PURPOSE
The purpose of this paper is to document the sequence of events that occurred before and after the incident involving Engine OR-BUD-2423 (E-423) and identify learning points for future operations.
INTRODUCTION
On Wednesday June 29, 2011, E-423, a Type-4 wildland fire engine was travelling south on US-395 returning to the Burns Interagency Fire Station in Hines, Oregon after visiting a recently controlled fire incident. In route to the station, the rear driver’s side dual lug nuts loosened and fell off causing the wheels to separate from the vehicle. One of the free wheels from the engine traveled into the opposing lane of traffic and struck a passing motorist causing damage to the frontend of the passenger side of the vehicle. E-423 came to rest on the left rear hub and sustained damage to the brake/hub assembly and surface damage to the rear body box. No serious injuries were sustained as a result of the incident. In accordance with direction provided in the Interagency Standards for Fire and Fire Aviation Operations 2011, a Lessons Learned Review (LLR) of the accident was initiated at the local level.

The purpose of the LLR and this report are to:

1. Identify the facts of the events and to develop a chronological narrative of the event;
2. Identify underlying reasons for success or failure;
3. Identify what was learned and what should/could be done differently in the future; and
4. Identify any recommendations that would prevent similar occurrences.

SUMMARY OF INCIDENT
On Tuesday June 28, 2011 the crew of E-423 was preparing their Fire Engine to be in the local 4th of July parade. Wheels were removed with a compressor and ¾ inch drive impact wrench at Bureau of Land Management (BLM) shop. The front wheels and driver side dual were painted and replaced on this day. A star pattern was used retighten the lug nuts during the mounting of the wheel back on the engine. Two lug nuts were tightened then the crew paused to give the air compressor time to rebuild to pressure to 120 psi before moving to the next two lug nuts. After the crew finished with all the lug nuts, they went back over all the lug nuts for a second time to ensure they were tight. On Wednesday June 29, 2011 the crew returned to the BLM shop to finish the job of painting the passenger side rear duals. They followed the same procedure on the passenger side dual. The crew drove to a local commercial tire center to get the lug nuts torqued. This is the BIFZ standard procedure since 2010. The tire center assistant manager stated that they do not have a torque wrench for that size of lug nut and that they tighten lug nuts on larger truck with an impact wrench. He offered to check the tightness of the lug nuts with their impact wrench. The crew stated that they had just done that with their impact wrench at the BLM shop and continued with their mission to check Incident OR-BUD 2011-10053. Before E-423 left the incident the engine captain checked the rear duals, on the passenger side he tried to turn the lug nuts with his finger and did not have movement. The dual on the driver side were visually checked for movement or scuff mark on the wheel surface, sign of loose lug nuts.

As the Engine Captain was negotiating a left banking curve while traveling south on Highway 395 North, approximately mile post 51C, the operator felt a jolt and sudden shift of weight to the driver side of the E-423. The Driver’s-side rear dual wheels separated from the Engine and traveled across the roadway striking the right front of a passenger vehicle heading north on Hwy 395. E-423 stopped a short distance passes the vehicle staying within their lane resting on the left rear hub in the upright position.
The Engine Captain notified Burns Interagency Communicate Center (BICC) of the incident and requested law enforcement and tow trucks. The other crew members set up traffic control on both sides of the curve. The Engine Captain exited the vehicle, assessed the situation, check the driver of the other vehicle for medical needs and relayed to BICC that medical attention was not needed for the driver of the other vehicle. BICC notified other fire crews in the area to support E-423 with Highway control, dispatched the fire supervisors to the scene, and notified Deputy Fire Manager Officer, Associated District Manager and Safety Manager. The Harney County Sheriff Department had control of the accident scene, with the assistance of Oregon State Police and they investigated the scene of the incident. The Harney County Sheriff Deputy requested an ambulance to check the driver of the passenger car, but the driver refused treatment and was not transported. The engine and passenger vehicle were towed to Burns for repair.

**FINDINGS**
The initial investigation indicated that the lug nuts had loosened; causing the wheels to separate from the driver side of E-423. On the passenger side the rear dual lug nuts had loosened to the point where six lug nuts could be turned by finger. Some of the key points:
• The engine crew had removed the wheels for maintenance on June 28th and June 29th and had installed them using a ¾ inch impact gun at BLM shop.
• On June 29th engine crew followed SOP by bringing the engine to a commercial tire center following dismounting of wheels for re-torque of the lug nuts.
• The commercial tire center did not have a torque wrench large enough to fit the lug nuts on the Heavy Fire Engine.
• The commercial tire center offered to put the tire center’s impact gun on the lug nuts. They refused the offer and then proceed to the field.
• BLM uses a ¾ inch impact wrench and commercial tire center uses a 1 inch impact wrench to tighten lug nuts on large truck.
• BLM shop air compressor has a maximum of 120 psi at the tank and the 3/8 inch inters diameter (I.D.) air hose in fire ready room. The compressor is set to maintain a pressure between 90 to 120 psi.
• BLM NAPA ¾ inch impact wrench has a forward maximum torque of 150-700 ft. lbs. to manufacture specification with a 1/2 inch I.D. air hose.
• The commercial tire center’s Chicago Pneumatic 1 inch impact wench has a forward maximum torque of 150-900 ft. lbs. to manufacture specification with a 1/2 inch I.D. air hose.
• The current style of one lug nut per stud on dual wheels has increased the chance of wheel lost. This type of lug nut is a nut with a built-in washer that rotated when installed and the wheel is center on the hub. The change from tapered nut and rim has change the way wheels are installed on larger truck.
• The engine crew had checked lug nuts before they left the incident by touching and visual inspection of the rear duals. However, the lug nuts were not checked with a lug/torque wrench, and visual inspection was to identify a movement of lug nuts on the wheel face, which is insufficient to notice any problems.
• Wear marks on passenger side wheels, studs, and hub show that the lug nuts had backed out away slightly.
• The other new Type-4 engine E-420 and E-425 from the same manufacture had their lug nuts check by the local commercial tire center and were found to be loose.

