NATIONAL TRANSPORTATION SAFETY BOARD
OFFICE OF AVIATION SAFETY
WASHINGTON, D.C. 20594

December 18, 1995

PROPELLER MAINTENANCE GROUP CHAIRMAN'S FACTUAL REPORT

NTSB ID No. DCA-95-MA-054

A. ACCIDENT

Location: Carrollton, Georgia

Date: August 21, 1995

Time: 12:53 Eastern Daylight Time (EDT)

Aircraft: Embraer EMB-120RT, N256AS, Atlantic Southeast Airlines, Flight No. 7529

B. PROPELLER MAINTENANCE GROUP

Gordon J. Hookey Group Chairman	National Transportation Safety Board Washington, D.C.
Barry Strauch	National Transportation Safety Board Washington, D.C.
Malcolm Brenner	National Transportation Safety Board Washington, D.C.
Gerry Shutrump	Atlantic Southeast Airlines Macon, Georgia
Cee Smallwood	Atlantic Southeast Airlines Macon, Georgia
Stuart Browning	Hamilton Standard Windsor Locks, Connecticut
William Neely	Federal Aviation Administration W. Columbia, South Carolina

John Rice	Air Line Pilots Association College Park, Georgia
Manuel Monteiro	Embraer Aircraft Corporation Fort Lauderdale, Florida

C. SUMMARY

On August 21, 1995, at about 1253 eastern daylight time (EDT), an Embraer EMB-120RT, N256AS, airplane operated by Atlantic Southeast Airlines (ASA) crashed after departing the Atlanta Hartsfield International Airport (ATL), Atlanta, Georgia. The flight was a scheduled passenger flight carrying 26 passengers and a crew of three operating under the provisions of Title 14 Code of Federal Regulations (CFR) Part 135. The flight was operating in accordance with instrument flight rules (IFR). While climbing through 18,000 feet, the flightcrew declared an emergency and initially attempted to return to Atlanta. The pilots advised they were unable to maintain altitude and were vectored toward West Georgia Regional Airport, Carrollton, Georgia for an emergency landing. The airplane continued descent until ground impact. The airplane was destroyed by impact forces and postcrash fire. The captain and four passengers received fatal injuries.

Examination of the airplane wreckage showed one of the four Hamilton Standard 14RF propeller blades on the left propeller assembly was fractured transversely approximately 13 inches from the blade butt end. The remaining blades on the left propeller assembly were intact. The fractured blade, PN RFC11M1-6A, SN 861398, was removed from the propeller assembly and returned to the NTSB Materials Laboratory in Washington, D.C., which confirmed a fatigue fracture had originated from the taper bore surface and propagated outward. The fractured propeller blade had previously been returned to Hamilton Standard because of an ultrasonic shear wave inspection indication in the taper bore. Following the repair of the taper bore and several other items, the propeller blade was returned to Atlantic Southeast Airlines as a serviceable part and subsequently installed on the accident airplane.

The Propeller Maintenance Group was established to review the taper bore repair process, PS960A, which had been accomplished on the fractured blade when it was repaired by Hamilton Standard at Rock Hill, South Carolina in June 1994, as well as to review the current taper bore repair process. The Propeller Maintenance Group convened on August 30, 1995, at the Hamilton Standard, Rock Hill, South Carolina, facility. The review was of the entire blade repair process; but highlighted the removal of the lead wool; initial inspection, repair, and final inspection of the taper bore; Alodine surface treatment application process, and propeller blade balancing including installation of the lead wool. Three Hamilton Standard employees: the technician who accomplished the taper bore repair to ASA propeller, SN 861398, the Engineering

Manager, and Production Manager; were interviewed to understand the repair process and the training that was provided for the repair. The Group completed the review on August 31, 1995.

