



# National Transportation Safety Board

Washington, D.C. 20594

## Safety Recommendation

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**Date:** December 12, 2000

**In reply refer to:** A-00-120

Honorable Jane F. Garvey  
Administrator  
Federal Aviation Administration  
Washington, D.C. 20591

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On March 24, 1999, at 1300 central standard time, an Extra Flugzeugbau GmbH EA-300S, N9K, operated by Above & Beyond Aviation, Inc., experienced a separation of the upper left longeron<sup>1</sup> and a diagonal brace tube member at the attach point of the horizontal stabilizer.<sup>2</sup> The separation occurred when the airline transport-rated pilot entered a roll maneuver while practicing for an airshow in Dow, Illinois. The pilot was able to land the airplane without further incident. The pilot was not injured, but the airplane was substantially damaged. The flight was operating under Title 14 *Code of Federal Regulations* (14 CFR) Part 91, in visual meteorological conditions, and without a flight plan.

The fuselage construction in the area of the attachment assembly for the horizontal stabilizer on the accident airplane is illustrated in figure 1 (enclosed). The fuselage assembly of airplanes in the Extra 300 series is manufactured from steel tubing. The ends of the tubing are cut at angles then welded to each other to form a frame structure. Four longerons (0.7-inch outside diameter tubing) run the length of the fuselage. An attachment assembly for the horizontal stabilizer is welded to the two upper longerons. This attachment assembly contains one forward and one aft fitting (bracket). On the upper left side of the airplane, two diagonal braces intersect the upper longeron in the vicinity of the attachment brackets for the horizontal stabilizer. The diagonal brace running forward and down from the horizontal stabilizer is called the forward diagonal brace in this letter, and the diagonal brace running aft and down from the attachment assembly for the horizontal stabilizer is called the aft diagonal brace. The brackets and braces on the right side of the airplane are a mirror image to those on the left side.

Metallurgical examination of the separated pieces from N9K was conducted at the Safety Board's materials laboratory. This examination disclosed a fracture through the upper left longeron that intersected a fillet weld located at the forward end of the base of the forward attachment bracket. This fracture contained a fatigue crack that emanated from the toe of the fillet weld. The length of this fatigue crack measured about 0.35 inch circumferentially. A thumbnail-shaped portion of the fatigue crack region contained a blue tint. This blue tint

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<sup>1</sup> A longeron is a main structural member that runs along the longitudinal length of the fuselage.

<sup>2</sup> NTSB Brief of Accident No. CHI99-F-A120, May 12, 2000.

measured 0.25 inch circumferentially at the surface of the weld and extended from the surface to a depth of 0.02 inch. The blue tint indicates the size of a crack that existed at the time of heat exposure, such as a welding operation, probably during the weld repair of a crack or installation of gussets and reinforcement plates after the operator's February 1998 annual inspection.<sup>3</sup> Visual examination of the fuselage at the materials laboratory disclosed the presence of a repair reinforcement plate (see figure 1) that had been welded between the upper left longeron and the forward bracket of the attachment assembly for the horizontal stabilizer. A similar repair reinforcement plate had been welded between the longeron and the aft bracket of the attachment assembly for the horizontal stabilizer.

Another fracture was through the forward diagonal brace and was located about 1 inch below and slightly forward of the attachment assembly for the horizontal stabilizer. The metallurgical examination determined that in the area below the attachment assembly for the horizontal stabilizer, a repair gusset had been attached by welds to the diagonal braces and the longeron; however, this gusset had been removed from the airplane before the fractured pieces were sent to the Safety Board's materials laboratory. The operator of the accident airplane indicated that the gusset was removed from the fuselage after the accident in an attempt to repair the fractured tubes, and that the Safety Board's requests to have the fuselage pieces shipped to the laboratory were made after the gusset had been removed.<sup>4</sup> The operator indicated that the gusset was manufactured from a flat steel plate, and that three separate plug welds<sup>5</sup> attached each diagonal brace to the gusset. Reinforcement plates and a gusset also had been installed on the corresponding area on the right side of the fuselage.

