Program Title

Abstract: This presentation acquaints the audience with: The latent hazard of installing incompatable STC Alteratons

Format: Information Briefing - Power Point presentation as pdf

Slides	Script
	**Slide 1** 2018/10-10-139(I)PP Original Author: (Edward Garino) (07/24/2018); POC (Guy Minor), AFS-920 (Airworthiness Lead), Office (707-704-3530); Revision: 1 **Presentation Note:** *This is the title slide for Frankenplane* *Presentation notes (stage direction and presentation suggestions) will be preceded by a* **Bold header**: *the notes themselves will be in Italic fonts.* ***Program control instructions*** *will be in bold fonts and look like this:* (Click) *for building information within a slide; or this:* (Next Slide) *for slide advance.* *Some slides may contain background information that supports the concepts presented in the program.* *Background information will always appear last and will*

	be preceded by a bold **Background:** *identification.* *We have included a script of suggested dialog with each slide. Presenters may read the script or modify it to suit their own presentation style.* *The production team hope you and your audience will enjoy the show. Break a leg!* **(Next Slide)**
	**Slide 2** **Presentation Note:** *Here's where you can discuss venue logistics, acknowledge sponsors, and deliver other information you want your audience to know in the beginning.* *You can add slides after this one to fit your situation.* **(Next Slide)**
	**Slide 3** **Presentation Note:** *These are pictures of the Brodie landing system. https://en.wikipedia.org/wiki/Brodie_landing_system. It probably pushed the J-3 cub well beyond what the designer intended. https://en.wikipedia.org/wiki/Piper_J-3_Cub* **(Next Slide)**

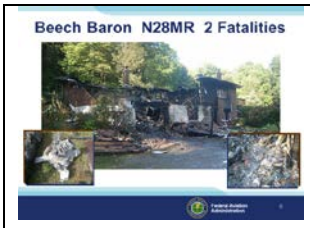
	**Slide 4** **Presentation Note:** *STC Compatibility is not a new issue. You can imagine that special mission aircraft, and even sometimes less than special aircraft, need multiple modifications. These modifications need to play well together. Sometimes it does not end well.* **(Next Slide)**
	**Slide 5** **Presentation Note:** *Two accidents brought about three NTSB recommendations, and prompted the FAA to publish an Advisory Circular.* *This is the first of the two. It is a very nice Beech Baron. It was modified under an STC that installed vortex generators, which decreased the airplane's air minimum control airspeed (Vmca) from 81 knots to 74 knots. Another subsequent STC modification installed more powerful engines, different propellers, winglets, and modified engine nose cowlings. The engine STC took into account a change to only the original type design and increased the airplane's Vmca to 87 knots; however, the airplane's airspeed indicator remained marked to indicate a Vmca of 74 knots.* **(Next Slide)** **Background:** The pilot had previously owned the accident airplane about 22 years ago, and it was subsequently modified

	under a supplemental type certificate (STC) that installed vortex generators (VGs), which decreased the airplane's air minimum control airspeed (Vmca) from 81 knots to 74 knots. Another subsequent STC modification, STC SA1762SO, installed more powerful engines, different propellers, winglets, and modified engine nose cowlings. STC SA1762SO took into account a change to only the original type design and increased the airplane's Vmca to 87 knots; however, the airplane's airspeed indicator remained marked to indicate a Vmca of 74 knots. A representative of the current holder of STC SA1762SO reported that, to his knowledge, no flight testing was performed on the accident airplane or any similar make and model airplane to determine the interrelationship between his company's STC and the previous STC. Therefore, the actual performance data for the accident airplane, including the Vmca, were unknown. However, the Vmca for the accident airplane was likely higher than the 74-knot Vmca marked on the airspeed indicator. The pilot purchased the airplane 4 days before the accident and performed three full-stop landings 2 days before the accident to get current. An individual familiar with the pilot believed that the pilot had not previously flown a reciprocating-engine-equipped airplane in about 3 years. Due to the pilot's recent purchase, an insurance company broker "suggested" that the pilot obtain a multiengine instrument proficiency checkride; a Federal Aviation Administration (FAA) designated pilot examiner acting as a certified flight instructor (CFI) was on board for the accident flight. The CFI did not have an exemption