Several members of the Propeller Maintenance Group returned to the Hamilton Standard Rock Hill, South Carolina facility on October 19, 1995, to reinterview the three Hamilton Standard employees. The purpose for the second interviews was to gain a better understanding of why the taper bore of ASA propeller blade, SN 861398 was blended and what were the instructions to the technicians for blending.

D. DETAILS OF THE INVESTIGATION

1.0 Hamilton Standard Customer Support Center, Rock Hill, South Carolina

The Hamilton Standard Customer Support Center (HSCSC) opened in Rock Hill, South Carolina in January 1992, initially as a spares planning and distribution center for commercial operators. In February 1994, the repair and overhaul of regional (commuter) aircraft propeller assemblies and blades was transferred from Hamilton Standard's East Windsor, Connecticut facility to Rock Hill. Management and engineering personnel were transferred from Connecticut to Rock Hill. The technicians performing the actual propeller blade maintenance and repair tasks were all new hires selected through a reportedly very competitive selection process. Hamilton Standard indicated that when they were starting up the Rock Hill repair operation, they had received over 500 applications for 20 open positions. Some of the key attributes that were considered for employment were mechanical aptitude, good work attitude, and a good reading level. The mechanical background of the new hires varied with some being former military personnel having U.S. Navy E-2/C-2 Hamilton Standard propeller maintenance experience to others having backgrounds in automotive repair. The HSCSC facility is in a 103,000 square foot building and employs 76 people.

2.0 14RF Propeller Inspection and Repair

Hamilton Standard Rock Hill Operations employees Messrs. Sebastiaan Demarteau, Director; Dennis Mayhew, Production Manager; and Randal Carter, Engineering Manager; took the Group on a "walk the process" tour of the PS960 and 960A 14RF propeller repair which included lead wool removal; inspection, repair, and final inspection of the taper bore, Alodine surface treatment application, and propeller blade balancing. Mr. Demarteau lead the Group to the various work stations and would identify the process that was accomplished at that location. Mr. Carter provided an explanation of the process. A technician assigned to the particular shop would then demonstrate the process. Mr. Mayhew, as well as Messrs. Demarteau and Carter, answered questions posed by the Group during the shop tour.

There were two repairs released by Hamilton Standard for the 14RF propeller blade taper bore. The first repair was PS960, which was issued on April 8, 1994, and required another cork plug be installed in the taper bore after the taper bore repair was completed. At that time, it was believed that the cork plug was required to ensure the lead wool would remain in the taper bore barrel. Shortly after the release of PS960, Hamilton Standard determined chlorine, leaching out of the cork and combining with any moisture, was the cause of the corrosion that was being found in the taper bores. Chlorine is added to cork during the manufacturing process to lighten the color and also as an antiseptic agent for the medical industry, which is the primary user of cork. PS960A was released on April 18, 1994, and was identical to PS960 except the cork was not installed and ProSeal, which is a rubber-like sealant, was used to keep the lead wool in the taper bore. ASA propeller blade SN 861398 had the PS960A taper bore repair accomplished at the Hamilton Standard Rock Hill facility in June 1994.

2.1 Lead Wool Removal

Lead wool is used to add weight to the propeller blade in order to balance the blade to minimize the vibration. The lead wool is tamped into the end of the taper bore and compresses very tightly making it difficult to remove.

Each of the four lead wool removal processes that have been used at Rock Hill were demonstrated by Mr. Chris Bender, who is a technician in the taper bore repair shop and who accomplished the taper bore repair to ASA propeller, SN 861398.

The initial method to remove the lead wool was a series of four tapered steel rods that were driven into the wool using an impact air hammer. One of the tapered rods would be driven into the center of the lead wool to compress the wool along the sides of the taper bore and back towards the blade butt end. The size of the tapered rod used was dependent upon the amount of lead wool in the taper bore and how much had to be removed. The largest diameter tapered rod would be used for the lead that was nearest to the blade butt end opening. The smallest diameter tapered rod would be used to remove the lead wool at the bottom of the taper bore. A 1/8 inch diameter aluminum rod which is bent over at the end to form a hook and then used to snare the loose wool and remove it from the taper bore. Hamilton Standard indicated this method was used from the start of Rock Hill operations to about April 1994.

