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2008 Annual Reports

We Size Up BLR's Upgrades

Access Intelligence

By Ron Bower, With Shannon Bower

Helicopter Booster

The former Boundary Layer Research's strakes and fin kits have impressed operators with their performance benefits. Now the company wants to get credit for those benefits in the books.

"I just don't understand how they can fly."

When someone finds out that you fly, maintain, or build helicopters, how many times have you heard them say: "I just don't understand how they can fly." That usually evokes a complex response from us that cause their eyes to quickly glaze over. Then they turn and walk away.

Grasping helicopter aerodynamics doesn't come easy, even for us in the industry (foremost, myself included). As I worked on this article, I discovered some important aerodynamic performance and safety information that I had been unaware of in my first 44 years of helicopter flying, and wished I had known. Hopefully, it will help you, too.

Our many helicopter aerodynamics "mysteries" are very different from our starched-wing brethren in airplanes, whose aircraft designs and performance are easily understood in the simple "four arrows" diagram we have all seen depicting thrust, drag, lift, and weight. They are central to fixed-wing performance and control, and tested in wind tunnels. Enhancing airplane performance is easy.

By contrast, the development of helicopters has largely been (and even still is in some areas) by trial and error, making modifications to design and configuration as the pre-certification "flight tests" proceed—and then often even after delivery, to the chagrin of customers. For the last several Heli-Expo conventions, Shannon and I have stopped by the booth of BLR Aerospace (formerly Boundary Layer Research, Inc.) of Everett, Wash. and visited with Bob Desroche, BLR president and founder, and Marketing Director Dave Marone to discuss and try to understand just how the BLR products work to increase helicopter performance. Admittedly, out of my own ignorance, I was dubious.

Wouldn't it be a dream come true for helicopter owners and operators to have a low-cost, non-moving, easy to install, no-maintenance-required, significant enhancement to helicopter performance and safety?

If the helicopter could easily gain a significant advantage to lift more weight to higher density altitudes for hovering in ground effect (HIGE) and out of ground effect (HOGE), the dream would be achieved. After all, that advantage translates to more safety margin and better performance below those maximum density altitudes, even at sea level. It also would improve stability and controllability while lessening the critical effect of crosswinds in a hover. Furthermore, it would produce a gain in economy of operations

For the many hardworking helicopter operators, such low-cost improvements in performance could give them a competitive edge without having to make the now-seemingly impossible capital outlays for new and bigger helicopters.

For many aircraft models, that dream will soon be here, if the smart folks at BLR have their way with two of their kit products: the dual strakes, and the FastFin.

The kits are certified through FAA supplemental type certificates (STCs) for installation on the Bell Helicopter 206B and L, OH-58A, TH-1, 204, 205, UH-1H/F/P/N/Y, Huey 2, 212 and 412, and the AgustaWestland AB212. They also are installed on some military Bell AH-1 Cobras, and testing has been under way on the Sikorsky Aircraft S-61 and H-60.

But only the physical installation of the strakes and FastFin are approved. The STCs were not matched with certified flight manual revisions reflecting the increased performance capability. The aircraft manufacturer's standard HIGE and HOGE limits still applied.

BLR is looking to change that. Over the last two months, it conducted flight tests to gather data necessary for an STC approving the performance gains for the Bell 212. The flight tests were to substantiate the performance increases to allow for more weight to be carried to higher altitudes, legally, and serve as the basis for new HIGE and HOGE hover charts in an STC flight manual supplement. These are the same flight tests that a new aircraft like the Bell 429 light twin must go through to determine HIGE and HOGE performance limits. (BLR is not attempting to increase max gross weight over that which Bell certified for the 212.)

Operators have attested widely to the benefits of the strakes and FastFin while operating in a hover or slow flight below the HIGE and HOGE limits. But their assessments—that the mods allow more tail-rotor authority and less control inputs, reduce the effect of tail winds, and lower overall wear and tear on structure and dynamic components—are subjective. BLR now is working on quantifying them.

BLR aims to get approval of those certified 212 performance increases early this year. Similar approvals for other aircraft types would follow.

We went to Leadville, Colo. last month to observe the arduous high-altitude flight test process. With a field elevation of 9,927 ft, Leadville's Lake County Airport (KLXV) is the highest airport in North America. As the testing progresses, I will fly the strakes-and-FastFin-equipped 212 and report in a subsequent article on my impressions of the performance gains.

