WITHOUT A REGULATOR, A NITROGEN SOURCE CAN CAUSE A WHEEL TO EXPLODE, MAKING THE WHEEL, WHEEL TIE BOLTS, OR THE TIRE DEADLY PROJECTILES.

Wheel/Tire Pressurization: Simple Precautions Can Save Lives

By Chris Dubuque
Senior Engineer, Landing Gear Systems

In the last 20 years, a number of severe injuries – including several incidents of dismemberment and three fatalities – occurred during the inflation of nose wheel/tire assemblies on airplanes. Over-pressurization can cause an explosion that fractures the wheel during tire inflation, ejecting fragments at a high velocity. Typically, an unregulated nitrogen supply is responsible for the explosion. Virtually every accident involving nose wheel/tire inflation can be prevented by consistently following simple precautions.

WHEEL DAMAGE DUE TO OVERINFLATION
Figure 1

A maintenance worker was fatally injured in 2006 during inflation of a 737 nose wheel/tire assembly with an unregulated nitrogen pressure source that allowed the wheel to be exposed to the full pressure inside the nitrogen bottle. In this case, the nitrogen bottle was reported to be at 3,000 psi while the service pressure for the wheel was 166 psi.

Inflating a commercial airplane's tires is a routine task that occurs without problems thousands of times each day. Yet this job can turn deadly if standard safety precautions are not followed.

This article provides information to operators and maintenance, repair, and overhaul (MRO) shops to help prevent injury or death when maintenance personnel are inflating a wheel/tire assembly.

CAUSES OF WHEEL/TIRE ASSEMBLY EXPLOSIONS

Airplane wheel/tire assemblies are inflated to high pressures, often in excess of 200 pounds per square inch (psi). Because the pressure in a nitrogen bottle or tire-servicing cart can be as high as 3,000 psi, connecting the nitrogen source directly to the wheel without a regulator subjects the wheel to sudden high pressure that can exceed the design limits for the wheel, the wheel tie bolts, or the tire. Consequently, the wheel, the wheel tie bolts, or the tire can explode and become projectiles (see fig. 1), causing severe injuries, dismemberment, or death.

In most of the reported cases of related injuries, the wheel/tire assembly that exploded was a nose wheel on a smaller-configuration airplane such as a 737 or DC-9. These tires present a greater risk because their smaller size means they reach dangerous pressures faster than the tires on main landing gear.

TIRE INFLATION TOOL
Figure 2

A tire inflation tool such as this adds another level of protection that can help prevent over-pressurization of the wheel/tire.

TIRE INFLATION PRECAUTIONS

Whenever an airplane tire is being serviced, three layers of protection are normally in place to protect maintenance workers from wheel fracture:

- A pressure regulator on the nitrogen supply.
- A pressure relief valve on the tire inflation tool.
- An overinflation pressure relief (OPR) valve installed in the wheel.

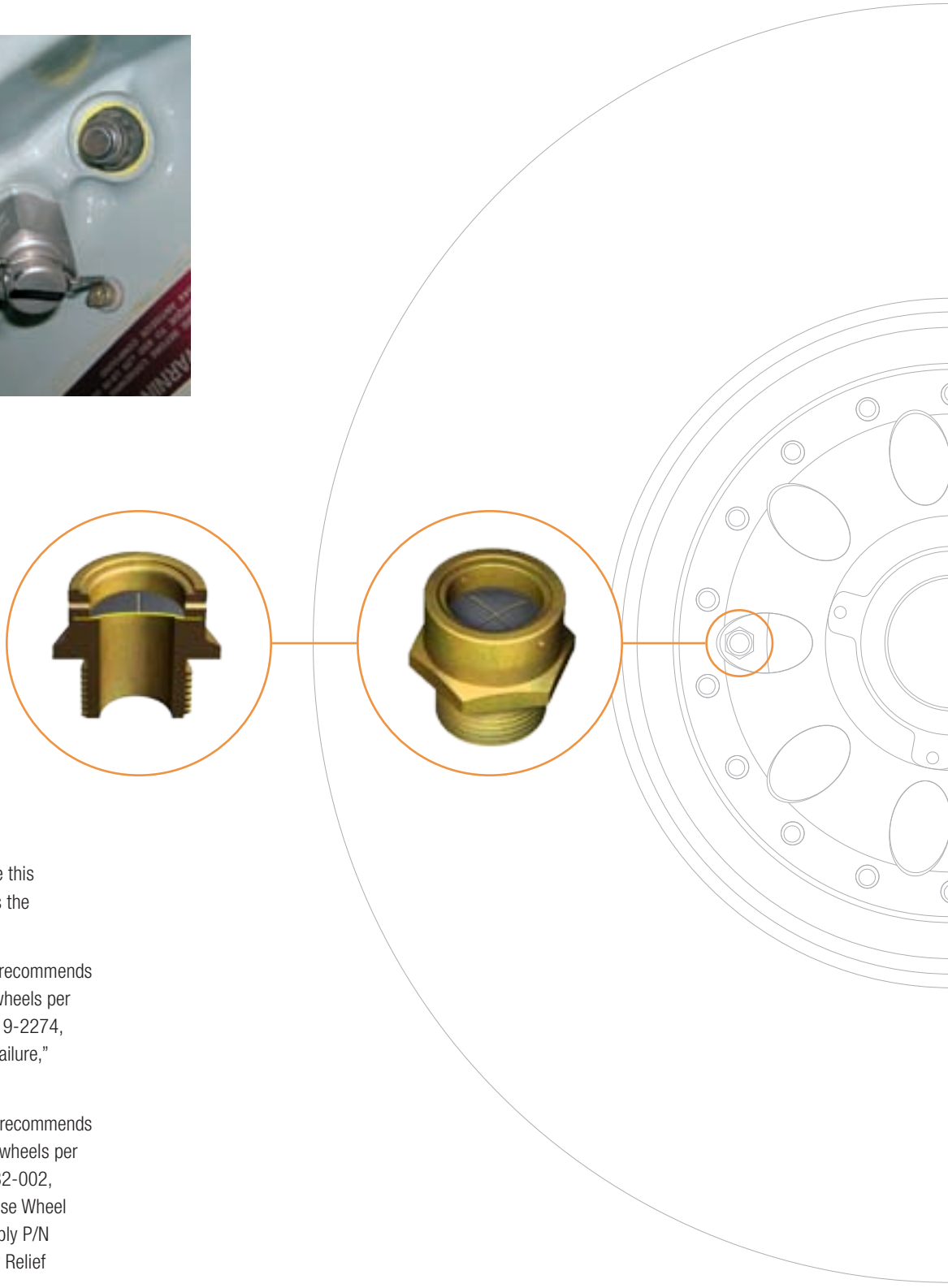
Pressure regulator on the nitrogen supply. Maintenance personnel should never attempt to inflate a wheel/tire assembly in any maintenance or shop location without a regulator between the pressure source — such as a tire-servicing bottle or cart — and the inflation valve on the wheels. It is *essential* that operators ensure regulated nitrogen sources are correctly used. Boeing also recommends operators have back-up protection (such as additional regulation or pressure-relief devices) installed in *all* high-pressure nitrogen sources in case the primary regulator is not adjusted correctly or fails to properly regulate. Procedures for inflating the wheel/tire assembly when it is installed on the airplane are located in Chapter 12 of the Airplane Maintenance Manual (AMM).

