



ALL FEDERAL, STATE, LOCAL AND MUNICIPAL LAWS AND REGULATIONS APPLY. VOID WHERE PROHIBITED. PLEASE NOTE THAT THIS IS NOT A PRIZE DRAW BUT A SKILL---BASED COMPETITION.

**THE NATIONAL SPACE SOCIETY'S SPACE ORBITAL DEBRIS MITIGATION COMPETITION INVITES ELIGIBLE PERSONS TO SUBMIT A PROJECT/EXPERIMENT THAT ADVANCES THE STATE OF THE ART IN ONE OR BOTH OF THESE AREAS:**

- Orbital debris mitigation and detection
- Space structures for future space development and settlement

**THE PROJECT/EXPERIMENT MAY BE BROUGHT BACK TO EARTH AND ITS STRUCTURAL AND/OR NANO- PROPERTIES MAY BE ANALYSED AT THE FACILITIES OF GLOBAL AEROSPACE CORPORATION ("GAC") LOCATED IN CALIFORNIA, USA. THE EIS ORBITAL DEBRIS MITIGATION COMPETITION IS EXPECTED TO LAUNCH INTO SPACE STUDENT EXPERIMENTS THAT WILL SUPPORT A NEW TECHNOLOGY FOR ORBITAL DEBRIS MITIGATION OR DEVELOP NEW EXPERIMENTS FOR ORBITAL DEBRIS DETECTION, TRACKING, OR COLLECTION. THE COMPETITION IS BEING ORGANIZED IN SEVERAL PHASES, AT THE END OF WHICH THE BEST EXPERIMENTS WILL FLY TO SPACE. GAC WILL MANAGE THE COMPETITION, SUPERVISE THE STUDENTS, AND SELECT THE BEST EXPERIMENTS. THE EXPERIMENTS WILL EITHER 1) SUPPORT THE GOSSAMER ORBIT LOWERING DEVICE (GOLD) INFLATABLE DEORBIT SYSTEM OR 2) WILL PERFORM ORBITAL DEBRIS DETECTION, TRACKING, OR COLLECTION.**

### **Eligibility**

Competition is open to:

1. All students across the globe.
2. who are 18 years of age or older at the time of entry.
3. Who are Virtual Crew Members of Enterprise In Space.
4. Due to United States export control regulations, international submitters (i.e., from outside the United States) are not allowed to submit white papers related to GOLD's performance assessment, but only white papers related to orbital debris detection tracking, and/or collection.

### **How to Enter**

**Step 1:** Sign up each member of your team (up to five persons) as a Crewmember on the [Orbital Debris Mitigation Competition Registration page](#). Beam your team up aboard the NSS Enterprise spacecraft by signing up each team member as a virtual Crewmember on the EIS page by March 15, 2017. (If you cannot afford the \$20 Donation to EIS, please contact us here: [spacedebris@enterpriseinspace.org](mailto:spacedebris@enterpriseinspace.org))

**Step 2:** Complete your application\* by [registering your team](#) to the Space Debris Mitigation Competition

**Step 3:** Upload your design submission package to the EIS Academy

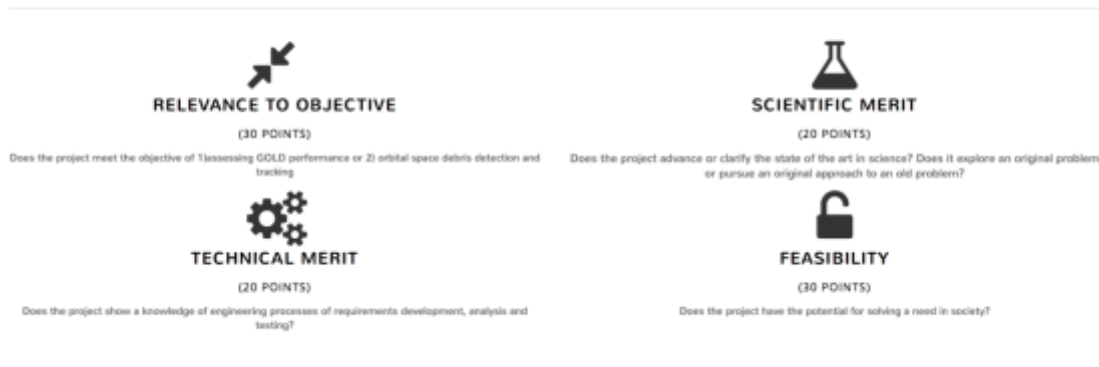


### White Paper Instructions

The White Paper is limited to 6 pages, written in 12 pt font size. All pages should have 1 inch margins all around – top, bottom, left, and right. White Papers must describe a preliminary concept for an experiment, according to the technical requirements in Section 6, and must also include a preliminary Statement of Work (i.e., a series of objectives and a list and description of tasks) and a preliminary project schedule. Submitters should also include in the White Paper a schematic or sketch of the proposed experiment.

