



U.S. Department
of Transportation
**National Highway
Traffic Safety
Administration**

ODI RESUME

Investigation: EA 04-032

Prompted By: VOQ 10052216

Date Opened: 11/23/2004

Date Closed: 12/30/2005

Principal Investigator: Tom Bowman

Subject: Wheel Separations

Manufacturer: Keystone RV Company

Products: 2003 -2004 Keystone Travel Trailer and Fifth Wheel

Population: 51732 (estimated)

Problem Description: Wheel separation caused by inadequate clamp and/or loosening of the wheel mounting nuts and/or wheel mounting stud fracture

FAILURE REPORT SUMMARY

	ODI	Manufacturer	Total
Complaints:	2	132	132
Crashes/Fires:	0	0	0
Injury Incidents:	0	0	0
# Injuries:	0	0	0
Fatality Incidents:	0	0	0
# Fatalities:	0	0	0
Other*:	0	0	0

*Description of Other:

Action: Close this EA. Keystone is conducting a Safety Recall Campaign 05V-309 to address 2,668 vehicles described below. See attached technical report for additional details on this investigation.

Engineer: Thomas Bowman

Date: 12/30/2005

Div. Chief: Richard Boyd

Date: 12/30/2005

Office Dir.: Kathleen C. DeMeter

Date: 12/30/2005

Summary: On June 20, 2005, Keystone RV notified ODI of Keystone's intention to conduct Safety Campaign 05V-309 to address 2,668 vehicles consisting of 1,677 MY 2004 Montana, 550 MY 2004 Everest, and 441 MY 2005 Everest vehicles equipped with aluminum wheels. This campaign proposes to remove the wheels, inspect the wheel ends for indications of prior loosening, and/or other damage, remove paint and other contaminants from the wheel mounting interface, and educate the owner about the importance of checking the torque of the wheel mounting nuts as prescribed in Keystone's Owner's Manual. On September 20, 2005, Keystone distributed wheel end servicing information in DVD format to 114, 618 owners of non-campaigned vehicles manufactured between May 1, 2003 and September 30, 2005.

Although Keystone has indicated that they have improved the quality and consistency of the wheel nut installation and torquing, ODI is concerned that the need for frequent retorquing may be indicative that other currently unaddressed factors may be involved. ODI will close this investigation but continue to closely monitor the wheel separation issue at Keystone RV.

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EA04-032 Closing Report
Wheel Separations in 2003-2004 Model Year
Keystone RV Trailers

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(1) Subject

This report addresses wheel separations associated with the wheel mounting and retention system in model year 2003 - 2004 recreational fifth wheel and travel trailers manufactured by Keystone Recreational Vehicles.

ODI has focused this investigation on 2003-2004 model year vehicles because ODI observed a significant number of wheel separation incidents in these vehicles.

ODI believes that wheel separations have been occurring in Keystone RV vehicles at a higher than acceptable level since the fall of 2002 which approximately coincides with the start of production for model year 2003 vehicles.

In order to protect the privacy of the affected vehicle owners, ODI has redacted (deleted the final six digits) of all VIN numbers contained in this report.

(2) Background

Late in December 2003, ODI initiated investigations of wheel separations in Fleetwood Enterprises (RQ03-009 followed by EA04-009) and Jayco, Inc. (PE04-016 followed by EA04-019) trailers. These investigations were aimed at identifying the causal and/or contributing factors for the wheel mounting nut(s) to loosen and/or the wheel mounting stud(s) to break and cause a wheel separation.

Fleetwood and Jayco manufacture "towable" travel trailer and fifth wheel recreation vehicles ("RVs") that are similar in design, application, and wheel end components (wheels, hubs, studs, and nuts) to Keystone RV vehicles. During vehicle inspections that ODI conducted under investigations EA04-009 and EA04-019, ODI engineers observed that excessive paint, coatings, and/or other contaminants had been present in the wheel-to-hub clamp joint and that this condition was a likely causal or contributing factor to the wheel nut loosening, stud breakage, and wheel separation issue.

Investigations EA04-009 and EA04-019 also concluded that a significant number of wheel separations have occurred early in the vehicle life (i.e., typically within the first approximately 1000 miles of service) and that aluminum wheels had separated at a significantly higher rate than steel wheels on equivalent vehicles assembled by these manufacturers.

On July 22, 2004, ODI initiated a Preliminary Evaluation (PE04-051) investigating Thor Industries because Thor Industries is the parent corporation to several divisions that manufacture towable recreational vehicles, including Keystone RV.

On August 24, 2004, ODI received a Vehicle Owners Questionnaire (VOQ 10091780) that reported a wheel separation from a Keystone RV Model year 2003 Montana fifth wheel vehicle. The owner forwarded photographs and described his concern that "the hole in the wheel is too large to fit the hub." ODI interviewed the owner of this vehicle by phone and determined that the wheel had separated soon after the vehicle had been driven over uneven pavement and that the owner had also advised Keystone RV of the incident.

ODI Note: This owner was describing the circumferential clearance between the center bore of the wheel and the mating pilot of the hub. Whereas many (non-towable) automotive applications utilize hub piloted wheels that are designed to fit with a close clearance between the wheel center bore and a pilot on the axle hub, a significant number of towable vehicles utilize a stud piloted mounting system that relies on the positions of the wheel mounting studs and the mounting holes in the wheels to "center" the wheel on the hub. Since the wheel center bores are not required to pilot the wheel, ODI has observed that a number of manufacturers of towable vehicles specify wheels with large center bores and use the bores to retain a decorative wheel hub cover installed from the back side of the wheel. On December 5, 2005, the Trailer Safety Industry Coalition (TSIC) provided a briefing to ODI intended to address ODI's questions about the industry's preference for the stud mounting system. ODI has posted this TSIC presentation in the Public File for EA04-032.