The two smallest diameter tapered steel rods had gouges and sharp edges on the ends. The concern for this noted condition was that the sharp edges could cause damage to the surface of the taper bore. Mr. Demarteau advised that these rods were no longer in use and that the damage to the ends may have been caused from workers using the rods as pry bars while moving some large equipment around the shop floor. Mr. Bender, one of the technicians who would have used the rods to remove the lead, examined the damage and indicated that he had never seen that type of damage when he used the rods. He indicated the smallest diameter rod end would get "mushroomed", which he would blend away to restore the end, but he had never seen any gouges and sharp edges while he was using the rods.

The next method used to remove the lead wool was identified by Mr. Carter as "corkscrew, phase 1", which was used from about April 1994 until September 1994. This method used the two smallest diameter tapered steel rods with the impact air hammer along with a partially threaded rod with a T-handle and slide hammer. The larger of the rods would be driven into the lead wool using the impact air hammer to start a pilot hole. The smaller tapered rod would then be driven deeper into the pilot hole with the impact air hammer. The T-handled rod, which was about 3 feet long and had a 6 inch long section at the end that looked like the threads on a 3/8 inch lag bolt, was twisted into the pilot hole in the lead wool. The slide hammer was then slammed against the T-handle to extract the rod and to remove the lead wool. This process would have to be repeated numerous times to get all of the wool out. In between extracting the wool with the threaded rod, the 1/8 inch diameter rod with the hook would be used to snare the loose wool that was in the taper bore. This would have been the method used to remove the lead wool from the ASA propeller blade SN 861398, when it was repaired in June 1994, according to Mr. Carter.

The next method used to remove the lead wool was identified as "corkscrew, phase 2" and was used from September 1994 up until November 1994. The tool looked like a large diameter screw extractor with a square wrenching socket at the end. A 1/4 inch diameter hole would be drilled into the lead wool to establish a pilot hole. The screw extractor would then be twisted into the pilot hole to twist out the wool in the same manner as a screw would be removed from a hole. This lead wool removal process used a number of guides and plugs to establish the correct alignment of the drill and screw extractor-like tool to the taper bore. The 1/8 inch diameter rod with the hook at the end was again used to snare the loose wool in the taper bore. Mr. Carter indicated this method of lead wool removal could take upwards of three hours per blade.

The current method used to remove the lead wool from the taper bore is a water jet, which was introduced into the repair process in November 1994. The water jet uses a spray wand that has an orifice at the tip and then several orifices along the side of the tip that are at a 45° angle. The wand is inserted into the taper bore against the lead wool and a 6,000 pounds per square inch (psi) water and soap-like solution is sprayed into the taper bore. A jet of solution from the center orifice is to bore a hole through the lead wool to loosen it from the taper bore and the solution sprayed from the 45° orifices are to blast the wool away from the walls of the taper bore. As soon as the water jet was turned on, large chunks of lead wool were ejected from the taper bore. The taper bore was completely cleaned with no residual traces of lead wool in about 2 minutes. Mr. Carter stated the 6,000 psi water solution was not harmful to the aluminum propeller blade material.

2.2 Taper bore inspection

The propeller blade taper bores are inspected using a white light borescope, a fluorescent penetrant inspection (FPI) with a ultraviolet light borescope, and a ultrasonic shear wave inspection.

The white light and fluorescent penetrant inspection procedures were demonstrated by Mr. Bender. Several of the Group members took the opportunity to inspect a propeller taper bore using the white light and fluorescent penetrant inspection procedures and equipment.

