GYROPLANE ASTM STANDARDS – PART 1

What is the Gyroplane Standard?

By Greg Gremminger

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How should my gyro fly to be safe? How do I tell if this gyro is safe? How should a gyro be designed? How should it fly? These are common questions that everyone who has an interest in gyros should eventually be asking.

Gyros are a very unique aircraft, capable of flight performance as no other aircraft type. And, many gyroplane designs behave almost as differently from other gyros as they do from other aircraft types. This is because a gyro can be designed, or mis-designed, with tremendous variability in its handling, performance, capabilities, and ultimately in its safety. This wide range of design outcomes is a major advantage and attraction of gyros. But, unfortunately, some un-intended consequences of a design can also lead to common safety issues with which the gyro sport has been plagued for too long.

SOME HISTORICAL PERSPECTIVE:

Over the history of our gyro sport, unfortunately unintended negative consequences of some designs have been a terrible and scary burden on the sport itself. Ask the average airplane pilot what they think about gyros, and you will, more often than not, get a very discouraging response! This is very unfortunate because gyroplanes can theoretically have much better safety and performance attributes than almost any other type of aircraft. But, the unintended consequences of some, intuitive, but less-than-technically-grounded designs, have led to some less than acceptable gyro safety attributes.

This isn't the first time this situation has occurred in aviation! In the early years of the airplane, there were many similarly deviations from safe design concepts. The first Wright brother's airplanes employed the very unstable version of a canard control surface. The Wright brothers did understand the significance of this configuration, but they traded pitch stability for what they thought would be better outcomes of inadvertent stalls! (It is just as likely that Igor Bensen understood the similar issues of the tailless gyrocopter.) Early intuitive evolutions of airplanes before and during WWI traded very unstable designs for the perceived advantages of more nimble airplanes. With airplanes then, as with gyroplanes today, it took too long and too many lives for designers to ultimately come to understand and apply the technology and implications of flight stability. As a result, it took many painful years to repair the negative reputation of airplanes. This is not dissimilar from where we are at this point in the evolution and acceptance of gyroplanes.

Along came the CAA, and eventually the FAA. Now, there may be many aviation impacts from regulation – some good and some less attractive. But, one inarguable historical benefit of regulatory oversight has been improvements in aviation safety with resulting acceptance of aviation by the public. How did this improved airplane safety evolve? One major influence was the identification and standardization of safe and desirable performance criteria for airplanes – creating standards of how airplanes should perform to be safe. Evolving airplane technologies, and sometimes with very painful trial-and-error experiences, aviation engineers learned what performance characteristics are safe and beneficial, and what performance characteristics are dangerous and incompatible with safe human operation. Over the years, these performance criteria have been catalogued and "standardized" in specific "standards" – 14 CFR 23 for airplanes for instance. As other aircraft types such as helicopters evolved and became more common, commercial and public pressures grew and similar "standards" were developed for these aircraft.

Gyros uniquely and unfortunately have not enjoyed the higher volume and abundant resources that had served to evolve safe design and performance "standards" for other aircraft types. Gyroplanes have had no formal practical "standards". With the absence of credible guidelines, technically appropriate performance criteria were not always or regularly applied in offshoot evolutions of the Bensen Gyrocopter. The teething process for gyros has been devoid of the commercial pressures and adequate resources with which airplanes and helicopters and some other aerial vehicles have benefited.

Actually, this lack of formality and standardization has probably been, to many of us, one of the strong attractions of gyros. But, unfortunately, this adventurous freedom has likely contributed to a safety record that has limited the growth and safe evolution of our sport as well! For too many years, as I am sure most of you are aware, the safety record of gyros has not fared well. This has brought the safety record of gyros in sharp focus in our gyroplane community – and to the FAA! But, over the same recent period, more and more people, including the FAA, have realized that there is no real technical reason why this unfortunate safety record need to continue.

