Sensors, Sensor Shipping Containers and Simulated Shipping Containers

1. Does the diameter of the sensor include any aerodynamic surfaces (stabilizers) attached to it or just the raw diameter of the sensor?
   
   If the front and rear of the sensor are tapered, does any region that has a diameter less than 1 inch count towards the sensor length measurement?
   
   Does the aspect ratio requirements for the sensor pertain only to storage, or does it include during deployment/flight: i.e. can the sensor have folding wings of fins that increase to more than 25% the sensor length (assuming the diameter is measured as the maximum lateral dimension of the sensor)?
   
   What counts as sensor length? Say our sensor is 20 inches long, but the first 4 inches of the nose is conically shaped. The remaining 16 inches are cylindrical with a constant diameter (D = L/4). Would the diameter be based on the full length of the sensor (20 inches) or the 16 inch cylindrical section? What length would count towards our score? The same goes for any other variation in diameter anywhere on the length.
   
   Regarding this year rule, we would like to raise a question about the size of the sensor. We decide to add fins to the sensor. As mentioned in the rule, the sensor should have a minimum diameter of 1.00 inch and a minimum length to diameter ratio of 4. We would like to ask if the fins are added to the sensor, should the fins be included when calculating the diameter?
   
   If the has folding wings, what would be the diameter measured, in the folded or unfolded position?
   
   Can we alter the sensor shape or add fins? (does it have to stay a cylinder?)
   
   Can the sensor have deployable surfaces?
   
   Sensor Length is one of the multiplying factors in Mission 3 scoring. Will Sensor Length be measured from absolute tip to absolute tail? In other words, would structurally rigid material coming off the end of the sensor be counted in the Sensor Length?
   
   How will sensor length be measured and length to diameter ratio measured? In particular, how will the diameter be considered for non-cylindrical elements of the sensor? Does the sensor have to be exclusively cylindrical/have a uniform diameter along its entire length?
   
   Can the sensor have a nose cone that tapers to a point?
   
   Do stabilization fins count as part of the aspect ratio? Or just the main body?
   
   And if so, are retractable fins that collapse to a 1:4 aspect ratio, but extend outside the 1:4 ratio, legal?
   
   If the deployed sensor has fins, do they count as part of the sensor diameter when calculating the length-to-diameter ratio?
   
   Can the sensors have wings? If so, would the wingspan be considered part of the diameter measurement used in the minimum length to diameter ratio?
   
   Can the Sensor being deployed be equipped with control surface? (As shown in the image below)
Does the sensor need to have constant dimensions throughout its length? (As shown in the image below)

Can we add any geometrical features to the sensor for stability?

The rules state, "The sensor must have a minimum diameter of 1.00 inch with a minimum length to diameter ratio of 4." To clarify, a sensor with a diameter of 1 inch with a length of 24 inches would have a length to diameter ratio of 24:1 and would therefore be permitted since the ratio is above the minimum of 4:1?

The minimum diameter of the sensor is required to be of 1 inch so can it have a pointed nose (for example an airfoil shape) keeping the diameter in the center greater than 1 inch?

Does the sensor have to be cylindrical? If not, is the sensor diameter requirement based on the bounding box or the minimum diameter in the entire sensor? If it is based on the entire sensor, is the length-to-diameter ratio determined by the minimum, maximum or an average diameter?

Is the sensor allowed to have some sort of fins/stabilizers?

Also does the sensor have to have a uniform shape like a cylinder or can we have something more like a tear drop or football?

Can we add any geometrical features to the sensor for stability?

Answer: The sensor must have a main body or fuselage that is cylindrical and a minimum diameter of one (1) inch. The length of the sensor for scoring will be the length of this main body or fuselage with a constant diameter. The sensor may have aerodynamic shapes, nose cones, boat tails, etc in addition to the main body or fuselage, but if less than the cylindrical cross-section, it will not count as part of the length of the sensor. Fins, wings and other stabilization features may be added to the sensor and will not count as part of diameter measurement. Any added features for aero stability must be fixed and cannot be deployable or unfolded when the sensor is deployed.

2. In mission 3, does the shipping container has to store the sensor?

Answer: The sensor must be in its shipping container for Mission 2. For Mission 3, the sensor must be in its shipping container when entering the staging box but only the sensor will be installed and attached to the deployment and retracting mechanism; the shipping container will stay behind with the ground crew.
3. Do the sensor (in shipping container) and shipping container simulators have to be loaded individually and by hand during the ground mission?

