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Burst & Containment: Ensuring Turbocharger Safety

"What would happen if one of the wheels in my turbo were to burst at speed? Would the housings be strong and resilient enough to contain all the pieces?"

These are questions that have not commonly been asked in the performance turbocharging world. For the average boosted street-driven car equipped with a quality turbo from a reputable manufacturer, chances of an actual wheel burst are slim to nil.

In amateur and professional motorsports however, the likelihood of a compressor or turbine wheel coming apart can become very real, very quickly. As the limits of today's turbos are reached, they are subjected to higher speeds, hotter temperatures and severe duty cycles.

New wheels, housings and complete turbos are constantly being developed to outperform the previous generations. The temptation can be great to ignore safety and go for broke with the lightest wheels and thinnest housings possible, in order to eke out every last bit of performance from the turbo and the race vehicle. But if a turbo manufacturer focuses on performance only and does not qualify their products to contain both compressor and turbine wheel bursts, then there is no guarantee that the high-velocity wheel fragments will remain inside the housings if the turbo is intentionally or accidentally pushed past its safe operating limits.

This Garrett® white paper will explain wheel burst: what it is and how it can happen, the amount of energy released by a burst, and how each and every Garrett® OE and aftermarket turbocharger for sale to the public is designed and qualified to safely contain the fragments of a bursting wheel.

Definitions of Burst & Containment

What is a wheel burst? Simply put, it is the failure of a turbine or compressor wheel to physically hold itself together against centrifugal forces.

At the speeds and temperatures reached by turbocharger turbine and compressor wheels, the strength limit of the wheel material becomes crucial for durability and safety. Turbo shaft speed can safely skyrocket to over *200,000* rpm for smaller units such as a Garrett® GT15, and even the largest GT55s can reach a still astronomical *90,000* rpm without cause for alarm.

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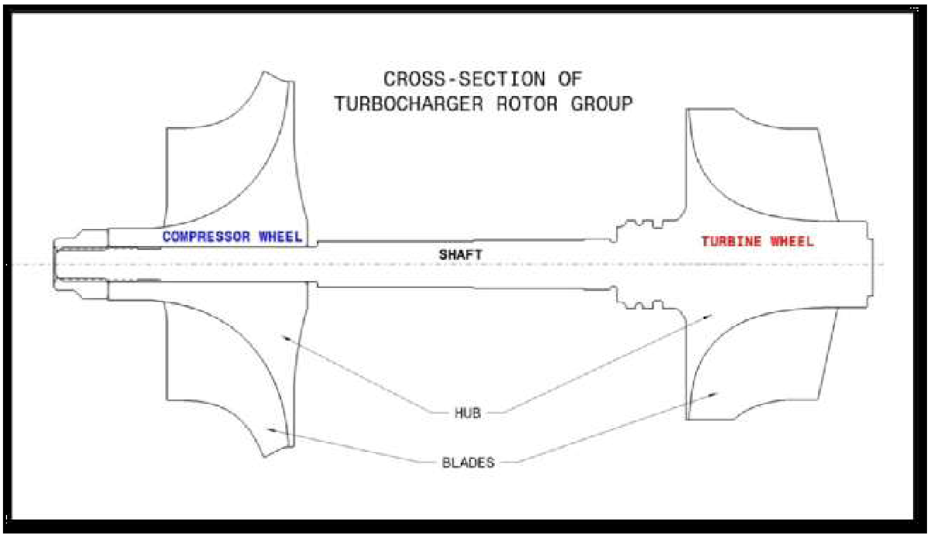
Turbine wheels flowing highly-boosted exhaust gas can reach *980ºC* and higher in typical turbo vehicles, and in top-level motorsports such as WRC they can regularly get up to *1050°C*.

The centrifugal stress that the wheel must resist is proportional to the rotational speed squared, and the strength of typical wheels falls off drastically at temperatures above their qualified limits. Wheels are designed to resist these stresses at high temperatures but there is always a limit; a combination of excessively high speed and temperature is a recipe for burst.

There are two major types of wheel burst: blade and hub.

- A ***blade burst*** occurs when the centrifugal force at speed acting to pull the blades off of the central hub overcomes the mechanical strength of the root sections connecting the individual blades to the hub. Under these conditions if a blade root is too weak it could leave the hub as easily as a petal is plucked from a flower.