On October 7, 2004, ODI visited Keystone RV in Goshen, Indiana to meet with Keystone management personnel, perform a preliminary review of Keystone's wheel assembly practices, and to remove and inspect the wheel end components of Keystone 2002 Montana VIN 4YDF2952334XXXXXX⁽¹⁾ that had been equipped with steel wheels and had experienced a wheel separation. During this visit, Keystone RV informed ODI that Keystone had previously issued Service Advisory A04-036 to correct a problem with wheel loosening and separation that had occurred in certain model year 2004 Montana vehicles. A copy of this Advisory is provided in Appendix A.

To further assess and monitor the wheel separation issue, ODI requested Keystone RV to notify ODI of all newly reported incidents within 48 hours after Keystone RV had been informed that a wheel separation has occurred. ODI initiated a "running list" of the "newly reported" incidents beginning on October 8, 2004, and has maintained surveillance for approximately twelve months. As of September 30, 2005, Keystone RV has notified ODI of 30 ⁽²⁾ relevant wheel separations in model year 2003 and 2004 vehicles that have been reported during this approximately twelve-month period. ODI has summarized these "newly-reported" incidents in Appendix B and provided some additional discussion in of these reports in Section 6, "ODI Investigation."

On November 23, 2004, ODI upgraded PE04-051 to EA04-032.

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- (1) During investigations at Fleetwood (EA04-009) and Jayco, Inc. (EA04-019), ODI had predominantly inspected the condition of aluminum wheels mounted with six wheel mounting studs that had experienced wheel separations. To broaden the scope of the wheel end configurations inspected, ODI focused inspections of Keystone RV vehicles to previously un-inspected wheel end configurations (1) steel wheels mounted with six wheel mounting studs, (2) aluminum wheels mounted with eight wheel mounting studs, (3) an older (model year 2000) vehicle equipped with aluminum wheels mounted with six wheel mounting studs, and (4) a triaxle vehicle equipped with aluminum wheels mounted with six mounting studs.
- (2) Keystone RV reported 62 wheel separation incidents during the twelve-month period from October 2004 through September 2005. ODI excluded the following 32 reports from this analysis since these incidents were caused by issues other than loose nuts and/or broken studs or pertain to model year vehicles outside the scope of EA04-032.
- (a) one wheel separation was caused by the wheel outer rim breaking away from the wheel's center and subsequently addressed by Keystone RV recalls 05V-201 and 05V-424;
 - (b) two wheel separations appear to have been caused by a bearing failure;
 - (c) seven wheel separations occurred in vehicles owned outside of the United States;
 - (d) five wheel separations occurred in model year 2000-2002 vehicles;
 - (e) sixteen wheel separations pertain to model year 2005 vehicles; and
 - (f) one wheel separation pertains to a model year 2006 vehicle.

ODI intends to continue to monitor wheel separations at Keystone RV until September 30, 2006. (See Section 9, "Conclusions")

(3) Population

Production of Keystone RV Trailers addressed by EA04-032

Model Year	Trailers Equipped with Aluminum Wheels	Trailers Equipped with Steel Wheels	Total
2003	(*) 732	(*) 6,411	(*) 7,143
2004	3,946	40,643	44,589
Total	4,678	47,054	51,732

Source: Keystone RV Response to ODI Request Nos. 8, EA04-032.

(*) Keystone RV was only able to provide partial model year 2003 vehicle production information.

(4) Description - Wheel Mounting and Retention System

The wheel assembly is mounted and retained to the axle hub by the wheel mounting nuts when installed and tightened on the wheel mounting stud. The wheel is "stud piloted" (i.e., the accuracy of the positioning or "piloting" (e.g., concentricity) of the wheel on the hub is controlled by the accuracy of the placement of the wheel mounting studs and the mounting holes machined in the wheel). The torque applied to the wheel mounting nuts provides the clamp that retains the wheel in position securely against the hub mounting face.

Typically, the wheel assemblies on recreational trailers that weigh less than 26,000 lbs. (such as those manufactured by Keystone RV) are mounted using 5, 6, or 8 stud mounting systems. The wheels are clamped with tapered or conical wheel mounting nuts that thread on to the wheel mounting studs and seat in a corresponding tapered or conical hole machined into the wheel.

(5) Product - Process Changes

Following is a verbatim summary of the product and process changes that Keystone RV has implemented since November 2004.

Date	Summary of Changes Pertaining to Wheel Installation and Wheel Mounting Torque
11/1/2004	Steel tabbed hub covers. Changed from plastic hub covers on steel wheels over [sic] to steel-tabbed hub covers.
12/6/2004	Star pattern. All wheels installed with the star pattern. Training done in each production plant.
12/6/2004	65 ft/lb torque sticks for impact wrenches. Staged torque process for initial installation
12/9/2004	Changed from 6 lug 16" aluminum wheels to 8 lug 16" on basis of recommendation from vendor. More clamp force achieved.
12/13/2004	Preset 100 ft/lb torque wrenches. Achieves final torque and used for checking torque in other departments
1/17/2005	Torque audits. Record torque values off [sic] sample units in all plants on weekly basis. Results reviewed by mgt.
2/14/2005	Cleaning hubs. Started removing paint from hub faces of all axles using aluminum wheels.
2/28/2005	Systems check in plant now uses 100 ft/lb preset torque wrenches ipso [in place of] adjustable wrenches.
2/28/2005	Midline torque check added to the process. Wheels now torqued or checked three time[s] before leaving plant.
6/16/2005	Torque wrench calibration tester program. All wrenches now tested on periodic basis.
7/11/2005	Torque Bay. Implemented a final check torque bay after the unit comes off the production line.
8/11/2005	Chrome wheels. Use of 16" chrome wheels stopped due to field failures and Tredit [Tire] recommendation.
[Keystone RV's] Summary	[Keystone RV has implemented] a staged torque installation process (65 ft/lb torque stick). [Keystone RV has] added two more torque checkpoints (midline and torque bay) to our process. [Keystone RV has] upgraded our tools (torque wrenches), changed specifications on parts used (hub covers) and implemented torque auditors. [Keystone RV] also clean hubs on aluminum wheel installations.