Can any tools, fixtures, or other mechanical aids be used to assist with loading the sensor (in shipping container) and shipping container simulators during the ground mission?

Are we allowed to use a speed loader or other external device to assist in the loading of containers for the Ground Mission?

Answer: The shipping containers may be loaded with tools, fixtures, etc, to assist with installation of the sensor and sensor deploying and recovery mechanism. Commercial off the shelf tools (screwdrivers, wrenches, etc) do not need to be stored in the shipping container or airplane. Anything used to assist in the loading such as jigs, tooling, fixtures must also be stored inside the shipping container or aircraft for the ground mission and Mission 2.

4. Does the sensor have to be in the same configuration when it is stowed in the airplane (prior to deployment) AND when it is fully deployed?

Are teams allowed to manually change the configuration of the sensor in between missions 2 and 3? For example, we would like to have our sensor's fins retracted in mission 2 and manually deploy them before mission 3. If this is not possible, are we allowed to have the fins spring deployable.

If multiple configurations are allowed for the sensor, in which configuration will the length of the sensor be measured?

Can we have multiple sensors (of different sizes/weights)?

Can we modify the weight of the sensor after the tech inspection? Or we have to only use the sensor with weight presented in the tech inspection?

What dimensions of the sensor will be measured for the mission requirements? If the deployed and retracted sensor has two separate dimensions which will be measured? If the sensor has fins do they count as part of the sensor diameter? If the front or back of the sensor is tapered to a smaller diameter, will the tapered portion be counted for overall sensor length?

Are we aloud to have a collapsible sensor? If so, do we apply the ratio to the sensor in a collapsed position or an extended position.

Answer: The sensor can have only one configuration approved in tech inspection and cannot be changed in any way between missions.

5. Regarding the sensor, does "internally to the airplane" just mean that the sensor must be inside of the airplane, not necessitating a full enclosure?

Answer: The sensor must be fully inside the airplane fuselage but a door or fully enclosed fuselage is not required. However, if there is an opening in the airplane for the sensor, all missions must be flown in the same configuration.

6. May the sensor be stored within the cargo container in multiple, quick-assemblable parts, or must the sensor consist of one complete piece while stored?

Can the sensor be collapsible?

For the Ground Mission, are sensors allowed to “snap together” or otherwise join into one structure to assist loading, so long as the containers are all identical?
Do the sensors have to be assembled while in the shipping containers, or can they be disassembled?

Can the sensor itself be foldable, or can it undergo any change in shape while in the container (e.g. telescopic sensor)?

Answer: The sensor must remain in the flight configuration for all phases of the competition.

7. Are the LEDs in the sensor expected to be visible at all times and all angles while signaled on: i.e. may the LED be momentarily obscured from view during aircraft 180 and 360 degree turns?

During M3 must a minimum of 3 lights be visible at all times or at least 1 of 3 lights?

Will it be okay if a light on the sensor is not visible for a while when the aircraft is moving in a certain direction or all 3 lights need to be visible all the time?

Answer: It is acceptable if the lights are temporarily obscured during turns.

8. Is there a specific pattern for the 3 external lights to be flashing? Is there a specific interval for the flashes or pauses between flashes?

How many times must the light operation pattern repeat? Just once or over the entire mission duration?

Must the airborne sensor light blink, or may the lights shine with a steady light?

Is the pattern of lights emitted by the sensor chosen during the competition by the team or can it be predetermined beforehand? Will the flight director ask us to show a particular pattern chosen by him/her when we start a run?

Answer: The pattern of the lights is up to each team to decide keeping in mind that the pattern must be distinguishable from the ground by the Flight Director. The pattern must be repeated for the duration of the mission.

9. What exactly does “the sensor lights must be controlled by a physical connection to the airplane via the tow cable” mean? Does the lights controller have to be inside the plane and send the appropriate commands to the sensor to display the pattern, or can the controller in the plane simply turn the sensor, which will have a pre-programmed light sequence, on and off?

Answer: Both implementations are acceptable.

10. Can there be active control surfaces on the sensor?

Answer: No.

11. How recessed in the sensor can the LED be before it is no longer considered external? Does the entire LED need to be contained outside of the sensor walls?

The ruleset states, “[The Sensor] must have a minimum of 3 external lights that can be viewed while in flight in the deployed position.” Does “external” mean the lights must be mounted on the surface of the sensor and protrude outwards? In other words, can the lights be flush with the surface of the sensor?

