UNITED STATES
CONSUMER PRODUCT SAFETY COMMISSION
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Memorandum

Date: October 17, 2014

TO : The Commission
Todd Stevenson, Secretary

THROUGH: Stephanie Tsacoumis, General Counsel
DeWane Ray, Deputy Executive Director

FROM : George Borlase, Assistant Executive Director
Office of Hazard Identification and Reduction
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Directorate for Engineering Sciences

SUBJECT : Supplemental Information on Recreational Off-highway Vehicles (ROVs).

This memorandum provides supplemental information on recreational off-highway vehicles (ROVs). Specifically, CPSC staff's responses to three subjects are addressed:

1. Effect of ANSI/ROVHA 1-2014 on staff's recommendations in notice of proposed rulemaking (NPR) package for recreational off-highway vehicles (ROVs) dated September 24, 2014.
2. Letter from Recreational Off-Highway Vehicle Association (ROHVA) dated July 31, 2014.
3. ROHVA presentation dated September 30, 2014.

1. ANSI/ROHVA 1-2014

On September 24, 2014, U.S. Consumer Product Safety Commission (CPSC) staff forwarded a briefing package to the Commission recommending that the Commission issue an NPR concerning recreational off-highway vehicles (ROVs) to address the risk of injury associated with the use of ROVs. On the same day, ANSI/ROHVA approved an updated voluntary standard. The updated voluntary standard is identical in all respects to the proposed revision of the voluntary standard that ROHVA circulated in March 2014. For the reasons set forth below, and as discussed in additional detail in the briefing package, staff believes that the newly approved voluntary standard will not adequately reduce the risk of deaths and injuries associated with ROV-related incidents because the standard does not increase the lateral stability of ROVs, does not correct oversteer handling in ROVs, and does not increase the occupant protection performance of ROVs.

When CPSC staff forwarded the briefing package to the Commission, ANSI/ROVHA 1-2011 *American National Standard for Recreational Off-Highway Vehicle* was the most current version of the voluntary standard for ROVs developed by ROHVA. However, staff was aware that

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ROHVA had proposed a revision of ANSI/ROHVA 1-2011 in a canvass ballot dated March 13, 2014.

Staff commented on ROHVA's proposed revisions to ANSI/ROHVA 1-2011 in a letter dated May 23, 2014. In that letter staff expressed the following concerns:

- The proposed method to measure lateral stability does not correspond to the rollover resistance of ROVs.
- The proposed hang tag does not provide information on the rollover resistance of ROVs to consumers.
- The rejection of a vehicle handling requirement allows sub-limit oversteer handling of ROVs that CPSC test data have shown can lead to an unstable condition where lateral acceleration increases suddenly and exponentially.
- The proposed seat belt reminder system that limits the speed of the vehicle to 15 mph if the driver's seat belt is unbuckled should be mandatory, not optional, and should include the seat belt status of occupied front passenger seats.

CPSC staff also assessed ROHVA's proposed new standard requirements in Section V of the NPR briefing package forwarded to the Commission.(See pages 64 to 69).

On September 24, 2014, ANSI approved the proposed revisions to ANSI/ROVHA 1-2011. Staff obtained a pre-publication copy of ANSI/ROHVA 1-2014 and compared the requirements with the proposed requirements that were balloted. Staff found that the requirements for dynamic stability, hang tag, vehicle handling , and occupant protection are identical to the requirements that were in the canvass ballot dated March 13, 2014, that staff had assessed in the briefing package. Therefore, staff's analysis of ROHVA's requirements for lateral stability, vehicle handling, and occupant protection has not changed from the assessment made in the briefing package. Staff finds that the ANSI/ROHVA 1-2014 standard will not adequately reduce the risk of injuries and deaths when the standard is in effect in model year 2017.

2. Letter from ROHVA to CPSC staff dated July 31, 2014

As mentioned previously, staff commented on ROHVA's proposed revisions to ANSI/ROHVA 1-2011 in a letter dated May 23, 2014. On July 31, 2014, ROHVA responded to staff's letter. In drafting the briefing package, staff took into consideration ROHVA's views on lateral stability, vehicle handling, and occupant protection as presented in its July 31, 2014 letter. A summary of ROHVA's positions and staff's consideration of those positions are detailed below.

<u>Dynamic Stability</u>

ROHVA comment: ROHVA believes that evaluating whether two-wheel lift occurs at a specified steering wheel input angle of 110 degrees is the preferable approach to assess sufficient dynamic lateral stability rather than measuring peak lateral acceleration at two-wheel lift.

CPSC staff response: CPSC staff's test data demonstrate that 110 degrees of steering wheel angle input in ROHVA's J-turn test does not correspond to rollover resistance, as measured by the lateral acceleration at two-wheel lift (A_y). Vehicle test engineers commonly measure lateral acceleration to characterize the vehicle rollover stability. Vehicle velocity, lateral acceleration, and steering wheel angle are basic test parameters that are specified in accepted standards such as:

- SAE J266 Surface Vehicle Recommended Practices, Steady-State Directional Control Test Procedures for Passenger Cars and Light Trucks.
- ISO 7401, Road vehicles – Lateral transient response test methods- Open-loop test methods.
- Federal Motor Vehicle Safety Standard (FMVSS) No. 126 to require electronic stability control (ESC) systems on passenger cars.

Steering wheel input angle does not assess rollover resistance because the A_y of a vehicle is a constant and steering wheel input angle at two-wheel lift varies according to factors that are specific to each vehicle. These factors include:

- The steer ratio of the vehicle determines the steering angle of the tire; therefore, two vehicles with dissimilar steering ratios will have different steering angles at the front tires (and generate different lateral accelerations) at the same steering wheel angle input.
- Vehicle handling affects how quickly a vehicle reaches a rollover condition; therefore, two vehicles with dissimilar vehicle handling will reach different lateral accelerations at the same steering wheel angle input.
- Tire wear, surface slope, and wind conditions can affect the amount of steering wheel angle input required to induce two-wheel lift of an ROV; therefore, a vehicle may or may not exhibit two-wheel lift at the same steering wheel angle input.

The results of J-turn tests conducted by CPSC contractor, SEA Limited (SEA), on 10 sample ROVs in terms of steering wheel angle and A_y are shown in Figure 1. The coefficient of determination between steering wheel angle and Ay is R^2=0.42, which indicates that steering wheel angle describes less than half of the variability in A_y and that steering wheel angle is not a surrogate for A_y for the 10 ROVs tested by SEA. More importantly, the reasons why steering wheel angle does not correspond to A_y demonstrate that steering wheel angle is not an appropriate measure of ROV rollover resistance

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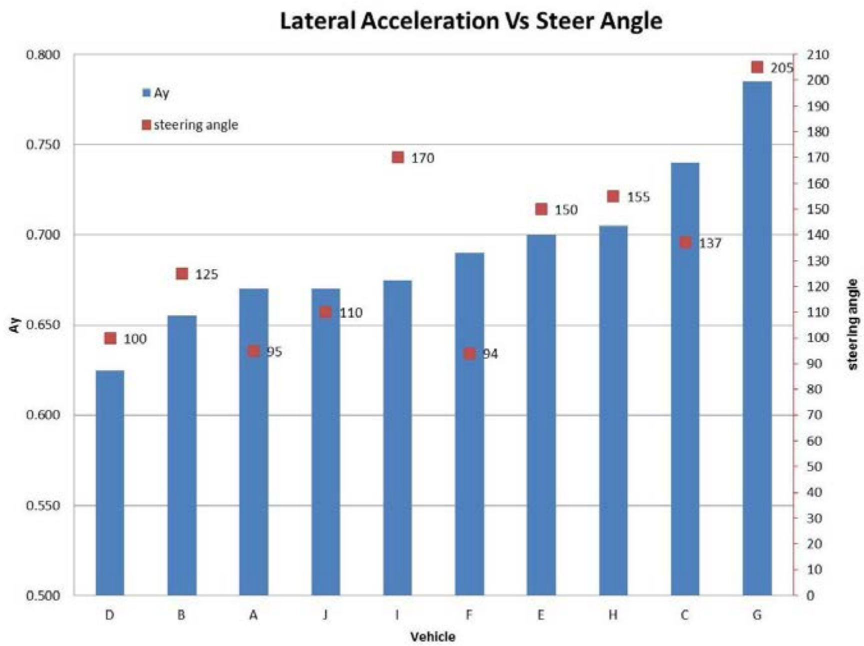

Figure 1. Lateral Acceleration and Steering Wheel Angle at Two-Wheel Lift for 30 mph J turn.
Adapted from: Heydinger, G. (2011) Vehicle Characteristics Measurements of Recreational Off-Highway Vehicles – Additional Results for Vehicle J. Retrieved from http://www.cpsc.gov/PageFiles/93928/rovj.pdf.

ROHVA's 110-degree J-turn test limits the performance evaluation of the ROV to one specific input maneuver. This maneuver could be evaluating the ROV near two-wheel lift or well below this limit. Therefore, the ROHVA J-turn measure has no relationship to the ROV rollover resistance. In contrast, the rollover resistance, as measured by the lateral acceleration at two-wheel lift, indicates when the ROV will roll over in *any* turning maneuver, irrespective of steering wheel input angle or how the lateral acceleration was generated.