The Safety Board examination of the fuselage member in the area where the gusset had been removed revealed three holes in each diagonal brace. These three holes, indicating the location of the plug welds, were actually circular fractures that were created along the fusion line between the plug weld and the base metal of the braces. The fracture in the forward diagonal brace intersected the circular fracture at the lowest plug weld. Metallurgical examination of the forward diagonal brace also revealed that a portion of the fracture contained features typical of fatigue cracking that emanated from the fusion line of the plug weld and that this fracture propagated around 90 percent of the forward diagonal brace circumference.

Hardness testing of a section through the plug welds indicated that the converted tensile strength of the weld (about 98 kilopounds per square inch [ksi]) was much lower than the tensile strength of either the heat-affected zone (182 ksi) or the tube members (166 ksi). Pre- and post-heating during welding can affect the tensile strength of the weld and heat-affected zone. A lower strength of the weld material makes it more susceptible to fatigue cracking.

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<sup>3</sup> The weld repair and installation of the retrofit parts are discussed in more detail later in the letter.

<sup>4</sup> The Safety Board laboratory found grinding marks on the left and right sides of the fuselage that outlined the location of the disassembled gusset. These grinding marks confirm that repair gussets had been removed from the fuselage prior to delivery to the laboratory.

<sup>5</sup> A plug weld is a circular weld made through a hole in the gusset, fusing the gusset to the diagonal brace. The hole is filled with weld metal.

Cracking of the longeron and diagonal braces in the area of the horizontal stabilizer is addressed in Extra Flugzeugbau (Extra) Service Bulletin (SB) 300-2-95, Issues A, B, and C. Issue A, dated May 3, 1995, and applicable for Extra models EA-300, EA-300S, and EA-300L,<sup>6</sup> indicates that the upper longeron located forward of the attachment bracket for the horizontal stabilizer should be visually inspected for cracking prior to the next flight. Issue A further indicates that visual inspection for cracking in that area should recur every 50 hours, and if cracking is found, the operator should contact the manufacturer for repair advice. If there is doubt about the cracking, operators are advised to remove paint and inspect for a potential crack in the area by the dye penetrant method.

According to the operator of the N9K, he performed an annual inspection in February 1998 and subsequently made repairs incorporating the actions described in Issue A of SB 300-2-95. At that time, the airplane had accumulated 856.3 hours. The operator indicated that he inspected the attachment assembly for the horizontal stabilizer by visual, dye penetrant, and magnetic particle methods during annual inspection. These methods disclosed cracking in the following areas:

- in the weld at the forward end of the forward bracket (the area identified for inspection in Issue A of the SB);
- in a weld on the aft end of the aft bracket for the attachment assembly for the horizontal stabilizer (an area not identified for inspection by Issue A of the SB); and
- in an area that intersected the longeron and a diagonal brace, between the forward and aft brackets (an area not identified for inspection by Issue A of the SB).

After detecting the multiple cracks, the operator contacted the airplane manufacturer for repair instructions, as advised in Issue A of the SB. The manufacturer indicated that the cracks should be repaired by weld and that reinforcement plates and a gusset should be installed on the left and right sides of the attachment bracket area. Reinforcement plates and a gusset would normally have been made from German 17734.4 alloy, the alloy used to manufacture the tube members of the fuselage. However, because the operator did not have immediate access to this alloy, the manufacturer instructed the operator to make the reinforcement plates and gusset from 4340-alloy steel, which is readily available in the United States. According to the operator, the repairs were completed using reinforcement plates and a gusset manufactured from 4340-alloy steel.