There are no technical reasons why gyroplanes cannot actually be the very safest form of aviation available today! Latter day pioneers in our gyro sport (Ernie Boyett, Chuck Beatty, Vittorio Magni, Jukka Tervamaki, Ron Herron, Carl Schneider, and others I apologize for failing to mention), have championed improved gyroplane stability technologies – a very major element of the gyro safety record. With the growing technical base and the sport's acceptance of some very important gyroplane stability concepts, many of us, and the FAA, have recognized that there are available and practical solutions to the deplorable safety record of gyroplanes. But, many efforts to promote these solutions have met unfortunate continued resistance and emotional argument from various corners of the gyro community. The biases and debates have mostly served to confuse and stagnate progress on gyro safety!

Then, along came Sport Pilot and the Light Sport Aircraft rules. Along with other benefits to gyros and all of aviation, Sport Pilot offered an opportunity to apply our newly understood issues of gyroplane safety to the development of an actual "Design and Performance Standard" for gyroplanes – at least for light sport gyroplanes. With some persuasion, and against an internal paradigm that gyros are too unsafe, the FAA included gyroplanes in the new SP/LSA rules. Part of the requirement of these rules, and for all LSA types, was to develop "consensus standards" for this new LSA category. ASTM International was selected by the FAA as the consensus standard body that would be utilized to generate these new "LSA consensus standards". Along with airplane and powered parachute and other LSA ASTM subcommittees, the gyroplane ASTM subcommittee was formed to develop the gyroplane "consensus standards" for the new rules. Actually, with the collaboration of the FAA and EAA and others, it was recognized that this "consensus standards" process now gave the gyroplane sport the opportunity to develop the first practical "Design and Performance Standard" for gyroplanes – There had never been any standard that practically and specifically addressed the real issues of gyroplane safety performance. (The British Section "T" gyroplane standard attempted to apply Section "S" airplane derived criteria to gyros, and as such, has never been effective or practical to implement!)

So, now, with new gyroplane technology understanding, and with the processes and resources of the ASTM now available, the FAA encouraged the gyroplane community to develop these standards for LSA gyroplanes through the ASTM system. The FAA and many of us saw this as the opportunity for positive influences on gyroplane safety – a much better alternative than the FAA forcing some ineffective regulatory edicts. Use of a consensus standards body enables a balance of consumers, users and producers to collaborate in a structured forum that regulates consensus. The standards are then referenced in regulation, rather than having the FAA independently legislate this technical information. The net result is that the "industry", in effect, has the opportunity to legislate itself through standards – a far better medium for the timely collection and assimilate of technical information. A credible "consensus standard", one developed through the ASTM "consensus standard" process with participation by consumers, manufacturers, aviation organizations, regulatory authorities, and other "stakeholders", could be expected to influence producers and the market to require and provide safer gyroplanes. A credible and practical gyroplane standard will help to educate the gyroplane consumer as to what expectations to have, and to require, for a safe gyroplane.

Another important aspect of encouraging standardized safe performance of gyroplanes is to make the limited available training more effective. Gyros, by their wide ranging handling characteristics, require fairly specific training for each gyro. Without somewhat standardized flight handling characteristics, it is difficult to get really effective training for your particular gyro. Especially with significant handling differences between many gyros, some training may have served to foster mis-placed confidences in actually less safe and less stable gyros. A gyroplane performance standard will promote reasonably "standard" handling characteristics so that flying each gyro is not like having to learn a completely new skill. This isn't to say that this might make gyros "boring" in their handling characteristics – gyros are uniquely able to be highly stable and forgiving while allowing the traditional unique maneuvering capabilities expected of gyros! The common gyroplane's miraculous cyclic control attributes allow properly designed gyros to maneuver dramatically, while the aircraft itself inherently self-stabilizes and virtually eliminates the effects of wind and/or pilot over-reaction disturbances.

WE NOW HAVE A STANDARD!

I am very happy to announce, that after over two years of work by subcommittee participants from all over the world with all levels of expertise and experience, we now have the approved Gyroplane ASTM standard F 2352, Standard Specification for Design and Performance of Light Sport Gyroplane Aircraft. This standard has also been accepted by the U.S. FAA for U.S. Light Sport Aircraft purposes.

