2016 NEAR SPACE CHALLENGE
COMPETITION RULES / GUIDELINES

S1. SCOPE
This document provides the rules for the 2016 Near Space Challenge High Altitude Balloon (HAB) competition, to be held as part of the 2016 Albuquerque International Balloon Fiesta® from 1-9 October 2016 at Balloon Fiesta Park.

S2. TERMS

Near Space Challenge. The Near Space Challenge (NSC) is a new part of the 2016 Albuquerque International Balloon Fiesta that focuses on student STEM, and which requires students to actually engineer High Altitude Balloon Vehicles aimed at achieving specific engineering goals. The competition has three very individual parts, the Scientific Engineering Challenge, the High Altitude Challenge and the Landing Accuracy Challenge.

HAB Vehicle. A HAB vehicle is a High Altitude Balloon assembly, measured from the top of the balloon to the bottom of the lowest payload on the balloon train.

HAB Train. The HAB train is anything that hangs below the bottom of and which is attached to the neck of the balloon envelope. The HAB train (line) is a single, uncut length of nylon line extending from above the top of the parachute to the top of the lowest payload.

Payload. A payload is any component attached to the HAB train and suspended below the parachute.

GPS. GPS stands for the Global Positioning System, a constellation of satellites in stationary orbit around the earth that provide digital positioning information to ships, aircraft and ground stations. It is very accurate, even in the non-military mode, and can be accurate to within a few meters. GPS satellites provide date, time, latitude, longitude, altitude above mean sea level (MSL), ground speed and heading over the ground to APRS beacon receivers onboard the HAB vehicle.

APRS. APRS stands for the Automatic Packet Reporting System. APRS beacons onboard the HAB vehicle receive GPS data, and then transmit their location to ground based repeaters and digi-peaters via digital packets of information. Ground based stations convert this information into useable data, and using a

device called an I-Gate, route this location information to the internet for display and real time tracking of the APRS beacons onboard the HAB vehicle.

FAR 101. Federal Aviation Regulations, part 101. These regulations govern the flight of unmanned, unmoored gas balloons in FAA controlled airspace.

NMSS. The NMSS is the New Mexico Space Studies group, a group of HAM radio operators and engineers interested in exploring near space via HAB vehicle.

NEAR SPACE CHALLENGE RULES

2.1 SAFETY

All HAB vehicles must be built and flown in accordance with the Near Space Challenge (NSC) Rules Committee guidelines, the New Mexico Space Studies Go-No-Go criteria, and Federal Aviation Regulations (FAR 101). HAB vehicles will be inspected for adherence to these guidelines, and will be observed during launch by an NSC official, whose judgment on the HAB Vehicle's compliance with these rules and airworthiness is final. Teams must consult with a designated NSC official who is running this event well before the competition day to resolve any questions about design, safety, or these rules.

Although HAB vehicles would seem to be very safe, generally speaking, due to the potential for payloads becoming detached and falling back to earth, as well as the potential for issues when compressed gases are in use, safety is the primary concern in this competition. Also, members of the recovery crew must remain safe throughout the recovery phase of operations. All competitors and ground based observers must be safe at all times. Therefore, these guidelines have been established to insure competitor and observer safety:

- All HAB envelopes will be filled to preplanned volume by members of the launch crew. Envelopes will then be handed over to teams for launch prep and eventual launch.
- All HAB crews must wear hard hats and safety glasses for all launch evolutions.
- All student science experiments to be flown must be inspected by the launch director for safety.
- All HAB vehicles must fly at least two APRS tracking beacons and one SPOT tracker in order to insure we have a confirmed location and track of each vehicle from launch to landing.
- All recovery teams must have a minimum of two vehicles in their recovery team in case of injury or vehicle malfunction.

- All FAA weather minimums, as well as New Mexico Space Studies GO-NO-GO criteria will be strictly adhered to for this event.
- Recovery crews will have a minimum of two vehicles on the recovery effort in case of vehicle malfunction or break down.
- Members of the recovery crew must wear clothing appropriate to the recovery area and weather, such as jeans, boots, rain gear, hats, etc.
- Recovery crews must have water, snacks and a robust first aid kit onboard their vehicles for use in the recovery effort.
- Recovery crews must have multiple methods of communications with mission control, including HAM radio, cell phone, text messaging or email.
- All competing HAB vehicles must have one operable flight computer onboard w/GPS logging capability (the flight computer must be able to log and store flight data for later retrieval and analysis).
- All recovery personnel should be thoroughly briefed on local wildlife and on procedures for inadvertent contact with wildlife. Rule of thumb: "Don't bother them and they won't bother you!"
- Recovery personnel should be familiar with Tribal contact info should a vehicle land on Native American Tribal lands. Contact numbers and information should be part of the event communications plan and appropriate recovery procedures on Native Tribal lands should be briefed as part of the overall recovery plan and prior contact should be made with Tribal governments to coordinate access to those areas.