- ***Hub burst***, on the other hand, is the extreme case wherein the main hub that the blades are attached to reaches its ultimate strength limit and breaks into two, three or more large pieces through the centerline of the wheel. The hub is more compact than the blades and is a continuous mass, therefore stronger than the root of each thin blade. However, the hub centerline is at the rotational centerline of the wheel, meaning that the internal stresses are at their maximum at the hub's core. The hub can actually burst at extreme speeds and temperatures. In some cases it may burst after the blades have been ejected, and during a Garrett® burst containment housing qualification test the hub is intentionally weakened to cause a worstcase scenario burst. Whatever the reason for hub burst though, it has the highest potential for damaging the housing and its surroundings because it is the heaviest single portion of the wheel and releases the largest amount of energy. In the case of a turbine wheel hub burst, the heaviest spinning portion of the entire turbocharger comes apart with explosive force.



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Even though a hub burst is a rare occurrence in practice, Garrett® by Honeywell qualifies its aftermarket and OE production turbochargers for containment of a worst-case-scenario wheel burst.

What is containment?

During a wheel burst, whether turbine or compressor, blade or hub, the housing that the wheel spins in is the main barrier between the flying debris and the outside world. Containment is the ability of a turbine or compressor housing to successfully absorb the ballistic energy released during a burst and radially contain the fragments within the confines of the housing. The housing should also contain damage caused by loose wheels that have not burst, such as if the central shaft is overloaded and breaks or if the weld joint between the turbine and shaft fails.

Details of the containment testing will vary depending on the turbocharger manufacturer because the manufacturers who test for burst containment each define their own criteria for acceptable containment performance.

Causes of Burst

What causes bursts to occur?

For one, the aforementioned combination of high temperature and high speed reduces material strength dramatically just as the internal stresses are becoming enormous. This is the obvious, albeit extreme, cause for wheel burst. Although a turbocharger's compressor wheel is usually made of aluminum, which has a lower material strength than that of the nickel-based Inconel turbine wheel, the lower density of aluminum leads to the compressor burst speed typically being slightly higher than the turbine.

However, the higher mass of the turbine wheel means that it is usually more difficult to contain in the event of a burst. One possible scenario is compressor wheel failure leading to turbine wheel burst. If the compressor wheel bursts or becomes detached from the shaft, it is no longer loading up the turbine with aerodynamic forces and inertia, but the exhaust flow usually continues if the engine is still running. After compressor failure the turbine wheel and shaft can instantly spool up to the speed at which the turbine wheel will naturally burst. Obviously, this is a bad day for the turbocharger!

Another less intuitive cause for wheel bursts is fatigue. All metals have a fatigue life; that is, loaded with enough stress cycles (even below the strength limit) the material will eventually crack and fail despite the fact that the forces at work are not enough to hurt the wheel on their own without this repetitive cycling. Aluminum's fatigue resistance is low enough to cause concern for turbocharger engineers and must be taken into account when designing new compressor wheels.

There are several types of fatigue failure modes but low-cycle fatigue (or LCF) is the one that leads to hub burst. LCF is a phenomenon that can cause burst in wheels that are sped up near their maximum safe speed and slowed down over and over again. A turbocharger on a city bus is a classic example of an extreme application that can produce LCF-induced failure. A city bus has to make frequent stops, and the bus driver needs to get to each stop on time, meaning that they will usually floor the accelerator whenever the bus is in motion, then stop and idle, then repeat. This constant on-off-on-off cycling of full-boost maximum shaft speed toidle and back again will eventually take