	from 14 Code of Federal Regulations 91.109(a) to give instruction in an aircraft equipped with a throw-over control yoke. According to uncorrelated radar data, after departure, the flight proceeded north-northwest and climbed to 3,600 feet where two 360-degree nearly level turns to the left were made, followed by a 360-degree turn to the right. The airplane then proceeded north-northwest and climbed to 4,200 feet briefly with the ground speed decreasing to 127 knots, then it descended to 3,900 feet and remained at that altitude, at which heading changes occurred, and the ground speed decreased to about 71 knots. Witnesses reported seeing the airplane flying level before it descended in a left spin and impacted a house. The only major components of the airplane that were not extensively heat damaged consisted of the outer section of the left wing and one cargo door, both of which were found in close proximity to the house. Both engines and their accessories and both propellers were extensively heat damaged. Although the right engine-driven fuel pump drive coupling was found fractured, this likely occurred during post accident rotation of the crankshaft in order to facilitate removal of the propeller. The extent of the heat and impact damage to the airplane limited the airframe and engine testing that could be performed; however, there was no evidence of pre-impact failure or malfunction on the observed components. Based on the airplane's decreasing airspeed and nearly level altitude, the pilot was likely performing either imminent stall or simulated loss of engine power airwork before the

	airplane aerodynamically stalled and then entered a spin. Because the airplane was equipped with only a throw-over control yoke, the CFI had limited ability to assist in the recovery of the airplane. Although it was not possible to determine which low-airspeed maneuver was being demonstrated, one scenario that is consistent with the radar data evidence (and is typically performed during multiengine checkrides) is the Vmca demonstration, which requires a power reduction on one engine(and is consistent with the witnesses' descriptions of "sputtering" engine sounds). If the pilot were performing a Vmca demonstration, it is possible that the airplane began to lose directional control earlier than expected because the actual Vmca of the airplane with multiple STC modifications was unknown, and the airspeed indicator was improperly marked. Although the limitations and conditions section of STC SA1762SO stated that the installer must determine that the relationship between that STC modification and any other previously approved modifications "will not produce an adverse effect upon the airworthiness of that airplane," the investigation found that the FAA does not provide any guidance to an installer to help determine the interrelationship between multiple STCs. As a result of this accident, on December 29, 2011, the FAA issued Airworthiness Directive (AD) 2011-27-04 that requires an inspection for airplanes equipped with STC SA1762SO and that specifies corrective action, if applicable, to ensure that the airplanes have the correct Vmca marking on the airspeed indicator, taking into consideration other

	STC modifications. AD 2011-27-04 is available from the FAA's website at <http://www.faa.gov>.

	**Slide 6** **Presentation Note:** *The aircraft, in its modified condition, was new to the pilot so he contracted with a flight instructor to increase his proficiency. The pilot was likely performing either imminent stall or simulated loss of engine power airwork before the airplane aerodynamically stalled and then entered a spin. Although it was not possible to determine which low-airspeed maneuver was being demonstrated, one scenario is the Vmca demonstration, which requires a power reduction on one engine. If the pilot were performing a Vmca demonstration, it is possible that the airplane began to lose directional control earlier than expected because the airspeed indicator was improperly marked. The aircraft crashed into a residential area.* **(Next Slide)**

Slide 7

Presentation Note: Our second example is this very nice Cessna 337. The most obvious alteration is the wing tip, but it was modified under 22 different supplemental type certificates (STCs), which included separate STCs for a short field take-off and landing (STOL) kit, an extended wingtip fuel tank, and winglets. The investigation found evidence that the combined effects of the multiple STC modifications on the accident airplane may have adversely affected the airplane's wing structure because the combined effects of the STCs were not taken into account.

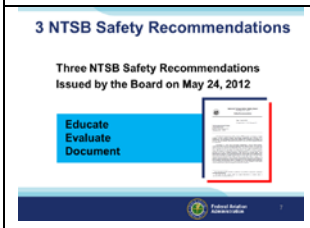
(Next Slide)

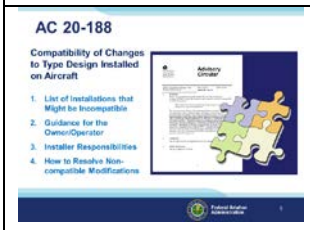
Background: One of the pilots announced over the airport's common traffic advisory frequency his intention to perform a low pass over the runway, and ground witnesses observed the airplane fly about 50 feet above the runway with the landing gear retracted. Global positioning system data recovered from the wreckage indicated that the airplane's ground speed at that time was about 160 knots (kts) (184 mph). Witnesses observed the airplane's nose pitch up just before the outboard 6-foot section of the right wing separated, and the airplane descended uncontrollably and impacted the ground. Although the pilot/owner seated in the left front seat was not rated to operate a multi-engine land airplane, he was known to perform ostentatious maneuvers in the accident airplane on previous