The white light inspection of the taper bore uses a rigid borescope with a removable 45° angled tip sleeve. The borescope is long enough to extend to the bottom of the taper bore. A 45° angled tip sleeve is placed on the end of the borescope to inspect the sides of the taper bore and is removed for the inspection of the bottom of the taper bore. The borescope equipment did not provide any magnification. The technician would insert and withdraw the borescope rotating the sleeve slightly on each pass to completely inspect the taper bore. Any indications that were seen would be noted on the accompanying paperwork so they could be reworked later in the repair process. There was no physical equipment in place with the white light borescope inspection equipment to ensure 100 percent inspection coverage of the taper bore. When asked, Mr. Bender indicated that he had never seen an actual crack in the taper bore either with a white light or with fluorescent penetrant inspection. He had seen cracks on hub assemblies and on test plates, but never in the taper bore while using the borescope equipment. The white light borescope inspection procedure was in use up until the August 1994 and was the visual inspection procedure in use in June 1994 when propeller blade SN 861398 was inspected at Rock Hill.

A fluorescent penetrant inspection (FPI) is utilized in the current taper bore repair in addition to the white light inspection. The FPI inspection uses equipment similar to that used with the white light inspection with a rigid borescope with a removable 45° angled tip sleeve except it has an ultraviolet (uv or black) light source. The penetrant solution is swabbed onto the taper bore surface and allowed to soak in for at least 20 minutes. The solution is then cleaned out of the taper bore and a fluorescent penetrent developing powder is sprayed into the taper bore and allowed to set for 10 minutes. The propeller blade is then moved into a blacked out enclosure booth for the inspection. Mr. Bender indicated that standard procedures require that he be in the booth for at least 3 minutes to permit his eyes to adjust to the dark. As with the white light inspection, the technician inserts and withdraws the borescope rotating the angled tip slightly to inspect all of the taper bore surface. Any indications that were seen would be noted on the accompanying paperwork so they could be reworked later in the repair process. And as with the white light inspection, there is no physical method available to ensure that 100 percent of the taper bore surface is inspected. On those propeller blades that have had the taper bore shotpeened, the peening process results in an irregular surface that can hold or entrap the dye penetrant solution. When illuminated with the ultraviolet light, the entrapped fluid causes a considerable amount of background fluorescence making it more difficult to find and identify an actual crack.

The shear wave ultrasonic inspection is done per the instructions contained in Hamilton Standard Alert Service Bulletin A66, which was mandated by an Airworthiness Directive, AD 94-09-06. During the initial stage of the propeller blades being inspected in the field, any rejects would be reinspected upon arrival at the Rock Hill facility to confirm the field's reported indication. Since almost all of the field rejects were subsequently reconfirmed when the propeller blade was reinspected upon arrival at Rock Hill, the practice of performing an as received ultrasonic inspection was discontinued.

The ultrasonic shear wave inspection was demonstrated by Mr. Greg Sabatello, a Hamilton Standard Level II nondestructive test (NDT) technician employed at Rock Hill.

The ultrasonic inspection of the taper bore is accomplished using a ultrasonic probe along with a Panametrics Epoch IIB Digital Ultrasonic Flaw Detector. The flaw detector calibration sticker showed it was last calibrated on April 21, 1995, and that the next calibration was due in one year. The probe and detector were calibrated against a standard with a manufactured defect and the detector is adjusted as necessary to indicate an 80 percent full scale height (FSH) indication within a prescribed area on an oscilloscope indicator. The unit is checked for vertical linearity by adjusting the sensitivity down 6 db, which cuts the signal in half, and the indication should show about 40 percent FSH. After the detector is returned to its original level of sensitivity, the propeller blade is prepared for inspection by cleaning the surface with methyl alcohol. A template is placed on either the face or camber side of the propeller blade against the trailing edge and secured in place. The ultrasonic probe and the area of the blade to be inspected are coated with couplant. The probe is placed on the blade surface so the tip of the probe is either pointed towards the blade tip or butt end. With the probe still pointing towards either the tip or butt, the probe is moved all around within the template to search for anything which would cause an indication on the oscilloscope. The probe is then rotated so it is oriented in the opposite direction and the inspection is redone. Any indication that is detected with the probe oriented in one direction must also be detected after the probe has been rotated 180 degrees before it is considered to be a valid indication. The ultrasonic inspection is then completely redone for the camber or face side of the propeller blade, respectively.