SEA's test data demonstrate that ROHVA's 110-degree J-turn test is less stringent than CPSC staff's recommended J-turn test.[1] Table 1 shows the average lateral acceleration and steering wheel angle measured at two-wheel lift for the 10 ROVs tested by SEA. Vehicles D, B, and I pass the ANSI/ROHVA J-turn test, and each vehicle has a rollover resistance that is comparable to, or less than, the rollover resistance of an unrepaired Yamaha Rhino (Vehicle A). In addition, staff has no confidence that Vehicle J fails the ANSI/ROHVA J-turn tests because steering wheel angle at two-wheel lift is highly variable, and the vehicle is on the borderline of the pass/fail value of 110 degrees. Therefore, staff believes Vehicle J may pass the ANSI/ROHVA J-turn test, and Vehicle J has a rollover resistance comparable to an unrepaired Yamaha Rhino ROV (Vehicle A).

[1] Heydinger, G. (2011). Vehicle Characteristics Measurements of Recreational Off-Highway Vehicles – Additional Results for Vehicle J. Retrieved from http://www.cpsc.gov/PageFiles/93928/rovj.pdf.

Table 1. Summary of Rollover Resistance (A_y) and Steering Wheel Angle Required for Two-Wheel lift in 30 mph J-turn.

Vehicle	Ay (g)	Steering Angle (deg)
F	0.690	94
A	0.670	95
J	0.670	110
D	0.625	122*
B	0.655	125
C	0.740	138
E	0.700	150
H	0.705	155
I	0.675	170
G	0.785	205

ROVs with Ay equal to or lower than unrepaired Yamaha Rhino (Vehicles D, B, I)

ROVs that pass ANSI/ROHVA J-turn test (Vehicles D, B, C, E, H, I, G)

* This value has been updated to the steering angle measured with new tires on the ROV

Adapted from: Heydinger, G. (2011) Vehicle Characteristics Measurements of Recreational Off-Highway Vehicles – Additional Results for Vehicle J. Retrieved from http://www.cpsc.gov/PageFiles/93928/rovj.pdf.

Figure 2 shows the average lateral acceleration versus the average steering wheel angle for Vehicles B, E, and I (each vehicle passes the ANSI ROHVA J-turn test), illustrating the wide range of lateral acceleration corresponding to the steering wheel angle of 110 degrees.

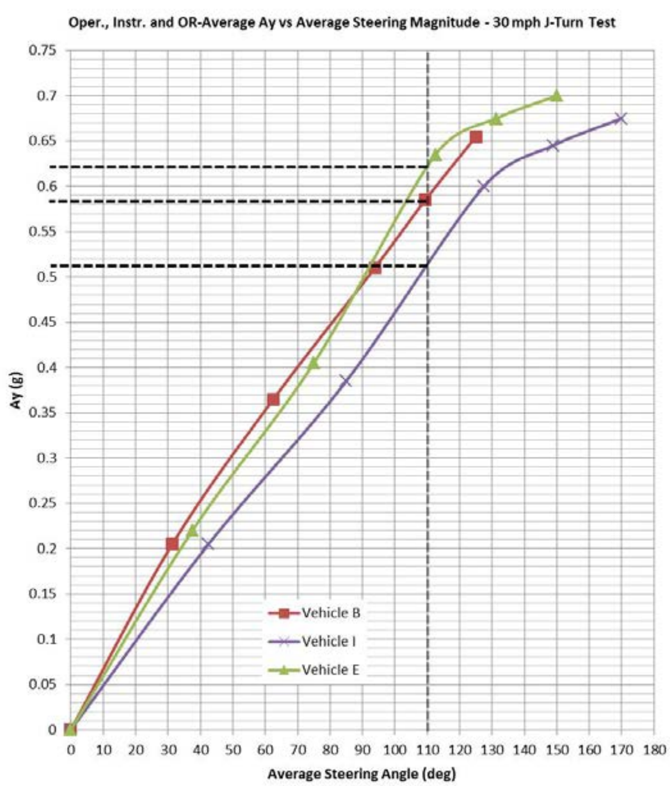

Figure 2. Average lateral acceleration versus average steering wheel angle for Vehicles B, I, and E, as measured during a 30 mph J-turn test.

Adapted from: Heydinger, G. (2011) Vehicle Characteristics Measurements of Recreational Off-Highway Vehicles. Retrieved from http://www.cpsc.gov/PageFiles/96037/rov.pdf. Appendix B.

For each of these vehicles at a steering wheel angle of 110 degrees, the corresponding lateral acceleration (A_y) can be estimated as shown by the dashed lines.[2] At 110 degrees of steering wheel angle, the corresponding lateral accelerations were:

- Vehicle I had a lateral acceleration of less than 0.52 g
- Vehicle E had a lateral acceleration of less than 0.59 g
- Vehicle B had a lateral acceleration of 0.63 g

Of the 10 ROVs tested, none exhibited a lateral acceleration at two-wheel lift that was less than 0.6 g. For this reason, CPSC staff is concerned that ROHVA's 110-degree J-turn requirement could result in ROVs with very low rollover resistance.

ROHVA comment: ROHVA states that ROHVA's proposed steering wheel angle J-Turn test is highly repeatable and reproducible, in part, because the test does not force vehicles to their limit and then measure their response. ROHVA states that the test is straightforward to conduct because the pass/fail metric is whether two-wheel lift occurs.

CPSC staff response: ROHVA has provided no data demonstrating that ROHVA's 110-degree J-turn test is repeatable and reproducible. In contrast, CPSC staff believes SEA's test results demonstrate that steering wheel angle at two-wheel lift is not a repeatable metric. In 2013, SEA conducted J-turn tests on Vehicles D, E, G, and J to study the repeatability of lateral acceleration measurements at two-wheel lift. Table 2 shows the SEA J-turn test data for Vehicles D, E, G and J as measured on different test dates. The data show that steering wheel angle at two-wheel lift may not be repeatable. For example, initial test data for Vehicle D indicated two-wheel lift occurred at 100 degrees of steering wheel angle when the ROV was tested in 2010. However, when repeatability tests were conducted in 2013 with new tires on the same ROV, two-wheel lift occurred at 122 degrees of steering wheel angle. The 22 percent difference in measured steering wheel angle at two-wheel lift illustrates the possible variability in ROHVA's pass/fail parameter. Table 2 also shows the variable steering wheel angle measurements for Vehicles E, G, and J at two-wheel lift.

Table 2. Comparison of steering wheel angle (deg) required for two-wheel lift in 30 mph J-turn measured for Vehicles D, E, G, and J on different test dates.

Vehicle	Steering Wheel Angle (deg) SEA report 2011	Steering Wheel Angle (deg) SEA report 2013	Difference in Steer Angle (deg)	Percent Difference from First Measurement
D	100	122	22	22%
E	150	164	14	9%
G	205	210	5	2.5%
J	110	105	-5	-4.5%

Adapted from: Heydinger, G. (2011). Vehicle Characteristics Measurements of Recreational Off-Highway Vehicles – Additional Results for Vehicle J. Appendix B. Retrieved from http://www.cpsc.gov/PageFiles/93928/rovj.pdf. and Heydinger, G. (2013). Repeatability of J-Turn Testing of Four Recreational Off-Highway Vehicles. Appendix E. Retrieved from http://www.cpsc.gov//Global/Research-and-Statistics/Injury-Statistics/Sports-and-Recreation/ATVs/SEAReporttoCPSCRepeatabilityTestingSeptember%202013.pdf..

[2] CPSC staff recognizes that the value taken from the graph is not the exact lateral acceleration value at a 110-degree J-turn, however we believe it is a good approximation of how the tested vehicles would perform in the 110-degree ROHVA J-turn.

SEA also conducted J-turn tests to compare the lateral acceleration value at two-wheel lift for worn tires and new tires on Vehicle D (see Table 3). The steering angle at two-wheel lift for Vehicle D when tested with new tires was 122.5 degrees and the steering angle when tested with worn tires was 102.5 degrees. Staff believes the difference in steering wheel angle at two-wheel lift indicates that steering angle is strongly dependent on tire condition. In contrast, the lateral acceleration at two-wheel lift is independent of steering wheel angle and tire conditions.

Table 3. Effects of Worn Tires and New Tires on steering wheel angle (deg) and Lateral Acceleration A_y required for two-wheel lift in 30 mph J-turn for Vehicle D.

Vehicle D, 30 mph dropped throttle J-turn test	Average Steering Angle (deg)	Percent Difference (steer angle)	Average A_y (g)	Percent Difference (A_y)
Worn Tires	102.5	19.5%	0.639	-1.2%
New Tires	122.5	-16.3%	0.631	1.3%

Adapted from: Heydinger, G. (2013). Repeatability of J-Turn Testing of Four Recreational Off-Highway Vehicles. P. 17, 63-72. Retrieved from http://www.cpsc.gov//Global/Research-and-Statistics/Injury-Statistics/Sports-and-Recreation/ATVs/SEAReporttoCPSCRepeatabilityTestingSeptember%202013.pdf

ROHVA comment: ROHVA states that ROHVA has concerns with staff's recommended dynamic stability performance test because, ROHVA states, peak lateral acceleration is not an easy-to-measure, repeatable metric for an off-highway vehicle standard test.

CPSC staff response: Staff believes the data collected from SEA's study, "Repeatability of J-Turn Testing of Four Recreational Off-Highway Vehicles," clearly refute the notion that measurement of peak lateral acceleration is either difficult to measure or non-repeatable from test to test. SEA conducted J-turn tests on Vehicles D, E, G, and J in sets of 10 runs in opposite longitudinal directions and in both lateral (left and right) directions. For the set of 10 runs, the standard deviation, which is a measure of repeatability, ranged from 0.0002 g to 0.013 g. The average of the standard deviations from all of the 10 run sets is 0.006 g. These results evidence the high level of repeatability of the A_y measurement.

