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

ODI RESUME

Investigation: EA 02-034
Prompted By: OWNER COMPLAINT
Date Opened: 12/03/2002 Date Closed: 02/17/2004
Principal Investigator: SONNY MURIANKA
Subject: OVERHEATING FRONT AND REAR BRAKES

Manufacturer: INTERNATIONAL TRUCK & ENGINE CORPORATION, INTERNATIONAL TRUCKENGINE CORPORATION
Products: INTERNATIONALW/BOSCH (ZOPS) DISC BRAKE CALIPER 1997-2002
Population: 137,987

Problem Description: THE BOSCH ZOPS BRAKE CALIPERS OVERHEAT RESULTING IN WHEEL END FIRES, SMOKING, DRAGGING, OVERHEATING, AND RELATED THERMAL EVENTS.

FAILURE REPORT SUMMARY

	ODI	Manufacturer	Total
Complaints:	136	0	136
Crashes/Fires:	13	130	130
Injury Incidents:	0	0	0
# Injuries:	0	0	0
Fatality Incidents:	0	0	0
# Fatalities:	0	0	0
Other*:	0	12125	12125

*Description of Other: "OTHER" IS WARRANTY CLAIMS; THE ODI COMPLAINTS WERE GLEANED FROM A REVIEW OF BOSCH DOCUMENTS

Action: THIS INVESTIGATION IS CLOSED. INTERNATIONAL IS CONDUCTING A SAFETY RECALL. SAFETY RECALL NUMBER # 03V-062 HAS BEEN ASSIGNED.

Engineer: *Sonny Murianka* Date: *02/17/2004*
Div. Chief: *Richard Boyd* Date: *02/17/2004*
Office Dir.: *Kathleen C. DeMeter* Date: *02/17/2004*

Summary:
This investigation focused on International medium duty trucks and school bus chassis weighing up to 33,000 pounds, equipped with hydraulic brakes and built with the Bosch zero offset pin slide (ZOPS) brake system calipers. International used the ZOPS calipers from April 1997 through June 2002. ODI was concerned about reports of the brake calipers sticking in the applied position, resulting in excessive heat. As the investigation progressed, ODI became aware of wheel end fires, some of which occurred on school buses. During the investigation, ODI obtained warranty data which was sorted and analyzed by VRTC test engineers and ODI to gain an understanding of the magnitude of the problem. After a thorough warranty data analysis, related testing and document reviews, ODI met with International, shared the data analysis and shortly afterwards, International agreed to a safety recall. Further details are included on pages 2 - 4.

Mk faxed on 2/24/04

SUMMARY REPORT

In 1997, Bosch started production of their Zero Offset Pin Slide (ZOPS) disc brake caliper assembly. This new caliper incorporated an "environmentally sealed suspension" system to allow the caliper to slide laterally with less friction. The lubricated pins in the ZOPS assembly are sealed in accordion-shaped boots, designed to provide continuous free floating calipers requiring less maintenance and longer pad life. Sliding freely is critical since the actuating pistons within this caliper are not mounted on both sides of the caliper to clamp the rotor disc, but protrude from only one side. The clamping force on the other side of the caliper (for the out board brake pad) is created from the reactionary force through the housing of the caliper. This new system, used by Bosch for years on lighter vehicles, replaced the standard medium-truck rail-slide disc brake design.

Some ZOPS calipers began to experience brake complaints shortly after introduction into the field. Bosch monitored the reports and formed Action Teams to inspect vehicles in the field and investigate why an advanced system, proven on smaller, lighter vehicles and in pre-production testing, was accumulating "failure to release" complaints from the field. Units were removed from complaint vehicles and collected for in-depth analysis. As more calipers were recovered from the field, the Bosch team identified numerous contributing causes. The resulting continuous improvements were incorporated into the ZOPS caliper production beginning in March 2001 (See Table – page 3). The ZOH-T caliper succeeded the ZOPS in June 2002 and incorporated all of the prior continuous improvement changes.