White Papers must be submitted in pdf format, by email, to GAC at this email address: [ECE@gaerospace.com](mailto:ECE@gaerospace.com). The White Papers must indicate all the names and contact information of each author, and the university/college and year level (undergraduate, graduate, or post-doc) for each author. The White Paper submission deadline is March 20, 2017. Submission of a White Paper is not a requirement to participate in the initial stage, but it can provide a head start to future proposing teams by encouraging them to develop a conceptual experiment design ahead of time. For questions about the white paper submission, please contact GAC at [ECE@gaerospace.com](mailto:ECE@gaerospace.com).

### WHITE PAPER EVALUATION CRITERIA



\*Limit One (1) entry per person, per email address, per team, and per institution, for the duration of the Contest Period, regardless of number of entry. Entries may be made by a team of up to five persons, but only one (1) person from that team may submit the entry, adhering to the same rules as single person entrants. No person from a team entry may submit individually or as part of a second team. Entries made by teams should list all of the persons who are part of the team, and include their contact information. Entries received from any person, email address, or household in excess of the stated limitations will be void. All entries become the property of the Sponsors and will not be returned. Entries will be acknowledged at Sponsors discretion.

### Official Rules Space Debris Orbital Mitigation Competition

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**USA. THE EIS SPACE ORBITAL DEBRIS MITIGATION COMPETITION IS EXPECTED TO LAUNCH TO SPACE STUDENT EXPERIMENTS THAT WILL SUPPORT A NEW TECHNOLOGY FOR ORBITAL DEBRIS MITIGATION OR DEVELOP NEW EXPERIMENTS FOR ORBITAL DEBRIS DETECTION. WHEN THIS COMPETITION STARTS (DATE DECEMBER 5, 2016). THE COMPETITION WILL BE ORGANIZED IN DIFFERENT PHASES, AT THE END OF WHICH THE BEST EXPERIMENTS WILL FLY TO SPACE. GAC WILL MANAGE THE COMPETITION, SUPERVISE THE STUDENTS, AND SELECT THE BEST EXPERIMENTS. THE EXPERIMENTS WILL SUPPORT THE GOSSAMER ORBIT LOWERING DEVICE (GOLD) INFLATABLE DEORBIT SYSTEM OR WILL PERFORM ORBITAL DEBRIS DETECTION AND TRACKING.**

## **1. Eligibility**

The Space Debris Orbital Mitigation Competition is open to legal residents of the fifty (50) United States, the District of Columbia, all United States of America properties and territories, and, all 204 nations of the world, who are 18 years of age or older at the time of entry, and who are crewmembers of Enterprise In Space. Employees of the National Space Society, Enterprise In Space and other companies associated with the promotion of the Contest, and their respective parents, subsidiaries, affiliates and advertising and promotion agencies as well as the immediate family (spouses, parents, siblings and children) and household members of each such employee are not eligible. The Contest is subject to federal, state, and local laws and regulations.

Submitters can be individuals or teams, and can be comprised of both undergraduate students and graduate students. Submitters must choose a name for their experiment and indicate it in their White Paper response. Due to United States export control regulations, international submitters (i.e., from outside the United States) will be limited to White Papers related to orbital debris detection and tracking.

## **2. Sponsor**

The Contest is sponsored by the National Space Society (NSS), located at 1155 15th Street NW, Suite 500, Washington, DC 20005.

## **3. Agreement to Official Rules**

Participation in the Competition constitutes entrants full and unconditional agreement to and acceptance of the Official Rules and the decisions of the Sponsor and judges, which are final and binding. Winning a prize is contingent upon being compliant with these Official Rules and fulfilling all other requirements set forth herein.