Extra released Issue B of SB 300-2-95 on April 2, 1998, shortly after the operator of the N9K airplane had completed repairs on the attachment assembly. Issue B identified the areas to visually inspect for cracking: the upper longeron located forward of the attachment bracket for the horizontal stabilizer (previously identified in Issue A), plus the longeron in the area between

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<sup>6</sup> Aero Sport, Inc., is the distributor of the Extra aerobatic airplanes in North America. According to the company's Web site ([www.aerosport.com](http://www.aerosport.com)), the EA-300S model is a one-seat low wing airplane, the EA-300L model is a two-seat low wing airplane, and the EA-300 model is a two-seat airplane with a slightly higher wing compared to the other two models. The attachment assembly for the horizontal stabilizer is the same for all three models.

the brackets, and the area where the forward and aft diagonal braces intersect the longeron. Issue B also indicated that the tail fairing, rudder, vertical stabilizer, elevator, and horizontal stabilizer assembly should be disassembled, and that the fabric in the area to be inspected for cracking should be removed to expose potential cracks.

Issue B part II provided repair instructions that would terminate action for the recurring 50-hour inspection specified in Issue A. According to these instructions, the type of repair is determined by the location of cracking. If cracking is found on the forward end of the bracket for the attachment assembly for the horizontal stabilizer, the crack should be covered by a sleeve,<sup>7</sup> and reinforcement plates and a gusset also should be installed in the area of the attachment assembly for the horizontal stabilizer. Alternatively, if cracking is found in the general vicinity between the brackets for the attachment assembly, reinforcement plates and a gusset should be installed in the area of the bracket assembly. Figure 2 illustrates the retrofit parts that should be installed on the fuselage according to Issue B of the SB.

Issue B part II also indicates that the terminating action (installation of reinforcement plates and a gusset) is mandatory on any airplane in which cracks are found, and on all EA-300S airplanes even when cracks are not found. The terminating action is optional for EA-300 and EA-300L airplanes on which cracking has not been detected. Issue B states that no further inspection<sup>8</sup> for cracking needs to be performed on an airplane after the terminating action is accomplished. The Safety Board materials laboratory determined that the reinforcement plates found in the N9K airplane were manufactured from 4340 steel and were installed on the left and right sides of the airplane in the positions indicated in Issue B.

Issue C of SB 300-2-95, released on July 15, 1998, contained several changes regarding the retrofit parts that should be installed on the fuselage (see figure 3). The gusset described in Issue C is made from a plate that contains two legs with rounded edges, whereas the gusset described in Issues A and B is made from a plate with straight edges. The Issue C gusset is also slightly larger than the Issue B gusset, and it has four plug welds<sup>9</sup> on each diagonal brace instead of the three plug welds for the Issue B gusset. A representative from Extra Flugzeugbau indicated that the Issue C gusset allows for better distribution of stiffness in the reinforcement area.

Issue C also indicates that the aft reinforcement plate must not be installed on EA-300 airplanes. The rationale for this statement was not explained in the service bulletin. (Issue B indicated that reinforcement plates were necessary on EA-300 airplane when cracks were found and were optional when cracking had not been found). The Safety Board contacted Extra Flugzeugbau to determine why the aft reinforcement plate should be left off the EA-300 series airplane. A representative from Extra Flugzeugbau indicated that the EA-300 series plane has a

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<sup>7</sup> The sleeve contains an upper and lower jacket. The upper jacket contains a slit that allows for the jacket to be installed between the horizontal stabilizer attachment bracket and reinforcement plate. The edges all around the sleeve are welded to the surrounding structure.

<sup>8</sup> The Safety Board interprets this as meaning inspection by any method.

<sup>9</sup> Each leg of the Issue C gusset is manufactured with holes. After the leg is placed over the diagonal brace, the hole in the gusset is filled with welding metal rod. The resulting weld metal that fills the hole is called a plug weld, and it bonds the leg to the brace.

slightly different attachment bracket at the rear side of the main spar of the horizontal stabilizer, and that the aft reinforcement plate cannot be installed at the attachment bracket. This representative also indicated that the absence of this reinforcement plate on the EA-300 series plane was acceptable because cracks had been discovered only on model EA-300S airplanes and the reinforcement of the EA-300 and EA-300L airplanes was only a precautionary action.