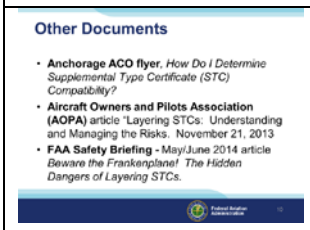
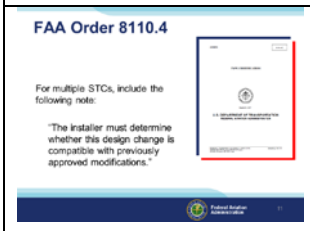
	occasions. The pilot seated in the right front seat was rated to operate a multi-engine land airplane. A placard above the airspeed indicator indicated, “Maneuvering --- 135 KTS (155 MPH)”; therefore, the pilot’s low pass and subsequent pitch up maneuver, consistent with an ostentatious display, was performed at an airspeed that exceeded this operating limitation. Post accident metallurgical examination of airplane’s structure revealed that the right wing forward spar upper cap failed in compressive buckling. Although the left wing did not fail in flight, it showed buckling characteristics similar to the right wing, indicating that both wings were overloaded in upward bending. The airplane was modified under 22 different supplemental type certificates (STCs), which included separate STCs for a short field take-off and landing (STOL) kit, an extended wingtip fuel tank, and winglets. The investigation found evidence that the combined effects of the multiple STC modifications on the accident airplane may have adversely affected the airplane’s wing structure because the combined effects of the STCs were not accounted for. For example, although not a factor in the in-flight breakup, skin fatigue cracks were observed at certain stations on the wing, which indicate that the airplane was subjected to vibratory stresses. Therefore, although each individual STC modification did not pose a concern, the combination of STCs on the accident airplane created wing loads that were not initially evaluated. As a result of this accident investigation, the Federal Aviation Administration (FAA) reevaluated the STCs and

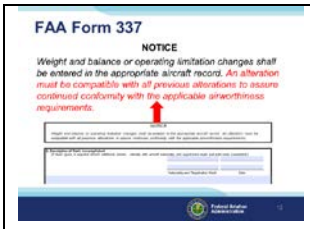
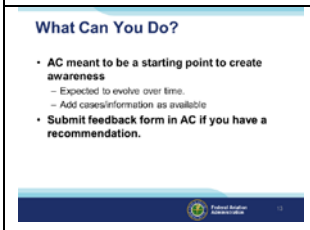
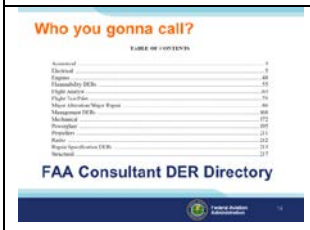
	determined that revised operating limitations should be disseminated and implemented for this airplane; the FAA issued airworthiness directives (ADs) 2010-21-18 and 2011-15-11 to help address these issues. These ADs are available from the FAA's website at <http://www.faa.gov>. In addition, concurrent with this investigation, the NTSB investigated another accident (NTSB identification ERA10FA404)involving an airplane with multiple STCs installed and discovered that the FAA does not provide any guidance to an STC installer to help the installer determine the interrelationship between multiple STC modifications.

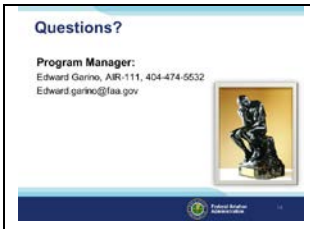
	**Slide 8** **Presentation Note:** *This is the main crash site.* *The pilot attempted a low pass over the runway, and ground witnesses observed the airplane fly about 50 feet above the runway with the landing gear retracted. GPS data the airplane's ground speed at that time was about 160 knots (kts) (184 mph). Witnesses observed the airplane's nose pitch up just before the outboard 6-foot section of the right wing separated, and the airplane descended uncontrollably and impacted the ground. A placard above the airspeed indicator indicated, "Maneuvering --- 135 KTS (155 MPH)"; therefore, the pilot's low pass and subsequent pitch up maneuver was performed at an airspeed that exceeded this operating limitation.* *The airplane was modified under 22 different STCs, which included separate STCs for a short field take-off and landing (STOL) kit, an extended wingtip fuel tank, and winglets. Each individual STC modification did not pose a concern, but the combination of STCs on the accident airplane created wing loads that contributed to the inflight breakup.* **(Next Slide)**

