

NALSA REGULATIONS FOR SPEED RECORD ATTEMPTS

Revision 4 June 2012

Overview: These regulations have been updated for top speed attempts for landyachts, iceboats and other hard surface, wind powered craft including additional rules for craft capable of sailing dead downwind (DDW) faster than the wind and dead upwind (DUW) faster than the wind. Categories have been added to differentiate between significantly different craft types. More may be added if there is sufficient interest. The Rule Comments and Definitions have been updated to provide more clarity of the meaning and intent of the rules.

RECORD CATEGORIES

C1) Maximum speed for wind powered craft of any type.

C2) Conventional Sailing craft: Landyachts or iceboats powered by wind only using a conventional sail or wing and sailing on a Natural Surface. There is a record for maximum speed land and another record for maximum speed on ice.

C3) Propeller or turbine powered sailing craft: A record for maximum speed for propeller mode and a separate record for maximum speed in turbine mode.

C4) Dead Down Wind and Dead Up Wind craft: Wind powered craft capable of sailing dead downwind faster than the wind or dead upwind faster than the wind. There is a record for ratio of craft speed to wind speed in propeller mode and a separate record for the ratio of craft speed to wind speed in turbine mode.

RULES FOR SPEED RECORD ATTEMPTS

S1) The yacht shall be propelled by wind energy only.

S2) The yacht shall have no stored energy other than for instrumentation, i.e. small batteries for speedometers or GPSs. Energy shall not be accumulated and later used for propulsion of the yacht or to operate the controls of the yacht. All controls on the yacht will be operated directly by the pilot without consumption of stored energy.

S3) The yacht shall start from a dead stop without assistance from any external source other than humans, on foot, pushing.

S4) No point of the run shall be lower than 3.3 feet from any previous point in the run.

S5) The pilot and crew of a yacht attempting a speed record shall release and hold harmless the North American Land Sailing Association (NALSA), its officers, agents, and members from any and all liability for any damage or injury to their persons or property sustained in such an attempt, whether such damage or injury be due to negligence of said association, its officers or any other cause. The pilot shall accept the responsibility for any damage done to NALSA's, land owners' or observers' property. It is the sole and exclusive responsibility of the pilot to decide whether or not to make their attempt.

S6) All official speed measurements shall be made with a scientifically valid method approved by the NALSA board. The primary speed measurement method must have a measurement uncertainty of 0.25 mph (0.16 kph) or less. In addition to this primary measurement, at least two secondary measurements shall be made by separate systems. All measurement systems will be calibrated. A Measurement Plan that addresses the measurement uncertainty of all measurement methods as well

as the identification and elimination of spurious data will be given to the observers prior to attempting to establish a record.

S7) Two impartial observers, one of whom shall be a NALSA officer, director or someone approved in advance by at least two members of the NALSA Board to represent NALSA, shall observe the record attempts. Their role is to assure that the measurements are scientifically and ethically valid. At least one of the observers will be competent to operate the primary and secondary measurement equipment and confirm its measurement uncertainty.

S8) NALSA Review and ratification: A report of the data from the record setting measurement session will be submitted to the NALSA Board. It will cover the measurement and calibration data from all measurement methods, commentary on spurious data, significant deviations from the measurement plan as well as anything else that is thought to be relevant. A copy of the original measurement plan will be attached. Data for the record run as well as other supporting information will be included. The observers will review this report before submission to the NALSA board. The observers will add a report of their observations especially regarding the scientific and ethical validity of the potential record setting run. The NALSA Board shall review the report and decide if the measurement data is valid and the regulations have been properly complied with. It shall request any supporting information that it believes will be of help. The Board's decision is final.

S9) To be a new record for craft speed the reported value must be at least 1 mph faster than the previous record.

ADDITIONAL RULES FOR DEAD DOWNWIND AND DEAD UPWIND FASTER THAN THE WIND CRAFT (Category C4)

Overview: The following are additional rules for craft that are designed for dead downwind or dead upwind faster than the wind (DDW/DUW) record attempts. A DDW/DUW record will consist of the ratio of craft speed to true wind speed over a 10 second measurement period.

DDW/DUW 10) On the in-run the pilot will steer the craft as close as possible to dead downwind or dead upwind. During the 10 second measurement period, the craft's travel direction, averaged over 10 seconds, will stay within 10 degrees of the 10 second average appropriate wind direction (down wind direction for DDW and up wind direction for DUW).

DDW/DUW 11) The craft speed and ratio of craft speed to wind speed will be calculated over the 10 second measurement period. A competitor, after reviewing the run data, may choose which 10 second period to use as the measurement period. The craft speed must be at least 0.2 mph faster in the tenth second of the measurement period than in the first second.