Certainly one of the most difficult helicopter design areas to understand, predict, and optimize is aft, from the tailboom attachment point to the tail rotor and horizontal and vertical fins. I know I have, and I believe most pilots, mechanics, and maybe even design engineers have simply viewed the tailboom and its appendages as just being necessary, incidental, benign fixtures. My view was very wrong.

BLR specializes in enhancing helicopter performance in this crucial aft area. Its proprietary and unique enhancement solutions and in-depth understanding of aerodynamic performance issues common to most single-rotor helicopters are based on proven research by NASA.

Tailboom designs have largely been based on providing adequate length and strength to support an extended arm to hold the tail rotor and its driveshaft and gearbox (and allowing attachment points for the vertical and horizontal stabilizers). In forward flight, a vertical fin provides yaw stability, offloads the tail rotor, and allows for a weathervane-like controllability in an emergency loss of the tail rotor (permitting a run-on landing). A horizontal fin in forward flight aids in pitch control and stability. However, neither the vertical nor horizontal fin performs useful functions in a hover.

BLR's Bell 212 (opposite) during December 2007 baseline testing in an unmodified configuration at Leadville, Colo. as part of the STC approval process. BLR's strakes (above on a different aircraft) are simple, small, lightweight fences attached to the side of the tailboom (see photo) to change the flow of air around the tailboom for better stability and control.

When I flew a pre-certified version of the Sikorsky S-92, I found the large hori-

zontal stabilizer (it's bigger than a sheet of plywood) had been tried at varying sizes, angles, and attach points—even on the opposite side from where it is today. During pre-certification flight tests, Sikorsky was trying to optimally adjust pitch controllability. It is not uncommon to see manufacturers change angles or sizes of the fins, or tack on lift-killing or airflow-smoothing devices that probably were not on design drawings before test flights. Some things aft just can't be figured it out in advance in an engineer's office.

This design difficulty is related to the many very dynamic forces unique to helicopters, which can't be tested easily in a wind tunnel. This is especially true in a hover, where you have pulsating downdrafts from the main rotor, variable surface winds moving that airflow, and an ever-changing perpendicular thrust from a tail rotor making the combined airflow more unstable. That is particularly so in a downwind hover. These factors are also why the pilot's four limbs are in perpetual motion on the controls in a hover.

BLR acquired an exclusive NASA technology-transfer license to research products from the Langley Research Center and has applied it with remarkable effect on helicopter performance. Some historical and aerodynamic background will be helpful in appreciating how and why these products already work so well on several models, and would likely work well on your helicopter in the near future.

The word "strake" derived from the same root word for "stripe" and was an early English nautical term for "a thick

BLR's FastFin (bottom) improves tail-rotor efficiency by replacing non-structural portions with a simple, lightweight carbon-composite end cap to change the vertical fin's shape.

plank of wood forming a ridge along the side of a wooden ship." That was designed to change the flow of water on the hull and improve stability and control. Must have been a good idea, since hundreds of years later, you still see them on boats and ships.

On helicopters, the BLR strakes are simple, small, lightweight fences attached to the tailboom's side. They have the same purpose: to change airflow for better stability and control. BLR's proprietary kit uses dual strakes set at different positions. The strake concept isn't NASA "rocket science," but knowing how to optimize its design and placement is.

During eight years of research in the 1980s, NASA documented that main-rotor downwash flows around the tailboom much like air around an fixed wing or rotor blade. It creates airfoil-like air pressures on the tailboom. This downward airflow is greatest in a hover, and increases with heavier loads, as the main-rotor pitch angle increases and more accompanying rotorwash is generated (see diagram, right).

In a counterclockwise rotating main -rotor system (like those in a Bell, Sikorsky Aircraft, Robinson Helicopter, MD Helicopters, AgustaWestland, and MBB product), NASA found, the rotorwash creates a substantial low-pressure area on the left side of covered monocoque tailbooms in a hover. This pulls the tail to the left, working directly against the tail-rotor thrust that is trying to pull or push the tail to the right to offset the main rotor's torque.

(For clockwise main-rotor helicopters like the French-made Eurocopter line, these same principles apply, but the low-pressure area is on the right side of the tailboom and the pedal inputs and thrust vectors are opposite of what is described herein.)