2.2 TEAMS

A competing NSC team must come from a single approved school or school club or organization. Due to the complexity of launch and recovery operations, there will be a limit to the number of teams that may enter this competition. The 2016 Near Space Challenge is an invitational event. The NSC Committee will approve all teams that apply to participate. HAB team members must be students who are currently enrolled in grades 6 through 12 in a middle school or high school. Teams must be supervised by an adult approved by the principal of the sponsoring school, or by an officially-appointed adult leader of their sponsoring organization. Minimum team size is three students and maximum is ten. Each student member must make a significant contribution to the design, construction, and/or launching of the team's HAB vehicle.

The 2016 NSC event will have three separate competitions. Six HAB crews will compete in the NSC Scientific Engineering Competition; three crews will compete in the first NSC High Altitude Challenge; three crews will compete in the Landing Accuracy Challenge. The following HAB vehicle requirements (2.3) apply to all entries.

2.3 HAB Vehicle requirements for all NSC flights

Balloon Envelope: The balloon envelope must be a Kaymont, 1,200 gram latex weather balloon.

HAB train requirements: The HAB train must be made of material that will break when exposed to a 50lb or greater breaking force. Each item on the HAB train must be securely attached (harnessed) to the train line with at least two lines, a bridle and the train itself. The parachute must have a swivel with a 300 pound test load or greater above the canopy and below the shroud lines to prevent shroud lines or parachute twisting. Quick links must be used to connect parachutes and payloads to the train line. No line-to-line connections are allowed. Quick links must be used to make all payload to train connections. The goal of the above rules is to assure that nothing in the balloon train becomes disconnected at any time during flight.

Payloads: Items that are attached to the balloon train like tracking devices, reflectors, science experiments, cameras, computers and sensors, must be housed or mounted in such a way that they will not become detached during flight, and so that they will survive reentry and landing. Payloads will be spaced 4 to 4.5 feet apart along the HAB train to prevent any tangling of or damage to payloads attached to the train.

Required Equipment: Two APRS tracking beacons and one SPOT tracker are required for all HAB flights. For the 2016 contest, a programed and tested Bionics, All-in-One, 10 watt APRS beacon is required as the primary APRS beacon for each flight. Other options for the backup APRS beacon are the High Altitude Science Radio Bug APRS beacon (.25 watt) or the Byonics MT-1000 (1 watt) APRS beacon. A SPOT tracker is also required as a back-up tracking system to establish final landing spot. A 36 inch to 72 inch, round parachute is required, and will be mounted below the 1,200 gram balloon. At least one camera must be attached to record the HAB flight (not required on HAB vehicles attempting an NSC altitude record). All HAB vehicles must also be equipped with an automatic (or manual) cut-down device that will insure some measure of control over the

HAB vehicle's flight profile. The cut-down device will be provided for each flight, and may have one or more of the following:

- Timer actuated (trigger is based on elapsed flight time)
- Altitude actuated (triggers at a predetermined time within an altitude range)
- Command actuated (triggered by cut-down mechanism "hearing" a command code by HAM radio)

Maximum HAB Payload Weight (sum of all payload weights): The combined HAB payload weight must not exceed 5.99 pounds (2717 grams) for any NSC flight, nor have a single payload weight more than 3.99lbs.

All balloons will be filled by the NSC Launch Officer who will inflate each HAB envelope according to the competing team's fill requirements as determined by the CUSF Burst Calculator. All calculations will be verified. A mass flow meter will be used to confirm the amount of helium put into the envelope, and a digital tension gauge will be used to confirm neck/nozzle lift.

2.4 The Scientific Engineering Competition Rules: These are HAB vehicles that have specific altitude, payload and time of flight requirements, aimed at achieving a specific scientific goal or study. In this competition, students control payload weight, helium fill and ascent/descent parameters that are used to determine the vehicle flight profile. The following competition rules apply to the HAB Scientific Engineering Competition:

- **The helium load, combined payload weight and desired ascent rate must be adjusted so the predicted/actual balloon burst height is as close to the <u>target of 85,000 feet</u> as possible.**
- **Each HAB vehicle must carry a payload of 4 grade A large eggs weighing 27-62 grams, provided by NSC officials before launch. The eggs must be flown with their long axis parallel to the HAB train. <u>Eggs must return to Earth intact with no cracks, breaks or holes in the shell or any other damage visible to NSC recovery officials.</u>**
- The eggs must have a specialized egg protection/container system which insures that the eggs survive the flight and landing. (Remember, the air temperature at altitude can reach -76 degrees Fahrenheit, and may cause eggs to burst if not insulated.) The descent rate may also be higher than predicted so the landing could be harder if the parachute shroud lines become tangled or twisted.