## **4. Contest Periods**

Entries may be submitted during the Contest Period from January 1, 2017 until February 15, 2017. Entries submitted before or after the Contest Period will be disqualified. Submissions will be accepted using the following methods: electronic through Sketchfab as per the detailed instructions under How To Enter below. The Contest judging rounds begin on February 15 at midnight UTC and ends on May 28, 2017 at midnight UTC.

## **5. How to Enter**

### **How to Enter**

**Step 1:** Sign up each member of your team (up to five persons) as a Crewmember on the [Orbital Debris Mitigation Competition Registration page](#). Beam your team up aboard the NSS Enterprise spacecraft by signing up each team member as a virtual Crewmember on the EIS page by March 15, 2017. (If you cannot afford the \$20 Donation to EIS, please contact us here: [spacedebris@enterpriseinspace.org](mailto:spacedebris@enterpriseinspace.org))

**Step 2:** Complete your application\* by [registering your team](#) to the Space Debris Mitigation Competition

**Step 3:** Upload your design submission package to the EIS Academy

\*Limit one (1) entry per person, per email address, per team, and per household, for the duration of the Contest

Period, regardless of method of entry. Entries may be made by a team of up to five persons, but only one (1) person from that team may submit the entry, adhering to the same rules as single person entrants. No person from a team entry may submit individually or as part of a second team. Entries made by teams should list all of the persons who are part of the team, and include their contact information. Entries received from any person, email address, or household in excess of the stated limitations will be void. All entries become the property of the Sponsors and will not be returned. Entries will be acknowledged at Sponsors discretion.

## 6. Submission Requirements

### White Paper Instructions

- The White Paper is limited to 6 pages, written in 12 pt font size. All pages should have 1 inch margins all around – top, bottom, left, and right. White Papers must describe a preliminary concept for an experiment, according to the technical requirements in Section 6, and must also include a preliminary Statement of Work (i.e., a series of objectives and a list and description of tasks) and a preliminary project schedule. Submitters should also include in the White Paper a schematic or sketch of the proposed experiment.
- White Papers must be submitted in pdf format, by email, to GAC at this email address: [ECE@gaerospace.com](mailto:ECE@gaerospace.com). The White Papers must indicate all the names and contact information of each author, and the university/college and year level (undergraduate, graduate, or post-doc) for each author. The White Paper submission deadline is **March 20, 2017**. Submission of a White Paper is not a requirement to participate in the initial stage, but it can provide a head start to future proposing teams by encouraging them to develop a conceptual experiment design ahead of time. For questions about the white paper submission, please contact GAC at [ECE@gaerospace.com](mailto:ECE@gaerospace.com).

## 7. GOLD, Technical Requirements and Design Selection

### 7.1 Gossamer Orbit Lowering Device (GOLD)

The Gossamer Orbit Lowering Device (GOLD), is a deorbit technology developed and patented by Global Aerospace Corporation (GAC). GOLD is applicable to a wide range of spacecraft from CubeSats to large scientific platforms, and can be utilized in low Earth orbit (LEO) up to about 1,000 km of altitude. GOLD increases the cross-section area of a satellite or launch vehicle upper stage by use of an inflation-maintained ultra-thin envelope, which accelerates the natural atmospheric drag decay of the object from centuries to months or weeks, based on orbit and mission parameters. The inflated envelope is protected from ultraviolet radiation and atomic oxygen erosion. In addition, the GOLD deorbit system consists of an inflation control and pressure maintenance system, a controller, and various sensors. GOLD can be attached to satellites or upper stages before launch or delivered to derelict satellites and upper stages by orbital tenders. It can also be used to perform targeted and controlled reentry of large space platforms. The figure below shows an example 94 m diameter GOLD envelope deployed to lower the orbit of the Hubble Space Telescope from 568 km to 200 km in just 120 days. It has been estimated that this system will lower the probability of destroying operating satellites and creating new debris compared to a bare spacecraft or other deorbit methods.

GOLD helps mitigate the issue of orbital debris because it enables spacecraft or upper stages to deorbit much more quickly, thereby lowering the risk of satellite or stage collision with other objects. GOLD can operate autonomously and with very little power, or it can utilize the power system of the spacecraft to which it is attached. If it uses its own power system, it can function even after a spacecraft has failed. GOLD is made of very lightweight materials and is less massive and costly than propulsive deorbit systems. Key system elements of GOLD are its ultra-thin and lightweight inflated envelope, the envelope storage

container, and the inflation and pressure maintenance system. Optional systems, depending on the degree to which it is integrated with its host, are a gas reservoir, system operation sensors, a controller to monitor the satellite, a countdown-to-deployment system, satellite interfaces (power and heartbeat), and power for dormancy and operational phases.