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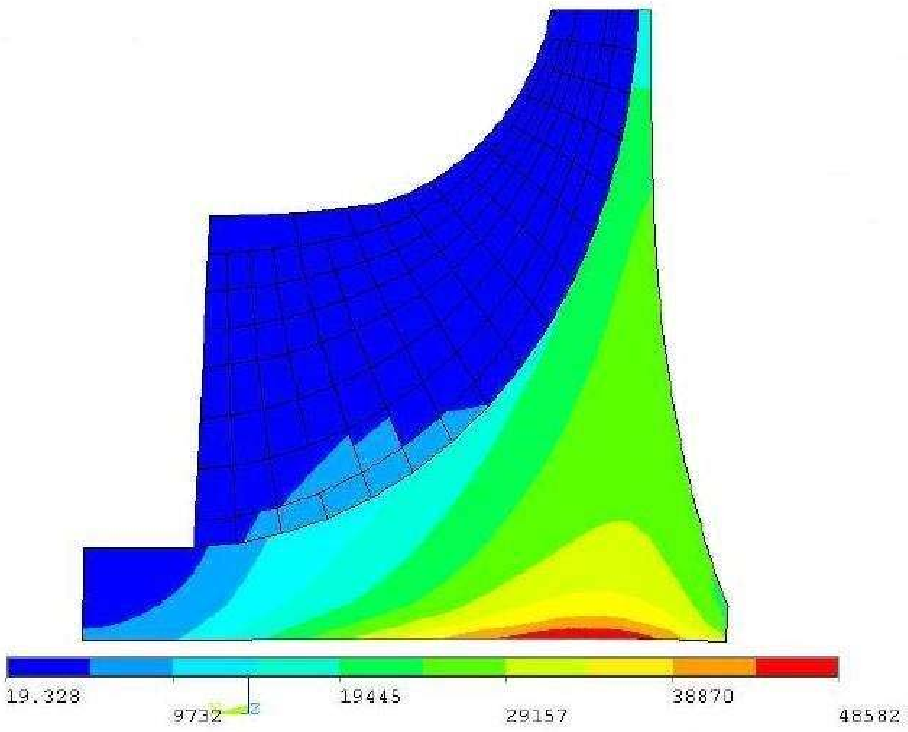
its toll on the turbocharger and can induce compressor wheel burst. LCF failures usually can be traced back to microscopic material defects in the wheel hub near the area of maximum stress, which is on the axis of rotation and in line with the backdisc (or major diameter) of the wheel.



Stress concentration in a compressor wheel running at full speed, shown in half of a cross-sectional view. The distribution represents tangential (hoop) stress, which drives LCF failure. Highest stress region is represented in red and is at bottom right corner, which is at the thru-bore of the wheel, in line with the exducer diameter. Cracks that lead to hub burst will most likely start in this red region.

No material is completely free of defects, and any small void or inconsistency can cause the internal stresses to rise in the immediate vicinity. Even if that defect is extremely small, a crack will form and grow over time as that location is stressed at speed. If the turbocharger was only used a few times and then retired, this would never be a problem. But turbos on city buses and many other severe-duty vehicles live a long and hard service life. Why care about city buses? Because meaningful similarities can be drawn to racing vehicles; their drivers also usually demand maximum power whenever they are on the throttle…otherwise, why would they race?

LCF failures can occur on racing turbochargers despite the fact that they will never see as many cycles as a city bus will in its lifetime, because they are regularly pushed well above their limits in competition. The more extreme the speeds and temperatures, the less cycles it will take to cause a fatigue-related failure. Because no material is perfect, every wheel will eventually fail if cycled enough times. With careful material selection and quality control however, the usable lifetime of the wheel can be extended long enough to outlive other components of the turbocharger and engine.

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The last major cause of burst is foreign object damage, or FOD. If a compressor wheel ingests a rock or piece of rubber kicked up from the racetrack, or an exhaust valve fails at redline and is blown violently into a turbine wheel, of course the wheel will be damaged but additionally there is a chance it may actually burst. A projectile hitting a wheel spinning at tens or hundreds of thousands of rpm can do much more damage than easily imaginable.

If the hit is hard enough or strikes the hub just right, a wheel can burst due to significant weakening. The best FOD prevention for the compressor wheel is using an air filter or at least a wire mesh screen, and thoroughly checking any pre-turbo plumbing for debris.

Even a rag sitting in the engine compartment during a dyno pull can quickly be sucked into an open compressor and cause major FOD.

For the turbine side, ensuring that the engineis built to handle the power and temperature being demanded will help to prevent FOD from internal engine failure.

Forged pistons, titanium valves and proper safe tuning will minimize the chances of the engine shooting bits of itself into the whirling turbine wheel.