Source: Keystone RV provided this summary to ODI on November 3, 2005.

(6) ODI Investigation

ODI conducted the following investigative activities:

ODI researched consumer complaints (VOQ) reported since January 1999 that indicated that a wheel separation or loosening incident had occurred. These reports did not indicate any particular trend or pattern and are regarded as isolated incidents.

On January 21, 2005, ODI requested information from Keystone RV. In response, Keystone RV identified 102 wheel separation incidents (*) that had occurred in model year 2003 and 2004 vehicles as of October 1, 2004.

(*) 51 reports pertained to model year 2003 vehicles and 51 reports pertained to model year 2004 vehicles. Since the incident information identified the affected vehicles by date of production rather than model year, ODI determined the model year associated with each incident by using August 1 of each calendar year as the model year "cut-off date."

ODI received an additional 30 "relevant" [See earlier footnote ⁽¹⁾] reports between October 1, 2004 and September 30, 2005. The following is a summary of all wheel separation reports associated with wheel mounting nut loosening and/or stud breakage in model year 2003 and 2004 Keystone RV vehicles.

**Summary of Wheel Separations Reported for
2003-2004 Model Year Keystone RV Vehicles**

Vehicle Model Year	Wheel Separation Incidents Reported prior to October 1, 2004	Separation Incidents Reported between October 1, 2004 and September 30, 2005	Total
2003	51	8	59
2004	51	22	73
Total	102	30	132

On February 14, 2005, ODI visited Keystone RV at Goshen, Indiana, to inspect the wheel end components of a 2005 Keystone RV Everest vehicle built on January 21, 2005 and equipped with aluminum wheels mounted with eight wheel mounting studs. This vehicle experienced a wheel separation on February 5, 2005, while being transported from the selling dealer to the owner's residence by the new owner. (See Appendix E.)

On April 20, 2005, ODI inspected a Keystone RV 2000 model year vehicle (VIN 4YDF3282714XXXXXX) that was stranded (waiting for replacement parts) near Staunton, Virginia, for several days following a wheel separation.

On June 6, 2005, ODI inspected a 2005 model year Keystone RV Raptor (VIN 4YDF361305MXXXXXX) vehicle in Huntington, Maryland, following a wheel separation. (See Appendix E.)

On June 20, 2005, Keystone RV notified ODI of Recall 05V-309 in which Keystone RV proposed to recall 2,668 vehicles consisting of 2004 Montana (1,677), 2004 Everest (550), and 2005 Everest (441) vehicles. Under this recall, dealers are instructed to "remove the wheels, clean any paint of other foreign materials from the hub and wheel mounting face, apply proper torque to wheels, educate and demonstrate to the consumer proper wheel torque procedures and maintenance..." The letter also stated that Keystone RV is issuing an Owner Notification Letter (ONP) to owners of vehicles manufactured between May 1, 2003 and September 1, 2005 that provides a DVD to the consumer demonstrating detailed torque procedures and requirements.

On August 22 and 23, 2005, ODI visited Bosch Proving Grounds to review the data collection methods and vehicle maneuvers being evaluated under testing conducted by the Trailer Safety Industry Coalition (TSIC) intended to assist the recreational and cargo "towables" trailer industry develop a better understanding of the duty cycle requirements, the capabilities of wheel clamp joints, and to develop and disseminate recommendations intended to improve wheel installation and quality control practices.

On September 8, 2005, Keystone RV responded to ODI's request to provide an explanation of the rationale that Keystone RV used to determine which vehicles Keystone RV had included, and which vehicles Keystone RV had elected to exclude, from Recall 05V-309. Keystone RV's response is provided in Appendix C.

On November 7, 2005, Keystone RV sent ODI a summary of the status of the Recall and Owner Notification letters that Keystone RV has issued:

9/10/2005-	2,669	Recall letters sent to owners
9/23/2005-	5,000	Owner Notification (ONP) Letters mailed to owners of non-recalled vehicles manufactured between May 1, 2003 and September 1, 2005 (See Appendix D).
10/14/2005-	50,000	ONP Letters mailed to owners
10/21/2005-	32,618	ONP Letters mailed to owners
11/7/2005-	<u>27,000</u>	ONP letters mailed to dealers who have unsold units in stock
	114,618	[Total ONP letters]

During the course of this investigation, ODI has conducted numerous phone interviews with owners of Keystone RV vehicles who have reported a wheel separation, Keystone RV engineering and service personnel, engineering representatives of affected supplier companies such as Enkei America (wheels), Tredit Tire (tire and wheel assemblies), Al-Ko Kober Corporation (axles), and Dexter Axle (axles). ODI has also met with and conducted many phone conversations with the Trailer Safety Industry Coalition (TSIC), which was formed to address wheel separation and other safety issues affecting the trailer industry, the Recreational Vehicle Industry Association (RVIA), the National Association of Trailer Manufacturers (NATM), and the National Marine Manufacturers Association (NMMA) about wheel separations and related issues.