2.3 Taper bore repair

The PS960A repair that was in effect at the time the propeller blade SN 861398 was at Hamilton Standard, Rock Hill allowed only tool marks to be blended. The taper bore would receive a visual white light borescope inspection following the blend and then an ultrasonic inspection. The current repair which is listed in the Component Maintenance Manual (CMM) requires that any indications that were observed with either the white light borescope inspection or the fluorescent penetrant borescope inspection are to be blended out. The technician would note from the paperwork where the indication was located in regards to depth and position in the taper bore. The technician would then reconfirm the location of the indication using a white light borescope. The technician would mark the depth of the area to be blended on the drill rod which had either a small diameter grinding wheel or a flap grinder. The small diameter grinding wheel is used in the deeper areas of the taper bore because of its smaller diameter. The initial grinding wheel or flap grinder, which was driven by an air powered drill gun, appeared to be about 100 grit and left a surface finish with obvious circumferential grind marks. The technician indicated he would then use finer and finer grit grinding wheels or flap grinders to obtain the necessary surface finish, 63 rms. The technician would check the surface finish using a surface finish comparator. A surface finish comparator is a flat rectangular plate about 4 x 6 inches in size. The plate has a series of squares, each one that has a different surface finish and is annotated with the rms finish number. He would rub a 1/4 inch diameter wood dowel over the comparator, then over the taper bore surface that had just been blended, and then back over the comparator to determine the taper bore surface finish. At this point, the white light borescope was used to ensure that all of the indications had been blended out and the taper bore was within CMM limits. The current repair requires an FPI inspection of the taper bore to be accomplished following the blend of the taper bore.

2.4 Taper bore Alodine surface treatment

The application of the Alodine surface treatment to the taper bore was demonstrated by Mr. Robert Ammons, a technician at Hamilton Standard Rock Hill.

Those propeller blades which had the taper bores repaired would require the taper bore to have an Alodine surface treatment. Hamilton Standard indicated the Alodine was an anodize-like chemical process which puts a protective coating on the taper bore surface. Since the propeller blade is made up of composite materials in addition to the aluminum spar, it was not possible to accomplish an actual anodize process on a finished propeller blade after repair. The Alodine surface treatment is carried out by first cleaning the taper bore cavity. The blade is placed in a fixture to hold the blade so the taper bore is pointing upward. The Alodine solution is then poured into the taper bore and is allowed to set from 3 to 20 minutes to ensure complete coverage and depth of the coating. Mr. Ammons indicated he tried to leave the Alodine surface treatment solution in for about 10 minutes. He also indicated that he could tell if the coating was adequate by the color and that he would reapply the coating if one did not look right the first time although he said he had not recycled one in a long time. The solution is then pumped out into a container and the taper bore rinsed out.

2.5 Propeller blade balancing

The propeller blade balancing process was demonstrated by Mr. Earl Nash, a technician at Hamilton Standard Rock Hill.

Following the completion of the repair process, the propeller blade is rebalanced. This is accomplished by installing the blade into a fixture that is attached to a balance arbor. The area is then closed off with a curtain to prevent any air currents within the building causing the propeller blade to move. If the propeller blade does not balance within the required limits, the technician takes a wad of lead wool and shapes it into a slug prior to inserting the wool into the taper bore. Then using a steel rod with a plastic tip, the lead wool is tamped down into the bottom of the taper bore. In the initial repairs and rebalancing of prop blades at Rock Hill which would have included the propeller blade which fractured, Hamilton Standard reported they had used a brass rod to tamp the lead wool into the taper bore.