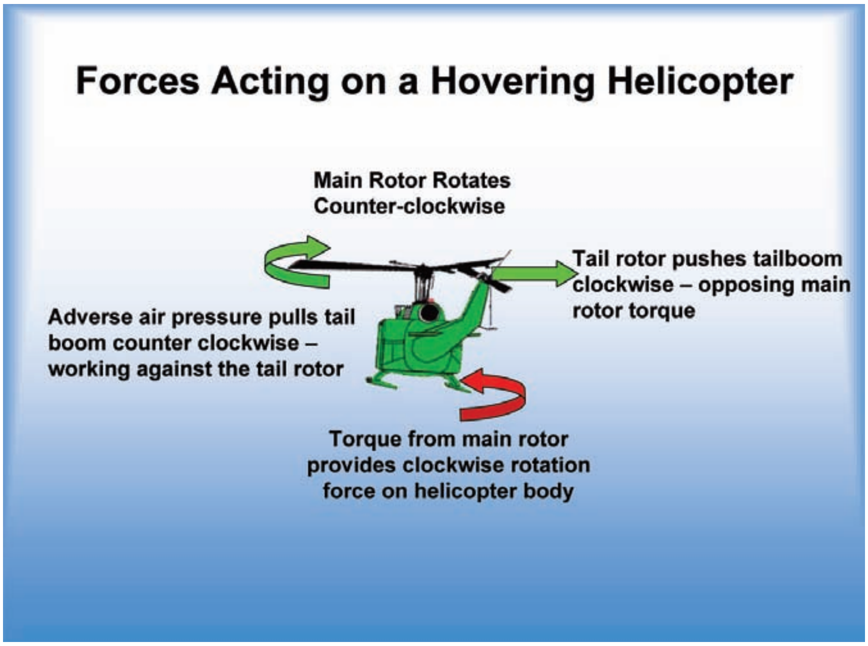
To offset this pull, the pilot must add a corresponding amount of left pedal input to maintain constant heading at a hover.

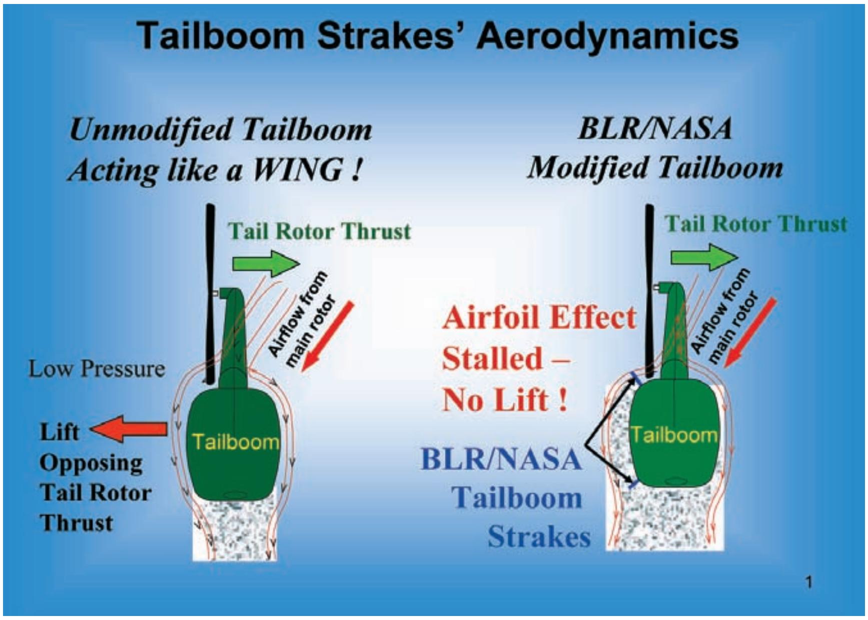
In the flight manual, hovering performance chart limits (HIGE or HOGE) are depicted at various density altitude/gross weight/wind azimuth combinations based on flight tests that determine when the left pedal input is ultimately limited by a mechanical stop of the pitch change on the tail rotor. If any additional collective pitch (torque) is applied, the pilot "runs out of tail rotor," and the helicopter will begin an uncontrolled turn to the right, since the tail rotor is already doing all it can do.

Simply put, the BLR dual-strake system disturbs, or stalls, the rotorwash airflow on the left side of the tailboom. This greatly reduces the adverse low-pressure area, eliminating its "lateral lift force" pulling the tail to the left. With approved strakes installed, in a hover, there will be an offsetting reduction of left tail-rotor pedal input needed to hold a constant heading. The amount of left-pedal input regained (and previously wasted) is then available as increased tail-rotor authority. That's always a good thing. Have you ever heard a pilot say, "Sure wish I had less tail-rotor authority"?