(7) ODI Assessment

Safety Risk Posed by A Separated Wheel -- A wheel end joint that loosens can quickly fracture the wheel-mounting studs and lead to a wheel separation. Wheel separations pose three risks:

- (1) A wheel and tire assembly that separates at highway speeds poses a risk of property damage, personal injury, and possibly death to other users of the roadway.
- (2) The affected vehicle may lose stability.
- (3) A vehicle disabled by a separated wheel(s) may expose the affected vehicle, vehicle occupants, and/or individuals servicing the wheel end to the hazards associated with moving traffic --- possibly traveling at high speeds --- in proximity to the affected vehicle.

ODI is also concerned that vehicles that experience a wheel separation may incur damage to the same-side, but unseparated, wheel end, if operated for even a short period of use after a vehicle has experienced a wheel separation. In certain of the reported wheel separation incidents, ODI inquiry determined that these tandem axle vehicles have been towed for extended distances either because the owner had not been aware that a wheel has separated or because circumstances required that the trailer be towed from the point of wheel separation to a location that could provide needed wheel replacement and service. In either case, the same-side unseparated tire, wheel, wheel mounting studs, and nuts are exposed to unexpectedly high loads following a wheel separation since the intact single wheel is supporting the entire weight of the affected side of the vehicle while the vehicle is towed to the point of service. These unexpected and high loads may damage the tire, wheel, studs, nuts or surfaces of the wheel to hub clamp interface of the same-side wheel equipment. Further, this damage may not be evident or checked by the owner and could lead to

later durability and/or retention problems in these wheel end components.

Technical Assessment -

As stated in Section 2 of this report, "Background," ODI has conducted investigations of wheel separations at Fleetwood Enterprises and Jayco, Inc. in 2004 and 2005. Through these investigations, ODI determined that a significantly higher rate of wheel separations had occurred from vehicles equipped with aluminum wheels than from vehicles equipped with steel wheels in vehicles manufactured by these companies. These investigations also determined that the presence of paint and/or other contaminants between the wheel and the hub face appeared to be a significant contributing factor to loosening and separation of wheels in Fleetwood and Jayco vehicles equipped with aluminum wheels.

ODI notes that the wheel separations that Keystone RV reported between October 1, 2004 and September 30, 2005, appear to be consistent with ODI findings at Fleetwood and Jayco in that vehicles equipped with aluminum wheels appear to experience separations approximately four to five times the rate of vehicles equipped with steel wheels.

**Summary of Wheel Separation Incidents from Vehicles
Equipped with Steel Wheels that Keystone RV has reported to ODI
between October 1, 2004 and September 30, 2005**

Vehicle Model Year	Wheel Composition	Number of Separations Reported	Production	Incident Rate (per 100,000 vehicles)
MY 2003	Steel	5	(*)	(*)
MY 2004	Steel	15	40,643	37

(*) ODI did not calculate an incident rate for 2003 model year vehicles since Keystone RV could only provide partial 2003 model year production information.

**Summary of Wheel Separation Incidents from Vehicles
Equipped with Aluminum Wheels that Keystone RV has reported to ODI
between October 1, 2004 and September 30, 2005**

Vehicle Model Year	Wheel Composition	Number of Separations Reported	Production	Incident Rate (per 100,000 vehicles)
MY 2003	Aluminum	3	(*)	(*)
MY 2004	Aluminum	7	3,946	177

(*) ODI did not calculate an incident rate for 2003 model year vehicles since Keystone RV could only provide partial 2003 model year production information.

Scoping Assessment -

In June 2005, Keystone RV implemented Recall 05V-309 that directed Keystone RV dealers to perform the following repairs on model year 2004 Montana and model years 2004 and 2005 Everest vehicles: remove the wheels, inspect the wheel and hub face for damage, clean paint and other contaminants from the wheel and hub mounting interface, re-install the wheels, and properly torque the wheel mounting nuts.

ODI requested Keystone RV to provide an explanation for which vehicles were included / excluded from this recall. On September 8, 2005, Keystone RV provided the requested explanation (See Appendix C) that summarizes the failure rates for recalled and non-recalled vehicles. While ODI concurs that recalled vehicles exhibited unacceptable high failure rates in the range of 303 – 450 wheel separations per 100,000 vehicles, ODI is concerned that the wheel separation rate in the range of 170 per 100, 000 vehicles evidenced by the non-recalled vehicles, though addressed by Keystone RV's informational - instructional DVD (see next paragraph), may also require future recall action.

During September-November, 2005, Keystone RV mailed an informational - instructional DVD to 114, 618 owners of non-recalled vehicles manufactured between May 1, 2003 and September 1, 2005, intended to educate owners about Keystone RV's recommendations for periodic re-torquing of the wheel mounting nuts.

ODI has reviewed the information that Keystone RV provided and monitored the newly reported wheel separation incidents that have been reported between October 2004 and September 2005.

ODI will continue to monitor the newly reported wheel separations at Keystone RV to be certain that the incident rate continues to decline and assess whether further recall actions and/or informational - instructional DVD initiatives are effective or whether additional recall actions are indicated.

ODI's analysis indicates the following:

(1) "Infant mortality" (i.e. incidents that occur early in a product life) wheel separations were a significant concern at the inception of the investigation since "infant mortality" failures are indicative of poor component design and/or poor manufacturing quality.