2.6 Training

The technicians accomplishing the inspections and repairs to the propeller blades were new hires when Hamilton Standard opened the Rock Hill facility for regional aircraft propeller repairs. Hamilton Standard indicated that each of the new hires received about 330 hours of training before being assigned to the shop. About 2 weeks of the training was general non-specific training with the remainder concentrated on the specific task they would be working out in the shop. This was in addition to general unpaid training they received on their own time prior to being hired by Hamilton Standard.

Mr. Bender, the technician who accomplished the taper bore inspection and repair to propeller blade SN 861398, had initially been assigned to fiberglass and nickel sheath replacement and repair. Mr. Mayhew stated that due to a slow down of parts going through the fiberglass and nickel sheath replacement and repair shop along with the increase of propeller blades going through the taper bore repair shop because of the ultrasonic inspection, Mr. Bender was reassigned to taper bore repair. Mr. Bender's training records indicated he received 89.8 hours of on-the-job training (OJT) on propeller blade taper bore evaluation and blending (PS960) from April 11, 1994 to April 23, 1994, from Mr. Carter, Engineering Manager at Rock Hill. (A copy of the page of Mr. Bender's training record showing the PS960 training is attached.) He started doing the taper bore visual inspections, initially under supervision, and then unsupervised. He went on to the taper bore blending, initially practicing on scrap blades, and then working on serviceable parts under supervision before being authorized to work on serviceable parts, unsupervised. He said he received 8 hours classroom training, along with 130 hours of practical hands on work experience to become a Level I Non Destructive Test (NDT) inspector. He also received 36 hours of classroom training, along with 480 hours of practical hands on work experience, after which he was able to test and qualify to become a Level II NDT inspector. According to Mr. Bender, he had received training on how to inspect the taper bore and blend out any damage; he had not received any training on the appearance of a crack nor had he ever seen a crack defect in the taper bore.

2.7 Technical Data

When PS960 was initially released around April 1994, the technicians utilized the maintenance instructions in the accompanying shop router to accomplish the taper bore inspection and repair. The PS960A instructions were subsequently incorporated into the Component Maintenance Manual (CMM) which the technicians refer to for the taper bore maintenance instructions.

Mr. Carter, as Engineering Manager, is responsible for maintaining the technical data at Hamilton Standard, Rock Hill. He stated that each technician has a personal copy of the CMM either at their work station or on a rolling cart if the individual moves between several work stations. There is a technical librarian at Hamilton Standard, Rock Hill, who makes copies of the CMM revisions and delivers the changes to the technicians for them to update their individual copy of the CMM. The technical librarian also conducts routine audits to ensure the copies are complete and up to date. A complete cover-to-cover check of each individual copy of the CMM is conducted annually. Disciplinary action could result for those individuals who are found to have a CMM which is not up to date or incomplete. During the Group's tour of the shop, several checks of CMMs showed the manuals were open to the section describing the work that was being accomplished by that technician.

3.0 Interviews, August 30 and 31, 1995

Three Hamilton Standard Rock Hill employees; Messrs. Chris Bender, Randal Carter, and Dennis Mayhew; were interviewed by the Propeller Maintenance Group. The interview of Mr. Bender was conducted on August 30, 1995 and present were Jim Hookey, NTSB; Barry Strauch, NTSB; John Rice, ALPA; William Neely, FAA; Manuel Monteiro, Embraer; and Gerry Shutrump, ASA. Messrs. Carter and Mayhew were interviewed on August 31, 1995. Present during those two interviews were Jim Hookey, NTSB; Malcolm Brenner, NTSB; William Neely, FAA; Manuel Monteiro, Embraer; Gerry Shutrump, ASA; and Stuart Browning, Hamilton Standard.

3.1 Chris Bender, Technician

Mr. Bender requested he be represented by Mr. Dennis Mayhew, Hamilton Standard Rock Hill Operations Production Manager.