Pressure relief valve on tire inflation tools. Because many inflation valves on airplane wheels are similar to automotive valve designs, automotive tools are frequently used for airplane wheels. However, many Boeing AMMs specify a tool for tire inflation that incorporates a pressure relief device designed to release at a pressure slightly higher than the tire service pressure, providing an additional layer of protection if the nitrogen source is inadvertently at high pressure (see fig. 2).

OPR valve installed in the wheel. The risk of explosion increases greatly on wheels that are not equipped with an OPR valve. An OPR valve is a device similar to that shown in figure 3. It is included in many wheel assemblies to limit the pressure in the wheel/tire assembly. If the pressure in the wheel exceeds a predetermined value, a disk in the OPR valve will rupture, allowing the gas to escape while reducing the pressure in the wheel before it can fracture. After the disk ruptures, the gas in the wheel exits through the OPR valve. The valve is designed so that when the disk ruptures, the gas will exit from the wheel faster than it can be supplied from the pressure source.

OPR VALVE
Figure 3

An OPR valve should be installed on every wheel assembly. It provides a valuable layer of protection that can help prevent wheel/tire explosions that result from introducing an excess of pressure to the airplane tire.



Certain older wheels do not include this valve. As a result, Boeing recommends the following retrofits:

DC-9/MD-80 operators: Boeing recommends retrofitting an OPR valve into all nose wheels per McDonnell Douglas Air Operator Letter 9-2274, "Nose Landing Gear Wheel Assembly Failure," dated July 21, 1992.

737-100/-200 operators: Boeing recommends retrofitting the OPR valve into all nose wheels per Honeywell Service Bulletin 2601045-32-002, "Modification of the 737-100/-200 Nose Wheel Assembly P/N 2601045-2 Into Assembly P/N 2601045-3, for Installation of a Safety Relief Valve," dated August 31, 2000.


FD-1207-04.05
3
5

PORTABLE NITROGEN CART
Figure 4

Portable nitrogen carts that are used to service both high- and low-pressure equipment should have hose and fitting sizes that are different between the high- and low-pressure sides. The high- and low-pressure sides also should be clearly marked.

Boeing recommends that operators and MROs train shop and maintenance personnel about the hazards associated with inflating wheel/tire assemblies.

USING PORTABLE NITROGEN CARTS

Portable nitrogen carts (see fig. 4) are often used to service high-pressure equipment (such as accumulators) as well as low-pressure equipment (such as tires). To accommodate this range of equipment, nitrogen carts are typically equipped with both a high-pressure regulator and a low-pressure regulator.

It is essential that operators ensure the hose and fitting sizes are different between the high- and low-pressure sides so that the high-pressure side cannot inadvertently be used on a low-pressure device. The high- and low-pressure sides also should be clearly marked.

INSPECTING WHEEL TIE BOLTS, NUTS, AND WASHERS

Because worn or damaged wheel tie bolts, nuts, or washers can cause (or contribute to) a dangerous wheel fracture, it is essential that operators and MROs place proper emphasis on inspection and replacement of this hardware. Each wheel Component Maintenance Manual (CMM) or overhaul manual provides specific inspection and rejection criteria for wheel tie bolts, nuts, and washers.

THE IMPORTANCE OF ONGOING TRAINING

Boeing recommends that operators and MROs train shop and maintenance personnel about the hazards associated with inflating wheel/tire assemblies. Boeing also recommends that operators and MROs place extra emphasis on wheel tie bolt, nut, and washer maintenance because this hardware can cause (or contribute to) dangerous wheel fracture.

SUMMARY

In the past 20 years, several accidents have occurred during tire servicing in which the wheel exploded because of over-pressurization, causing dismemberment or death to service personnel or damage to equipment. It is essential that tire-servicing equipment be equipped with a regulator to prevent tires from being subjected to excessive pressures that can result in an explosion. In addition, strict adherence to established procedures in the AMM and CMM will help ensure the safety of maintenance personnel during tire servicing. For more information, please contact Chris Dubuque at christopher.v.dubuque@boeing.com. A