In June 2002, ODI opened a Preliminary Evaluation on Bosch based on a complaint received from the owner of a 40-foot motor home. The owner alleged that repeated attempts had been made by the final stage manufacturer to correct problems that resulted in what he believed were increased stopping distances from severely overheating disc brake calipers. He also reported smoke and heat damage to the ABS sensor. During the PE, Monaco and Western RV both submitted safety defect reports (02V-278 and 02V-243), to address these concerns. Although ODI initially focused only on recreational vehicles, it became apparent that other types of vehicles equipped with the ZOPS calipers were suffering similar problems. Thus, ODI opened an Engineering Analysis on International Truck Corporation in December 2002. On February 24, 2003, after meeting with ODI, International filed a safety defect report, (03V-062), to address concerns of calipers sticking in the partially applied position. This defect report applied to the school bus chassis and was supplemented in December 2003 with additional chassis. ODI's primary analysis was based on a review of warranty claims received by International for the period April 1997 through December 2002. In total 23,195 claims were reviewed. The Vehicle Research and Test Center (VRTC) examined the data set with Excel's Visual Basic for Applications (VBA) using keywords such as fire, flame, burn, smok, smk, drag, slide pin, etc. There were 11,070 claims eliminated as related to a previous recall (02V252), leaving 12,125 claims of various brake problems. The primary claims that concerned ODI were fire (130), burn (279), "smok" (425), drag (5,526), pin (945), and caliper (366). These claims were normalized by model designation and, to the extent possible, body type. Claim rates (normalized data) between vehicle models were not equal. ODI believes that there are many possibilities for the differences in rates, primarily due to the variability of the ingress of moisture past the environmental boot and the variability in the propagation of corrosion at the critical seal land area. Some of those variabilities relate to vehicle types (school buses vs. trucks). Reasons for these different rates between vehicle types are that the utilizations of the vehicles are different. There is a lag time from the date the chassis is completed vs. the date the chassis is shipped to the dealers and customers and placed into service. International's Conway plant builds chassis for cargo hauling trucks, such as UPS and FedEx and some bus chassis. These vehicles tend to

have a turnaround time (to final completion) of a couple of months or less, depending on the demands being placed by the final stage manufacturers. The Springfield Ohio plant, by comparison, builds truck and bus chassis that tend to sit at the final stage manufacturer's plant (school buses) up to 15 months before being placed in service. Many of these vehicles are stored outside and are continuously subject to the environment. Some of the other considerations of this defect are the multiple failure modes including lack of grease or corrosion within the slide pin bore, slide pin camming (due to a required but nonstandard installation procedure that may be skipped by assembly or service technicians, the pins may not be parallel, leading to high slide forces), rolled hydraulic seals, etc. With this number reliability problems, it is expected that the rates or trends would have a significant degree of unpredictability. Other theories presented were brake line pressure being maintained by the ABS system, master cylinder holding line pressure, wheel bearing adjustment, collapsed brake lines, excessive flow to the booster, vehicle loading, environment and driving style. The other theories were anecdotal with no hard data to support them.

The following is a chronology of the various changes incorporated by Bosch into the ZOPS caliper, that ODI believes are related to thermal events. "Thermal events" pertain to one or more wheel ends and may be reported singularly or in combination as fire, burn, smoke, brake drag, and/or failure to release. Field reports and customer complaints may also mention pin failures, pin camming, and or poor caliper slide. We have included the date of the change, the purpose and a brief description. Any problem which prevents the piston from fully retracting from the rotor would result in increased heat at that wheel end and depending on the amount of drag, ultimately, smoking, burning, and fire.

Date	Problem Category	Problem Detail	Fix Implemented
March 2001	Thermal events	Caliper not sliding on mounting pins	Improve pin grease distribution
April 2001	Broken/loose pin bolts	Poor joint integrity	Improve pin ear surface finish
April 2001	Thermal events	Rolled hydraulic seal during installation	Increase amount of piston seal lubricant
Oct 2001	Thermal events	Water intrusion and corrosion of caliper bore	Add BATCO grease to piston seal land
June 2002	Broken/loose pin bolts	Poor joint integrity	Bolt has longer, finer threads, shoulder, oil
June 2002	Thermal events	Water intrusion and corrosion of caliper bore	Increase piston boot squeeze
June 2002	Thermal events	Rolled hydraulic seal during installation	Wide piston seals & modify seal groove
Oct 2002	Broken/loose pin bolts	Poor joint integrity	New Loctite patch on pin bolt
Dec 2002	Thermal events	Caliper not sliding on mounting pins	New pin grease (Albida)

Safety Risk

Although the investigation included all International vehicles built with a ZOPS caliper, ODI believes that certain classes of vehicles, those being school buses, transit buses, recreational vehicles, emergency vehicles, ambulances and hazardous cargo carrying vehicles have a higher safety risk than other vehicles included in the investigation. The risk quantification stems from

ODI's concern about vehicles with multiple passengers who would have to exit safely in the event of a wheel end fire (school buses, transit buses and recreational vehicles), emergency vehicles, and hazardous cargo carrying vehicles. Vehicles with one person, generally a commercial driver with a CDL, who most likely would have a fire extinguisher in the vehicle, were deemed to be a lower risk for which a safety recall is not warranted.

ODI believes the safety recall action taken by International of 35,078 vehicles is an appropriate solution to this problem. Therefore, ODI is closing this investigation, as further utilization of resources is unwarranted at this time. ODI will continue to monitor this issue and if necessary take further action in the future. A copy of International's recall is included in this file.

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