Although not strictly fitting the definition of burst containment, housings should also contain damage caused by other types of wheel failures which have their own distinct root causes. Shaft and hub weld failures usually result from over-speeding the turbocharger so extremely that the bearing system cannot effectively support and control the spinning wheels and shafts any longer. The shaft moves and bends in ways it was not meant to handle, and the wheels can literally crash into the housings since they too are moving and distorting past the allowable limits.

Compressor and turbine wheels usually run at clearances less than 40 thousandths of an inch (0.040 in, or 1.00 mm) from their housings so the limits of allowable shaft motion and wheel distortion are very sensitive and must be respected. Use of a turbocharger speed sensor will reveal if the unit is in danger of overspeed.

Bearing failure will also result in excessive rotor group motion and potential wheel failure, but high-quality clean oil at the recommended temperatures and pressures will go a long way towards keeping bearings alive.

Wheel-to-shaft joint failures can otherwise result from quality issues compromising the strength of the wheel, shaft, or weld or from improper material selection – it is the duty of the turbo manufacturer to specify materials and treatment processes that will allow the rotor group to withstand the combination of speed, temperature and loading for the intended engine application.

Burst Energy

At the heart of every turbocharger is a rotor group, which is just a pair of spinning wheels connected by a shaft and supported by bearings. Given the right conditions either wheel can burst, with the potential to release a large amount of energy.

In order to design turbine and compressor housings properly this amount of energy must be known and quantified, so that the housing can be made strong enough to stay together and yet elastic enough to absorb all of this energy in the event of a burst.

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The specific type of energy stored in a spinning turbine or compressor wheel is called rotational kinetic energy, and can be calculated using the following equation:

$$E_k = \frac{1}{2} I \omega^2$$

Where E_k = the kinetic energy of a spinning object, I = the moment of inertia of the spinning object, and ω = the angular velocity of the object (the speed or RPM at which it is spinning).

Determining I, the moment of inertia, can be done using 3D CAD software to quickly calculate the value from the original 3D model, or by spinning a real wheel on a test rig and measuring the amount of power needed to get it to a known speed. For calculating I, we can think about the turbine or compressor wheel of a turbo as a spinning solid cylinder to make the math in the example much simpler. The moment of inertia of a spinning object is its resistance to applied torque. For a solid cylinder this is calculated by the following equation:

$$I = \frac{1}{2} m r^2$$

Where I = the moment of inertia of the solid cylinder, m = the mass (or weight) of the solid cylinder, and r = the radius of the solid cylinder (1/2 of the outer diameter). Plugging the equation for simplified moment of inertia into the equation for rotational kinetic energy, we get:

$$E_k = \frac{1}{4} m r^2 \omega^2$$

From this we can see that the energy contained by a spinning turbine or compressor wheel is not only approximately proportional to the mass of the wheel, but also that its energy is proportional to the outer radius of the wheel *squared* and the rotational velocity (or RPM) *squared*.

This is significant because if two wheels are spinning at the same speed and have the same mass but one is twice as large as the other, then the rotational energy of the larger wheel will be *four times* that of the smaller one.

Similarly, if a specific wheel accelerates from a given speed up to four times that speed, it now possesses *16 times* the rotational energy that it did at the slower speed.

Rotational kinetic energy can quickly become huge at the speeds experienced by turbocharger wheels. But why should a turbocharger manufacturer care about the kinetic energy of a spinning turbine or compressor wheel, and why should turbo users care?

Because all of that energy is released during a wheel burst, and it has to go somewhere.

Housing Design – Absorbing Burst Energy

Of course, that "somewhere" is immediately into the housing. If the turbine or compressor housing is too thin, too brittle, too weak, too hot, or if the material is defective, it will not be able to effectively absorb all of the violent kinetic energy released by a wheel burst. Consequently it will provide little protection for the turbocharger's

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surroundings if fragments of the wheel come through the housing without losing much of that energy.

When designing a turbine or compressor housing from scratch, Garrett® engineers have a tall order to fill. They must balance the equally important requirements of high flow capacity, high aerodynamic efficiency, low weight, very tight clearances and tolerances to the wheel, dimensional stability at high temperature, and of course the capacity to contain bursts and other wheel failures. The ability of a particular housing to contain a burst is a function of overall shape, material wall thickness, strength, elongation and ductility.