In the rules, the sensor is just specified as a sensor with lights. And since the sensor goes into the shipping container does it mean the lights are actually on the shipping container? The rules also specify that the shipping container fully encloses the sensor so I would think the lights would be on the shipping container?
Should the LED’s be placed in all the individual sensors or the sensor containers

Answer: The lights must be externally visible on the sensor. There is only one sensor for each team. They can be mounted flush or even recessed to the sensor fuselage outer surface as long as they are visible on the ground by the Flight Director during Mission 3. There are no requirements for lights on the shipping container or shipping container simulators.

12. Can the lights be circumferential (i.e., wrapped around the sensor)?

Answer: It is possible but could be difficult for the Flight Director to verify all three lights are working as required by the rules. The DBF OC recommends a linear pattern on both sides of the sensor for easier observation from the ground.

13. By defining the sensor shipping container as having 6 sides, does that mean the shipping container must be rectangular? Could it be a cylinder instead?

Are the creates required to be a rectangular prism?

The ground mission ruleset states, “The assembly crew member will drop the sensor in shipping container on all six sides from a height of 10 inches.” Does the shipping container need to have rectilinear sides and does it need to have structural rigidity?

For the drop test - is it required that the shipping container suffers no damage?

Are the dimensions of the shipping container simulator measured in all directions or are they only measured by the major dimensions? For example, can the shipping container simulator have missing walls or can it be a wireframe design?

Answer: The shipping container may be rectangular or cylindrical. If cylindrical, it will be up to the Ground Mission judge to determine the six orthogonal sides for the drop test. The container must be structurally sound to withstand the drop test with only cosmetic damage allowed and also protect the sensor from damage. Shipping container simulators must be the same overall size and weight as the sensor shipping container, but are not required to be “solid” throughout – side walls can be modified to achieve weight requirements.

14. Another question on the sensor is what is the sensor? It says it needs a battery, but I am assuming the lights are powered from the UAV since the UAV controls the lights. So, at the minimum, could the sensor just be the battery? Can the sensor be a small microcomputer to collect data on the flight that is powered by the battery?

Answer: The sensor for Mission 3 is a towed, deployable sensor. The battery to power the lights on the sensor must be contained inside the sensor. An example of a towed sensor can be found at:


15. Do the sensor lights need to be different colors?

Answer: No, just visible on the ground by the Flight Director.

16. For the airborne sensor, the rule reads “lights must operate one at a time in the deployed position in a pattern to be determined by each team”. Does this indicate that each light must be controllable, or is it permissible to have a microcontroller operate the lights in sequence and the pilot simple sends an on signal?
As stated at the top of page 8 of the 2021 DBF rules, the lights must be controlled by the physical connection to the plane, does this mean that any receivers must be inside the plane rather than the probe?

The rules state that the sensor lights must be controlled by a physical connection to the aircraft. Does this mean that the light operation system (Arduino or similar tech) has to be on the aircraft rather than on the sensor?

Answer: The lights should be controlled by a microcontroller on the airplane. Manual control of a repeating pattern by the pilot or observer would be difficult.

17. The rules state “The sensor must contain its own battery power supply compliant with the battery requirements herein.” Does this mean the battery must be inside the sensor (completely encapsulated within the casing) or simply that the lights must be powered by their own battery? In other words, can the sensor battery stay aboard the aircraft rather than inside the sensor during the towed flight?

Is there any requirement on what the battery onboard the sensor must be used to power via the tether? i.e. a retraction/deployment mechanism, motor control board, etc.

Is there any specific batteries for the lights in the sensor?

As mentioned in the rules, the sensor should have a separate battery, does the battery have to be on the sensor, or can it be placed inside the aircraft instead?

Answer: The sensor must contain its own battery internal to the sensor to power the lights and that is the only function of the sensor battery. The lights must be controlled via signal over the tow cable from the airplane. The actual microcontroller that turns the lights on and off per the pattern of the team’s choice can be in the airplane or inside the sensor, but will have be activated by the airplane over the tow cable.

18. Should the sensor be connected to the aircraft via a physical connection that transfer the signal to sensor or can be transmitted via a radio signal?

Answer: The sensor must be connected by physical link to the airplane.

19. For mission 3 of the upcoming DBF, regarding the 3 lights (or sets of lights) that need to operate one at a time, would LEDs that have 3 different colors (white, green and red) within the same casing be acceptable? My team has been testing a set of lights comprised of 6 LEDs that can produce white, green, or red lights one at a time (all 6 LEDs light up at the same time in the same color), however each individual LED contains three distinct LEDs inside the same casing, one for each color. Can this be considered as “3 lights” although they are contained within the same plastic casing?