SEA also compared the measurements of lateral acceleration at two-wheel lift for Vehicles D, E, G, and J with past measurements taken on different dates. As shown in Table 4, the lateral acceleration values varied by 4 percent or less. In contrast, as mentioned previously, the variability in ROHVA's proposed steering wheel angle measurement was up to 22 percent, for Vehicle D at two-wheel lift.

Table 4. Lateral Acceleration At Two-Wheel Lift (A_y) Values Compared to Previously Reported Values

Vehicle	A_y (g) SEA report 2011[3]	A_y (g) SEA report 2013[4]	Difference in A_y	Percent Difference from First Measurement
D	0.625	0.631	0.006	1 %
E	0.700	0.703	0.003	0.4 %
G	0.785	0.769	-0.016	-2.0 %
J	0.670	0.643	-0.027	-4.0 %

Adapted from : Heydinger, G. (2013). Repeatability of J-Turn Testing of Four Recreational Off-Highway Vehicles. Retrieved from http://www.cpsc.gov//Global/Research-and-Statistics/Injury-Statistics/Sports-and-Recreation/ATVs/SEAReporttoCPSCRepeatabilityTestingSeptember%202013.pdf.

As staff has noted previously and on multiple occasions, the J-turn test is a common test conducted by vehicle manufacturers and vehicle dynamics test laboratories,[5] which are well versed in instrumentation, data processing, and data analysis. CPSC staff believes that vehicle test engineers commonly measure vehicle velocity, acceleration, roll, and steering wheel angle to characterize the vehicle and aid the engineers in the design process.

The rollover resistance of an ROV is defined by the lateral acceleration measured at two-wheel lift because the ROV vehicle *rolls over after this value is exceeded*. Not only has staff proved that the threshold lateral acceleration value is easily measured in a J-turn test, staff also has proven that the results are repeatable and independent of variable factors, such as steering wheel angle input or tire wear conditions.

ROHVA comment: ROHVA states that the SEA repeatability testing results raised additional repeatability concerns. ROHVA suggests that SEA excluded runs in which two-wheel lift did not occur "to compensate for the variation in testing outcome."

CPSC staff response: The purpose of SEA's testing, as explained in SEA's test report, was to measure threshold lateral acceleration at two-wheel lift.[6] If an ROV does not exhibit two-wheel lift, the lateral acceleration threshold *cannot be measured* because the incipient rollover event did not occur. Therefore, test runs in which two-wheel lift did not occur were not used in the study because the value being studied was not reached.

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[3] Heydinger, G. (2011). Vehicle Characteristics Measurements of Recreational Off-Highway Vehicles – Additional Results for Vehicle J. Appendix B. Retrieved from http://www.cpsc.gov/PageFiles/93928/rovj.pdf.
[4] Heydinger, G. (2013). Repeatability of J-Turn Testing of Four Recreational Off-Highway Vehicles. Appendix E. Runs 211, 212, 213, 214, 216, 218, 219, 220, 221, 223, 224, 225. Retrieved from http://www.cpsc.gov//Global/Research-and-Statistics/Injury-Statistics/Sports-and-Recreation/ATVs/SEAReporttoCPSCRepeatabilityTestingSeptember%202013.pdf.
[5] Boyd, P. (2005). NHTSA's NCAP Rollover Resistance Rating System. Paper Number 05-0450. p. 4. Retrieved from http://www-nrd.nhtsa.dot.gov/pdf/esv/esv19/05-0450-O.pdf.
[6] Heydinger, G. (2013). Repeatability of J-Turn Testing of Four Recreational Off-Highway Vehicles. Retrieved from: http://www.cpsc.gov//Global/Research-and-Statistics/Injury-Statistics/Sports-and-Recreation/ATVs/SEAReporttoCPSCRepeatabilityTestingSeptember%202013.pdf.

ROHVA comment: ROHVA states that the filtering technique used by SEA in its post-processing of the data was subjective and affected the accuracy of the lateral acceleration value measurement. ROHVA states that in SEA's original ROV testing for CPSC, SEA used a 5 Hz 8^{th}-Order Butterworth filter, but in SEA's lateral acceleration repeatability testing, SEA used a 2 Hz Butterworth filter. ROHVA states that the filtering technique can have a material effect on the value selected as the "peak lateral acceleration."

CPSC staff response: Filtering of raw data is a customary practice used to separate data signals that the tester is interested in from "noise." For example, SAE J266 *Steady-State Directional Control Test Procedures for Passenger Cars and Light Trucks* explains the filtering process to ensure that noise is correctly filtered from the data in tests conducted to measure vehicle handling. As explained in Appendix D of SEA's report, "Repeatability of J-Turn Testing of Four Recreational Off-Highway Vehicles," SEA filtered the raw data gathered during testing to separate the data signals that the test was measuring, *i.e*., the lateral acceleration generated during a turn, from data signals that the tester is not interested in, such as engine vibration.[7] SEA studied the effect of using a 10 Hz, 5 Hz, and 2 Hz filter to plot the lateral acceleration at two-wheel lift. Because the fundamental frequency of the lateral acceleration was below 1 Hz, the data curves for the 10 Hz, 5 Hz, and 2 Hz filters were essentially on top of each other.

The difference between using a 5 Hz filter and 2 Hz filter relates to SEA's method of selecting the lateral acceleration value from the curve plot. The 5 Hz method requires the data analyst to manually select the value by visual inspection; the 2 Hz method uses a computer algorithm to select the value. SEA found that both methods produce the same lateral acceleration value and there was no material effect on the value of peak lateral acceleration due to filtering.

ROHVA comment: ROHVA states that its contractor, Carr Engineering, Inc., was unable to reproduce SEA's results of the Lateral Acceleration J-turn testing.

CPSC staff response: CPSC staff has requested the full data set and report generated by Carr Engineering Inc. (CEI), for ROHVA and is interested in better understanding ROHVA's argument regarding the non-reproducibility of the J-Turn Lateral Acceleration test. Thus far, ROHVA has not made details of its studies available to CPSC staff and has only provided limited J-turn plots without a full description of the test parameters. CPSC staff and SEA investigated the limited J-turn plots that were presented to CPSC Commissioners[8] and found that the lateral acceleration plots: (1) show values that oscillate in a way that is inconsistent with the generally linear increase of lateral acceleration during a J-turn test, and (2) show values that exceed the rollover resistance of the ROV, as defined by its track width and center of gravity, or

[7] Heydinger, G. (2013). Repeatability of J-Turn Testing of Four Recreational Off-Highway Vehicles. Appendix D. Retrieved from http://www.cpsc.gov//Global/Research-and-Statistics/Injury-Statistics/Sports-and-Recreation/ATVs/SEAReporttoCPSCRepeatabilityTestingSeptember%202013.pdf.

[8] Presentation titled "ROHVA Update: Standards Development and Safety Programs" Retrieved from http://www.cpsc.gov/Global/Regulations-Laws-and-Standards/Voluntary-Standards/ROHVA/ROHVAMtgLogwithPresentation111011.pdf., Presentation titled "ROHVA/CPSC Technical Discussion" Retrieved from http://www.cpsc.gov/Global/Newsroom/Public-Calendar/Meeting-Logs/2012/071912MtgLogROHVACPSC.pdf., and Appendix to ROHVA Responses to CPSC Staff Questions. May 1, 2012. Retrieved from http://www.regulations.gov/#!documentDetail;D=CPSC-2009-0087-0126.

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its static stability factor (SSF). An ROV's rollover resistance cannot exceed its SSF value. Based on these findings, CPSC staff is unable to evaluate the merits of these data plots as evidence for the reproducibility or non-reproducibility of the J-turn test.

ROHVA comment: ROHVA states that ROHVA asked CPSC to arrange reproducibility testing of at least 10 test runs per vehicle, to be conducted by a different testing entity, on a different day, and at a different location. However, ROHVA states that such testing has not occurred.

CPSC staff response: On October 25, 2012, ROHVA sent CPSC staff a letter expressing ROHVA's concerns regarding the repeatability of the J-turn test based on discussion at a public meeting between CPSC staff and ROHVA on July 19, 2012. On April 13, CPSC staff held a public meeting at the Transportation Research Center in East Liberty, Ohio. At this meeting, SEA demonstrated the repeatability of the J-turn tests and explained the test procedure and data processing to ROHVA member engineers. CPSC staff requested that ROHVA conduct its own J-turn tests and allow CPSC and SEA staff to attend. It was staff's understanding that ROHVA and CPSC staff were working together to resolve concerns regarding repeatability and reproducibility. To staff's knowledge, ROHVA did not perform these J-turn tests and did not invite staff to attend.

ROHVA comment: ROHVA states that the 110-degree J-turn maneuver reflects real-world use and provides a rationale for the 110-degree steer angle value. ROHVA's rationale is based on supposition regarding how an inexperienced ROV driver would avoid an unexpected obstacle while driving on a trail.

CPSC staff response: ROHVA's rationale and justification for a single input of 110 degrees in a 30 mph J-turn is speculative. A test method that relies on a single-steer input that is not related to the actual rollover resistance of the vehicle is inadequate. Although turning a steering wheel to 110 degrees is a constant input regardless of the ROV model, the amount that the tires turn, and therefore, the lateral acceleration generated, is not independent of the ROV model because each model has a different steer ratio. Data on the real-world use of ROVs indicate that the rollover resistance of ROVs is exceeded (68 percent of reported, ROV-related incidents involved rollover) and often occurs while the vehicle is in a turn (52 percent of rollover incidents).[9] A turn of 110 degrees is not a large steering input, especially in comparison to a U-turn maneuver that is a common method of reversing vehicle direction. Staff is aware of several incidents in which the ROV rolled over while the operator was making a U-turn on level ground (IDI 091130CBB3125, IDI 130104HCC3274, IDI 101201HCC3228). Given the myriad conditions that occur in real-world incidents, staff believes ROHVA's method of testing a single unrepeatable input maneuver does not adequately address the risk of deaths and injuries associated with ROV rollovers.