ODI has noted a diminishing number of infant mortality wheel separations, which is most likely associated with manufacturing quality control improvements that Keystone RV has adopted during the past year (2005).

(2) ODI is concerned that model year 2005 Montana and model year 2005 and 2006 Raptor vehicles equipped with aluminum wheels appear to be experiencing wheel separations at a greater count/rate than other Keystone RV model vehicles. In addition, ODI's inspection of a 2005 Raptor (summarized in Appendix E) indicates very similar paint and contamination conditions observed in Keystone RV vehicles and peer manufacturer vehicles that are being recalled.

Since model year 2005 and 2006 vehicles are not within the scope of investigation EA04-032, ODI will initiate a separate monitoring activity during 2006 to further assess whether these vehicles or other vehicles may require further action. See Section 9 of this report, "Conclusions."

(3) Although Keystone RV has indicated optimism that the informational - instructional DVD that Keystone distributed to owners of vehicles manufactured between May 1, 2003 and September 1, 2005, will be effective, ODI has informed Keystone RV that this informational-instructional program may not be completely effective because (a) many owners will not watch the training material and (b) the effect that the educational message may have toward influencing owners to check their wheels may diminish soon after the DVD is viewed and that owners will, over time, resume their former maintenance practices.

ODI is also concerned that the owner's DVD-based informational - instructional information is a restatement of the towable RV industry's position that wheel separations are largely associated with owner's inattention to the wheel nut retorquing recommendations.

ODI remains skeptical that a properly designed and assembled wheel end system should require multiple wheel nut torque checks and/or re-tightening to maintain its attachment integrity. ODI has interviewed several owners who have provided credible accounts that describe reasonably diligent attention to wheel nut retorquing and who have nonetheless experienced a wheel separation.

(8) Keystone RV's Actions

In response to this investigation activity, Keystone RV has taken the following actions:

- (1) During the course of this investigation (November-December 2004 and 2005) Keystone RV has implemented various changes / improvements in the installation and torquing processes of the wheel end components. These changes are summarized in Section 5 of this report, "Product and Process Changes."
- (2) Keystone RV conducted Recall 05V-309 in June 2005 to address (inspect, remove paint, torque properly, and educate owner) 2668 MY 2004 and 2005 Everest and MY 2005 Montana vehicles.
- (3) Keystone RV distributed approximately 114,618 informational-instruction DVDs to owners of vehicles manufactured between May 1, 2003 and September 1, 2005 (representing approximately 29 months of vehicle production).
- (4) Keystone RV has also been a principle supporter of the Trailer Safety Industry Coalition (TSIC) which has developed and issued recommendations to industry intended to improve the assembly and quality control and coordinated a data collection exercise intended to measure the forces imposed in the wheel and wheel end clamp joint when subjected to various vehicle maneuvers such as striking curbs and potholes, encountering rough road surfaces, etc. TSIC has not completed the data analysis as of the date of this report.

(9) Conclusions

ODI is closing this Engineering Analysis based on Keystone RV's Recall 05V-309, which addresses a portion of the subject population with a procedure intended to improve clamp integrity and the Owner Notification Letter with the enclosed informational-instruction DVD which is intended to improve owner education and awareness.

Due to the number of open issues and concerns relating to this investigation, ODI will continue to monitor the wheel separation issue at Keystone RV through 2006 to determine (1) whether Keystone RV vehicles exhibit ongoing wheel separation incidents, (2) the effectiveness of the Owner Notification Letter containing the owner education and awareness information in DVD format that Keystone RV has distributed to non-recalled vehicles, and (3) whether further investigation indicates that currently unaddressed factors may be pertinent to wheel loosening and separation..

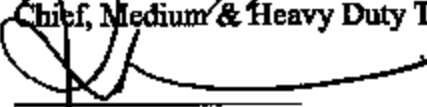

G. T. Bowman, Safety Defects Engineer

12/29/05
Date

I Concur

Chief, Medium & Heavy Duty Truck Division

12/29/05
Date


Director, Office of Defects Investigation

12-24-05
Date

Keystone RV Company

Appendix A

SERVICE ADVISORY # A04-036

Montana aluminum wheel retention

Models Included:

2004 Montana Fifth Wheels with aluminum wheels and Dexter 6 lug axles

Serial Number Range:

From 508282 to 508484

Some units in this range are equipped with Dexter 6 lug axles. Excess paint on the hub face of these axles can cause aluminum wheels to experience loss of torque. This can result in catastrophic wheel loss.

Parts Required: Dexter is replacing the drums and hubs of all affected units.

This applies only to Montana fifth wheels (not Big Sky) with 6 lug aluminum wheels and Dexter axles. Only the units within the serial number range listed above are involved. We have identified the location of all units involved and you have been contacted by Keystone to hold those units. Dexter is already arranging shipment of the replacement hubs and drums to your dealership.

Attached is information concerning the proper torque procedure for the wheels. It is extremely important that you adhere to the torque procedure. Recognize that by the time a typical unit reaches your dealership the lug nuts have been tightened at the factory (twice) and by the transporter at the 25, 50 and 100 mile intervals. By replacing the hubs and drums we must start the tightening process over from the beginning. Make sure the customer understands the critical importance of adhering to this schedule. Detailed instructions for removing and reinstalling the hubs and drums will be enclosed with your parts shipment from Dexter Axle.

