (km)
       PMD Apogee Altitude = 40302.300000 (km)
       PMD Inclination = 63.400000 (deg)
       PMD RAAN = 329.894000 (deg)
       PMD Argument of Perigee = 180.000000 (deg)
       PMD Mean Anomaly = 180.000000 (deg)

**OUTPUT**

       Collision Probability = 0.011640
       Returned Error Message: Failed Assessment.  Probability of Collision too great
       Date Range Error Message: Normal Date Range
       Status = Fail

==============

**INPUT**

       Space Structure Name = GEO2-4000-15yr
       Space Structure Type = Payload
       Perigee Altitude = 31569.500000 (km)
       Apogee Altitude = 31569.500000 (km)
       Inclination = 63.400000 (deg)
       RAAN = 309.894000 (deg)
       Argument of Perigee = 180.000000 (deg)
       Mean Anomaly = 180.000000 (deg)
       Final Area-To-Mass Ratio = 0.090000 (m^2/kg)
       Start Year = 2010.000000 (yr)
       Initial Mass = 6000.000000 (kg)
       Final Mass = 4200.000000 (kg)
       Duration = 15.000000 (yr)
       Station-Kept = True
       Abandoned = False
       PMD Perigee Altitude = 40302.300000 (km)
       PMD Apogee Altitude = 40302.300000 (km)
       PMD Inclination = 63.400000 (deg)
       PMD RAAN = 129.894000 (deg)
       PMD Argument of Perigee = 180.000000 (deg)
       PMD Mean Anomaly = 270.000000 (deg)

**OUTPUT**

       Collision Probability = 0.014860
       Returned Error Message: Failed Assessment.  Probability of Collision too great
       Date Range Error Message: Normal Date Range
       Status = Fail

==============

**INPUT**

       Space Structure Name = GEO1-15yr
       Space Structure Type = Payload
       Perigee Altitude = 35786.000000 (km)
       Apogee Altitude = 35786.000000 (km)
       Inclination = 0.000000 (deg)
```

```
       RAAN = 39.894000 (deg)
       Argument of Perigee = 180.000000 (deg)
       Mean Anomaly = 180.000000 (deg)
       Final Area-To-Mass Ratio = 0.090000 (m^2/kg)
       Start Year = 2010.000000 (yr)
       Initial Mass = 6000.000000 (kg)
       Final Mass = 4200.000000 (kg)
       Duration = 15.000000 (yr)
       Station-Kept = True
       Abandoned = False
       PMD Perigee Altitude = 40302.300000 (km)
       PMD Apogee Altitude = 40302.300000 (km)
       PMD Inclination = 63.400000 (deg)
       PMD RAAN = 349.894000 (deg)
       PMD Argument of Perigee = 180.000000 (deg)
       PMD Mean Anomaly = 270.000000 (deg)

**OUTPUT**

       Collision Probability = 0.011301
       Returned Error Message: Failed Assessment.  Probability of Collision too great
       Date Range Error Message: Normal Date Range
       Status = Fail

==============

**INPUT**

       Space Structure Name = GEO2-15yr
       Space Structure Type = Payload
       Perigee Altitude = 35786.000000 (km)
       Apogee Altitude = 35786.000000 (km)
       Inclination = 0.000000 (deg)
       RAAN = 309.894000 (deg)
       Argument of Perigee = 180.000000 (deg)
       Mean Anomaly = 180.000000 (deg)
       Final Area-To-Mass Ratio = 0.090000 (m^2/kg)
       Start Year = 2010.000000 (yr)
       Initial Mass = 6000.000000 (kg)
       Final Mass = 4200.000000 (kg)
       Duration = 15.000000 (yr)
       Station-Kept = True
       Abandoned = False
       PMD Perigee Altitude = 40302.300000 (km)
       PMD Apogee Altitude = 40302.300000 (km)
       PMD Inclination = 63.400000 (deg)
       PMD RAAN = 239.894000 (deg)
       PMD Argument of Perigee = 180.000000 (deg)
       PMD Mean Anomaly = 270.000000 (deg)

**OUTPUT**

       Collision Probability = 0.012502
       Returned Error Message: Failed Assessment.  Probability of Collision too great
       Date Range Error Message: Normal Date Range
       Status = Fail

==============

=============== End of Requirement 4.5-1 ===============
```