[9] Garland, S. (2012). Analysis of Reported Incidents Involving Deaths or Injuries Associated with Recreational Off-Highway Vehicles (ROVs). Briefing Package Proposed Rule on Safety Standard for Recreational Off-Highway Vehicles (ROVS). Tab D. Retrieved from: http://www.cpsc.gov/Global/Newsroom/FOIA/CommissionBriefingPackages/2014/SafetyStandardforRecreationalOff-HighwayVehicles-ProposedRule.pdf.

ROHVA comment: ROHVA states a J-turn with a lateral acceleration pass/fail metric does not reflect real-world use because ROHVA believes the lateral acceleration value at two-wheel lift does not evaluate how a vehicle behaves in normal or realistic operating situations and does not predict the likelihood of a rollover incident in off-highway conditions.

CPSC staff response: Thomas Gillespie's text book, *Fundamentals of Vehicle Dynamics*, defines "rollover" in a vehicle as the point when the roll generated by lateral acceleration overcomes the vehicle's counter balance.[10] The lateral acceleration at which rollover begins is the "rollover threshold" and represents the vehicle's resistance to rollover. The value of the lateral acceleration at two-wheel lift for a vehicle is independent of variable factors like steering wheel angle input, and irrespective of how the value is reached, the vehicle will roll over when that vehicle's rollover resistance is exceeded. The physics of rollover, an object with higher rollover resistance is harder to roll over than an object with lower rollover resistance, refute ROHVA's statement that rollover resistance does not relate to real-world rollovers of ROVs because an ROV rolls over when its rollover resistance is exceeded.

ROHVA comment: ROHVA states that there is no reasonable basis for a pass/fail threshold of 0.7 g, and cites an ROV study (Brown, J., Larson, R., Fowler, G. and Kuhn, R., "Recreational Off-Highway Vehicle (ROV) Handling and Control," SAE Technical Paper 2012-01-0239, 2012, doi 10.4271/2012-01-0239), in which five test subjects drove ROVs in off-road conditions and only reached maximum lateral accelerations of slightly over 0.6 g.

CPSC Response: CPSC staff's basis for a minimum 0.70 g lateral acceleration value is the improvement in rollover resistance achieved in the Yamaha Rhino vehicle through the Yamaha Rhino Repair program. The rollover resistance of an unrepaired Yamaha Rhino vehicle is 0.67 g, compared to 0.70 g for a repaired vehicle. A study of five ROV drivers in which rollover failed to occur is not a basis for evaluating rollover resistance values. In contrast, staff's analysis of ROV-related incident data indicates that the majority of the reported incidents involved ROV "rollover,"[11] by definition, a situation in which the rollover resistance of the ROV is exceeded. Staff's analysis of reported Yamaha Rhino-related incidents also indicates that the number of reported incidents decreased after the repair program that increased the rollover resistance of the vehicle and corrected the vehicle's oversteer handling (see Figure 3).[12]

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[10] Gillespie, T. (1992). Fundamentals of Vehicle Dynamics. Society of Automotive Engineers, Inc. p. 309-311.

[11] Garland, S. (2012). Analysis of Reported Incidents Involving Deaths or Injuries Associated with Recreational Off-Highway Vehicles (ROVs). Briefing Package Proposed Rule on Safety Standard for Recreational Off-Highway Vehicles (ROVS). Tab D. Retrieved from: http://www.cpsc.gov/Global/Newsroom/FOIA/CommissionBriefingPackages/2014/SafetyStandardforRecreationalOff-HighwayVehicles-ProposedRule.pdf.

[12] Paul, C. (2014). Yamaha Rhino Incidents. Memorandum. Briefing Package Proposed Rule on Safety Standard for Recreational Off-Highway Vehicles (ROVS). Tab J. Retrieved from: http://www.cpsc.gov/Global/Newsroom/FOIA/CommissionBriefingPackages/2014/SafetyStandardforRecreationalOff-HighwayVehicles-ProposedRule.pdf

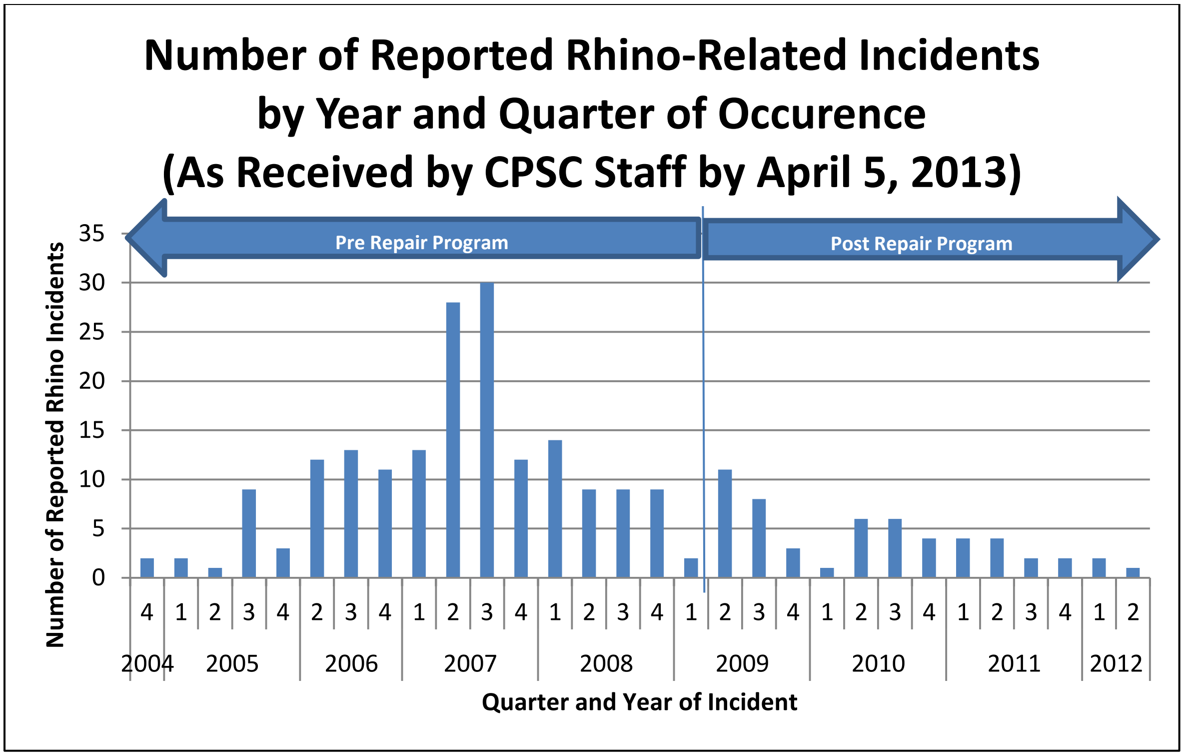


Figure 3. Number of Reported Yamaha Rhino Incidents from January 2003 to May 2012.
Source: Briefing Package: Proposed Rule on Safety Standard for Recreational Off-Highway Vehicles (ROVs). Retrieved from http://www.cpsc.gov/Global/Newsroom/FOIA/CommissionBriefingPackages/2014/SafetyStandardforRecreationalOff-HighwayVehicles-ProposedRule.pdf.

ROHVA comment: ROHVA states that requiring a vehicle to reach a lateral acceleration of 0.7g at two-wheel lift will result in the unintended consequence of preventing or substantially delaying the development of advanced technology, such as stability control. ROHVA states: "[b]y taking a derivative measurement at a limit condition and creating a pass-fail standard, the Lateral Acceleration J-Turn actually prevents the use of technology that could in the future prevent the vehicle from ever reaching that limit condition."

CPSC Response: CPSC staff welcomes any information on ROHVA members' intentions to introduce advanced technology, such as electronic stability control, to ROVs. Staff's interpretation of the proposed standard assumes that any vehicle which either cannot exhibit two-wheel lift under the specified conditions of the J-turn test or which does not exhibit two-wheel lift under those conditions when experiencing Ay of at least 0.7 g inherently meets the requirement.

ROHVA comment: ROHVA states that their ROHVA J-Turn test directly addresses the real world concern of lateral rollovers because their test meets what ROHVA perceives is the goal of preventing two-wheel lift (and ultimately rollovers) without restricting the means available to a manufacturer (now or in the future) to achieve that goal.

CPSC staff response: The goal of any standard should be to increase the rollover resistance of ROVs to address the deaths and injuries associated with ROV-related rollover incidents. However, CPSC staff believes that ROHVA's standard will not increase the rollover resistance of ROVs because the test method measures a metric that does not correspond to the rollover resistance of ROVs.

ROHVA comment: ROHVA characterizes CPSC staff's concern that a manufacturer could numerically increase a vehicle's steering ratio to pass the proposed ROHVA J-Turn as "misplaced and entirely speculative." ROHVA states that steering ratios are deliberately chosen as part of a holistic engineering process for the vehicle.

CPSC Response: Figure 4 shows the steering ratios of the 10 sample ROVs that were measured by SEA. The range of steering ratios demonstrates the flexibility manufacturers have in choosing a steer ratio for their vehicles. It is not inconceivable that the steering ratios of ROVs that fail ROHVA's J-turn maneuver (Vehicles A, F, and J) might be modified, as part of a holistic engineering process, to a value that is still within the norm for this class of vehicles, resulting in vehicles that would pass the ROHVA J-turn maneuver. Therefore, staff does not believe this concern is misplaced or speculative.