LESSONS LEARNED
This section shall identify the underlying reasons for the incident and the lessons learned by personnel involved in the incident.
These included:
• Needed of torqueing this new style of lug nuts after the installation of tires.
• Needed to works with local commercial tire center to get them to not let the crews leave without have the lug nuts checked.
• The daily inspection of lug nuts with a torque wrench on all fire equipment. It is no longer appropriate to just tighten lug nuts and forget.
• The painting of wheel rim will create an additional layer and will wear down, causing a space to develop.
• The types of impact wrenches different in their capacity to tighten the lug nuts at a foot/pounds rate. The ability of an air gun system to tighten lug nuts is not only based on
the rated power of the gun, but the ability of a system to supply a constant level of air pressure to the end of the hose.

WHAT WAS DONE WELL

• They followed the recommendation that stated last fire season on checking the lug nuts at local tire center, after removal of a tire.
• Was aware that lug nuts could loosen and visually checked the lug nuts before leaving the incident.
• The engine captain exhibited good situational awareness in controlling the engine and likely averted a potential rollover and called BICC for help.
• Crew member stayed calm and immediately put on the safety vest and took on traffic control to reduce the possibility of more accidents at the scene.
• All employees were wearing seatbelts.
• The engine captain controlled the situation with the driver of damage vehicle and asked if they were in need of medical treatment.
• The engine captain keep BICC informed of the situation until fire supervisors and law enforcement was on scene.

RECOMMENDATIONS

The following recommendations are offered for consideration as a result of this incident.

• Development a written Standard Operation Procedures in changing tires in the field.
• Employees are advised to check specifications in vehicle owner’s manuals referring to installation of wheels and tightening lug nuts.
• Wheels and lugs must be cleaned of dust and debris before installing on the vehicle. Foreign debris and a dirty surface can cause a space to develop after a period of travel, which can cause the lugs to loosen.
• Control the repainting of wheel, the surface of the wheels that touch the hub and inter surface of the duals will not be repainted.
• It is recommended to put only a single drop of oil between the lug nuts and the washers.
• After installing wheels, re-torque lug nuts after 100 miles, then re-torque after 500 miles using an appropriate torque wrench (Manufacturer recommendation for International Workstar Truck lug nut torque pressure is 450-500 ft. lbs.)
• Purchase of torque wrench for each vehicle
• Acquire training from local commercial tire center on the method of torqueing the tires on all Fire Equipment with this new type of lug nut and train the trainer (Engine Captains) shall trained the other member of the fire zone.
• Weekly inspection sheets shall include a check for proper torque of lug nuts.
• Purchase of ½ inch hose for each of impact wrench.

All individuals involved in the incident and the LLR should be commended for their cooperation and honesty as well as their willingness to learn from this incident.

JOURNEY TO NO HARM

Show the hub wear and damage to the lugs.
The type of lug nuts and ft. lbs. torque.

Show paint surface wear.
Tire Removal Policy

To be added to Unit 30 of our Fire Operational Procedure Reference.

In the event of a flat tire, or tire removal for any reason, we will follow current policy and procedures as listed below.

If the event of tire removal, we will put the tires back on using the air guns that are provided with each Heavy Engine. In addition, we will torque each lug nut to manufactures specifications using the torque wrenches that will be provided with each vehicle, we will also (at our earliest opportunity) take the vehicle to Les Schwab tire center and have them check the torque, to ensure that the lug nuts are sufficiently torqued on.
• We will no longer remove wheels from vehicles for cosmetic maintenance: i.e., painting etc., or will we paint the inside dual. Rather, we will leave the wheels mounted and achieve the same results.

• We currently do daily engine inspections that are documented. We will incorporate the lug nut inspection into this program. To ensure that they are torqued correctly, we will use the wrench (that will be provided for each vehicle) daily.

• On the required standard form 1520-35, Annual Motor Vehicle Maintenance/Safety Inspection Checklist, wheels and tires are covered. We are going to add that lug nuts and studs also be inspected.