GOLD offers a low-cost, mission-end option for compliance with deorbit regulations; allows satellites to use their entire propellant load to satisfy mission objectives, rather than for deorbit; reduces the probability of future debris-generating collisions; and offers lower risk to other operating satellites than competing deorbit methods. GOLD can also be used to augment a propulsion system for targeted reentry, and can provide propulsionless satellites a low-cost and mass means to change orbit to avoid predicted collisions. Finally, if used in an Active Debris Removal (ADR) program, it could further prevent future loss of satellites. More information about GOLD can be found on the [GAC website](#).

## **7.2 Technical Requirements**

The Debris Mitigation CubeSat consists of a 3U CubeSat (30 x 10 x 10 cm) that is expected to demonstrate up to 4 student experiments. There are two types of experiments that will be considered: 1) experiments that assess the performance of the GOLD system and 2) experiments that do orbital debris detection and tracking. For example, experiments could measure GOLD's performance during deployment and operation.

### **7.2.1 Assess GOLD Performance Experiments**

Experiments to assess GOLD performance could include tracking the envelope internal pressure, micrometeoroid and small debris holing detection and characterization, envelope stress measurements or assessing the envelope's physical integrity. Experiments could also include stagnation and internal gas pressure, temperature, and atomic oxygen sensors. Students could propose where to place sensors, and how to operate them. Experiments could be attached to the envelope to monitor impacts and to measure stagnation pressure indirectly. Other experiments could assess holing in the envelope generated by micrometeoroid and small debris impact. The experiments can be characterized by sensors placed either on the balloon envelope, inside the balloon, or separate from the balloon.

### **7.2.2 Orbital Debris Detection and Tracking Experiments**

Orbital debris detection and tracking experiments are expected to detect orbital debris in the vicinity of the CubeSat. The debris that is detected can be either close to the CubeSat or far from it, as long as the measurements are meaningful and have practical utility. The experiments that can be considered include sensors or debris collection and examination systems. If needed, they can be characterized by extensible components (e.g., telescopic components).

### **7.2.3 Interface Requirements**

The total volume available for all the experiments is 1U (10 x 10 x 10 cm). The volume limitation for each experiment is 1/4U (10 x 5 x 5 cm). The mass limitation is 0.5 kg.

Experiments that consist of mechanisms deployed after CubeSat deployment and out of the CubeSat bus are allowed, as long as the total extended length is less than 1 m and the experiment does not present any risk of damaging the GOLD envelope or other CubeSat systems. Additionally, any extensible experiments

must comply with the mass and volume limitations provided above when stowed. These extensible experiments might be used for example for particle detection or particle collection and examination.

Experiments can also be placed inside the envelope to conduct measurements of internal gas pressure. The volume limitation for experiments placed inside the envelope is 1/4U and such volume counts toward the total 1U available. There is room for only one experiment being placed inside the envelope. If this type of experiment is proposed, the submitters must explain how it will be integrated in the CubeSat and how it will not damage the envelope before deployment, during deployment, and during post-deployment operation.

The expected primary sources of power for the CubeSat are solar power and batteries. The CubeSat bus can supply up to 1 W (peak) power so experiments should not require more than such peak power. The daily average power consumption should not exceed 500 mW. Experiments should have a life of at least 6 weeks. The bus is expected to have a voltage of  $4.2V \pm 1V$  and supports SPI, I2C, and RS 232 interface formats. The maximum interface data rate is expected to be about 115,200 bps for RS 232. All interfaces have typically orders of magnitude higher data rates than can be downlinked from the radio. White Paper submitters do not need to propose any new data downlink capability, however they should mention how the experiment is expected to interface with the CubeSat bus. The bus is expected to use a Command and Data Handling (C&DH) subsystem for command, control and data return. The satellite's C&DH subsystem is expected to provide data to insure successful CubeSat deployment and successful operation of the experiments.

### **7.3 Design Selection**

The odds of being selected depend on the number of entries received. The contest will take the form of one preliminary round of judging to narrow the field to no more than 5 semi-finalist teams; these teams will be notified and asked to submit additional information about their experiments; judges will narrow the field to 3 finalist teams who will be invited to the National Space Society's International Space Development Conference® to present their experiment/project papers to the public and a final panel of judges selected by Enterprise In Space for their expertise relating to the state of the art of orbital debris detection and remediation and useful experiments for living and working in space.