The total amount of time allotted for this repair is three (3) hours. Submit labor expense to Dexter on a Keystone Warranty claim form with the Service Bulletin (# A04-036) noted in the customer complaint section of the form. Please note "Attention: Service and Warranty" when mailing. Dexter's address is:

Dexter Axle

2900 Industrial Parkway East

P.O. Box 250

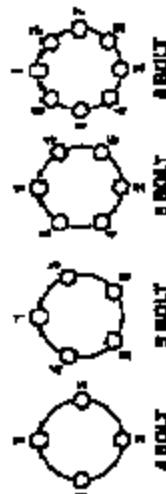
Elkhart, IN 46515

If you have any questions please call our Team Montana service group at (866) 273-1450. Dexter's service and warranty department can be contacted at this number: (574) 295-8666.

Wheels and Tires

Wheel Torque Requirements

Wheel Size	Torque Sequence		
	1st Stage	2nd Stage	3rd Stage
12"	20-25	35-40	50-75
13"	20-25	35-40	50-75
14"	20-25	50-60	90-120
15"	20-25	50-60	90-120
16"	20-25	50-60	90-120
16.5" x 6.75"	20-25	50-60	90-120
16.5" x 8.75"	55-60	120-125	175-225
14.5" Demount	Tighten sequentially to		
17.5" Hub Pilot	50-60	100-120	190-210
Clamp Ring & Cone Nuts			
17.5" Hub Pilot	50-60	90-200	275-325
1/8" Flange Nuts			



CAUTION

Do not attempt to repair or modify a damaged wheel. Even minor modifications can cause a dangerous failure of the wheel and result in personal injury or death.

Torque Requirements

It is extremely important to apply and maintain proper wheel mounting torque on your trailer axle. Torque is a measure of the amount of tightening applied to a fastener (nut or bolt) and is expressed as length force. For example, a torque of 90 pounds applied at the end of a wrench one foot long will yield 90 lbs.-ft. of torque. Torque wrenches are the best method to assure the proper amount of torque is being applied to a fastener.

CAUTION

Wheel nuts or bolts must be tightened and maintained at the proper torque levels to prevent loose wheels, broken studs, and possible dangerous separation of wheels from your axle, which can lead to an accident, personal injuries or death.

Be sure to use only the fasteners matched to the cone angle of your wheel (usually 60° or 90°). The proper procedure for attaching your wheels is as follows:

1. Start all bolts or nuts by hand to prevent cross threading.
2. Tighten bolts or nuts in the sequence shown for Wheel Torque Requirements.
3. The tightening of the fasteners should be done in stages. Following the recommended sequence, tighten fasteners per wheel torque chart below.
4. Wheel nuts/bolts should be torqued before first road use and after each wheel removal. Check and re-torque after the first 10 miles, 25 miles, and again at 50 miles. Check periodically thereafter.

Appendix B

**Summary of Wheel Separation Incidents from Vehicles Equipped with Aluminum
Wheels that Keystone RV has reported to ODI between
October 1, 2004 and September 30, 2005**

Model Year	Montana	Everest	Others	Total
2001	0	0	Challenger - 1	1
2002	1	0	0	1
2003	2	0	No Model Specified - 1	3
2004			0	7
2005	5		Raptor - 3 No Model Specified - 1	12
2006	0	0	Raptor - 1	1
Total	13	5	7	25

Source: ODI summary of "newly reported" incidents.

Shaded cells indicate vehicles addressed by Keystone RV Recall 05V-309. The incidents listed in the shaded cells occurred prior to Keystone RV's decision to recall or prior to owner's receiving Recall notification.

Light shaded cells indicate vehicles addressed by Keystone RV Owner Notification Letter providing "Lug Nut Torque Requirements and Maintenance" information in DVD format.

Although MY 2005 Montana and Raptor and Model Years 2005 – 2006 Raptor vehicles have exhibited several wheel separation incidents and are addressed by Keystone RV's Owner Notification Letter and informational – instructional DVD, Keystone RV has not addressed these vehicles with a Recall action.

**Summary of Wheel Separation Incidents from Vehicles Equipped With Steel Wheels
that Keystone RV has reported to ODI between
October 1, 2004 and September 30, 2005**

Model Year	Montana	Laredo	Cougar	Others	Total
2000	2	0	0	0	2
2001	0	0	0	0	0
2002	0	1	0	0	1
2003	1	0	2	No Model Specified - 2	5
2004	0	2	4	No Model Specified - 2 Hornet - 1 CG301 - 1 Cabana - 1 Mountaineer - 1 Outback - 1 Springdale - 1 Zeppelin - 1	15
2005	0	1	3	Laredo - 1 Mountaineer - 1 Outback Travel Thr - 1	4
2006	0	0	0	0	0
Total	3	4	6	14	27

Source: ODI summary of "newly reported" incidents reported by Keystone RV.

ODI Analysis and Observations –

Other than the model year 2004 Cougar, the number of wheel separations from vehicles equipped with steel wheels does not appear to indicate any concentration or trend. Nonetheless, ODI is concerned about the overall number of separations reported.

Appendix C

Keystone RV's Rationale for Vehicles Included in Recall 05V-309

On September 8, 2005, Keystone RV responded to ODI's request to provide an explanation of the logic that Keystone RV had used to determine which vehicles had been included and which vehicles had been excluded from Recall 05V-309.

