SKYBOLT
AEROSPACE FASTENERS

Cessna Cowling Mounts

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Skybolt has considerable experience with aircraft engine cowlings and the supporting fasteners. We have manufactured STCd and TSOd components for Cessna cowlings for over 30 years. This white paper will focus and build on previous Skybolt articles describing Cessna cowlings that utilize the rubber isolator mount, commonly known as the J7444 series mounts.

Our team of aviation A&Ps, IAs, and engineers have looked at the isolator mount cowlings from every possible angle. We have tried solid mount replacements. We have tried semi-solid mount replacements. We have considered re-designing the entire cowling to a solid mount cowling. Almost every solid mount cowling in existence has stood the test of time without excessive vibration or noise levels the isolator mount was designed to subdue. What we have learned in 30 years is that what looked good on paper was very lacking in reality, particularly the C172 cowlings. For years, we blamed it all on the O360 engine. Other airframes used the O360 without major problems. The common thread, as of this writing, points to the clearance issues with the nose of the C172 cowling and the engine. On occasion, we see similar issues with the C182. Rarely do we see issues with the C150 or C177 airframes.

The best information we can come by from Cessna and seasoned airframe maintenance shops and flight schools is the unofficial documentation of the engine inclination and the engine mounts. Seasoned Cessna maintenance shops suggest that the C172 engine was designed to have zero inclination and zero centerline angle (although we have yet to find any Cessna literature that states this). Lord has information on inspecting engine mounts and limits.

Skybolt is located on a busy general aviation airport. We are closely monitoring C172s based on our field. One can walk up to any C172 produced since 1967, place slight pressure on the cowling nose and have some idea as to the condition of the cowling mounts. In fact, we suggest that this be included in any and all pre-flight. If the cowling shows signs of rub marks at the nose to the spinner, this should be grounds to inspect the airplane prior to flight. The mounts, particularly the lower mounts, are either cracked and/or probably broken.

Yet, we find some cowlings very easy to move up and down at the nose to the limit of the internal snubber with no abnormal history of mount failure. We find 'S' model C172s with notorious mount failures. Skybolt experienced this early in the O360 game with the conversions before Cessna began installing the O360 on new models. Then Cessna experienced the same problems we were dealing with the introduction of the 'R' and 'S' models. Skybolt recently performed a test flight of a C172S model to video tape the dynamics of the inside of the cowling during startup, takeoff, flight, and shutdown.

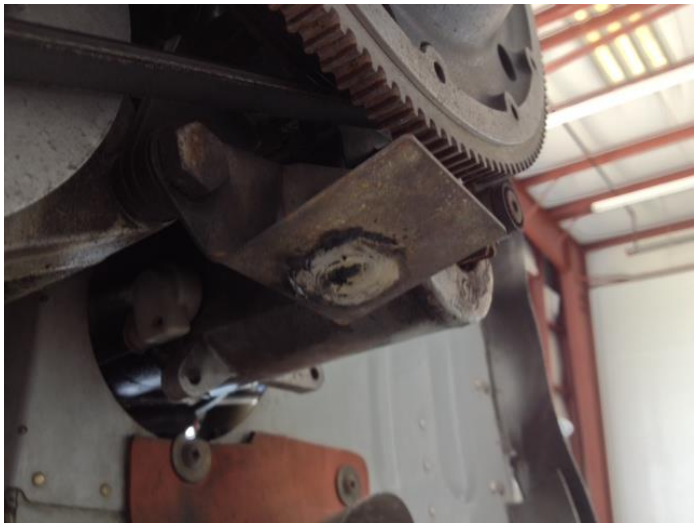
See http://www.youtube.com/embed/de9hrCiv5iA

We were looking for a smoking gun when we performed this test. Although we learned a lot from the test and the video, we did not see the dramatics we expected, particularly during an intentional firm landing. However, this was attributed to a well maintained later model C172S that had recent engine mounts installed. What we did note was that the engine had a notable negative inclination of about 2.0 degrees. Note, the Cessna Service Manual describes longitudinal leveling via two screws on the left fuselage, just aft of the baggage door. We chose the door frame as a reference that matches the leveling screws. Either reference determined that our engine had a notable negative inclination or about 2 degrees.