For clarity please see the picture below:
20. Can the sensor be made from a combination of materials, e.g., a rigid front body with a cloth back part?

Must the sensor be made with a rigid skin? Can it flutter like a flag?

Do we have to manufacture our own sensor or do we buy a sensor that meets the requirements?

If we need to manufacture our own sensor, can we make the sensor using any materials (e.g., 3D print a box with the desired dimensions of the sensor)?

Answer: The sensor can be made with any combination of materials as the team chooses but must be a rigid body construction and must maintain its shape and construction during all phases of the competition. It could be a modified version of a commercial item if it meets the requirements in the rules and Q&A.

21. For mission 3 should we deploy and operate all shipping containers placed for mission 2 or should we deploy and operate one shipping container with one sensor in it?

… do the shipping container simulators have any function?

What is the difference between container simulation and containers?

Answer: To clarify, there is only one shipping container and one sensor. The shipping container holds the sensor for the Ground Mission and Mission 2 and stores the sensor when entering the staging box for Mission 3. The shipping container does not fly on board the aircraft for Mission 3, only the sensor connected to the deployment and recovery mechanism. The shipping container simulators have no function other than replicating the size and weight of the actual shipping container with sensor included.
22. What is the minimum number of containers and sensors?
Answer: There is only one sensor and one shipping container allowed. There is no limit to the number of shipping container simulators.

23. In M3, Does the sensor have to be inside the container or just inside the plane?
Answer: For M3, the sensor is only in the shipping container when you enter the staging box and start the 5 minute window to prepare for flight. The shipping container does not fly on the airplane for M3. The sensor in the shipping container will fly on the airplane for M2 along with any shipping container simulators each team chooses to add.

24. Is the sensor required to be separable from the towing system? Or can the two be combined into one whole system?
Answer: The sensor and deploying and recovery mechanism must be two separate items.

25. What is the ordination of the sensor during flight? vertical or horizontal?
Answer: Horizontal.

Sensor Deploying and Recovery Mechanism

26. Are there any requirements for the tow cable?
   Is there any limitation on the material of the “tow cable” used for sensor towing? Could we use, for example, Kevlar wire?
Answer: The tow cable materials can be made of any material(s) each team chooses to meet all requirements.

27. The Sensor and Deploying Recovery mechanism both have a requirement to be internal to the airplane. However, we would like to ask if that is the case for both Missions 2 and 3?
Answer: Yes.

28. Is it required that the sensor recovery mechanism be made removable, or can a team elect to have it permanently mounted in the aircraft?
   The ground mission ruleset states, “The timed mission will begin with the aircraft in the flight configuration inside the “mission box” along with the uninstalled sensor in shipping container, maximum allowed number of container simulators and deploying and recovery mechanism.” Does the “uninstalled” apply to the “deploying and recovery mechanism” in this case as well? In other words, must it be possible to uninstall the deployment and recovery mechanism, or can it be fully integrated into the structure?
Answer: The sensor deployment and recovery mechanism can be permanently installed in the airplane at each team’s discretion. If permanently installed, it must be flown in all missions, including Mission 1.

29. Is it allowed to have multiple tethers attached to the sensor?
   Can there be more than one tow line attached to the deployed sensor?
The rule states that “the sensor lights must be controlled by a physical connection to the airplane via the tow cable”. Does that mean that only one cable could be used, or could we use multiple ones?

Answer: There can be multiple tethers or tow cables.

30. Regarding the tow cable, are we allowed any other devices to come out of the plane to guide the tow cable along the path to the sensor, or are we only allowed to have the tow cable suspend the sensor?

Answer: Yes, as long as it retracts when the sensor is recovered.

**Batteries:**

31. Is it allowed to use high voltage LiPo batteries if the nominal power (given on the manufacturer's label) complies with the 100Wh limit?

Answer: Yes, but all manufacturer requirements for charging and use must be strictly followed.

32. If multiple sensor batteries are used, if allowed, may these batteries be wired in series or must they be wired in parallel like the propulsion and avionics batteries?

Answer: As stated in the rules, if multiple LiPo batteries are used for a single purpose, they must be wired in parallel.

33. Can we use the same battery for both deploy and recovery mechanisms, lights in the shipping container, and aircraft propulsion?

Answer: There are no lights in the shipping container, only on the sensor. The sensor is required by the rules to have its own battery for powering the lights. The deploy and recovery mechanism may be powered by the propulsion battery(ies) or have its own battery. It cannot be powered by the servo battery.

34. Does the servos Battery count for the 200WH limit?

Answer: No.