- The egg container will be located in the lower half on the balloon train just above the heaviest payload on the vehicle, which normally includes cameras recording the flight.
- The egg container must be designed in such a way that no part can fall off in flight, nor can the container become detached from the balloon train. The container may dent or crush on landing as part of the payload design.
- The eggs will be inspected by the recovery crew after landing at the recovery site, so easy access must be designed into egg package (container) so the crew can inspect the condition of the eggs and relay their condition to mission control for scoring purposes.
- All teams must fly a 36 inch parachute with no spill hole.
- **The flight time goal for this event is 90-100 minutes.**
- **Score-sheets for this event will be published separately.**
- If conditions change significantly and HAB vehicles are flying well outside of predicted norms, the NSC scoring committee can cancel the flight duration part of the scoring or change flight targets (alt, time).
- Teams must use at least one approved flight prediction system to determine their HAB vehicle's flight characteristics and predicted flight profile. APRS flight data will be compared to onboard flight computer data to determine the most accurate information to be used in scoring the contest. If there is an equipment problem, or questionable data from the APRS, the Eagle Flight computer alone will be used. SPOT can also be used to verify the landing location if there is an APRS malfunction. The NSC Scorekeeping Committee will arbitrate and resolve any issues related to APRS data and flight computer data.

2.5 The High Altitude Challenge: The High Altitude Challenge has one primary goal, to launch a HAB vehicle to the highest possible altitude, while meeting all the requirements of section 2.3. **The ascent rate must be no lower than 3 meters per second and each balloon competing in this category must have a provided NSC approved cut-down device.** If a high altitude competitors' HAB vehicle appears to be a floater, the cut-down device may be activated and the maximum altitude achieved at the time of cut down will stand as that team's score. **The NSC Tracking Control Officer makes the cut down decision. The NSC control officer's decision to cut-down a HAB Vehicle will not be challenged.** The following are additional rules for this competition:

- Teams must use at least one approved flight prediction system to determine their HAB vehicle's flight characteristics and predicted flight profile. APRS flight data will be compared to onboard flight computer data to determine the most accurate information to be used in scoring the contest. If there is an equipment problem, or questionable data from the APRS, the Eagle Flight computer alone will be used. SPOT can also be used to verify the landing location if there is an APRS malfunction. The NSC Scorekeeping Committee will arbitrate and resolve any issues related to APRS data and flight computer data.
- Minimum equipment requirements for tracking and recovering HAB vehicles in the High Altitude Challenge are as follows:
    - Minimum of two APRS tracking beacons
    - One SPOT tracker beacon
    - Onboard flight computer (Eagle Pro or other approved flight computer)
    - Cut-down device
        - Timer actuated (trigger is based on elapsed flight time)
        - Altitude actuated (triggers at a predetermined time within an altitude range)
        - Command actuated (triggered by cut-down mechanism "hearing" a command code by HAM radio
- Care must be taken to package the required components (listed above) so they are protected during the flight and on reentry and landing.

2.5 The Landing Accuracy Challenge: The Landing Accuracy Challenge has one primary goal, to land as close to a predicted landing spot (latitude / longitude), while meeting all the requirements of section 2.3. **The ascent rate must be no lower than 5 meters per second and each balloon competing in this category must have a provided NSC approved cut-down device.** During this competition, if filled precisely with helium and with the exact predicted neck lift, and by using a cut-down device that actuates at the predicted maximum altitude (85,000'), the competitor's HAB vehicle should land in close proximity to its predicted landing site. **Should a HAB vehicle become a floater, the NSC Tracking Control Officer makes the cut down decision. The NSC control officer's decision to cut-down a HAB Vehicle will not be challenged.** The following are additional rules for this competition:

- Teams must use at least one approved flight prediction system to determine their HAB vehicle's flight characteristics and predicted

flight profile. APRS flight data will be compared to onboard flight computer data to determine the most accurate information to be used in scoring the contest. If there is an equipment problem, or questionable data from the APRS, the Eagle Flight computer alone will be used. SPOT can also be used to verify the landing location if there is an APRS malfunction. The NSC Scorekeeping Committee will arbitrate and resolve any issues related to APRS data and flight computer data.

- Minimum equipment requirements for tracking and recovering HAB vehicles in the Landing Accuracy Challenge are as follows:
    - Minimum of two APRS tracking beacons
    - One SPOT tracker beacon
    - Onboard flight computer (Eagle Pro or other approved flight computer)
    - Cut-down device
        - Timer actuated (trigger is based on elapsed flight time)
        - Altitude actuated (triggers at a predetermined time within an altitude range)
        - Command actuated (triggered by cut-down mechanism "hearing" a command code by HAM radio
- Care must be taken to package the required components (listed above) so they are protected during the flight and on reentry and landing.
- **Crews in the Landing Accuracy Challenge may make two updates to their predicted landing site while the vehicle is airborne, and before burst occurs.**
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