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December 1, 2015

Mr. Thomas S. Yager
Vice President
Recreational Off-Highway Vehicle Association
2 Jenner Street, Suite 150
Irvine, CA 92618-3806

Dear Mr. Yager:

On November 2, 2015, U.S. Consumer Product Safety Commission ("CPSC") staff received the Canvass Draft of the proposed American National Standard for Recreational Off-Highway Vehicles, ANSI/ROHVA 1-201X.[1] Staff appreciates the opportunity to comment on the canvass draft and is very pleased to see ROHVA taking significant steps to improve the voluntary standard with the addition of requirements in the areas of lateral stability, vehicle handling, and occupant protection. CPSC staff supports the proposed changes to the voluntary standard and believes the aggregate effect of improved vehicle stability, handling, and occupant protection will reduce injuries and deaths associated with ROV rollovers.

The proposed standard includes significant changes to ANSI/ROHVA 1– 2014 as follows:

- Section 4.17. *Hang Tag* – Modify hang tag information to include tilt table angle at two-wheel lift;
- Section 8.1 *Tilt Table Test* ─ Increase the minimum tilt table angle for vehicle loaded in operator-plus-passenger;
- Section 8.2 (in 2014 standard) *Stability Coefficient (K_{st})* ─ Delete requirement for stability coefficient (K_{st});
- Section 10 Vehicle Handling - Add vehicle handling requirement based on yaw rate gain in a constant steer angle test;
- Section 12.2 *Seat Belt Reminder and Speed-Limiter* ─ Add mandatory seat belt speed-limiter reminder to vehicles equipped with electronic throttle control ;

[1] The comments in this letter are those of the CPSC staff and have not been reviewed or approved by, and may not necessarily reflect the views of, the Commission.

- Section 12.3.2 *ORS Zone Test and Performance Requirements* ─ Increase deflection allowed in Zone 2-Shoulder/Hip performance requirement;

Static Lateral Stability

Tilt Table Stability and Hang Tag

Tilt Table Stability Summary of Draft Provision. Section 8.1Tilt Table Test specifies a procedure to place a vehicle, with test weights to simulate two different test load configurations, on a tilt platform and laterally tilt the platform until the vehicle achieves the minimum tilt angle requirements. A vehicle configured with two occupants must reach a minimum of 33 degrees before lateral tip over to meet the tilt table requirements. A vehicle configured with the maximum number of occupants and full cargo load must reach a minimum of 24 degrees before lateral tip over to meet the tilt table requirements.

In addition, the tilt table test platform is specified with a 1-inch high rail parallel to the tilt axis to engage the side of the downhill tires to prevent the vehicle from sliding during the tilt table test.

Tilt Table Hang Tag Summary of Draft Provision. Section 4.17 Hang Tag requires that every vehicle be sold with a hang tag that provides consumers with the tilt table angle ("TTA") at two-wheel lift ("TWL") for that vehicle when loaded in the operator-plus-passenger configuration and the gross vehicle weight rating ("GVWR") configuration. In addition, the hang tag shall contain the following statements:

1) "Lateral Stability as determined by the manufacturer in accordance with the tilt table lateral stability test in the ANSI/ROHVA standard for Recreational Off-Highway Vehicles."
2) "Training courses to teach ROV driving are available. For information contact your dealer and/or rohva.org.
3) "Check with your dealer to find out about state or local laws regarding ROV operation."
4) "This hang tag is not to be removed before sale."

CPSC Staff's Comments. CPSC contracted SEA Limited ("SEA") to measure the TTA, with and without a 1-inch trip rail, at two-wheel lift of several model year 2014 and 2015 ROVs.[2] The tilt table angles at two-wheel lift ranged from 36.0 to 40.7 degrees.

Based on these test results, staff believes that a TTA of 33 degrees is easy to achieve and should be considered a baseline minimum requirement. Staff believes it is more important to provide information on a vehicle's TTA at TWL to allow consumers to evaluate the stability of the vehicle in comparison with other vehicles. Therefore, staff supports ROHVA's addition of a hang tag that provides consumers with needed safety-related information. CPSC staff

[2] Heydinger, G. (2015) Tilt Table Measurements on Twenty-Two Recreational Off-Highway Vehicles. Retrieved from http://www.cpsc.gov//Global/Research-and-Statistics/Injury-Statistics/Sports-and-Recreation/ATVs/SEAReportTiltTableResults22ROVsSept2015.pdf.

understands that the ROHVA members have not had sufficient time to draft and test hang tag designs. Staff encourages the subcommittee to develop hang tags to convey the following:

1. ROVs that exhibit a higher TTA at two-wheel lift are generally more stable and more resistant to rollovers.
2. Rollovers can occur on a flat surface when ROVs turn too sharply or at too high a speed.
3. Consumers should use the stability metric to compare with other vehicles before they make a purchase.