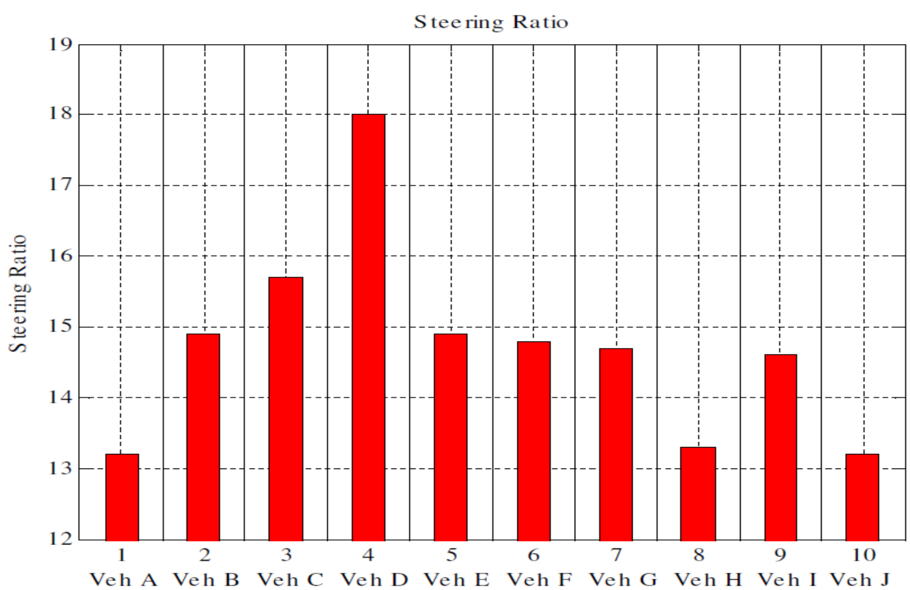
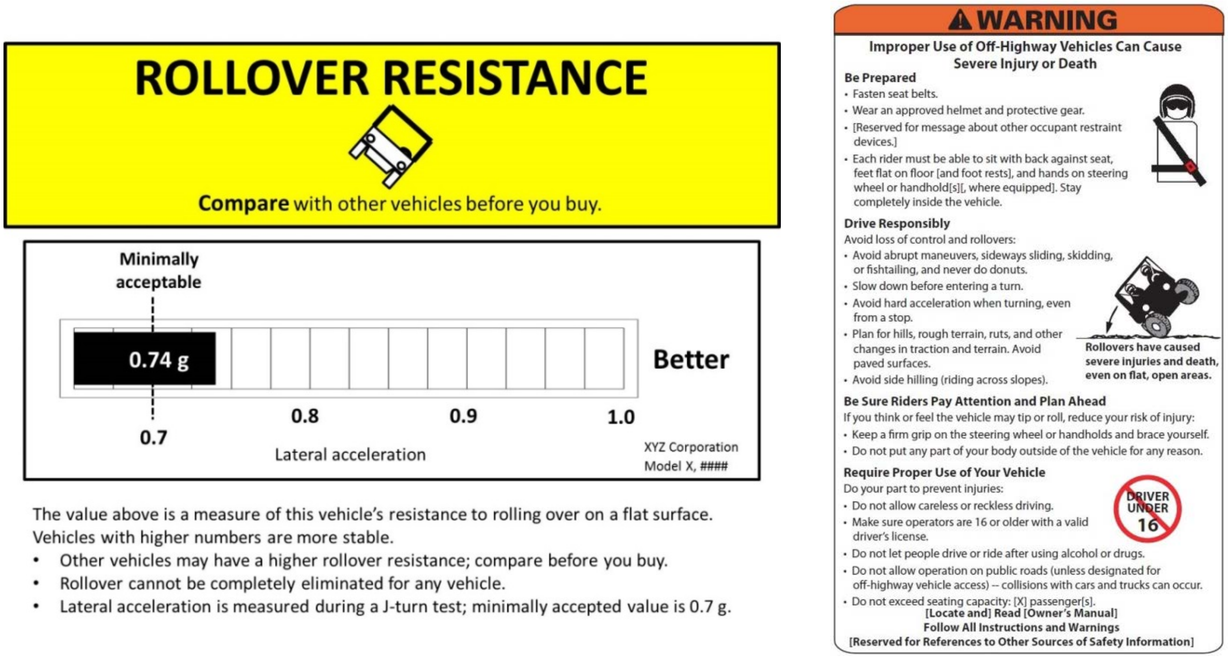


Figure 4. Steering Ratio = steering wheel input (degrees)/change in front wheel angle (degrees)
Source: Heydinger, G. (2011) Vehicle Characteristics Measurements of Recreational Off-Highway Vehicles – Additional Results for Vehicle J. Retrieved from http://www.cpsc.gov/PageFiles/93928/rovj.pdf.

<u>Hang Tag</u>

ROHVA comment: ROHVA disagrees with CPSC staff's recommendation that the hang tag display each vehicle model's lateral acceleration at two-wheel lift. Instead, ROHVA would prefer simply to reiterate the general warning label content on the hang tag for ROVs.

CPSC staff response: In the preceding section on dynamic lateral stability**,** staff addresses ROHVA's comments on the validity and repeatability of the lateral acceleration at two-wheel lift of an ROV. Furthermore, staff is not aware of any evidence that a hang tag with warnings that are already displayed on an ROV will provide information to consumers on the safety of the vehicle or provide incentive for manufacturers to increase the safety of their vehicles. In contrast, staff's recommended hang tag displays each vehicle model's lateral acceleration at two-wheel lift (see Figure 5). Staff's recommended hang tag allows consumers to compare the rollover resistance of ROVs and provides competitive incentive for manufacturers to increase the rollover resistance of their ROV models.



CPSC staff recommended sample hang tag **ANSI/ROVHA sample hang tag**

Figure 5. Comparison of CPSC staff recommended hang tag and ANSI/ROHVA 1-2014 hang tag

Staff's recommended hang tag is based on the information labels developed by the National Highway Traffic Safety Administration (NHTSA) and the Federal Trade Commission (FTC). NHTSA developed the New Car Assessment Program (NCAP) star-rating system to provide consumers with information on the safety of vehicles. After NHSTA included rollover resistance information in its NCAP rating, the stability of automobiles increased for all vehicle types. CPSC staff believes a similar increase in rollover resistance can be achieved in ROVs with a similar consumer awareness program.

<u>Vehicle Handling</u>

ROHVA comment: ROHVA states that a requirement for sub-limit understeer is not necessary or appropriate. In support, ROHVA cites a report from Dynamic Research Inc., (DRI) dated April 18, 2011, in which DRI replies to comments made by CPSC staff on vehicle handling.

CPSC Staff Response: DRI's replies do not directly address the design of sub-limit oversteering into the behavior of vehicles. The discussion by DRI focuses on limit oversteer, as opposed to *sub-limit* oversteer, as an inevitable condition. Therefore, discussions by DRI do not address the recommendations of CPSC staff.

ROHVA comment: ROHVA states that there are no data supporting the assertion that understeer provides any safety benefit in an off-highway environment or that sub-limit oversteer is in any way correlated to lateral rollover incidents involving ROVs. ROHVA cites an ROV study in which five test subjects drove ROVs with different vehicle handling characteristics in off-road environments and provided their subjective opinions of the vehicles (Brown, J., Larson, R., Fowler, G. and Kuhn, R., "Recreational Off-Highway Vehicle (ROV) Handling and Control," SAE Technical Paper 2012-01-0239, 2012, doi 10.4271/2012-01-0239).

CPSC staff response: The data supporting a requirement for understeer are contained in the previously mentioned reference material on oversteer in CPSC staff's briefing memorandum. The study referenced by ROHVA is a non-scientific, subjective evaluation by five individuals on the vehicle handling of three versions of one ROV model. This study provides no compelling or definitive scientific information on the subject of vehicle oversteer. ROHVA has failed to explain the safety benefits of including sub-limit oversteer in vehicle designs, while the study "Recreational Off-Highway Vehicle (ROV) Handling and Control," found the understeering vehicle to be controllable.

ROHVA comment: ROHVA states that understeer gradient measured on dry pavement does not reflect how the ROV will behave in off-highway surfaces.

CPSC staff response: SEA conducted tests to measure understeer gradients on a groomed dirt surface, and the report was published on the CPSC website in 2013.[13] In this testing, vehicles displayed the same characteristics on a dirt surface that were measured on a paved surface, albeit less consistently and with reduced repeatability. From these test results, CPSC staff concluded that testing on paved surfaces represents the characteristics that will occur on unpaved surfaces and have the advantage that the test results will be more reliable than results obtained by testing on unpaved surfaces.

The authors of the study, "Recreational Off-Highway Vehicle (ROV) Handling and Control," cited by ROHVA, also conducted understeer gradient testing of ROVs and found corresponding results on dirt and pavement.

ROHVA comment: ROHVA states the real-world consequences of different understeer gradients, as measured by the required steering input to stay on path, are minor, and based on Brown (2012), equally appealing to the operator. ROHVA provided a figure that presumably illustrated that the steering differences are imperceptible to a driver (see Figure D).

[13] Heydinger, G. (2013). Circle Testing of Two Recreational Off-Highway Vehicles on a Dirt Surface. Retrieved from: http://www.cpsc.gov/Global/Research-and-Statistics/Technical-Reports/Sports-and-Recreation/ATV-ROV/ROVCircleTesting.pdf.