DDW/DUW 12) The primary wind speed measurement device must have a measurement uncertainty of 3% or less at the wind speed the craft attempts to set a record in. Wind speed will be recorded at 1/2 hz or faster with no averaging by the instrument electronics beyond two seconds. All primary wind speed measurements will be made between propeller hub height and 5 feet above hub height. Primary wind direction measurements will have an uncertainty of 4 degrees or less.

DDW/DUW 13) At least one off board, wind direction and wind velocity instrument that meets the primary instrument requirements must be within 200 feet of the position of the craft during some part of the measurement period.

DDW/DUW 14) All recorded primary instrument data will be time stamped within 1 second to allow correlating measurements.

DDW/DUW 15) To be a new record, the reported value of ratio of craft speed to wind speed must be at least 6% higher than the previous record.

RULE COMMENTS

No specific rules or techniques have been adopted by NALSA for the setup or calibration of measuring devices. It shall be the contestants' responsibility to convince the NALSA Board of Directors that the measurements are scientifically valid. The following discussion will give the contestant guidelines for things the NALSA Board will be considering in validating a claim for a record.

Category C3 has been rewritten to better differentiate between sail/wing powered craft and propeller/turbine driven craft. The category does not have the restrictions associated with DDW and DUW wind sailing. The NALSA board may, at its discretion, disallow craft designs that it believes receive significant drive from features other than a propeller or turbine.

Category C4 has been revised to better define DDW and DUW sailing.

Comment on Rule S2: It is not permissible to use stored energy to propel the yacht or operate its controls. This might include things like compressed gas, stressed springs, batteries, capacitors and flywheels. This includes energy stored before a run or during a run. No pumps, generators or mechanical devices that are intended in part or whole to provide energy to storage devices are permitted. Stored energy in the form of momentum of the yacht, its wheels or other normally moving or flexing parts of the yacht is allowed. These forms of stored energy are inherent in the operation of the yacht and either do not add energy useful for increasing the speed of the yacht or do so in a trivial way.

Comment on S4: This rule was changed in Rev 3 to allow uphill sailing.

Comments on S6: A high performance GPS with data logging is the preferred yacht velocity measurement method. For example the popular Locosys GT31 meets these requirements. The preferred set up to record NMEA sentences 'GGA' and 'RMC' at one hertz. Other NMEA sentences are optional. The top speed will be the average over the measurement period with no spurious data within 30 seconds of the measurement period. The measurement period for categories C1, C2, and C3 is 3 seconds. C4 (DDW or DUW) requires a measurement period of 10 seconds. Other methods such as timing traps or radar have been used in the past but are no longer recommended unless there is good reason why GPS measurements should not be used.

The recommended secondary method for speed is logging GPS. Alternative secondary methods include, non-logging GPSs, speedometers, radar, video recording, etc. The secondary methods should be calibrated or confirmed as being suitable for their intended use. An analysis of the sources and likelihood of spurious measurement data for the primary and secondary measurement methods should be included in the Measurement Plan.

The measurement plan must address calibration, measurement uncertainty, handling of the measurement equipment (eg: to assure it does not get a ride in a fast car in the middle of a measurement session), and handling of the data to assure that false data cannot be substituted. It is preferred that measurements be made without unnecessary filtering (smoothing of the raw data before recording it). If filtering is present it must be explained. A common filter is a 'low speed cut off' that shows a speed of 0 when the speed drops below some value (typically 0.5 or 1 mph). The uncertainty of GPS measurements can be calculated from unfiltered fixed position (static) data.

Comments on S7: The observers should confirm the measurement uncertainty of all primary and secondary measurement methods. The observers may add their own measuring devices. The NALSA board or observers may have any measurement device inspected at any time.

NALSA may request that a competitor cover certain expenses of observers. Payments will be made to the NALSA Treasurer. Comments on S8: A record speed or DDW/DUW boat speed/wind speed ratio will be reported to the nearest 0.1 mph. The rounding rule: xxx.0499 is reported as xxx.0, xxx.05 is reported as xxx.1. All calculations and conversions will be done with at least five significant digits. The conversion factor for miles to kilometers is 0.62137 mi/km. Knots to mph is: $\text{mph} = 1.15078 * \text{knots}$ Comments on DDW/DUW 10: As a practical matter wind direction and speed changes frequently and significantly. This rule is intended to provide sufficient latitude to chase the down wind direction but still demonstrate that the craft is capable of accelerating down wind at angles lower than iceboats, the long reigning champions of this feat

Averaging of data will be centered on the time value in question. For example, if a craft starts a measurement period at 2:15:42 the period will end after 2:15:51. The 10 second average craft direction for 2:15:44 should be the average heading from 2:15:39 through 2:25:48.