The Safety Board is aware that the operator of the N9K airplane contacted Extra to determine if the work performed on the airplane was in compliance with Issue C. On September 18, 1998, Extra informed the operator of the N9K airplane, through SE Aero Services,<sup>10</sup> that if an EA-300S airplane was in compliance with Issue B, that airplane was also in compliance with Issue C. The Safety Board notes that without the sleeve, the repair was not in compliance with Issue B. The operator of the N9K airplane stated that even though he was not required to inspect the attachment area per Issue B, he continued to visually inspect this area. The operator of the N9K airplane indicated that no further cracking was detected between the time of the repair and the accident.

On March 15, 1999, the operator of the N9K airplane performed another annual inspection, at which time the airplane had accumulated 1,038 total hours. The attachment assembly for the horizontal stabilizer was inspected visually, and no cracking was detected in the airplane. Separation of the attachment assembly occurred on March 24, 1999, at a total time of 1,052.4 hours.

The operator's weld repair of the upper left longeron was made in accordance with instructions from Extra. However, repair instructions contained in Issues B and C of Extra SB 300-2-95, published later, specifically stated that a sleeve should have been installed on the upper longeron if a crack was found in front of attachment assembly for the horizontal stabilizer. The Safety Board's metallurgical investigation disclosed that the upper left and right longerons of N9K contained no sleeve in the area located forward of the forward bracket for the attachment assembly. The Safety Board concludes that cracking of the upper left longeron probably could have been avoided had the sleeve been installed after Issue B was released.

Heat from a welding operation is sufficient to produce a blue-tint discoloration on the surface of a crack. Such discoloration can be found only in exposed fractures after an accident. The metallurgical examination by the Safety Board materials laboratory disclosed a 0.25-inch circumferential blue-tint thumbnail discoloration on the fracture surfaces of the longeron. On the basis of this discovery, the Safety Board concludes that the 0.25-inch circumferential preexisting fatigue crack was present in the longeron during the inspections conducted in February 1998, was not detected by the visual method, and was heat tinted during weld repairs of the structure.

Although the accident airplane was an EA-300S model, the attachment assembly for the horizontal stabilizer on that model is similar to that used for the EA-300 and -300L models. All three models are high performance airplanes that can perform aerobatic maneuvers which subject the horizontal stabilizer to high stresses. The in-flight separation of the N9K longeron and the

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<sup>10</sup> A U.S. company that specializes in assembly of Extra airplanes. Portions of an Extra airplane are shipped disassembled from the factory in Germany and require assembly in the United States.

disparity of inspection and repair information in Issues A, B, and C of Extra Flugzeugbau SB 300-2-95 relative to the three airplane models raise concerns about the airworthiness of the EA-300 series airplanes. Detailed discussion follows.

Issues A, B, and C of SB 300-2-95 specify visual inspections for detecting cracks. Using the visual inspection method to detect cracks at the toe of the weld is a difficult and time consuming task; it also is insufficient for detecting small cracks in weld joints, as demonstrated by the preexisting crack in the upper left longeron of the N9K that was not detected at the last annual inspection (March 1999) by the operator's visual inspection. At the last annual inspection, the preexisting crack had grown to a size of about 0.35-inch circumferential and was within the detection range of the dye penetrant inspection method. Issues A, B, and C inform operators to use the dye penetrant method in case of doubt. Given the SB's emphasis on visual inspections, the Safety Board is concerned that operators of EA-300 series airplanes may perform only visual inspections of the attachment assembly for the horizontal stabilizer. As a result, cracks in a weld joint or suspect area in the tube members may go undetected and lead to additional in-flight separations. The Board thus believes that the FAA should issue an airworthiness directive (AD) to make compliance with Extra Flugzeugbau Service Bulletin 300-2-95 Issue C mandatory with the exception that the visual inspections be replaced with dye penetrant inspection.