Following is a redacted summary of Keystone RV's response



Keystone RV Company

EA04-032

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RECEIVED
NVS-210

2005 SEP 16 P 2:42

September 8, 2005

OFFICE OF DEFECTS
INVESTIGATION

U.S. Department of Transportation
Attn: Tom Bowman
National Highway Traffic Safety Administration
Office of Defects Investigation
NVS-210, 400 7th Street, SW
Washington, DC 20590

RE: Keystone RV Company
Recall No. 05V-039
Keystone Owner Notification

05V-309
✓
001

Dear Mr. Bowman:

As you know Keystone RV Company is conducting a voluntary recall campaign for the purpose addressing aluminum wheel separations on our Montana and Everest fifth wheels manufactured between May 1, 2003 and January 1, 2005. Although I believe you have already reviewed the recall documentation which we have submitted to NHTSA, including the 573 Notice, you have asked that we provide you a written summary containing a little more detail of how we narrowed the recall to aluminum wheels on the Montana and Everest product lines.

There were a number of factors we considered in arriving at the decision to conduct a recall on Montana and Everest fifth wheels built between May 1, 2003, and January 1, 2005. We looked at a significant amount of data regarding wheel separations and also compared the similar recalls conducted by both Jayco and Fleetwood. We determined that May 1, 2003, as the beginning date based upon the (i) minimal separations as determined from representative samples of vehicles manufactured during the period beginning March 2002 through February 2003, (ii) retail sales data taken from our computer data base with the computer data being available beginning in April 2003, (iii) model year change over dates, (iv) tire replacement recommended frequency, (v) normal maintenance schedules for bearings, wheels, brakes, axles, etc., and (vi) difficulty in finding owners of older or used vehicles. The completion date of December 31, 2004, was selected due to the fact that on January 1, 2005, Keystone implemented significant process improvements in all of our plants resulting in virtually no additional reported wheel separations on products manufactured after December 31, 2004.

As for Montana and Everest being the selected products affected by the recall, each product line has similar wheel configuration in terms of component design and product. For example, both product lines have six (6) lug axles, sixteen (16") inch aluminum wheels, a

smaller bolt circle on six (6) lug (5.5 inches) versus a larger bolt circle on eight (8) lug (6.5 inches)*, and the Montana and Everest are Keystone's larger fifth wheels and our heaviest units with the highest center of gravity. In addition, the wheel configuration has the highest failure rate within Keystone product lines at forty-five one hundredths of a percent (0.45%) percent between Montana and Everest. Keystone also took into consideration that the same wheel configuration has been recalled by both Jayco and Fleetwood.

As for specific data, please refer to the following:

Type	Wheel	Axle	Bolt Circle	#Units w/Aluminum Wheels	Number of Wheel Issues	Percent of Wheel Issues
Everest FW	16"	6 lug	5.5 "	991	3	.30%
Montana FW	16"	6 lug	5.5 "	1,677	9	.54%
Subtotal				2,668	12	.45%

Our other configurations which have sixteen inch (16") wheels maintain eight (8) lug axles and six and one-half (6.5") inch bolt circle. The average percentage of wheel separations for that specific configuration is only seventeen one-hundredths of a percent (0.17%).

Our Raptor product line maintains a fifteen inch (15"), six (6) lug axle, five and one-half inch (5.5") bolt circle configuration and there were only two (2) separations during the subject period out of One Thousand Two Hundred (1,200) units resulting again in only a seventeen one-hundredths of a percent (0.17%) failure rate.

Again, based on the analysis of the most likely combination for wheel separation, that being sixteen inch (16") wheel, six (6) lug axle with a five and one-half (5.5) inch bolt circle on large fifth wheels, Keystone proceeded to move forward with the recall on that specific configuration. If you have any more questions concerning the basis for the recall of aluminum wheels please contact Mark Bullock, Rick Deisler, or me at any time.

Appendix D

IMPORTANT NOTICE!**WHEEL LUG NUT TORQUE REQUIREMENTS & MAINTENANCE**

September 20, 2005

RE: Consumer Education Program: 05-059

Dear Keystone Owner:

Keystone RV Company, working in conjunction with axle assembly manufacturers, AL-KO Kober Corporation and Dexter Axle, has recently released an educational DVD that will be included in every Keystone unit starting September 1, 2005. The information contained in the DVD outlines the most recently recommended processes involving Lug Nut Torque and takes precedent over any information regarding Lug Nut Torque shown in your Keystone, Dexter or AL-KO Owners Manuals.

Because of its importance, Keystone has taken an extra step to heighten your awareness of the Lug Nut Torque Requirements and Maintenance of Recreational Vehicles and decided to also send this DVD to all owners of 2004, 2005 and 2006 units manufactured before September 1, 2005.

Enc:



Lug & Recreational Vehicle.

- A Coupon/Acknowledgement is provided should you feel uneasy in any way performing this maintenance service yourself the first time. The Coupon entitles you to one (1) free wheel torque Demonstration & Torque check through an authorized Keystone Dealer through December 31, 2005. We ask that you sign to acknowledge the dealer did provide the Demonstration & service as outlined on the back of the coupon.

A variety of torque wrenches (priced from \$20 to hundreds of dollars depending on the individual's need) can be obtained through a local auto parts supply (Auto Zone, NAPA), tool company (Sears & Roebuck), or on the "Web" using a keyword search "Torque Wrench". Should there be any uncertainty with completing this maintenance service yourself after reviewing the DVD, reviewing the "Acknowledgement" and redeeming the Coupon, these services can be provided by your dealer or local tire store for a nominal fee.

A written version is available for review online at http://keystonerv.com/media/pdf/lug_nut_torque.pdf and should a paper version be needed or there be any questions regarding this program, please contact us at our newly dedicated Toll-free number established specifically for this program at 1-877-U-TORQUE (1-877-886-7783).