Comment on DDW/DUW 11: Requiring the craft to exit the measurement period 0.2 mph faster than it entered is to assure that the craft is capable of extracting more than enough energy from the wind sailed through during the measurement period to sustain its speed in that wind strength.

Comments on DDW/DUW 12: The primary wind speed measurement may be made on a chase vehicle with adjustments for the speed and direction based on GPS and anemometer and wind vane data from the chase vehicle and GPS data from the craft. The adjustments should be made with vector addition of the relevant parameters.

There is not a specific rule for the height of wind direction measurements. Wind direction typically does not show a significant vertical gradient like wind speed usually has. Wind direction measurements should be made at a height that reflects the wind direction at propeller hub height.

Comment on DDW/DUW 13: The off board wind measurement required by DDW/DUW 13 may be either on a chase vehicle or a static position. Onboard wind speed measurements are difficult to make without substantial bias because of the effect of the propeller or turbine. For example with a static 40" propeller (fan) operating in still air with an exhaust velocity of about 10 mph had a 1.5 mph inflow velocity a fan diameter in front of the fan. In light of this, if onboard measurement of wind speed for use as a primary measurement is being contemplated, a convincing explanation will need to be made to the NALSA observers and board.

Comments on DDW/DUW 15: When the first DDW or DUW record is established the results will be as reported. All subsequent records will apply rule DDW/DUW 15.

Comment on S9 and DDW/DUW 15) It is the nature of uncertainty that you can never know the true value of what you are measuring. The record increase increments were made big enough to minimize the probability of the true value of a new record being less than the previous record while, at the same time, not making the increments so big they are unreasonably hard to get over.

DEFINITIONS

- Run: the path traveled from when the craft starts from a stop through the measurement period. The craft must stop in order to start another run. There is no need to end a run by stopping as long as rule S4 is not violated.
- In-run: The part of a run between the start and the beginning of the measurement period.
- Measurement period: The period in which performance is measured (3 seconds for speed records in C1 to C3 or 10 seconds for C4)

- Measurement uncertainty: The probable amount of error in a measurement. Here it is used as the combined uncertainty of a measurement with a coverage factor of one. It is essentially the standard deviation of the error values from multiple measurements. See <http://physics.nist.gov/cuu/Uncertainty/basic.html>. Example: If the measurement uncertainty of an anemometer is 2% of the reading, then about 68% of the measurements will be within +/-2% of the true value.
- Measurement Plan: A full description of the planned measurement process, the uncertainty of the measurement methods, possible sources of spurious measurement data and what actions will be taken to avoid and identify spurious data.
- Accuracy : Replaced by the more meaningful term Measurement Uncertainty
- Calibration: a method for determining the measurement uncertainty of an instrument. For primary measurement instruments, traceability to NIST or similar national standard is desired (but not required).
- Confirmation: a process similar to calibration, but less rigorous, that verifies that a measurement instrument is working properly.
- Bias: error between the average of several measurements and what is believed to be the true value. Example: if 10 bullet holes in a target are grouped within an inch of each other but are four inches from the bulls eye the bias is 4”.
- Natural Surface: Commonly used hard sailing surfaces including dirt and salt playas, beaches and ice but not including manmade surfaces such as runways, roads and rails.
- Primary Measurement Instrument: The instrument that will be used as the official measurement for speed, wind speed or wind direction. The primary instrument does not have to be specified prior to a run.
- Secondary Measurement Instrument: All measuring devices not used as primary instruments. They serve as a verification of the primary measurements. They have no specific measurement uncertainty requirements but shall be a reasonable device for the intended measurement.
- Spurious Data: Measurement data that is outside what would be expected based on the uncertainty of the measurement method. Example: If a GPS has a poor view of the sky or weak batteries it may report wildly wrong speeds.
- Propeller Mode: the use of a propeller driven by the wheels to propel the craft
- Turbine Mode: the use of a turbine to drive the wheels to propel the craft.
- The terms 'yacht' and 'craft' are used interchangeably
- The terms 'regulations' and 'rules' are used interchangeably

If you are planning a record attempt in an existing category we encourage you to establish a dialog with NALSA early in your project so we can assist you in complying with these regulations. If you are interested in a new category, submit a proposal to NALSA when you have a reasonably complete concept of what you want to build. When considering a record for ratification the NALSA board is likely to weight the intent of the rules more than a stretched interpretation of the wording of the rules. Ask questions, if in doubt. See www.nalsa.org for examples of measurement plans and final reports.