This standard is only the first strategic step of our overall efforts to improve gyroplane safety and acceptance into the mainstream of sport aviation. Our next step is to help the gyroplane community understand and appreciate the issues addressed by this standard. This standard is not a "requirement" on anybody or any manufacturer. This standard actually only has regulatory authority for those manufacturers who want to produce gyroplanes for sale under the U.S. LSA rules. But, through education and promotion of the criteria, principles and guidelines promoted by this standard, it is expected that the gyroplane sport community will influence and be influenced to accept and require safer gyroplanes.

That is the intent of this series of articles. This first article in this series is to introduce an overview and genesis of the new gyroplane standard. The standard addresses a number of gyroplane design and performance issues that the gyroplane subcommittee considered important to the safety of gyroplanes. Table 1 below lists the sections in the actual standard. Many of these issues may seem picky or minor to some of you. But, essentially, all of these issues have been real elements in a safe gyroplane design. Again, this standard by no means requires any of you or even any manufacturer to meet all of the criteria in the standard. This standard is only legally binding in entirety for those manufacturers who wish to sell gyroplanes under the new U. S. LSA rules. For the rest of us, the standard serves as a guide as to what to aspire toward in our own particular gyro, gyro project, or gyro purchase.

HOW WILL THIS STANDARD INFLUENCE IMPROVED SAFETY?

With the existence of this gyroplane standard, more informed gyroplane customers may now ask very specific questions when shopping for a gyro or considering a gyro project. The "informed market" and others of us will be encouraging gyroplane manufacturers to provide gyroplanes that "comply" with this standard. Even if there is no intent to sell or purchase a true regulated LSA gyroplane, these informed market pressures can be a strong influence on gyroplane producers to supply standards "compliant" gyroplanes. Not that the manufacturer necessarily need comply with every aspect of this standard if they are not selling under the LSA rules, but an informed customer will now be able to ask those specific questions and base their purchase on a better understanding of just what the safety exceptions might be.

Manufacturers selling under the LSA rules in the U.S. will need to comply with all criteria in the "standard." Their self-compliance under the LSA rules is simply by issuing a "Letter of Compliance" with all LSA aircraft sold under the new rules. But any manufacturer may, and their customers may require, that they provide a similar "Letter of Compliance" as a condition of any sale, LSA or not. For sales outside of the LSA rules, such as a normal Experimental gyroplane kit, the manufacturer's "Letter of Compliance" may identify exemptions to that compliance, for instance, an exemption to the "drop test" criteria. Compliance with the standard, in this case, is not binding. But, with better customer understanding of what areas might not comply with the standard, a more informed decision to purchase can be made. And, the manufacturers, under such informed market pressures, can decide whether and which issues of compliance are necessary to promote the sale of their product – or not! The beauty of this is that an informed market can, through competitive and "informed" market pressures, influence the availability of safer gyroplanes.

Additionally, those of us now flying our particular gyro, or considering the purchase of a "used" gyro, or modifying a gyro to improve a safety margin, can now better evaluate the safety issues of that particular gyro. For instance, the standard provides simple and effective performance criteria that, upon simple flight or ground testing, can identify the limitations and any particular operational areas in which that gyro may present lesser margins of safety. I intend, through this series of articles, and through continuing discussion and promotion, to identify the more important criteria in this standard; and in laymen's terms, to show how you can actually evaluate these criteria in your own gyro. The intent here is not to necessarily "force" anyone to meet the standard's criteria - especially not for every specific criterion in the standard. But some criteria have been historically more important than others, and all of the criteria can serve as a guide so that you may evaluate and more thoroughly understand any safety issues and limits of your particular gyro.

Since a number of criteria in the standard should be evaluated over a range of conditions – such as some gyros get less stable at higher power and/or airspeed – evaluating these criteria will likely identify the Never Exceed airspeed (Vne) or other limiting parameters for that particular gyro. For instance, when testing identifies that a particular criterion is no longer met at a certain airspeed, that would identify a particular limitation or area of operation you would want to avoid. Often gyro accidents are the result of the pilot not really knowing the safety margins or limits of that particular gyro. Understanding some important concepts in the standard, and how to measure your own gyro's performance in that those areas, will help pilots avoid inadvertent operation in areas that present perhaps unanticipated hazards.