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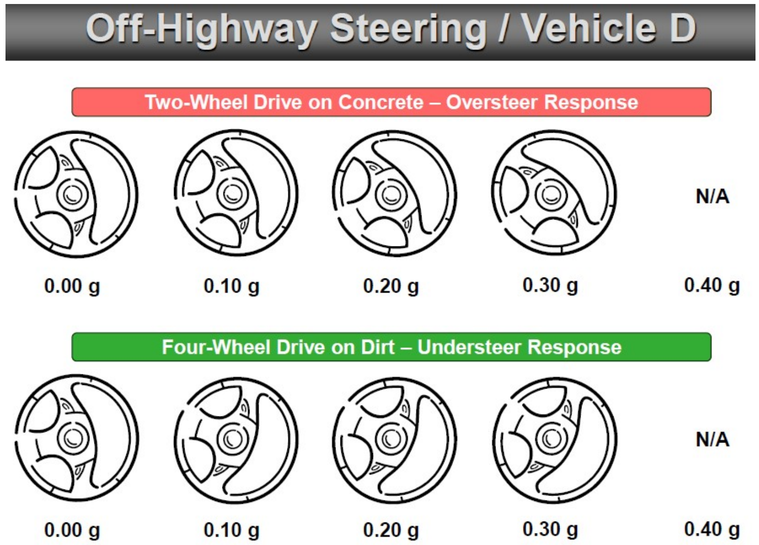


Figure D

CPSC Staff Response: The static graphics portrayed in Figure D from the Carr Engineering comments to the ROV ANPR, belie the dangerous steering characteristics inherent in oversteer. The steering response that occurs in an oversteering vehicle is dynamically unstable. This dynamic instability creates a steering requirement that is constantly changing, due to the instability in vehicle response. The driver of a vehicle operating in a dynamically unstable condition has a constantly changing steering requirement that cannot be followed by the driver to the extent that control will be lost. Therefore, it is not possible to represent the steering condition in a static image.

ROHVA Comment: ROHVA cites the text book, *Fundamentals of Vehicle Dynamics*, by Thomas D. Gillespie and states that Gillespie supports ROHVA's belief that oversteer vehicles are stable and not implicitly connected with divergent instability.

CPSC staff response: Chapter 6 of *Fundamentals of Vehicle Dynamics* refutes ROHVA's claim. On page 203, Gillespie explains how the path of an understeering vehicle is associated with a linear increase in lateral acceleration compared to an oversteering vehicle that spirals into a turn, and the "lateral acceleration that follows causes the rear to drift out even further and the process continues unless the steer angle is reduced to maintain the radius of turn." A vehicle exhibiting a non-linear increase in lateral acceleration is an unstable vehicle. On page 205, Gillespie explains the divergent instability, infinite lateral acceleration, and yaw rate gain, which are specific to vehicles in oversteer. Simply stated, divergent stability only manifests in vehicles exhibiting oversteer; the condition does not exist in vehicles exhibiting understeer. Contrary to ROHVA's claim, Gillespie and accepted engineering principles on vehicle dynamics convey the negative consequences of oversteer, and provide guidance on how to avoid this condition when designing vehicles.

ROHVA comment: ROHVA states that its J-turn test takes into consideration the vehicle's handling characteristic and implies that vehicles will have to exhibit understeer to pass the ROHVA J-turn test.

CPSC staff response: A J-turn at 110 degrees will not detect oversteer. While oversteer may be induced in the most poorly designed vehicles at 110 degrees, the fact that oversteer has occurred will not be determined by the J-turn test. Manufacturers will not have enough information from the J-turn test to know that oversteer exists or to know to compensate for oversteer. Vehicle D of the CPSC characteristics study is an example of this situation. Vehicle D has a severe oversteer, coupled with the lowest measured rollover resistance in the study, and still passes the 110-degree J-turn test with new tires. [14]

ROHVA comment: ROHVA states dynamic tests that measure vehicle handling, developed by the Society of Automotive Engineers, simply measure how the vehicle handles in an imperceptibly varying way on pavement and have no relation to vehicle rollover.

CPSC staff response: Although ROHVA dismisses vehicle handling as an imperceptible characteristic, CPSC staff believes that a significant concern with oversteer is that such a dangerous condition is difficult to perceive. Drivers of ROVs do not perceive that oversteer occurs until the vehicle suddenly overturns; and even then, the drivers often do not know what happened. The causal relationship between oversteer and rollover is well explained in vehicle dynamic text books through graphs and equations that describe the infinite yaw and lateral acceleration gains that occur in oversteering vehicles. The very real consequence of reaching divergent instability in an ROV is the immediate rollover of the vehicle because the lateral acceleration threshold for rollover was reached suddenly and uncontrollably.

ROHVA comment: ROHVA states that the method for measuring understeer gradient is not precise, generally is not repeatable, and thus, is not an appropriate metric for a standard. ROHVA further states that tire dynamics have an effect on understeer gradient testing.

CPSC staff response: SAE standard J266 establishes consistent test procedures for measuring understeer gradient in vehicles, and CPSC staff's test data refute ROHVA's claim that measuring understeer gradient in ROVs is not precise and repeatable. The authors of the ROV study cited by ROHVA, "Recreational Off-Highway Vehicle (ROV) Handling and Control," also measured understeer gradients of ROVs on pavement and off-highway surfaces as a matter of course. The real advantage to conducting live dynamic testing is that *all* vehicle effects are included in the results, including the non-linear tire effects. The polynomial curve fits done by SEA are accepted industry practices, and the individual tire effects are not necessary to be known when those effects are known to be included in the test results.

Occupant Protection

ROHVA comment: ROHVA quotes CPSC staff's comment letter dated March 10, 2011, in which staff cites the feedback feature of the seat belt reminder system in the Federal Motor Vehicle Safety Standard (FMVSS) for occupant protection in automobiles, and praises the

[14] Heydinger, G. (2013). Repeatability of J-Turn Testing of Four Recreational Off-Highway Vehicles. Appendix D. Retrieved from http://www.cpsc.gov//Global/Research-and-Statistics/Injury-Statistics/Sports-and-Recreation/ATVs/SEAReporttoCPSCRepeatabilityTestingSeptember%202013.pdf.

feedback feature as a means to educate and motivate users to buckle seat belts. ROHVA states that ROHVA is perplexed that CPSC staff now suggests that an auditory/visual reminder system is inadequate.

CPSC staff response: CPSC staff continues to believe that motivating users to buckle seat belts is the most effective method to increase seat belt use in ROVs. In the three and half years since staff's comment letter to ROHVA, the state-of-the-art in seat belt reminder technology has moved beyond auditory and visual reminders. Automobile studies show that seat belt reminders that hinder vehicle function after a threshold speed, if seat belts are not buckled, successfully motivate participants to buckle their seat belts up to a 100 percent use rate. In 2010, one ROV manufacturer (ROHVA member) introduced a seat belt speed limiter system that limits the vehicle speed to 6 mph if the driver's seat belt is not buckled. In 2014, another ROV manufacturer (ROHVA member) has announced that its model year 2015 ROV models will include a seat belt speed limiter system that limits the vehicle speed to 15 mph if the driver's seat belt is not buckled. Staff believes that requirements to increase seat belt use in ROVs should be based on the state-of-the-art knowledge and technologies.

ROHVA comment: ROHVA states that ROHVA has made the seat belt speed limiter technology optional for manufacturers because only one manufacturer has incorporated such technology in its vehicle, and ROHVA recognizes the challenges of implementing the system in ROVs.

CPSC staff response: Staff is aware that another manufacturer will soon include the seat belt speed limiter technology in its model year 2015 ROVs. Staff believes manufacturers are capable of bringing this technology to market. Staff is not aware of specific circumstances that justify making the seat belt speed limiter technology optional.

ROHVA comment: ROHVA states that seat belt speed limitation technology should not be tied to the front passenger seat belts because drivers would lose responsibility for operation of the vehicle. Specifically, ROHVA states that passengers could unlatch their seat belts during operation of the ROV and the resulting loss of engine power could cause an accident.

CPSC staff response: Staff acknowledges the added cost and complexity of including front passenger seat belts in the seat belt speed limitation system. However, staff believes the sensing technology for seat belts and occupant presence is robust and staff's regulatory analysis indicates a significant benefit when deaths and injuries of front passengers are reduced by increased seat belt use. Staff believes that vehicle response to passenger unlatching can be designed to reduce throttle in a safe and gradual manner. Staff is unaware of problems in design of deceleration for existing vehicles with seat belt interlocks, in the event that the interlocked belt would suddenly unlatch.

3. ROHVA presentation dated September 30, 2014

On September 30, 2014, ROHVA made a presentation to Chairman Elliot Kaye and Commissioner Joseph Mohorovic. Staff is concerned that some statements in the presentation are misleading and inaccurate. Staff's annotations to ROHVA's presentation are attached in Appendix A.