35. Is it acceptable to have different battery sizes for a particular mission? i.e. Use a larger battery for mission 2 and a smaller battery for mission 3?

Answer: Yes, but all batteries must be approved in tech inspection prior to flight and the heaviest battery configuration must be included in the wing tip test in tech inspection.

36. Do the batteries inside the sensor have to be a rechargeable NiMH, NiCad, or LiPo battery or are we allowed to use disposable (AAA, AA, etc.) batteries?

Answer: Disposable batteries for sensor power are acceptable.
37. For Mission 2 as we increase shipping containers the score gets increased so, should we place a sensor in each shipping container (i.e if 2 shipping containers then should we have 2 sensors?)

Answer: Only one sensor and one shipping container are allowed per team. There is no limit to the number of shipping container simulators. For the Mission 2 score, the “#containers” is the sensor in shipping container plus additional shipping container simulators each team chooses to fly, if any.

38. For mission 3 should we deploy and operate all shipping containers placed for mission 2 or should we deploy and operate one shipping container with one sensor in it?

Answer: For Mission 3, only the sensor inside the shipping container is required in the staging box. Any shipping container simulators used in Mission 2 are not part of Mission 3. For Mission 3, the sensor is removed from the shipping container while in the staging box in the 5 minute staging time and installed inside the airplane along with the deployment and recovery mechanism and prepared for flight. No shipping containers will be in the airplane during Mission 3.

39. Can the sensor be fixed in the fuselage and it's container with magnets? Can the container be mounted in to the fuselage with magnets?

Answer: Magnets are not an acceptable restraint mechanism.

40. In the ground mission must the crewmate load the sensor in its container after removing it from the airplane or can he mount a different pre-prepared sensor in its container in the plane?

Answer: There is no requirement to load the sensor in the shipping container after removal from the airplane at the end of the Ground Mission. The sensor will be removed after drop testing to verify no damage has been incurred and then must be loaded back into the shipping container in preparation for the next phase of the Ground Mission. Only one sensor and one shipping container is allowed per team, so a pre-pared sensor is not allowed.

41. Is active flight stabilization allowed on the plane? Or on the sensor?

Since it it not specified in the rules, could we use a flight controller with IMU?

Answer: No active flight stabilization or flight controller is allowed in DBF.

42. Can the deployment and recovery system be in the mission 2 configuration for the start of the ground mission?

Answer: Yes, it is required to be in the same configuration.

43. Can sensor containers be stored underneath the wings, external to the aircraft?

Answer: No, all payload components must be carried internal to the airplane.

44. For mission 3, if we open the fuselage for the deployment mechanism, do we need to close the fuselage when we recover the mechanism back into the aircraft?

Answer: Yes.

45. In mission 3 (sensor flight) improvement can I improve with longer sensor without repeating mission 2(delivery flight)?

Answer: Once all missions are successfully completed, a single attempt at improving a mission can be made in order the team chooses. For Mission 3, only one sensor is allowed per team, so the only
improvement possible for Mission 3 is to increase the number of laps flown in the 10 minute mission window.

46. Can the plane be placed upside down staging box for the ground mission for easier sensor-loading access?

Answer: The airplane must start the mission in the flight configuration, which means it must be upright in the mission box at the start of the mission. But, the crew member can flip it upside down in order to load the payload.

47. Mission 3 rules state that "After a successful, the sensor will be deployed by remote command and must be fully deployed prior to the first 360 degree turn." Was this supposed to say that the sensor can be deployed after successful takeoff and prior to the first 360 degree turn?

Answer: Correct, the final rules published with team selection announcement has this correction.

48. What is the minimum number of sensors to load/unload in the Ground Mission?

Answer: As stated in the rules, the Ground Mission required the sensor in shipping container plus the maximum number of shipping container simulators approved in tech inspection.

49. According to the DBF rules 2021 competition, the scoring for mission 3 will be evaluated with the following criteria: “M3 = 2 + [N (#laps X sensor length X sensor weight) / Max (#laps X sensor length X sensor weight)], where Max (#laps X sensor length) is the highest #laps X sensor length score of all teams”; the maximum score wouldn’t have into account the variable of the sensor weight? this is because in the description, the variable of the sensor weight does not appear, but in the main formula, it does.

Answer: The draft rules had inadvertently left this out but the final rules published with the team selection announcement included this correction.

50. Just as props may be exchanged between missions, may motors be exchanged between missions?

Answer: No.

51. Can the propulsion batteries be moved within the plane between different missions?

Answer: Yes.