Judges will select the top three (3) highest voted designs to move on to the final round. The third and final round of presentations by each team and voting by EIS judges, called the "Finalist Round", will be held at the ISDC in St. Louis, MO, on or about May 25-29, 2017, where up to 3 team leaders will be expected to present their designs/experiments. Finalists unable to travel to the ISDC may record and submit their presentation(s) to EIS for the judges and conference attendees to view at the ISDC. During this period, the panel of judges selected by Enterprise In Space will select one (1) Grand Prize winner, from the remaining three (3) top entries. Selection of winning entries will be determined by input from Enterprise In Space judges and winners will be notified during the Conference at a plenary or meal event, where all 3 entries will have 2 minutes each for a brief presentation. All decisions are final.

### **Program Dates**

Students are encouraged to submit White Papers to start presenting their ideas before the actual competition starts. This will allow a preliminary assessment of various possible concepts. The best White Papers will be presented during the International Space Development Conference ([ISDC 2017](#)). White Papers are being accepted now. Submitting a White Paper is not a requirement for participating in and does not increase the chances to proceed to further competition phases. Participation in this White Paper competition will help students to work out some of the challenges they will face in future phases of this competition, which will

intimately produce an experiment that will be designed, built, and flown in space. The key dates related to this White Paper challenge are the following:

- March 20, 2017: White paper submission deadline
- April 17, 2017: Announcement of best White Papers, which will be presented at ISDC 2017
- May 25-30 2017: White Paper presentations at ISDC 2017 in St. Louis, MO

## 8. Winner Notification

The Sponsor will attempt to notify the potential winners by email, mail, or phone, promptly after each phase. Each potential Grand Prize winner (parent or legal guardian if a minor in his/her state/country of residence) will be required to complete, electronically sign and submit a Declaration of Compliance within five (5) days of the date notice or attempted notice is sent in order to claim his/her prize. If a potential winner cannot be contacted or fails to submit the Declaration of Compliance within the required time period (if applicable), or prize is returned as undeliverable, potential winner forfeits prize.

If the potential winner is at least 18 years of age but still considered a minor in his/her jurisdiction of residence, the Sponsor reserves the right to award the prize in the name of his/her parent or legal guardian, who will be required to sign the Declaration of Compliance on the potential winner's behalf and fulfill any other requirements imposed on the winner set forth herein. Potential winners must continue to comply with all terms and conditions of these Official Rules, and winning is contingent upon fulfilling all requirements. In the event that a potential winner cannot be contacted within seven (7) days after the date of the first attempt to contact him/her, and/or is disqualified for any reason, the Sponsor may select an alternative potential winner in his/her place at random from the remaining non-winning, eligible entries.

## 9. Judging Criteria

Winners will be chosen based on the following:

The evaluation criteria for the White Papers are the following, in order of priority: Relevance to the objective of the competition; Scientific and technical merit; Potential feasibility. These criteria will be scored and weighted based on a judging rubric similar to this:

White Paper Evaluation Criteria	Weighting Factor
Relevance to objective of 1) assessing GOLD performance or 2) orbital debris detection and tracking	30 Points
Scientific/technical merit	40 Points
Potential feasibility	30 Points

## 10. Prizes

All participants who sign up as Enterprise In Space crewmembers with a minimum \$20 donation to support Enterprise In Space and with qualified entries\*(need to define) in the contest will receive:

- Your name in space aboard the NSS Enterprise spacecraft
- Virtual crewmember certificate. Your name displayed with orbiter at museum after re-entry
- Admission to the Competition Department
- Access to exclusive EIS content

Up to five semi-finalist teams will receive all of the above, plus...

- Project/experiment proposals published in Enterprise Center for Excellence for orbital space debris mitigation & remediation
- Behind-the-scenes tour of NASA Johnson space center in Houston, Texas (travel not included)
- Complimentary associate membership in National Space Society for one year

GRAND PRIZE TEAM (up to three people) will receive all of the above, plus...