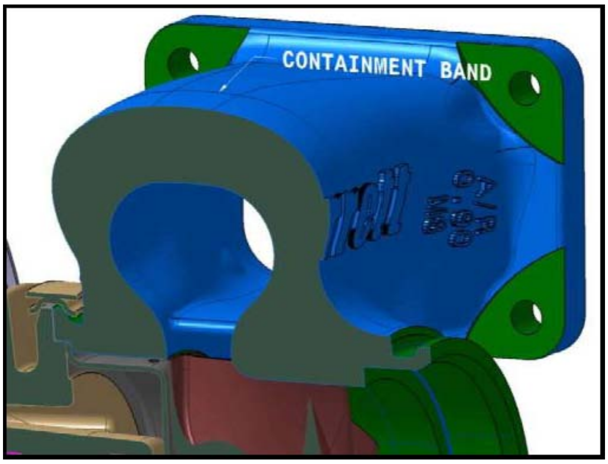
Shape and wall thickness are most critical in the region called the containment band, which is the outermost wall of the housing that will see the brunt of the impact from wheel fragments during a burst. Since the wheel spins along a relatively constant axis, it is straightforward to predict the trajectory of the major pieces, which will be tangentially outward from the path on which the fragments were traveling the instant before the burst.

Newton's First Law of Motion tells us that every object in motion will remain in that state of motion unless an external force is applied to it [1]. In the case of a spinning turbine or compressor wheel, the inertia of every molecule tries to take a straight-line trajectory.

However the internal bonds in the material provide the force necessary to keep the wheel together so it can spin around its center as a unit. When these bonds are broken and the material fails this centripetal force is no longer present and the pieces are free to take their preferred trajectory. A fragment of the wheel will not continue to spin around the shaft axis after it has broken off; it will immediately take a straight path in the direction it was moving the instant before the burst.

Hence, the housing's containment band needs to be there to stop it. The containment band needs to be thicker than the other walls of the housing since it is the major line of defense. It also needs to smoothly blend into the side walls of the gas passage (or volute) to minimize internal stresses.

Garrett® engineers use extensive company history, experience and guidelines to initially set the containment band thickness when a new housing is designed. Of course it must be physically verified with actual containment tests, but the starting point is not just a wild guess.



The turbine housing containment band is visible in this crosssectional view a Garrett® GT55R. The containment band isbthe thickest section of the housing outside wall, radially outward from the wheel. If the wheel bursts, this thick wall needs to absorb the ballistic energy without failing in order to keep the wheel fragments contained within the housing.

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The strength of a housing is of course partially determined by the shape and thickness, but material properties play a crucial role as well. Of course a weak material should not be used; e.g. an aluminum turbine housing would stand no chance of containing an Inconel wheel burst unless the housing was made ridiculously thick.

But it is not enough for the housing material to simply be strong. It must also be ductile and able to absorb the ballistic energy of the wheel fragments without breaking. A strong but brittle material would simply shatter into many pieces upon impact and in this way it would be equally as ineffective as a soft but weak material.

Correct housing material selection for containment takes into consideration the yield strength, ultimate tensile strength, and elongation percentage of the particular metal alloy. There are many different alloys of cast iron used in turbine housings that possess all of the right properties; ductile iron, high-silicon molybdenum iron, and “Ni-resist” ductile iron are three examples, in order of increasing temperature resistance.

There are stainless steel alloys that provide even better high-temperature stability and strength than Ni-resist, but ductility can suffer.

Wall thickness must be altered to provide the extra absorptive capacity for burst containment to prevent the housing from catastrophically fracturing. High material cost becomes a significant issue with the higher grade stainless steel alloys as well, such as HK30 and other austenitic stainless steels.

In many cases stainless turbine housings become cost prohibitive for all but the truly serious racing teams, but if light weight and high temperature resistance are paramount then they become very attractive. Caution must be exercised to be sure that a particular stainless housing will successfully contain a wheel burst.

Regardless of the ideal properties of the housing material, if quality control is not strict then the actual housings being produced will be compromised. Rigorous qualification and verification of the material chemical composition is needed to ensure consistency from housing to housing. Garrett® by Honeywell follows the OE automotive industry standard PPAP (production part approval process) inspection requirements to verify that mass production housings retain equivalent material quality and dimensional accuracy to the housings that were used for testing.