Thank you for buying a Keystone and we wish you many years of safe travel.

Sincerely,

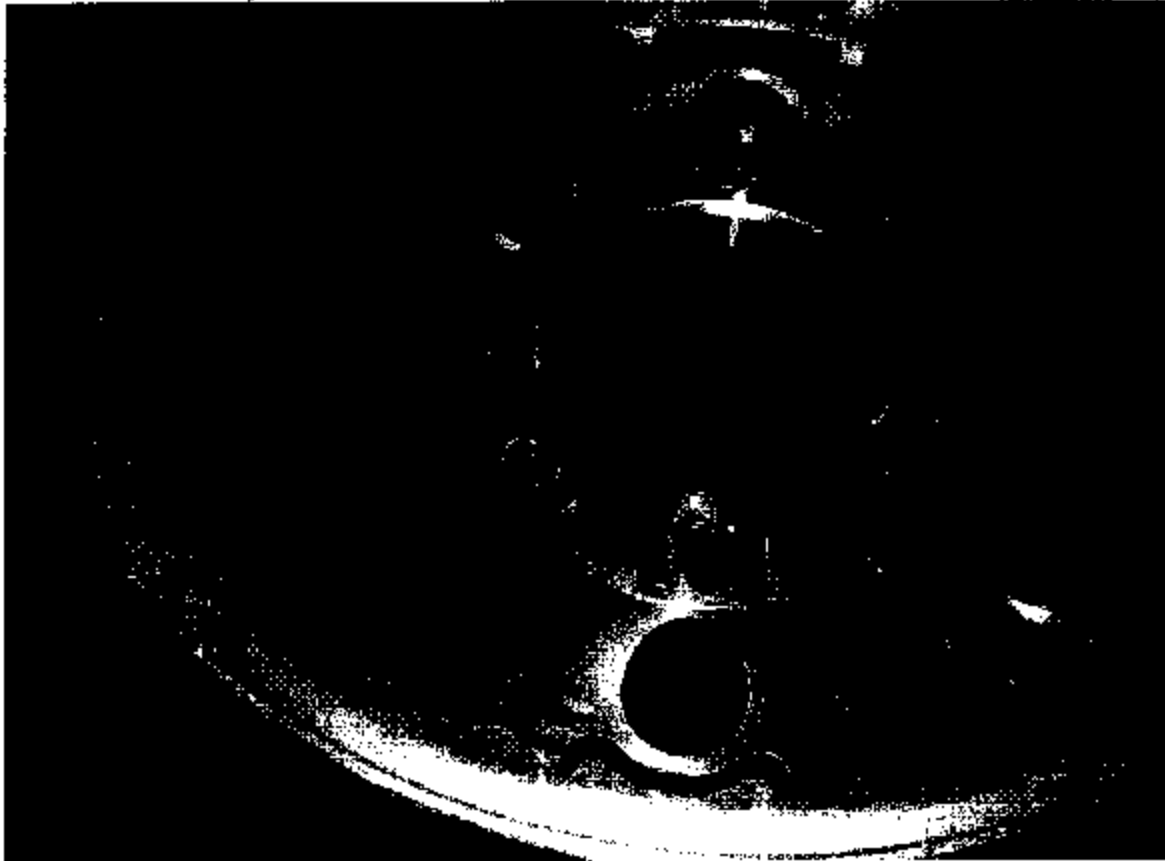
Keystone RV Company

Rick Deisler
Customer Service Manager

cc: National Highway Traffic Safety Administration (NHTSA)

Appendix E

Inspection Summary – 2005 Model Year Everest inspected on February 14, 2005 in Goshen, Indiana



Photograph of the back face of the aluminum eight-hole wheel that separated from a newly purchased 2005 Everest in transit from the selling dealer to the owner's home. Residue of the black paint that has transferred from the hub to the wheel can be observed outboard of each of the mounting holes. No paint can be observed to have transferred inboard of the mounting holes because the wheel is intentionally machined with a shallow counter-bore that extends inward from the bolt circle of the mounting holes which prevents or minimizes the likelihood of the wheel contacting this area of the hub.

The separation of an eight stud mounted wheel indicates that excessive paint may compromise the higher clamp provided by an eight stud mounted wheel system compared to a six wheel stud mounting system.

A properly installed and torqued eight wheel mounting stud system improves the clamp capability and associated safety margin of the wheel end and appears to be directionally correct and prudent action. The wheel separation incident analyzed above indicates that providing increased clamp by means of an eight wheel stud system by itself may not be sufficient to compensate for compromised integrity of the wheel to hub clamp interface.

**Inspection Summary – 2005 Model Year Raptor inspected on June 10, 2005 in
Huntington, Maryland**



Photograph of the back face of the aluminum six -hole wheel that that been installed on the passenger side of the second (middle) axle in a tridem installed on a 2005 model year Raptor that had accumulated (by the owner's estimate) approximately 3000-4000 miles.

The opposite side wheel had separated and was never recovered. Five of the six mounting nuts of the separated wheel had backed off leaving the studs intact (bit with threads galled). The sixth mounting stud had fractured.

This vehicle also exhibited a broken front spring and bent rearmost axle that could be indicative that the vehicle had experienced severe service.

Residue of the black paint that has transferred from the hub to the wheel can be observed outboard of each of the mounting holes. No paint appears to have transferred inboard of the mounting holes because the wheel is intentionally machined with a shallow counter-bore that extends inward from the bolt circle of the mounting holes and prevents or minimizes the likelihood of the wheel contacting this area of the hub.