The Safety Board is also concerned that cracks in the aft end of the aft bracket for the attachment assembly for the horizontal stabilizer could go undetected because no Issue of SB 300-2-95 specifies inspection of that area. The operator of the N9K airplane found cracks in the aft end of the aft bracket, which highlights the need for operators to inspect the area. The Board thus believes that the AD should also require dye penetrant inspection of the welds associated with the aft end of the aft brackets for the attachment assembly of the horizontal stabilizer.

As indicated earlier, Issues B and C of SB 300-2-95 state that cracks in front of the forward bracket for the attachment assembly of the horizontal stabilizer should be covered with a sleeve. These SB Issues, however, contain no statement that specifically indicates that the crack in the upper longeron should be weld repaired prior to installing the sleeve. It is standard practice to weld repair all cracks to ensure that cracking does not reinitiate during flight. If a crack is not weld repaired, the sleeve will carry the load of the longeron rather than providing reinforcement. To clarify the actions operators need to take, the FAA's AD should also require weld repair of any crack in the upper longeron area before installing the sleeve described in Issues B and C of SB 300-2-95.

A search in the FAA service difficulty reports (SDRs) for the period between August 1991 and June 2000 indicated that in the first 3 months of 1998, the fuselage of three other Extra 300 airplanes was found to have cracks in the area of the horizontal stabilizer. The information in these reports did not differentiate between the 300, 300S, or 300L models. However, Issues B and C of the SB 300-2-95 indicated that cracks have been reported only on the EA-300S models. According to the SDRs, cracking in the attachment assembly for the horizontal stabilizer was found during routine maintenance and inspection. No information was available in the SDRs regarding the number of hours or cycles between inspections for the airplanes. Because detecting cracks in the structure is critical to the airworthiness of the airplane, the Safety Board believes that the FAA should also require the dye penetrant inspection, weld repair, and sleeve installation

to be completed on an expedited basis, but no later than the next inspection required by Issue C or annual inspection, whichever is sooner.

As indicated earlier in this letter, the operator of the N9K contacted Extra to determine if the work performed on the airplane per the instructions in Issue B of SB 300-2-95 was in compliance with Issue C. The operator was told that if the airplane is in compliance with Issue B of SB 300-2-95, it is also in compliance with Issue C. The Safety Board contacted Extra Flugzeugbau to verify this information. A representative from Extra Flugzeugbau concurred with the statement made by the operator. However, this information is not reflected in the service bulletin.

The gusset in Issue B is slightly smaller than the gusset in Issue C, and it contains fewer plug welds than the gusset in Issue C. Issue B gussets may have been installed in the fuselage of EA 300 series airplanes, and this gusset may not have been replaced with an Issue C gusset. The Safety Board believes that the round edges and larger size of the Issue C gusset will provide better stress distribution at the attachment area of the horizontal stabilizer. The Safety Board is concerned that the Issue B gusset may not adequately reinforce the attachment area and, as indicated earlier in this letter, believes the FAA should mandate the installation of Issue C gusset on EA-300 series airplanes.

Issue C of the service bulletin indicates that EA-300 airplanes with serial Nos. 1 through 62, EA-300S airplanes with serial Nos. 1 through 29, and EA-300L airplanes with serial Nos. 1 through 5 are affected by the inspection and repair. The N9K airplane (model EA-300S) was serial No. 22. A representative from Aero Sport, the distributor of the EXTRA airplanes in North America, indicated to the Safety Board staff that about 29 EA-300S airplanes had been manufactured at the time this letter was written, and that 21 of these airplanes are registered in the United States. About 65 EA-300 airplanes have been manufactured, 21 of which are registered in the United States. About 99 EA300L airplanes have been manufactured. As of this writing, it is not known how many EA300L models are registered in the United States or which airplanes are in compliance with particular Issue(s) of SB 300-2-95.