Effects of Burst – An Example

For an illustration of the energy released by a turbine wheel burst, consider the speed of a bullet being fired from a gun as it leaves the barrel. Specifically, consider a 250-grain Remington .350 Magnum bullet, which has a muzzle velocity of 2576 ft/s. Now consider a Garrett® GT55R turbine wheel being spooled up past its safe speed limit.

The tip speed of the Inconel turbine wheel just before natural burst is roughly equal to the muzzle velocity of the .350 Magnum bullet. In other words both of these projectiles, the .350 Magnum bullet and the tip of the GT55R turbine wheel pre-burst, are traveling at approximately 2500 ft/s or **1700 mph** (2740 kph). Given that the tip diameter of the GT55R turbine wheel is 111.5 mm (4.39 in) and its tip speed is 2500 ft/s, the rotational speed of the wheel is 130,500 rpm. This is well into the unsafe over-speed zone; it is

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39,500 rpm past the wheel's qualified speed limit of 91,000 rpm. By measuring the moment of inertia (*I*) of the GT55R turbine wheel and knowing the rotational speed (ω), we can calculate that the kinetic energy stored by the wheel just before burst is 60,662lb.ft (by $E_k=½I\omega^2$). Going back to the .350 Magnum bullet ballistics, its mass is 250 grain = 16.2 grams = 0.036 lb. Therefore the kinetic energy stored by the .350 Magnum round leaving the barrel is 3,682 lb-ft (by $E_k=½mv^2$).

Comparing the two ballistic projectiles, we can liken the GT55R turbine wheel pre-burst energy to the equivalent of firing (60,662) / (3,682) = 16.5 of these .350 Magnum bullets simultaneously.

The actual energy that the housing will absorb will be less however, because turbine wheels will usually break into three large pieces when the hub bursts. Each of these pieces will travel at about 1/2 of the tip speed of the pre-burst wheel tip speed, and has about 1/3 of the mass of the entire wheel. Therefore the kinetic energy of each piece is about 22% of the total pre-burst wheel energy. Now consider these three pieces flying towards the turbine housing: (22% of pre-burst energy) x (3 pieces) = 66% of the pre-burst energy must be absorbed by the housing in total, which is (60,662 lbft) x (0.66) = 40,037 lb-ft of energy.

Finally we can say that the turbine housing must absorb the equivalent of (40,037 lb-ft) / (3,682 lb-ft) = **10.8** of these .350 Magnum bullets fired at point-blank range into the inside wall, from the center outwards (if that were physically possible to do). If you find yourself in the position of choosing a turbine housing for a GT55R or similarsized turbocharger, it might behoove yourself to ask: "Will this housing survive being hit simultaneously by nearly eleven .350 Magnum rounds at point blank range?" If it's a true Garrett® turbine housing, then it was intentionally designed and qualified to contain the wheel, and you can bet the answer is "yes."

Garrett® Burst & Containment Qualification and Testing

Every new Garrett® aftermarket and original equipment turbocharger is qualified to contain compressor and turbine wheel bursts – that much should be clear.

But how is this verified?

When a new wheel is designed, testing of unmodified parts is conducted to determine the "natural" burst speed of the wheel. Turbochargers are built and instrumented with speed and temperature sensors and installed in a specially constructed containment stand that supplies hot compressed air to the turbine. The turbocharger is brought up to speed and temperature for a dwell period, and then intentionally and immediately sped up to well beyond the qualified speed limits.

Turbo shaft speed is recorded and a successful test will empirically reveal the natural burst speed.

When a new Garrett® housing is developed, it is qualified in conjunction with the specific compressor or turbine wheel that will be running inside of it. New combinations of existing wheels and housings are also qualified.

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If the housing in question is a compressor housing, the backplate is included as part of the qualified combination since it forms one wall of the diffuser (throat) and wheel fragments pass through this channel on their way to the containment shroud.