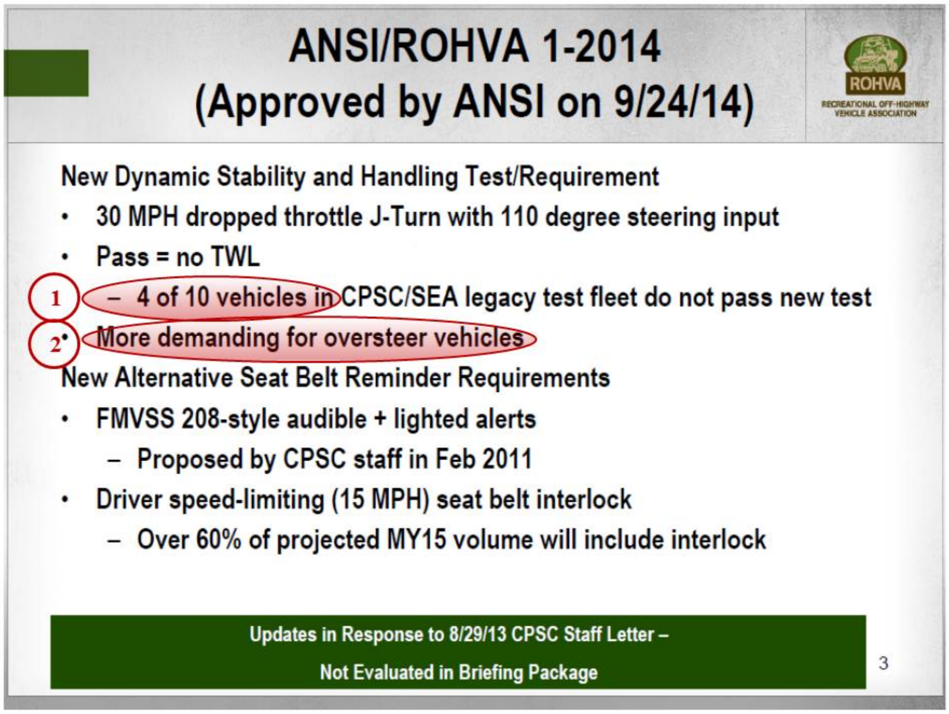
Staff's primary concern is that ROHVA has not provided ROHVA's own data to support the requirements in ANSI/ROHVA 1-2014. It appears that ROHVA relied on the data generated by SEA (through reports published on CPSC's website). SEA's test data demonstrate that ROHVA's J-turn test methodology is flawed; therefore, ROHVA's attempts to support the 110-degree J-turn maneuver with SEA's test data on 10 sample vehicles are based on misinterpretations of SEA's data.

Standard requirements should be based on sound test data that support outcomes that reduce deaths and injuries from a product hazard. Staff believes the recommended requirements in the briefing package submitted to the Commission on September 24, 2014, are supported by sound test data that were generated with the expressed purpose of identifying vehicle characteristics that relate to rollover risk. This same test data cannot be used to justify a test methodology that does not correspond to vehicle rollover.

Staff is willing to continue to work with ROHVA to reduce the risk of injuries and deaths with ROVs.

Appendix A:

Slide 3:

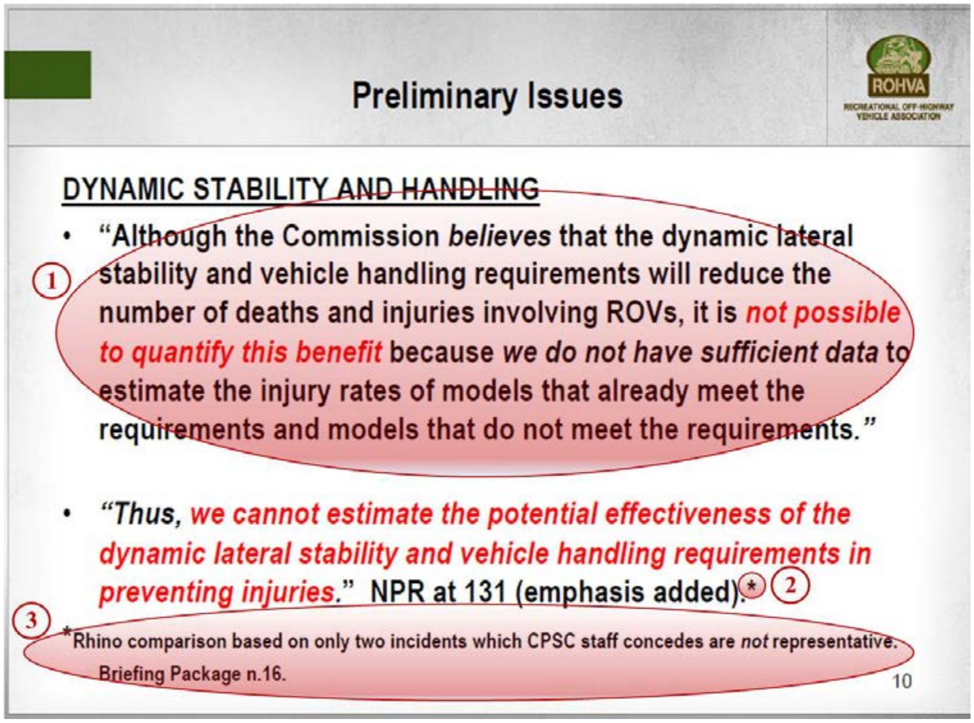


Staff comments on Slide 3 are highlighted and labeled:

1) ROHVA states that 4 out of 10 vehicles tested by SEA fail the ANSI/ROHVA J-turn test when in fact only 2 out of 10 vehicles fail, definitively. ROHVA's claim is based on the failure of Vehicles A, D, F, and J. Staff's analysis shows:
   - Only Vehicles A and F fail the ANSI/ROHVA J-turn test.
   - Test data from SEA's repeatable study shows that Vehicle D passes the ANSI/ROHVA J-turn test.
   - Staff has no confidence that Vehicle J fails the ANSI/ROHVA J-turn test because steering wheel angle at two-wheel lift is unrepeatable and Vehicle J is on the borderline of pass/fail value.

2) ROHVA states the 110-degree J-turn test is "more demanding for oversteer vehicles" when there is no basis for this claim. Vehicles D, I, and J exhibit oversteer and pass the ANSI/ROHVA J-turn test.

Slide 10:



Staff comments on Slide 10 are highlighted and labeled:

1) Although CPSC staff could not quantify the benefits associated with these requirements, staff was able to state that the requirements would have to prevent less than 0.2 percent of rollover incidents during a turn for the benefits to exceed the costs.
2) ROHVA implies that staff's economic analysis concludes that the potential effectiveness of the dynamic lateral stability and vehicle handling requirements cannot be estimated because only two incidents were used to determine the effectiveness of the Yamaha Rhino Repair program. The CPSC staff's economic analysis did not refer to the Yamaha Rhino.
3) ROHVA implies that the "Rhino comparison [was] based on only two incidents which CPSC staff concedes are not representative." The Rhino comparison was based on 41 incidents that involved unrepaired Rhino vehicles compared to 2 incidents that involved repaired Rhino vehicles. Staff regularly informs (as opposed to "concedes") the reader that incidents reported to CPSC are not statistically representative samples.

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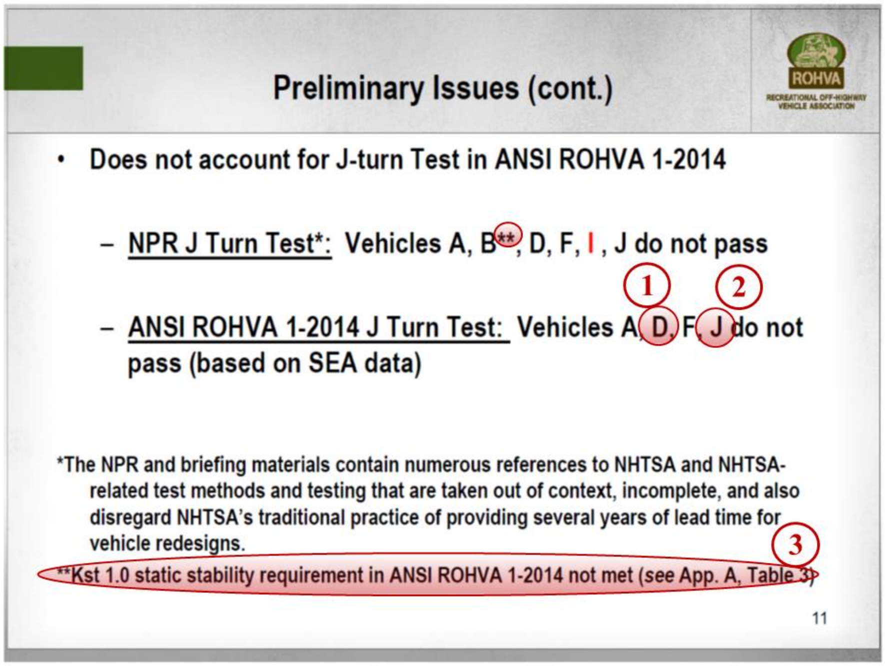
Slide 11:



Staff comments on Slide 11 are highlighted and labeled:

ROHVA has not presented their data to support ROHVA's lateral stability requirements. An analysis of SEA's test data shows that 6 of 10 vehicles do not pass the CPSC NPR (Vehicles A, B, D, F, J, and I). In comparison, only 2 of 10 vehicles do not pass the ANSI/ROHVA 1-2014 standard (Vehicles A and F).

1) ROHVA incorrectly states that Vehicle D does not pass the 110-degree J-turn test. SEA's test data shows that Vehicle D, when tested with new tires in the repeatability study, exhibited two-wheel lift at 122 degrees and therefore passes the ANSI/ROHVA J-turn test. [15]
2) ROHVA states that Vehicle J does not pass the 110-degree J-turn test. However, staff has no confidence that Vehicle J fails the ANSI/ROHVA J-turn test because steering wheel angle at two-wheel lift is not repeatable and Vehicle J is on the borderline of the pass/fail value.
3) ROHVA erroneously states that Vehicle B fails the ANSI/ROHVA requirement for ROVs *with no occupants* (K_{st}=1.0 or greater). ROHVA based this statement on SEA test data for Vehicle B *with two occupants*. Vehicle B passes the ANSI/ROHVA 1-2014 K_{st} requirement.