No deaths or injuries have been reported in the EA-300, EA-300S, and EA-300L airplanes as a result of cracking and fractures in the area of the attachment assembly for the horizontal stabilizer. However, these airplanes can be flown in aerobatic maneuvers that can cause severe stress in the areas of the horizontal stabilizer. Those stresses can lead to cracking of the upper longerons and diagonal braces. If the cracks are not detected, they could lead to in-flight separation of the empennage and possibly result in loss of life.

Therefore the Safety Board recommends that the Federal Aviation Administration:

Issue an airworthiness directive to make compliance with Extra Flugzeugbau Service Bulletin 300-2-95 Issue C mandatory with the exception that the visual inspections be replaced with dye penetrant inspection and that the inspection areas be expanded to include the welds associated with the aft end of the aft brackets for the attachment assembly of the horizontal stabilizer. For any crack detected in the upper longeron area, require operators to weld repair the crack before installing the sleeve described in Issues B and C of the service bulletin. Compliance with this service bulletin should be accomplished on an expedited basis, but no later than the next inspection required by Issue C or annual inspection, whichever is sooner. (A-00-120)

Acting Chairman HALL, and Members HAMMERSCHMIDT, GOGLIA, BLACK, and CARMODY concurred in this recommendation.

By: Jim Hall  
Acting Chairman

Enclosure



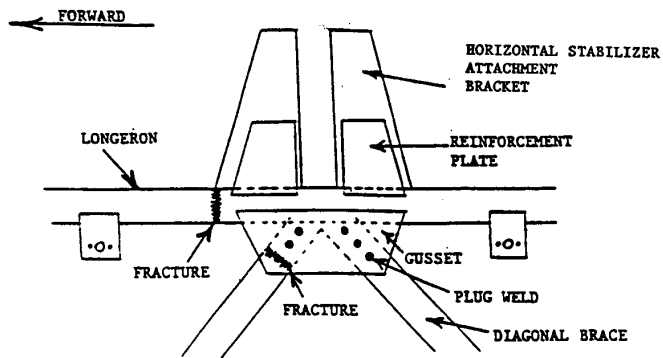


Figure 1. The attachment assembly for the horizontal stabilizer on the N9K accident airplane.

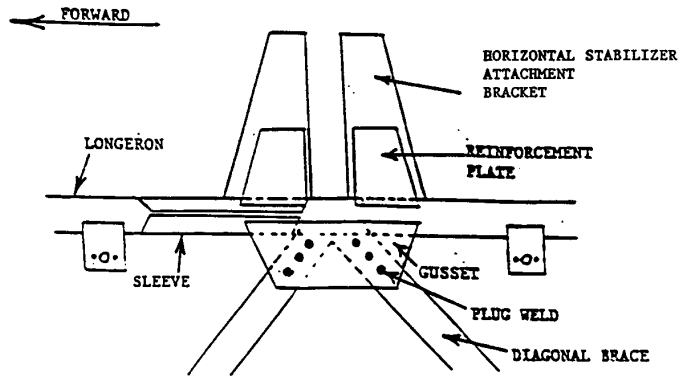


Figure 2. The retrofit parts according to Issue B of Extra Flugzeugbau Service Bulletin SB 300-2-95.

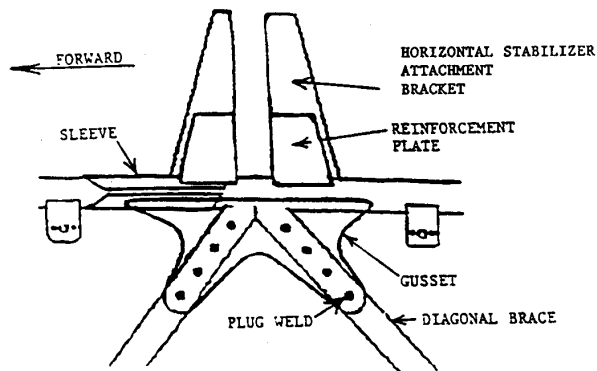


Figure 3. The retrofit parts according to Issue C of Extra Flugzeugbau Service Bulletin SB 300-2-95.