CPSC staff believes that a hang tag should allow consumers to make informed decisions regarding the stability of ROVs when purchasing an ROV. The hang tag information should also provide a comparison between the rollover resistance of different ROV models. Therefore, the hang tag should be effective at conveying information and must be easily understood by the spectrum of consumers.

CPSC Staff Recommendation #1: Staff recommends that ROHVA form a task group after publication of the revised standard to develop and finalize the hang tag requirements. Staff will actively participate in such a task group.

Staff notes that the center of gravity height of a 95th percentile male in the seated position is approximately 10 inches above the seat, instead of the minimum 6 inches specified in the canvass draft, and 10 inches forward of the seat back.[3]

CPSC Staff Recommendation #2: Staff recommends that the tilt table test methodology include the following to provide additional detail on the test methodology for evaluating TTA at TWL, reducing ambiguity and possible variances in the way the tilt table test is conducted:

- Test occupant weight equivalent requirements with the CG location for each occupant that is 10 inches above the seat and 10 inches forward of the seat back.
- A specific test procedure to measure the TTA at TWL for the operator plus passenger configuration.
- Clarification that the angle measurement of the tilt table needs to be with an accuracy of ± 0.1 degree.

Vehicle Handling

Summary of Draft Provision. Section 10. Vehicle handling introduces a method to: (1) measure and evaluate the extent of oversteer behavior in a vehicle; (2) identify vehicles that could exhibit divergent instability; and 3) establish performance criteria that limit the amount of permissible oversteer.

The test procedure describes a tire break-in procedure, followed by procedures to establish the steer angle required to drive the test vehicle on a 50-foot radius at a slow speed. Once the steer

[3] Schultz, R. et al. (1996) Whole Body Center of Gravity and Moments of Inertia. Retrieved from http://www.dtic.mil/cgi-bin/GetTRDoc?AD=ada328863.

angle is established and the test vehicle's steering wheel is locked at this angle, the driver slowly increases the speed of the vehicle until one of the following occurs:

- The vehicle no longer accelerates, or
- The vehicle achieves two-wheel lift.

The test procedure requires five test runs in the right/clockwise and five test runs in the left/counter-clockwise directions, with instrumentation recording the vehicle speed, yaw rate, and steer angle. Plots of the vehicle's yaw rate versus speed are used to determine the pass/fail criteria for vehicle handling. The proposed test computations calculate the slope of the yaw rate from 0.1 to 0.2 g[4] (a condition when the vehicle is moving slowly around the circle) and the slope of the yaw rate from 0.4 to 0.5 g (a condition when the vehicle is moving around the circle at higher speed). The ratio R is defined as the slope of the yaw rate plot at the end of the test, divided by the slope of the yaw rate plot at the start of the test, as follows:

$$R = \frac{(Y2/V2)}{(Y1/V1)}$$

Where:

Y2/V2 = Linear slope of yaw velocity versus time plot divided by linear slope of vehicle speed versus time plot in region between 0.4 and 0.5 g of lateral acceleration

Y1/V1 = Linear slope of yaw velocity versus time plot divided by linear slope of vehicle speed versus time plot in region between 0.1 and 0.2 g of lateral acceleration

The R values for the five test runs in the right/clockwise direction are averaged for the Final Slope Ratio Right and the R values for the five test runs in the left/counter-clockwise are averaged for the Final Slope Ratio Left. The performance requirements state that no test shall result in two-wheel lift, and the ratio Final Slope Ratio Right and Final Slope Ratio Left cannot exceed a value of 4.5 before 0.5 g of lateral acceleration is achieved.