	**Slide 9** **Presentation Note:** *This is the outboard section of the left wing. It was found on the runway.* **(Next Slide)**
	**Slide 10** **Presentation Note:** *The NTSB issued three Safety Recommendations.* *They are:* *Develop specific guidance and/or a checklist to help installers performing supplemental type certificate (STC) modifications determine the compatibility and interaction between a new STC and any previously installed STCs …* *Instruct installers to document in the Description of Work Accomplished block of Federal Aviation Administration Form 337 how the installer determined the compatibility and interaction between the new supplemental type certificate (STC) and previously installed STCs…* *Educate:* *Educate owners and operators of all aircraft with multiple STCs about the potential hazards of incompatible STCs;* *Encourage them to have their aircraft evaluated to determine if the multiple STCs adversely affect the aircraft's structural strength, performance, or flight*

	characteristics *Document any evaluation in FAA Form 337 for that aircraft.* **(Next Slide)**
	**<u>Slide 11</u>** **Presentation Note:** *One of FAA responses was to release an AC that explained a method to ensure compatibility of modifications. In December 2016 FAA released AC 20-188, It is titled, "Compatibility of Changes to Type Design Installed on Aircraft". It states "The installer must determine whether this design change is compatible with previously approved modifications." By compatibility we mean ensuring that changes to type design approved separately do not create a safety issue if installed together.* *AC 20-188* *Promotes awareness* *Provides "examples" of potentially incompatible STCs to help installers.* *Promotes owners to review aircraft history.* *Provides recommendations for sources of information.* *This includes the design approval holders and designees.* *Focuses on STC; could apply to alterations* **(Next Slide)**

	**Slide 12** **Presentation Note:** *Transport Canada has publicized this information as well. For their perspective you can go to the Transport Canada website and find Airworthiness Notices - B045, Edition 1 - 15 May 1998* **(Next Slide)**
	**Slide 13** **Presentation Note:** *Here are three other documents that may be helpful.* **(Next Slide)**
	**Slide 14** **Presentation Note:** *FAA Order 8110.4 is the order that sets procedures for evaluating and approving aircraft, engine, and propeller type design data **and changes to** approved type design data.* *FAA addresses follow on installations through the Limitations Section of STCs. The "installer" is responsible for determining compatibility. This is typically the authorized repair station or an Authorized Inspector (AI) who returns the aircraft to service. We also require the STC holder to give written permission to the installer. This can open communication between the STC holder and the installer if there are issues.* **(Next Slide)**

	**Slide 15** **Presentation Note:** *On the back of the Major Repair & Alteration Form 337, just above the Description of Work Accomplished the FAA Form 337 includes a notice that reminds the installer of their responsibility.* **(Next Slide)**
	**Slide 16** **Presentation Note:** *Spread the word. Everyone needs to know of the hazards of layering STCs. The AIR engineers are also asking for your feedback. If you have a suggestion as to how to improve the AC please submit the suggestion in the AC feedback form*. **(Next Slide)**
	**Slide 17** **Presentation Note:** *"The installer must determine whether this design change is compatible with previously approved modifications." How can you do that? Perhaps you are an engineer, and a test pilot, but most of us are not. You will need to get professional help. If you will search the words, "FAA Consultant DER Directory". You will find a list of people who can help.* **(Next Slide)**

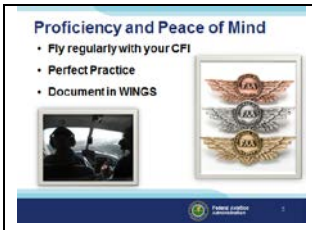


Slide 18

If you have questions about the content of this presentation or the AC please contact Ed Garino. If you have questions about your particular aircraft alterations please contact your Principle Maintenance Inspector.

Presentation Note: *You may wish to provide your contact information and main FSDO phone number here. Modify with your information or leave blank.*

(Next Slide)



Slide 19

There's nothing like the feeling you get when you know you're playing your A game and in order to do that you need a good coach **(Click)**

So fly regularly with a CFI who will challenge you to review what you know, explore new horizons, and to always do your best. Of course you'll have to dedicate time and money to your proficiency program but it's well worth it for the peace of mind that comes with confidence. **(Click)**

Vince Lombardi, the famous football coach said, "Practice does not make perfect. Only perfect practice makes perfect." For pilots that means flying with precision. On course, on altitude, on speed all the time. **(Click)**

And be sure to document your achievement in the Wings Proficiency Program. It's a great way to stay on top of your game and keep you flight review current.

(Next Slide)

	**Slide 20** Your presence here shows that you are vital members of our General Aviation Safety Community. The high standards you keep and the examples you set are a great credit to you and to GA. Thank you for attending. **(Next Slide)**
	**Slide 21** **(The End)**