Mr. Bender has been employed by Hamilton Standard since January 1994. He is employed as a technician performing Level II magnetic penetrant inspection, fluorescent penetrant inspection (MPI,FPI) in non destructive test (NDT), serviceability reviews, fiberglass and nickel sheath replacement, and the evaluation and blending of the taper bore. NDT means either an MPI or FPI inspection process. He is currently qualified to perform repairs for FPI indications, but not yet for MPI indications. He does not perform other types of NDT inspections such as the ultrasonic inspection. He is receiving training on the other types of NDT inspections, but does not yet have enough hours on those inspection procedures to be considered qualified. He said he was also not qualified to ream out the propeller blade taper bore.

Before Mr. Bender was employed by Hamilton Standard, he was an auto mechanic at a local garage and then at a Chrysler/Jeep/Eagle dealership for about four or five years. He had attended college for two years prior to working at the garage and auto dealership. He said he left the auto dealership to work for Hamilton Standard because he had always been interested in the airline industry and wanted to get into a different line of work. He was getting tired of the grease at the auto dealership and saw an opportunity for advancement at Hamilton Standard. Since starting at Hamilton Standard, he has been able to advance by becoming a Level II NDT inspector and he has learned several different repair processes for propeller blades. He likes the detail associated with doing his job. He thinks Hamilton Standard is a nice place to work and that the workers are treated well and with respect. He did not have any problems with any of the people he works with and there wasn't anything that he really disliked about the job.

He said when he applied for the job, he had to take a test for basic mechanical background at York Technical College. He also had to take a personality test to see how well he could get along with other people. He thought the people who did not make it all the way through did so because their work ethic was not that good or they did not get along with people.

When he joined Hamilton Standard, he went through 3 months of training on fiberglass and nickel sheath replacement. The training consisted of 2 weeks of general training, with the remainder being in what would be his area of concentration, fiberglass and nickel sheath replacement. For about a month after that, he trained exclusively on scrap blades. After three or four months, he began to do inspections at about the time when the PS960 and 960A repair became effective. He started doing the visible dye NDT inspection, under supervision, about two months after he started. Then he took a class on the duties of a Level I inspector. He had to take a test to qualify as a Level I inspector. Mr. Bender was qualified to perform FPI when the manuals were changed in about September 1994. He became a Level II inspector after Mr. Greg Sabatello asked if he would be interested. When he had enough hours, around Thanksgiving 1994, he was given a test for Level II inspector. He thought the number of hours required for a Level I inspector was 8 hours of classroom training and 130 hours of "hands on" experience and for a Level II inspector was 36 hours of classroom training and 480 hours of "hands on" experience. Mr. Bender said the test for a Level II inspector was conducted by Mr. Clyde Hensley, who was brought in from Greenville. Mr. Hensley is a certified American Society of Non-Destructive Testing (ASNT) instructor. The test consisted of a practical test where he is observed performing work and inspections. There were also written questions administered about the documents that accompany the work and on the penetrants that were being used.

Mr. Bender received specific training on the taper bore and what to look for when the PS960 and 960A repairs were issued as well as from the service bulletins. He said there was one service bulletin that had a picture showing the taper bore and along with some verbal information, they were shown what to look for. The parts they used for training were in-service parts along with a few scrap propeller blades. They were shown pitting, tool marks, and mechanical damage. He said Mr. James Devanski, Quality Manager from Hamilton Standard, East Windsor, Connecticut, had come down and spent about a day with them when they were first getting started with PS960. Mr. Thomas Tatro, Hamilton Standard Field Service Representative, had also come down once or twice. When the grit blasting process was established; Mr. Carter, who at time was still based in Connecticut and had not yet transferred to Rock Hill, was the mechanical engineer who set up the process demonstrated it to Mr. Bender and provided hands-on training.