PERFORMANCE RESULTS CRITERIA vs. "PRESCRIPTIVE" DESIGN:

It is interesting to note a permeating concept in the development of this standard. All efforts were made to avoid "prescribing" how a gyroplane should be designed. To the dismay of some, where it is possible, the standard intentionally avoids hardware specifics, such as a specific propeller thrustline or certain size horizontal stabilizer. Those would be "prescriptive solutions" that, although a designer might employ, are not specifically required in the standard. The standard presents "performance results" criteria that identify the desirable PERFORMANCE attributes of the design. The standard does not "prescribe" the design to achieve that performance! The reason for this is that there may be any number of ways to "skin the cat"! The intent of the standard is not to limit the options of a designer. The designer can solve the problem by any means they can invent or apply. So for instance, the designer may meet a stability criterion by application of horizontal stabilizer and prop thrustline principles, or they may meet the criterion by any other means they might invent. The important thing is not how they meet the performance criterion, it is that they meet the performance criterion. This is the historically typical approach of such standards in order to promote, while not limiting, new or alternate ideas and innovation. Experience has shown the aviation world what performance criteria are acceptable and safe for a human to perform or endure. The standard sets the acceptable performance criteria in test results or engineering evaluation format. No matter what the design then looks like, it is a simple matter to test it to see if the performance criteria are met. There may be many ways to "skin the cat."

Also, contrary to "simple solutions" we might desire, achieving a particular performance criterion is not often a simple matter. There is often no specific pill or "cookbook" solution to solve a particular problem. For instance, a desirable pitch stability performance criterion may be achieved with any number of combinations of horizontal stabilizer attributes, airframe aerodynamic moments, and propeller thrustline offsets. It would be nearly impossible, and probably very limiting, to try to identify equations or hardware combinations to achieve the desirable performance results when so many variables are involved. To try to identify those multitude of combinations, or some magic formula of all these combinations, would require engineering resources beyond anyone's capacity. To try to identify such "prescriptive solutions" would likely mean that we would all have to be flying gyros that look exactly the same! So, instead, in standards such as these, we try to identify "performance results criteria," ascertained by testing or engineering analysis, that will verify whether or not this particular design does or does not meet the desired performance criteria.

The next parts to this series of articles will specifically address individual criterion in the standard, what the specific language in the standard means in laymen's terms, how to evaluate a gyro for this criterion, and some typical or recommended design concepts that may be important hardware elements a designer might apply to meet that criterion.

As you read the subsequent articles in this series, I encourage you to truly try to understand the concepts we are presenting. I understand that some readers appreciate a technical depth that can foster real strong insight and understanding, while at the same time others can be frustrated with such long and technically challenging articles. I believe that pilots are smart people. I believe pilots need to be smart people. There are lots of decisions and evaluations every pilot needs to make to fly safely. Good decisions come from good understanding. I understand that such technically involved concepts may be difficult to absorb or understand. I have organized each article in this series of articles to present more basic concepts in the first part of the article. The latter parts of these articles provide more technical depth. I truly hope these articles can be helpful and instructive to everyone. I suggest you might read these articles in several sittings, to help keep the points of each section in better focus. I hope this series of articles will really help you be safer gyro pilots and consumers.

Fly safe, Greg

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Table 1: Table of Contents, Gyroplane Design and Performance Standard

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Sidebar 1:

What is the ASTM?

Originally known as the American Society of Testing and Materials, ASTM International is a commercial organization that has been in the business of creating and providing industry "standards" for well over 100 years. The ASTM provides administrative and oversight facilitation to "stakeholders" participating in the development of industry standards. A common example of an ASTM series of standards would be those for amusement park equipment or sports equipment. The ASTM oversight assures legally correct development participation and procedures of legally defined "consensus standards". Such oversight might include assuring appropriate participation and balloting procedures to assure the standards meet all legal requirements. Participant "stakeholders" are required to equitably represent all facets of the particular industry: "producers", "users", consumer organizations, regulators, etc. The ASTM standards are recognized worldwide, and participants in the development may represent worldwide "stakeholders". In return for providing administrative resources, the ASTM then owns the copyright of the documents. To make their money, the ASTM then sells copies of the final approved standards to the public – manufactures, insurance companies, regulators, etc.