The net effect of the latest STC BLR is seeking (if the kits stay true to past performance) would be certified increases in HIGE and HOGE performance limits. That would allow the 212 to carry more weight to higher density altitudes. At lower weights or altitudes (even at sea level), with the low-pressure area reduced by the strakes, the modification still should reduce the amount of tail-rotor thrust needed during hovering, thus providing more tail-rotor reserve authority and enhancing safety. It also should increase hover stability and reduce pilot workload.

Remember, too, that when a pilot has to add left-pedal input to increase the tail rotor's thrust and offset the low-pressure "pull," more engine power must be applied to the tail-rotor driveshaft. At a torque or TOT engine limit (even at sea level), this reduces the horsepower available to drive the main rotor. One advantage of coaxial, or





other dual rotor, systems like those on the Kaman K-Max or Boeing/Vertol CH-46s and -47s is that no engine power is used on a tail rotor. It is all used for lifting. The BLR dual strakes help recover that engine power and make it available to the main rotor.

After thinking about the NASA tailboom research, I deduced that one reason the uncovered, welded-frame tailbooms of earlier helicopters like the Bell 47G-series and the Eurocopter SA315B Lama have performed so well and endured so long is that the main-rotor downwash couldn't create this adverse effect on the sides of their open tailbooms. Also, I noticed their displaced and very small vertical fins didn't greatly obstruct the airflow to the tail rotor, and I expect their open tailbooms probably didn't "catch" as much crosswind at or near a hover. Who knows, if Igor had an enclosed tailboom on his first Sikorsky VS-300 tethered flight in 1939 and he started rapidly spinning, he might have just thrown in his famous Fedora and made washing machines instead. What a price we have unknowingly paid for "sleek and pretty."

Since the rotorwash is generated by the main rotor, and its blades make up only a small part of the main-rotor disc, the downward airflow is not steady but constantly varies, or pulsates. That is why helicopter pilots have to constantly adjust cyclic, collective, and pedal inputs a hover, even in no wind. NASA determined that if you can spoil or "stall" the airflow causing the lower air pressure on the left side of the tailboom, you can greatly reduce the varying, leftward, lateral lift tendency.

This was accomplished with the simple installation of a top strake. Lower on the tailboom, a second strake further reduces the variable airflow burbling, thus reducing the pedal inputs and pilot workload required to hold a constant heading and altitude in a hover.

These are the benefits of BLR's dual strakes. It would logically follow that if tail-rotor inputs are reduced, stress and wear on both dynamic and structural tailboom and tail-rotor parts would be less. That has been measured, and they are.

The BLR dual strakes can be attached to the tailboom in 16 hr by an A&P mechanic, utilizing existing rivet holes, causing no structural damage to the tailboom. They are light, weighing just 5 lb, and require only basic sheet metal tools.

I am not aware of any performance disadvantages or anomalies in installing or using the lightweight dual strakes and BLR's FastFin. Nor have there been any accidents or incidents caused by the BLR Strakes or FastFins that I know of. There is no additional pilot training needed other than familiarity with the improved performance charts and limitations in the STC flight manual supplement. ("Anti-whining" psychological training may be required for pilots that have to go back to flying helicopters without BLR's strakes and fin).

BLR's strake technology is neither new nor untested. Some 600 BLR strake-equipped aircraft have accumulated about 1 million flight hours by 128 operators, according to the company, which said no warranty claims have been filed on "properly installed kits." Yet I believe that most helicopter pilots, designers, and manufacturers are unaware, as I was, of how important strakes can be to inexpensively increasing performance.

Several manufacturers have begun to recognize the benefits of strakes. But because of BLR's exclusive NASA license, others can only gain partial benefit by installing just single strakes. I found a large single strake on the tailboom of AgustaWestland's AW139 and a strake on its A119 Koala when I flew those aircraft. The Eurocopter AS350B2 has one. As I recall, there was, strangely, very little said by the manufacturers about why the strakes were there or what they did. In addition, the AW101 has a large strake, and the latest pre-certification design of the Bell 429 is reported to have a recently added strake. I expect that as the benefits of this proven technology are better understood and accepted, we will see many more strake-equipped new helicopters, and likely some manufacturers will capitalize on the benefits of the BLR dual strakes and the company's expertise.