For completing a housing qualification, the first step is a detailed analysis of the wheel and housing to calculate the target burst speed, which set at a specific percentage of the wheel's inherent natural burst speed. The burst energy at this speed is determined, and if the result is higher than previously qualified for the housing family, a physical test must be conducted. Whether a compressor or turbine housing test, the wheel is prepared in order to force a worst-case-scenario hub burst and do the most damage possible to the housing.

The test is carried out in the same dedicated burst test cell, and the turbocharger is again instrumented with speed and temperature sensors. After a dwell period the speed is ramped up and the burst is almost instantaneous. The turbo is allowed to cool down and then examined. A "verification shroud" made from thin aluminum sheet metal surrounds the housing during the test as a witness to the event. If this shroud is pierced in any way, the housing has failed the test and is not qualified.

The housing will also fail if there is any separation from the turbocharger at the attachment joint, or if there are any holes or material missing from the containment band area.

If the housing burst containment test was successful, the turbocharger is still not necessarily qualified! Metallurgical analysis is required to verify material specifications after a successful test to show that the actual housing and compressor backplate (if applicable) that survived the burst were indeed made from the exact material alloys that were specified by engineering.

This is the result of a successful turbine burst containment test. Note large chunks of wheel embedded in housing, and torn sheet metal heat shroud. Despite internal damage, exterior walls of the housing have remained intact.
The aftermath of a successful compressor burst containment test. Turbocharger is Garrett® GTX3582R. Hub burst was induced intentionally and wheel has fractured into two main pieces. Shroud contour wall between wheel and port has absorbed most of the burst energy through deformation. Outer housing wall and containment band remain unaffected.

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The aftermath of a successful compressor burst containment test. Turbocharger is Garrett® GTX3582R. Hub burst was induced intentionally and wheel has fractured into two main pieces. Shroud contour wall between wheel and port has absorbed most of the burst energy through deformation. Outer housing wall and containment band remain unaffected.

There are limited Honeywell *OE Motorsports* turbochargers that are not qualified to contain a wheel burst; however, these are not available to the general public. For top-level professional racing series such as Le Mans and the World Rally Championship, OE vehicle manufacturers cannot accept the weight penalty associated with thicker housings that would be necessary for burst containment.

The OE customer assumes responsibility to include secondary containment measures on the racing vehicle and assumes all liability in the event of a wheel burst. Again, these turbochargers are not available to purchase unless the customer is a large OE vehicle manufacturer and is willing to accept the associated risk.

The average independent racing team cannot realistically assume such risk because of limited resources, and this is exactly the reason that commonly available Garrett® turbochargers are qualified to successfully contain.

Burst containment testing can get exciting.This still image was taken from video of a Garrett® GTX3076R compressor housing containment test. The turbocharger is barely visible behind the cloud of sparks the object in the foreground is the turbine outlet pipe that collects the exhaust gases. After the compressor wheel burst, the turbine wheel contacted the turbine housing, causing the sparks.

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Guidelines for Designing a Burst-Safe Turbo System

Testing and qualification from the turbo manufacturer is just the first step to building a system that will withstand the worst possible failures.

In order to maximize the safety of a turbo system, start with a true burst containment qualified turbocharger, and do not modify the housings in such a way that would compromise their strength. Do not drill holes in the housings or weld on tabs for mounting, and do not remove any material from the housing to reduce weight.

A Garrett® burst containment qualified turbocharger comprises an exact, unique combination of wheels, housings, and compressor backplate, so do not swap wheels, housings or backplates with parts from another turbocharger or from another manufacturer.

Regardless of the turbo being used, consider the consequences of a wheel burst and the chain of events that could take place. Are there any fuel or oil lines near the vicinity of the turbocharger? Any fuel or oil tanks that would be in the path of an escaping wheel or fragment?

A non-qualified turbocharger could eject shrapnel towards these flammable liquids, causing a leak and potentially a fire.

Garrett® by Honeywell qualifies turbocharger housings to contain radial bursts, but cannot prevent the turbine wheel from escaping through the turbine housing outlet because of the need for efficient discharge of turbine flow.

In the case of an aftermarket turbo build, the vehicle owner must assume responsibility to prevent unsafe escape of the turbine wheel, should the shaft or weld joint fail. Even if a containment qualified turbo is used, care must be taken when designing the downpipe and/or post-turbo exhaust system.