CPSC Staff's Comments. On June 4, 2015, OPEI provided a pre-canvass draft standard that included requirements for vehicle handling based on measuring the vehicle's yaw rate gain in a constant steer angle test. On August 21, 2015, CPSC staff sent a letter to OPEI, and sent a copy to ROHVA, explaining staff's concerns that the methods used to calculate yaw rate slopes and ratios in a pre-canvass draft version of the vehicle handling requirement did not accurately capture the vehicle's handling and the resulting performance requirement was not effective in preventing divergent instability. In response, ROHVA revised the vehicle handling requirements and staff is encouraged that ROHVA addressed staff's concerns by normalizing the yaw rate data to speed, fully defining the slope regions, and separating the performance of the vehicle in the right/CW and left/CCW directions. In addition, at a public meeting on October 5, 2015, ROHVA member representatives stated that manufacturers will build ROVs with R values below 4.5 due to reproducibility concerns and manufacturing margins and tolerances. Based on ROHVA's efforts in addressing staff's concerns, staff supports ROHVA's vehicle handling requirement specified in the canvass draft.

[4] Acceleration is expressed as a multiple of free-fall gravity (g), which is equal to 9.81 m/s^2 (32.2 ft/s^2).

Staff also recommends that ROHVA specify the tolerances for the location of the center of gravity of the loaded test vehicle.

CPSC Staff Recommendation #3: Staff recommends the following edit to the test methodology in the voluntary standard to improve the standardization of the test methodology:

Add - Section 10.2 Test Vehicle Configuration

h) The center of gravity of the instrumented and loaded test vehicle shall be within 0.5 inch of the center of gravity of the vehicle loaded with an operator and passenger configuration.

Occupant Protection

Seat Belt Reminder/Speed Limitation

Summary of Draft Provision. Section 12.2.2 Seat Belt Reminder System Performance requires a seat belt reminder system that limits the vehicle's maximum speed to 15 mph if the driver's seat belt is not buckled. The proposal specifies a maximum speed test on level ground with the vehicle loaded in the curb weight plus one operator configuration. The vehicle speed cannot exceed 15 mph with the driver's seat belt unbuckled, thus increasing seat belt use by motivating the driver to use the seat belt to achieve higher vehicle speed.

CPSC Staff's Comments. CPSC staff supports ROHVA's effort to strengthen significantly the occupant protection of ROVs by requiring a seat belt reminder system that limits the speed of the ROV to 15 mph if the driver's seat belt is unbuckled.

Seat Belts

Summary of Draft Provision. Section 12.1 Seat Belts requires a Type 2, 3-point seat belt (lap/shoulder belts) that conforms to SAE J2292, *Combination Pelvic/Upper Torso (Type 2) Operator Restraint Systems for Off-Road Work Machines*. There is no requirement for Emergency Locking Retractors (ELR) which lock the seat belt when the vehicle tilts to a specified angle, determined by the manufacturer.

CPSC Staff's Comments. On July 7, 2015, CPSC staff sent a letter to OPEI, and provided a copy to ROHVA, explaining staff's concerns that the seat belt requirements in a pre-canvass draft version of the voluntary standard appeared to allow manufacturers to omit ELR technology in seat belts. Staff provided results from roll simulation tests showing that a seat belt without ELR technology did not lock during a 90 degree roll, and consequently failed to restrain an occupant during a simulated rollover event.

SEA roll simulator testing showed that ROVs without a solid shoulder retention barrier and a tilt sensing ELR could result in the occupant coming out of the safety zone during a 45-degree roll over. Vehicle H shown in Figure 1 does not have a passive shoulder barrier, nor was it equipped with a tilt sensing ELR. CPSC staff's testing of Vehicle H shows that the seat belt does not lock

throughout a 90-degree tilt range. Figure 2 shows the seat-belted occupant coming out of the protective zone of the rollover protective structure ("ROPS") during a simulated roll over.

Figure 31: Vehicle H Side View

Figure 1. Vehicle H with shoulder and lap belt, without shoulder barrier.

Figure 32: Occupant H at 45° Roll

Figure 2. Occupant coming out of the safety zone during a simulated roll over. Seatbelt does not have a tilt sensing ELR.

SEA roll simulator testing showed that vehicles with tilt sensing ELR performed better. Vehicle C, shown in Figure 3, does not have a passive shoulder barrier but was equipped with a tilt sensing ELR. CPSC staff test of Vehicle C shows that the seatbelt locks at approximately 53-degree tilt angle. By cross-referencing the lateral acceleration seen in the SEA sled tests with the acceleration associated with the locking angle of the inertial seat belt, the inertial spool lock engaged at approximately 10 degrees of vehicle roll. Figure 4 shows the occupant remaining in the protective zone of the ROPS during a simulated roll over.

Figure 23: Vehicle C Side View

Figure 3. Vehicle C with shoulder and lap belt, without shoulder barrier.