Another performance-enhancing BLR modification kit is the FastFin. This kit improves the efficiency of the tail rotor by reducing the excess, non-structural aft portion of the vertical fin by changing its size and adding a simple and lightweight carbon-composite end cap structure to change its shape. The end cap is designed to allow smoother airflow and greater thrust from the tail rotor. It has molded, rounded edges, replacing the original sharp edge.

You don't have to be a NASA engineer to look at most conventional tail-rotor attachments to see that the vertical fin seems to be in the way of an efficient airflow for the tail rotor. The reality is that whether it is a pusher or puller (tractor) tail rotor, that vertical fin adversely affects tail-rotor thrust efficiency. Remember, the vertical fin is only there for use in forward flight. It has no positive benefit in hovering. On counterclockwise main-rotor helicopters, pusher tail rotors are on the left side and the fin partially blocks the flow of air into the tail rotor. Puller or tractor tail rotors are on the right side of the fin; they draw in a clear flow of air, but have to push their outflow against and around the fin.

In a simple "non-NASA" demonstration test that I did at home, I could easily hear and feel a home box fan's thrust difference by putting a piece of cardboard partially covering either the back (pusher), or moving it to the front (tractor) sides of the fan. The noise increases, I presume from disturbed air flow, and the airflow from the fan is reduced. I concluded that is also what is happening to the tail rotor.

Research has shown that, regardless of whether the tail rotor is a pusher or puller, air is usually forced around the fairly sharp edges of most vertical fins begins to burble, inducing control instability. Some manufacturers have tried to deal with this with various designs. The Eurocopter fenestron concept embeds the tail rotor within the vertical fin, and MD's Notars put the fan generating anti-torque air under the cowling and vectors thrust with the clever Coanda Effect airflow design of their tailbooms. Both

BLR used wireless rigs (left and opposite) to collect data on key components during high-altitude flight tests last month in Leadville, Colo.

of these approaches considerably increase safety by greatly reducing the likelihood of a person walking into the tail rotor or the pilot hitting the ground or an object with the tail rotor.

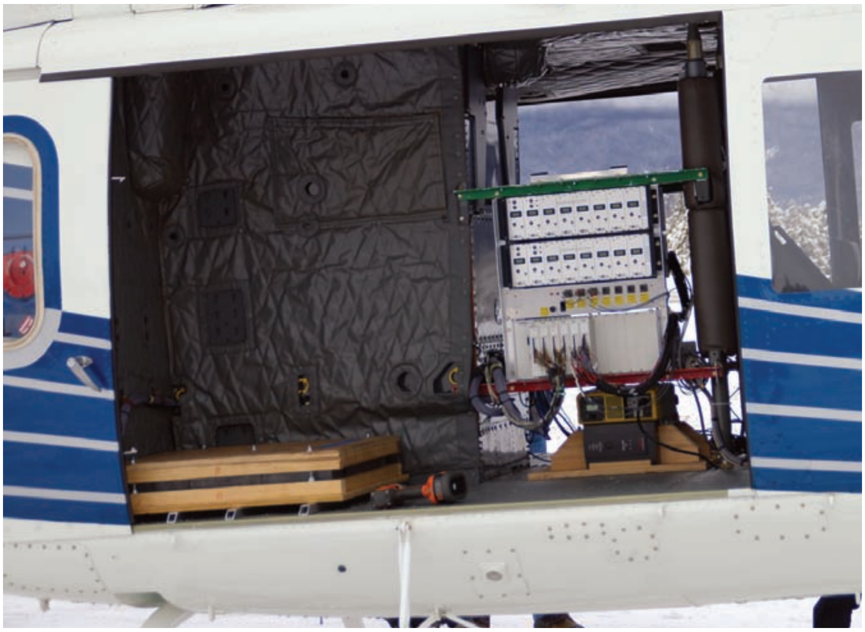
The downside of those very worthy tail rotor designs can be performance inefficiency, additional weight, and increased manufacturing costs. Otherwise, the MD-500E with a conventional exposed tail rotor would have been discontinued and the MD-520N Notar would have replaced it several years ago. Most pilots agree that the -500E out performs the -520N in almost every measurement. I am sure there are some, but I can't recall seeing a single picture of a Notar or fenestron tail-rotor aircraft regularly doing heavy long-line sling work for an operator.