Aluminum is used by many drag racers as a downpipe material due to its light weight; however it will pose little to no resistance to an escaping turbine wheel or wheel fragment. If safety is the priority, 1020 steel is the best material to use for downpipes and post-turbo exhaust tubing because it has an extremely high capacity to absorb ballistic energy; the combination of high strength *and* high ductility allow a thick enough piece of 1020 steel to “catch” the wheel or fragments without shattering apart as a more brittle material would.

Also consider that even though a straight-shot downpipe will be the least restrictive to turbine flow and therefore the best for power production, it will also be the least restrictive to impeding a detached turbine wheel from exiting the vehicle and shooting away as a projectile. A bend can help slow the wheel down, and crossed bolts installed in the downpipe or a thick steel grating in the tube can help to catch a wheel and absorb a good deal of its energy.

Consider a turbine housing with a straight downpipe and no means of slowing down an escaping wheel. If the wheel-to-shaft weld joint or hub fails, or if the shaft breaks allowing the turbine wheel to detach, angular momentum is conserved and the wheel

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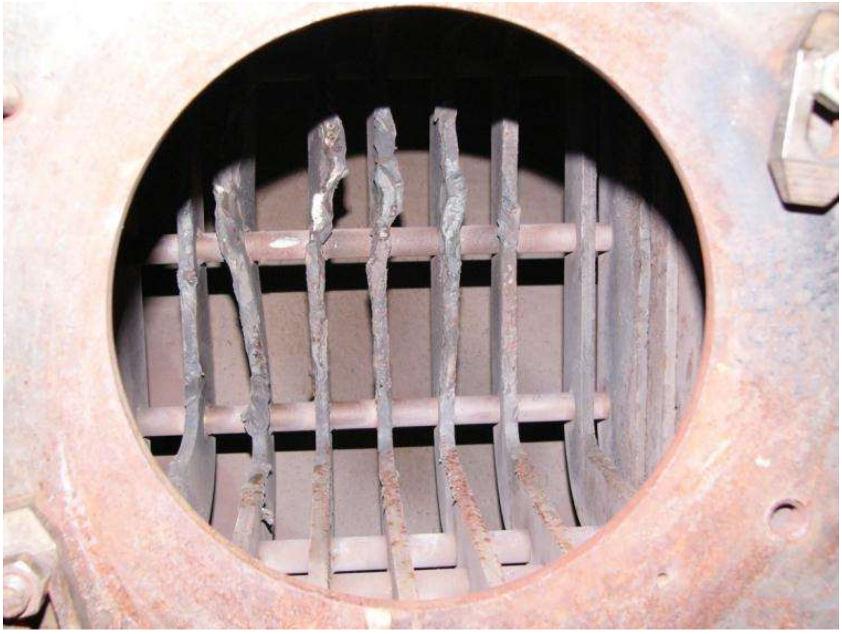
can exit the outlet of the turbine housing with a tremendous amount of energy due to the high rotational speed. Even an un-burst intact turbine wheel skipping down a racetrack at rotational tip speeds of 2000 ft/s (**1360 mph**) can have the potential to damage anything that it contacts, until this energy is absorbed and/or the wheel speed slows down due to air resistance.



This grating is made of thick steel bars and is known as the "bug catcher." It is placed behind the turbine housing for Garrett® burst containment tests, to catch turbine wheels that may be ejected from their housings. This type of grating may be overkill on a racing vehicle, but it illustrates the need for some type of structure to impede turbine wheels from escaping through the housing outlet.

Conclusion

Turbochargers are generally very reliable, but even the highest quality turbos may fail when subjected to excessive abuse.

A wheel burst is the extreme example of turbo failure but is a contingency that must be planned for with utmost care. Using a non-burst containment qualified turbocharger presents a very real risk to the end user and their surroundings, especially in racing situations.

Garrett® by Honeywell performance aftermarket, replacement aftermarket and original equipment turbochargers are all qualified to successfully contain a wheel burst, as long as the specific combination of Garrett® wheels and housings intended for the turbo remains unaltered.

Using a genuine Garrett® turbocharger for highway, street or racing use ensures that a catastrophic wheelburst will be successfully contained by a high-quality housing that was designed and qualified from the ground up to do so.