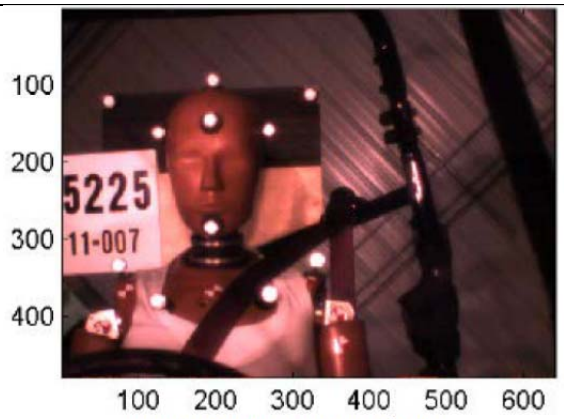

Figure 24: Occupant C at 45° Roll

Figure 4. Occupant remaining in the safety zone during a simulated roll over. Seatbelt has a tilt sensing ELR.

CPSC staff believes that the combination of the belt routing and the tilt sensing ELR contributed to limit occupant excursion.

CPSC Staff Recommendation #4: Staff recommends that ROHVA include a seat belt requirement for ELR with a locking angle determined by the manufacturer based on the vehicle's use, as recommended in the CPSC staff letter to ROHVA and OPEI on October 15, 2015.

Occupant Side Retention Devices

Summary of Draft Provision. Section 12.3.1.2 and 12.3.2.2 Zone 2- Shoulder/Hip require passive barriers/structures or single-hand operation barriers in the shoulder/hip area of vehicle to prevent arms and legs from entering pinch points of the vehicle in the event of rollover. The barriers must withstand an outward force of 163 lbf and not deflect more than 4 inches past the vehicle width. The force is applied through a 3 inch diameter disk-shaped probe at a point that is 17 inches above the occupant seat and 6 inches forward of the seat back. The canvass draft increases the allowable deflection in the probe test from 2 inches (in the 2014 version of ANSI/ROHVA 1) to 4 inches, and the rationale provided in Annex A states that a net with 4 inches of deflection accomplishes the goal of side retention.

CPSC Staff's Comments. The occupant retention system requirements in ANSI/ROHVA 1-2014 (the latest revision of the voluntary standard for ROVs published in October 2014) specify a performance requirement for the shoulder/hip barrier that limits the allowable barrier deflection during a probe test to 2 inches, instead of the 4 inch deflection proposed in the canvass draft. Specifically, ANSI/ROHVA 1-2014 states:

> **Section 11.3.2.2 Zone 2 – Shoulder/Hip**. Barriers and structures for Zone 2 shall be capable of withstanding a horizontal, outward side force of 725 N (163 lbf), applied for 10 seconds at points R and R2 and any point in between and shall be tested at points R for a fixed seat and R2 for an adjustable seat. There shall be no deflection greater than 50 mm (2 in) past the width of the ROV upon application and removal of the force. The two planes determining the width of an ROV are shown in Figure 10 and are defined by the widest hard points on the ROV.

CPSC staff performed rollover simulations, with and without side barriers, and tests showed that a belted occupant is likely to remain within the protection zone of the rollover protective structure ("ROPS") if a rigid barrier is in place near the occupant's shoulder. Staff believes a barrier that deflects less than 2 inches, as published in the ANSI/ROHVA 1-2014 standard, will perform as well as the vehicles with rigid shoulder barriers tested in the roll simulation tests.

Staff is confident that robust shoulder barriers and seat belts will keep occupants contained within the vehicle during quarter-turn rollover events; therefore, staff supports ROHVA's shoulder/hip zone requirements in the canvass draft. However, staff does not have any data to evaluate the effectiveness of a side barrier that deflects more than 2 inches and up to 4 inches. Staff plans to conduct future roll simulation tests of model year 2014-2015 vehicles with passive and one-hand operation barriers, and plans to study the effects of nets with 4 inches of displacement. The results of these future tests will then be used to inform any possible staff recommendations to future improvements to the voluntary standard.

In summary, CPSC staff supports the proposed changes to the voluntary standard and believes the aggregate effect of improved vehicle stability, handling, and occupant protection will reduce injuries and deaths associated with ROV rollovers.

Thank you for this opportunity to comment. CPSC staff looks forward to continued communication with ROHVA regarding the ANSI/ROHVA 1-201X draft standard. If you have any questions or comments, please feel free to contact me.

Sincerely,

Caroleene Paul

cc: Scott Heh, CPSC Voluntary Standards Coordinator