BLR's FastFin is aimed at optimizing the traditional exposed pusher or puller tail-rotor designs to further expand their efficiency, but it certainly seems that the BLR dual strakes would benefit the fenestron- equipped Eurocopters.

BLR's patented FastFin technology improves tail-rotor efficiency and authority, adding to the benefits of the strakes. You cannot (and would not want to) install the FastFin without installing the dual strakes. Also, BLR says, the FastFin's smooth contours significantly reduce instability by lessening the burbling around the vertical fin, and aid in tailwind control.

As a helicopter flight instructor for 40 years, I include among the perception building-block demonstrations in hovering these two. First, it takes more power to hover with a tailwind than a head-wind. Second, it takes more cyclic, pedal, and collective inputs to hover with a tailwind than a headwind. With no wind or a headwind, I show students rapid small movements of the cyclic at a 2-3-ft hover while keeping the collective at a fixed position. The result is the helicopter will begin sinking and even settle to the ground.

What is the point? Cyclic control inputs reduce main-rotor efficiency. Both the dual strakes and the FastFin help reduce cyclic inputs and pilot workload and thus keep the main rotor more efficient, requiring less power and less wear on the parts powering it.



The flight-test data collection unit on the 212 is critical to BLR's efforts to convince the FAA that operators should be given credit for its strakes and fin's performance capabilities.

Certainly, in the 1960s, when the Bell 212's military predecessor airframe, the UH-1, was being sent in droves into Vietnam combat, concern over possibly losing a tail rotor to ground fire was a reasonable concern for designers of the vertical fin. (In retrospect, I certainly wish my UH-1B gunship had BLR's kits on it in 1965-66.) BLR has now reshaped and optimized the vertical fin, still providing the needed emergency "weather vane" assistance in the unlikely event a tail-rotor function is lost in flight.

Like the dual strakes, the FastFin can be easily installed in the field by an A&P mechanic. BLR says it normally takes a day.

I don't believe there is anything on the market or the horizon that can give comparable performance increases for as low an acquisition and installation cost as the BLR dual strakes and FastFin.

In addition to the improved performance, NASA and others have documented the reduction in pilot workload and wear and stress on rotating components and airframe structures, a considerable increase in operational safety, and even faster speeds and reduced fuel consumption on aircraft fitted with the kits.

Because of the documented benefits of the strakes, their low installation cost, and no downside risks, I cannot understand why all makers of single-rotor, enclosed tailboom helicopters are not incorporating strakes into all their new-production aircraft to increase the operational safety margin (even without changing existing HIGE/HOGE limits).

For used helicopter owners, BLR has an aggressive plan to take a variety of aircraft types through similar FAA-approved flight tests and STC approvals. It seems to me a reasonable follow-on to their in-process 212 STC certification of the dual strakes and FastFin would be the Bell 412, in part because of the similarity of their tailbooms and vertical fins. I expect there will be many more to come.

Not unlike some important aerodynamic truths of Frank Piasecki's SpeedHawk design (featured in the December 2007 *R&W*) that also have had too long a gestation period, I believe the time has come for BLR's application of their dual strake and FastFin technology. That will be greatly beneficial for our industry.

COMPANY PROFILE

BLR Aerospace:

Performance Innovation Is Our Mission

BLR's package of aerodynamic enhancements for rotorcraft is revolutionizing the industry. Our technology expands the envelope for helicopter operators striving to achieve maximum return on their capital investment.

Helicopters limited to less than fully productive payloads now lift more. They achieve greater in-flight stability and they operate at higher density altitudes with greater payloads than ever before. More and more operators are flying new and more challenging missions because BLR technology makes it possible.

To kick off 2008, BLR is introducing its package of FastFin™ technology for Bell 212 helicopters and will follow shortly after with a similar package of enhancements for Bell 412s. Preliminary tests already show a dramatic increase in payload for 212s and the results will be even stronger when tests are concluded for 412s.

Dramatic payload increases will enable greater mission effectiveness for 212 and 412 operators worldwide. And, its not just payload. Flight stability also is improved and that means lower pilot fatigue and less fatigue on your airframe, both enhancing safety.

It is all part of BLR's mission to help operators perform better: More payload, greater stability, more efficient operations and increased safety. BLR continues to be the only company focused on improving the aerodynamic performance in widely produced helicopters.

BLR's legacy is improving the performance for both fixed- and rotary-winged aircraft. That's all we do and we do it very well. ■

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