Airframe level (measured at door post) was 11.6 degrees nose up. The engine level was 9.6 nose up. This indicates that the engine is sagging or has an inclination of 2.0 degrees down.

Referencing the video, frames beginning at :33, the engine is resting solidly against the snubber even before engine start. From engine start (frames beginning :41) till engine stop, the cowling mounts on this test aircraft are under stress. Note the amount of engine compression against the forward snubber during climb out (frames beginning 2:02).

What this video did not indicate was excessive stress on the lower cowling mounts during landing (frames beginning 3:40). The test did indeed indicate the amount of stress the engine places on the cowling (mounts) during engine start and stop (frames beginning 4:18). This was more of an issue with the engine baffling than the forward snubber.



The snubber plate mounted to the O360 engine. Note the wear marks from a worn out snubber. A new snubber plate mounted to the forward nose of the cowling. Note: earlier C172 cowlings had landing light fixtures in lieu of the snubber bracket.

We also obtained temperature readings in 3 separate areas of the cowling on an 84°F day. We mounted two probes adjacent to the lower left mount (#1) and adjacent to the lower right mount (#2) in addition to the lower frontal area of the cowling. All 3 probes did not see any readings above 137°F for the entire test session.

Here is the big question: Did Cessna install this snubber to cushion engine down flex? Hardly! What if the snubber and bracket were removed? The cowling could move up at the nose and strike the spinner? Only under two conditions: First, worn out lower cowling mounts or second, broken lower cowling mounts will allow the cowling to rise and strike the spinner. The snubber was installed to prevent the cowling from striking the spinner if the lower mounts are worn or failed. (This makes one wonder about the integrity of the design in the first place.) *Yet the system designed to prevent this situation actually helps cause it.* On this airframe, if maintenance were poor or an annual inspection fails to check the condition of the cowling mounts, the lower mounts will eventually (sooner than later) fail. The "sooner" is because of the fact that the engine is sagging and placing constant stress on the lower mounts. "Sooner" would be even sooner if the engine mounts were beyond service. Not only is the engine sagging, the engine will flex severely on climb out and landing due to worn engine mounts.

This answers the many questions we were out to resolve. Why some airframes "eat" cowling mounts and other airframes (even C172 airframes with O360 engines) hardly ever wear out cowling mounts.

Our conclusion begins with the cowling alignment, possibly even the engine alignment when it was new from the factory. Bring the engine mounts into the mix and problems begin to surface with certain airframes versus others.

We have talked for years about cowling hole alignment to the mount. Skybolt developed a very efficient alignment method (See SK203 Series Instructions) and Platemount camwashers to easily correct alignment, both hole to mount and cowling to spinner alignment. Now, we are talking about engine mounts and engine inclination. The test aircraft was relatively new with good hole alignment. However, with the 2.0 degree engine sag, this airframe will cause excessive cowling mount failures. The only fix is to replace the engine mounts as per the Lord or Barry instructions. Pay particular attention that the engine mounts are specific for each location and the installation of washers is specific for the upper and lower mounts and model/year. Then, we will also suggest that some factory mounts may not be properly aligned. Could engine mount frames be tweaked after hours of service? Absolutely! As there is no known alignment specifications or drawings of such, this leaves a topic for another white paper. The fix for a questionable engine frame mount is a major expense. Short of this expense, our conclusion is as follows:

If your aircraft seems to have more than its share of cowling mount failures, check the condition of the cowling snubber. If it is resting on the engine bracket with the engine not running, check that the snubber is not excessively shimmed. Reduce the shims to remove some of the shear loads placed on the cowling mounts.

Check the condition of the engine isolator mounts. Mounts more than 5 years in service or at engine change should be replaced (as per the best practices of major flight schools).

Preflight the cowling mounts. Check for spinner marks on the leading edge of the cowling. Move the cowling to check for excessive free movement. It is not uncommon to un-cowl any Cessna 150, 172, 177, 182 isolator mount cowling to find one to two broken mounts.