Sidebar 2:

What is a "Consensus Standard"?

The U.S. FAA Sport Pilot / Light Sport Aircraft rules require development of "consensus standards" for production LSA aircraft. According to the U.S. FAA, "Consensus standards" are those industry, equipment or materials standards developed according to U.S. Congressionally mandated criteria for certification of Light sport Aircraft. Consensus standards are developed with equitable participation and representation of the various associated "stakeholders". Typically, "stakeholders" would be both the producer of a product or service, and the consumers of that product or service. Other "stakeholders" might be regulatory organizations, consumer organizations (such as the PRA or EAA), insurance companies, and other "users" of that product or service – including interested individuals. As a part of the overall LSA standards development, the ASTM process is also being utilized to create standards or practices for other LSA ancillary issues – such as airparks, maintenance manuals, parachutes, etc. As a result of successes in the LSA standards development, the FAA has started other ASTM standards developments such as standards for remotely piloted vehicles. The use of industry "consensus standards", developed by the industry and users who best know their enterprise, is increasingly being seen as a favorable alternative to often overly-burdensome federal regulation. The application of "consensus standards" encourages more internal self-regulation, and less regulatory attention and interference.

A finally approved "consensus standard", according to the rules applied by the ASTM, either received no "negative" comments from the committee members, or has had any such "negatives" resolved in accordance with the process. All ballots must equitably represent the various "stakeholder" groups. All negative ballots are discussed, and determined to be "persuasive" or not. Appropriate changes are made, and the document is re-balloted. This process repeats until the document survives a final ballot of both the gyroplane subcommittee and the Main LSA committee (and a Society-wide review from all 30,000 members in 130 countries) – with no outstanding negatives! "Affirmative" or "abstain" comments may also be considered and implemented for subsequent ballots. Once a standard or document has been approved, it can still be change later by request of a "stakeholder" to the subcommittee to consider such changes. Approval of those changes is again made through the balloting process. So, the standard is able to evolve and improve as problems or improvements are identified, considered and balloted. The standard is intended to be a "living document" utilized world wide.

Sidebar 3:

Who is on the gyroplane subcommittee?

The gyroplane ASTM subcommittee, through various stages of the gyroplane standards development, consisted of some 30 or more people representing several gyroplane producers, the U.S. FAA and Australian CASA, "user" organizations such as the PRA and EAA, and individuals from around the world. Gyroplane producers with balloting privileges on the gyroplane and main LSA committee included Sport Copter, Air Command, Rotary Air Force, Little Wing, Magni Gyro, Rotor Flight Dynamics, and American Autogyro Incorporated. Membership is open to any individual with a legitimate interest in the scope of activities covered by a subcommittee (or Committee).

Aside from the official ASTM subcommittee and main committee members, who were members of ASTM, other individuals participated in Task Group development of the documents to submit to the committees for ballot. Email, and internet gyro forums were utilized intensely for Task Group and subcommittee discussions and development.

We much appreciate all individuals and organizations who generously donated their time to participate in this standards development.

Sidebar 4:

How can I get a copy of the standard?

The ASTM earns its money by the sale of approved ASTM standards and documents. Typically ASTM standards are sold to producers, regulators, insurance companies, etc., who require the application of "standards" in their business. Such entities are required to purchase the standards. ASTM's business model is to provide inexpensive access to technical information. Individual standards generally cost around $40, and the entire collection of LSA standards is about $160. "Producers", regulators and other user groups may require a number of copies for their various departments – subscriptions are available from the ASTM. Any individual may purchase any set of ASTM standards – visit www.astm.org. Also, ASTM members on the LSA committees ($75 annual membership fee) are entitled to one copy of all the approved LSA standards.

However, for the promotion of safer gyroplane aviation, the subsequent parts of this series of articles will explain several important sections of this gyroplane standard. An informed community and gyroplane market will promote safer gyroplanes and safer decisions by those who design, purchase, build and fly gyroplanes.