- \*Complimentary registration for up to three (3) members of each team to the National Space Society's International Space Development Conference® (ISDC), may 25-29, in St. Louis, MO, to present their papers and receive their awards, travel not included.
- Results paper published in *Ad Astra magazine* and industry trade journal for orbital space debris mitigation and remediation
- Scholarship for one person from Kepler Space Institute (\$5000)

## 11. General Conditions

In the event that the operation, security, or administration of the Contest is impaired in any way for any reason, including, but not limited to fraud, virus, bug, worm, unauthorized human intervention or other technical problems, or in the event the Contest is unable to run as planned for any other reason, as determined by the Sponsor in its sole discretion, the Sponsor may, in its sole discretion, either (a) suspend the Contest to address the impairment and then resume the Contest in a manner that best conforms to the spirit of these Official Rules or (b) terminate the Contest and, in the event of termination, award the prize at random from among the eligible, non-suspect entries received up to the time of the impairment. The Sponsor reserves the right in its sole discretion to disqualify any individual or team it finds to be tampering with the entry process or the operation of the Contest or to be acting in violation of these Official Rules or in an unsportsmanlike or disruptive manner. Any attempt by any person to damage the website or undermine the legitimate operation of the Contest may be a violation of criminal and civil law, and, should such an attempt be made, the Sponsor reserves the right to seek damages (including attorneys fees) and any other remedies from any such person to the fullest extent permitted by the law. Failure by the Sponsor to enforce any provisions of these Official Rules shall not constitute a waiver of this Contest Agreement.

## 12. Release and Limitations of Liability

By participating in the Contest, entrants agree to release and hold harmless the Sponsor, and each of their respective parents, subsidiaries, affiliates, advertising and promotion agencies, other companies associated with the Contest, and each of their respective officers, directors, employees, shareholders, representatives, and agents (the Released Parties) from and against any claim or cause of action arising out of participation in the Contest or receipt or use of the prize (including travel or activity related thereto), including, but not limited to (a) any technical errors associated with the Contest, including lost, interrupted or unavailable Internet Service Provider (ISP), network, server, wireless service provider, or other connections, availability or accessibility or miscommunications or failed computer, satellite, telephone, cellular tower or cable transmissions, lines, or technical failure or jumbled, scrambled or delayed, or misdirected transmissions or computer hardware or software malfunctions, failures or difficulties; (b) unauthorized human intervention in the Contest; (c) mechanical, network, electronic, computer, human, printing or typographical errors; (d) any other errors or problems in connection with the Contest, including without limitations, errors that may occur in the administration of the Contest, the announcement of the winner, the cancellation or postponement of the event and/or the flyover, if applicable, or in any Contest- related materials; or (e) injury, death, losses or damages of any kind, to persons or property which may be caused, directly or indirectly, in whole or in part, from entrants



participation in the Contest or acceptance, receipt or misuse of the prize (including any travel or activity related thereto). Entrant further agrees that in any cause of action, the Released Parties liability will be limited to the cost of entering and participating in the Contest, and in no event shall the entrant be entitled to receive attorneys fees. Released Parties are also not responsible for any incorrect or inaccurate information, whether caused by site users, tampering, hacking, or by any equipment or programming associated with or utilized by the Contest. Entrant waives the right to claim any damages whatsoever, including, but not limited to, punitive, consequential, direct or indirect damages.

### **13. Disputes**

Except where prohibited, each entrant agrees that any and all disputes, claims and causes of action arising out of, or connected with, the Contest or any prize awarded shall be resolved individually, without resort to any form of class action, and exclusively by the appropriate court located in the District of Columbia. All issues and questions concerning the construction, validity, interpretation and enforceability of these Official Rules, entrants rights and obligations, or the rights and obligations of the Sponsor in connection with the Contest, shall be governed by, and construed in accordance with, the laws of the District of Columbia, without giving effect to any choice of law or conflict of law rules, which would cause the application of the laws of any jurisdiction other than the District of Columbia.

### **14. Privacy**

Information collected from entrants is subject to sponsors privacy policy, which can be viewed here:  
[http://www.nss.org/docs/NSS\\_Privacy\\_Policy.html](http://www.nss.org/docs/NSS_Privacy_Policy.html)

### **15. Winner List**

To request the name of the winner send a self-addressed, stamped envelope to Enterprise In Space, c/o Tanya Luken CPA PC, 107 SE Washington, Suite 164, Portland, OR 97214. Winner list requests will only be accepted after the promotion end date (listed above). For the Winner List, you can also consult the Enterprise In Space website.