Failure to pay attention to the cowling mounts and the root cause of the failure can lead to inflight failures of the cowling such that it can move forward and strike the spinner. The very snubber that should prevent this from happening will not stop the cowling from striking the spinner with multiple mount failures.

The designs we have produced in the past, Gen I (aluminum) and Gen II (stiff rubber) assume that the engine mount, engine isolator mounts, and cowling holes are all textbook. Our experience with Cessna cowlings is that too many airframes are not textbook and that the root cause is not part of an ordinary inspection, pre-buy or annual. Even a good annual will not address misaligned holes or measure engine inclination or even check engine isolator mounts (typically requires removal of the engine). The Gen I and Gen II mounts fix one problem while creating worse problems with airframes that are not textbook. The mounts may not break but the firewall mounts they are mounted to will crack and worse, the firewall will crack. That failure is expensive, thus, we discontinued the design for a good reason, thanks partially to the introduction of the O360 engine on C172s.

The new Skybolt Gen IV SK2003 Series mount is similar to the Gen III design except we greatly enhanced the design, the specifications of the raw material, and our quality control procedures to include 100% testing on every mount that we produce and ship. Skybolt has adapted a zero defect program for every mount we sell. Skybolt Gen IV mounts are 100% manufactured in the USA with DFARS materials under FAA TSO-C148 approval to replace similar J7444 mounts.

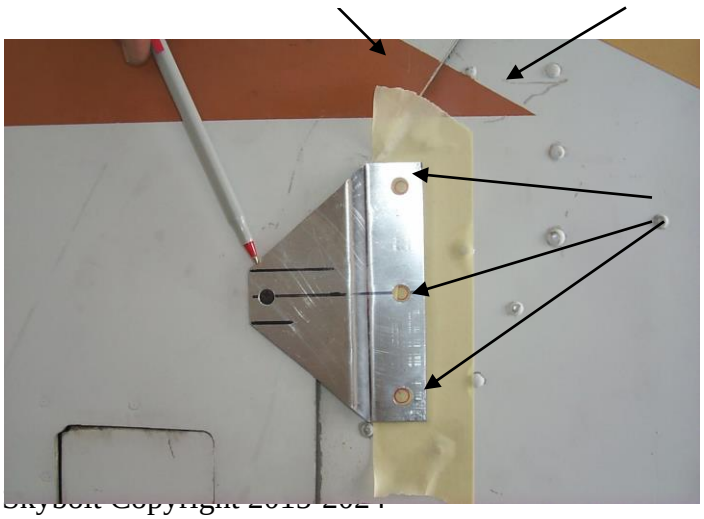
In early 2015, in co-operation with Cessna and a major US flight school as an independent test lab, data was derived for the OEM J7444 mount versus the Skybolt GenIV mount. We supplied 100 mounts as did Cessna. The Skybolt product out-performed the OEM mount by a wide margin. Knowing that this fleet of over 50 C172s has a high maintenance standard, both the J7444 and the SK2003 mounts all exceeded 400 hours. Aircraft operated under a lower standard, which 99% of them are, is where the real test begins. Our previous GenIII mounts had a mixed bag in the 99% market. We traced this to the quality standards of the rubber material and the bonding process. Skybolt changed vendors and adapted a 100% stretch test for each basic mount before we even assembled the finished part.

How to Fix a Cowling

Unfortunately, cowling mount issues are discovered after the cowling is removed. If your airframe and cowling mounts do not seem to get along, take a moment and evaluate the cowling before it is removed.

Note the cowling nose in relation to the spinner bulkhead. Look for any signs of the engine (or spinner) striking any portion of the cowling externally and internally as noted above. Decide on a plan of action that will eventually resolve platemount failure.