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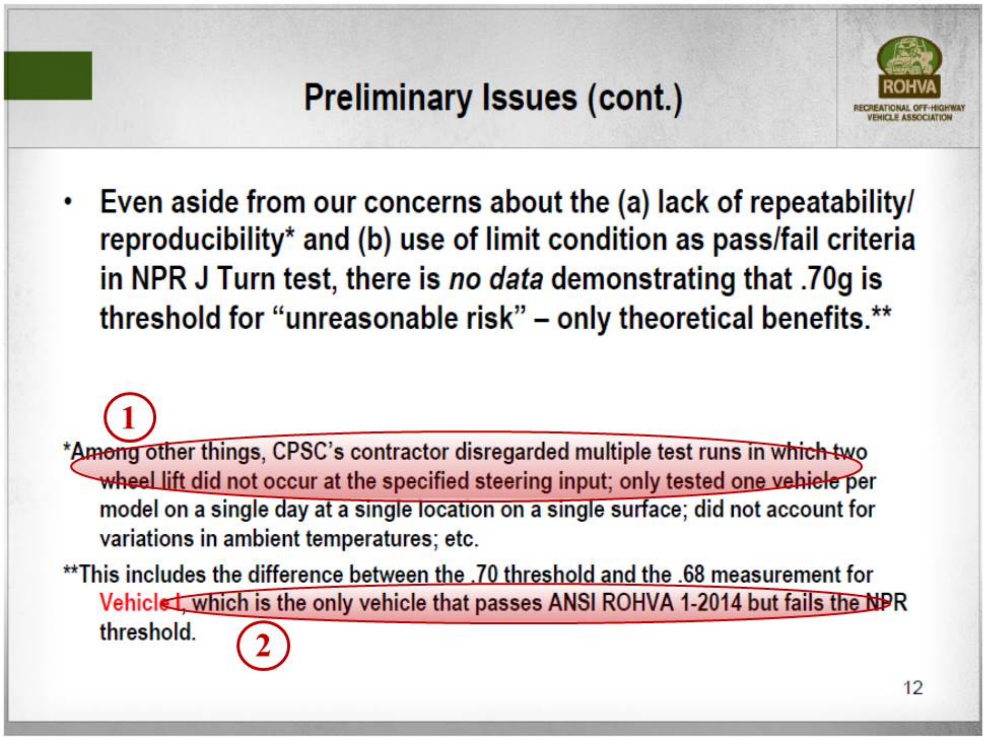
[15] Heydinger, G. (2013). Repeatability of J-Turn Testing of Four Recreational Off-Highway Vehicles. Retrieved from: http://www.cpsc.gov//Global/Research-and-Statistics/Injury-Statistics/Sports-and-Recreation/ATVs/SEAReporttoCPSCRepeatabilityTestingSeptember%202013.pdf.

Slide 12:

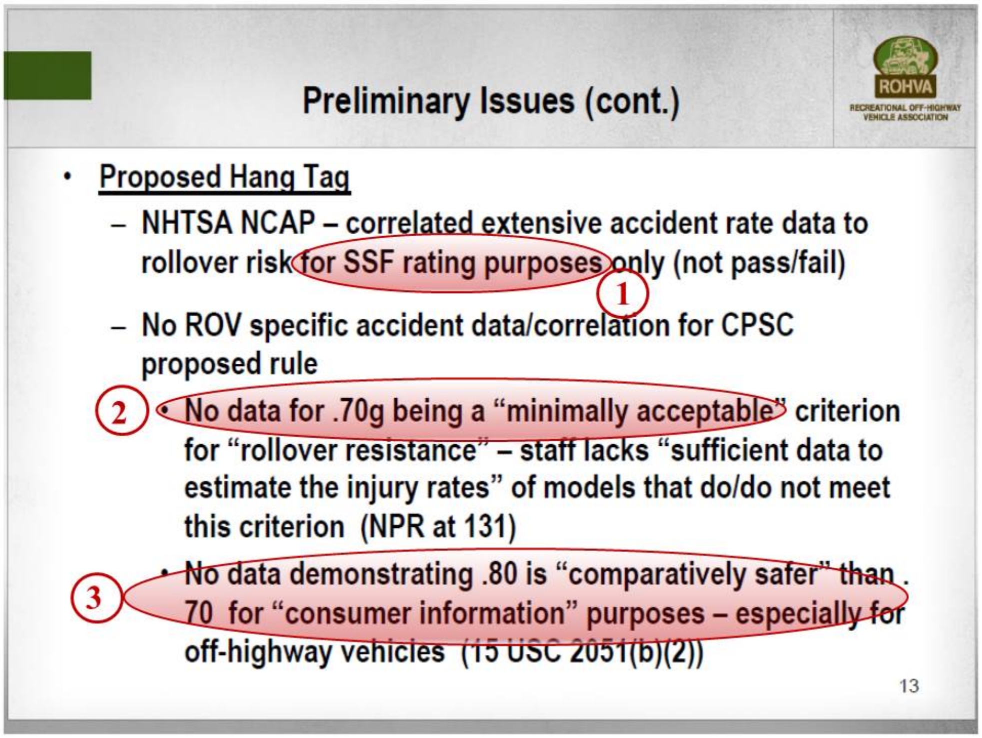


Staff comments on Slide 12 are highlighted and labeled:

ROHVA disregards that the stated purpose of the SEA repeatability study, "Repeatability of J-Turn Testing of Four Recreational Off-Highway Vehicles," was to measure lateral acceleration at two-wheel lift. In addition, ROHVA disregards that the repeatability study includes comparisons of lateral acceleration values that were measured on different dates and in different weather conditions.

1) Contrary to ROHVA's claim that SEA disregarded data, SEA did not include test runs where two-wheel lift did not occur because the value being measured was not reached. However, the test runs without two-wheel lift are noted for demonstrating that steering wheel angle at two-wheel lift is not repeatable.
2) ROHVA erroneously states that Vehicle I is the only vehicle that passes ANSI/ROHVA 1-2014 but fails the CPSC NPR. Vehicles B, D, I, and J pass ANSI/ROHVA 1-2014 and have lateral acceleration values at two-wheel lift that are equal to or lower than an unrepaired Yamaha Rhino ROV.

Slide 13:



Staff comments on Slide 13 are highlighted and labeled:

1) NHTSA's New Car Assessment Program informs consumers of a vehicle's rollover risk on a star-rating scale. CPSC staff recommends a similar consumer awareness program in which ROVs are sold with a hang tag that displays each model's rollover resistance value on a progressive scale.
2) Contrary to ROHVA's claim that there is no data supporting a 0.70 g minimum value for lateral acceleration at two-wheel lift (A_y), the Yamaha Rhino repair program improved the rollover resistance of an unrepaired Rhino vehicle from 0.67 g to 0.70 g. Staff believes this value represents a minimum increase in lateral stability that is achievable with minor modifications to an ROV (as demonstrated by the repair program).
3) Contrary to ROHVA's claim that there is no data demonstrating that 0.80 g is "comparatively safer" than 0.70 g, the physics of rollover demonstrates that a vehicle with A_y=0.80 g requires more force to roll over than a vehicle with A_y=0.70.

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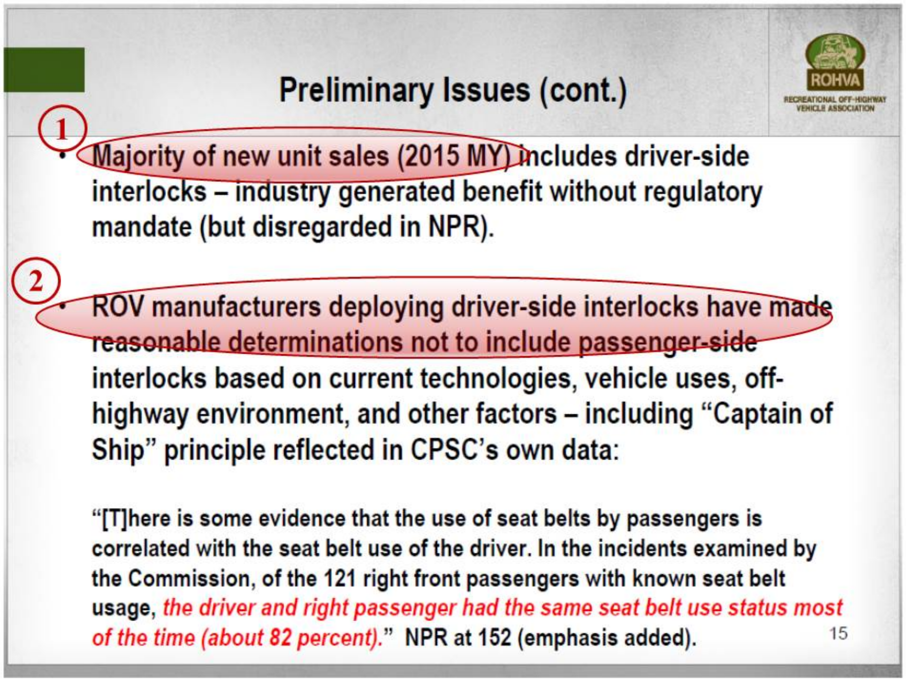
Slide 15:



Staff comments on Slide 15 are highlighted and labeled:

1) ROHVA's statement about the future sales of MY 2015 ROVs is speculative. There is no data for 2015 MY sales at this time.
2) Staff analyzed such a situation in the regulatory analysis. Staff concluded that even if 80 percent of the front passengers followed the driver and buckled their seat belts when the driver did, the benefits of extending seat belt/speed limitation requirement to the front passengers would be $140 per ROV compared to a cost of about $26 per ROV.