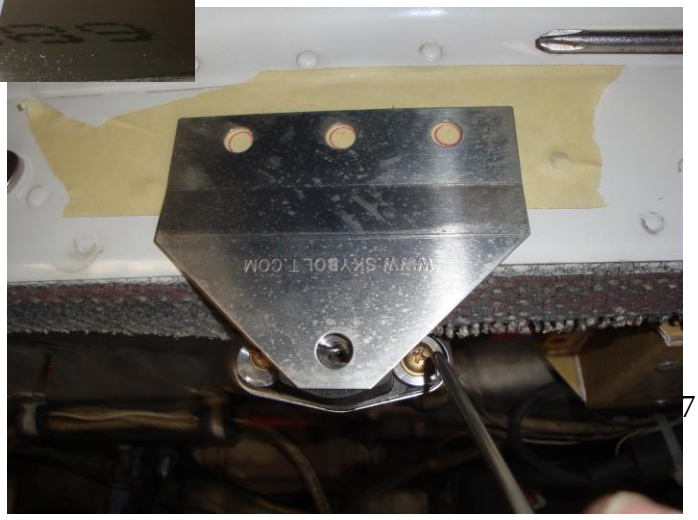
If you experienced failed mounts in the past, take a moment and glance at any Skybolt SK203 Installation Instructions (www.skybolt.com). Before you remove the cowling, tape off the airframe skins as suggested in the photograph below. Place the centering hole over the fastener and mark the reference holes (3 holes) as shown.



The Skybolt SK203-TEM1 - Prior to removing the cowling, locate each fastener center using this template. Marking the three holes onto masking tape as shown establishes the cowling hole location with the cowling removed.

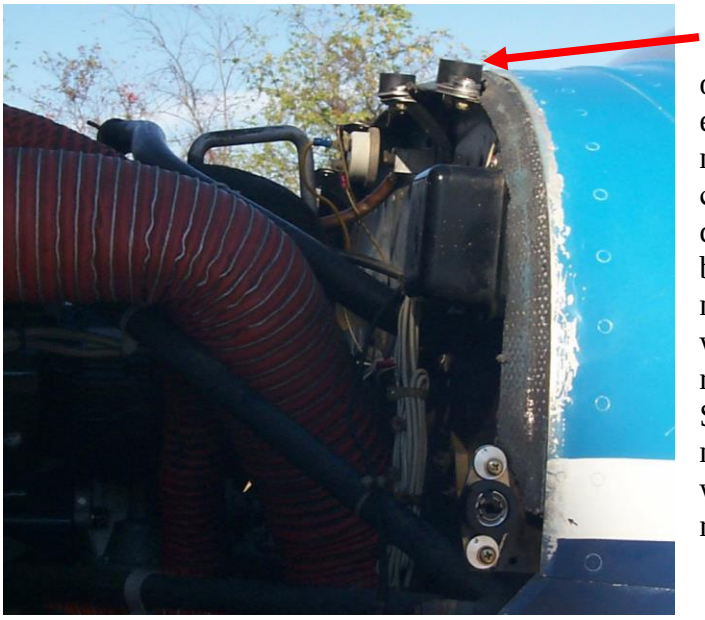
This example is all too common. The fastener, with some coaxing, will lock but the mount is pre-stressed before adding additional stress by the engine striking the cowling. If left alone, mounts are going to fail.

With Skybolt SK2003-AW Camwashers installed, simply "dialing" the mount to agree with the corresponding hole (centered), we have neutralized static stress. We can also "shift" the cowling in all axis to match paint lines, but most important, prevent the engine from hitting the cowling, particularly as a result of a firm landing. There are other factors, but the engine striking the cowling is the most notorious for failures.



Example of Skybolt SK2003 Mount drilled to accept the SK2003-AW Camwasher set. (Skybolt SK203 Instructions suggest a simple way to successfully drill these holes). Note: Drilled shim is only required for the -50ADJ mounts and are predrilled in SK2003-AW5 SET.

By rotating the Camwashers, this mount can be relocated in all axis by a considerable amount without altering the mounting brackets or relocating the brackets (as suggested by the Cessna Service Bulletin SB98-53-02).



Here is another common observation. Mounts are angled excessively up or down. With the mount removed, the mounting bracket can be "aligned" to agree with the cowling slope by bending the 2-piece bracket, clamp, and re-drill the mounting holes. This may (probably will) relocate the mount center relative to the cowling hole. Using the SK2003-AW Camwashers, this mount is now faced (angled properly) with the cowling and centered to relieve static load.

(Pictured are our GenII Mounts