Mr. Bender explained that some of the steps of the taper bore inspection and repair that he does are easy such as the acid etch. Other parts of the repair are more difficult such as the blending and the FPI and visual inspection requires more knowledge and training. He said the blending of the taper bore can be even more difficult if the damage is deep. He would have to go back and do a visual inspection with a borescope. After the blending; he would do the complete inspection again, acid etch the taper bore, and then do another complete inspection. He said when he does a visual inspection, he makes six passes and the passes overlap each other. Each pass takes about five minutes if he does not see anything. If he does see something, the pass takes about 10 to 12 minutes. He said it took at least six weeks of doing borescope inspections before he felt confident that he would not miss anything.

Mr. Bender also does the examination of the propeller blades, which is called a serviceability review, when the parts are initially received. The serviceability review is contained in the CMM. Different features and parts of the propeller blade are checked such as an ohm resistance, a "megger", check for the insulation of the blade heater; a check of the teflon strips, fiberglass, and paint for any damage; check the nickel sheath for debonding, cracks or chips; and check the outside of the shank for any nicks, gouges or cracks as well as the blade pin and hardware.

The CMM requires the technician doing the taper bore evaluation check to see if it had been peened and if it conformed to the +A, +B, or +C that is marked on the blade butt. The marking code is defined in the CMM. Propeller blades that are marked (+A) have never been blended or reamed, (+B) propeller blades were blended, and (+C) propeller blades were reamed. The technician also determines whether PS960 or 960A had been complied with. They would look into the taper bore to check for any damage or pits. He has visual comparators to determine how deep any damage is and he can also take mold impressions of the damage to determine the size and depth.

The propeller blade serviceability review is typically accomplished first followed by the taper bore evaluation. When the technician accomplished the taper bore evaluation first, he would then tell whoever did the serviceability review what was required for the taper bore.

Mr. Bender explained that when they receive a propeller blade for repair, it is accompanied by a work package which has the work instructions detailing what must be accomplished to that blade. The terminology for the paperwork is a router. The router is prepared by the technician who does the serviceability review. It is a computer-generated document and is usually about 20 pages long. The numbers along the left side of the router are the service numbers generated by the computer and refer to the CMM or various service bulletins. To the right of the service number is the description of the work that must be accomplished to the propeller blade. The first thing he does with the router is match the serial number on the paperwork to the number on the hardware. He checks to ensure that all previous work up to that point has been done and that it had been signed off correctly. He then opens the CMM to the correct repair and proceeds with the particular repair. Mr. Bender explained that the CMM is the actual working document. He always refers to the CMM and he believes that everyone else does the same thing. After he finished a task on the propeller blade, he would sign off the work to show what had been accomplished. Then he would go on to do the next task listed on the router or move the propeller blade to the person who does the next task. He knows who can do what repairs or procedures because there is a board in the shop area that lists who is qualified for the different repairs or inspections. Mr. Bender can perform and sign off work only what he is qualified to do. Within a flow center, all of the assigned people are generally qualified on the same tasks. There are eight flow centers on the blade line. There are two other lines at Rock Hill: the propeller line and propeller control unit (PCU) line. He only works on the blade line because it was the first line at the Rock Hill facility and that is what he was trained to do.

The original process of lead wool removal began by removing the cork with an aluminum type shovel. They would then look into the taper bore for the powder-like appearance of corrosion. They would have first measured off the depth of the cork so they concentrate on that area of the taper bore for any pitting. To actually remove the lead wool; they would drive the tapered rods with the compressed air impact hammer into the lead wool which would be pushed out along the taper bore walls. Mr. Bender said he would know when he was getting close to the bottom and the walls of the taper bore because he had measured the depth of the taper bore and he would put a piece of tape on the rod to show that dimension. The time required to remove the lead wool with the steel rod and impact hammer during the demonstrated was typical. There were occasions, maybe 1 propeller blade out of 25, when the steel rod would hit the side of the taper bore. If the damage was within limits, then they could repair the propeller blade. They would then take the lag screw which was on the smallest rod to remove the last amount of lead wool. Any lead wool remaining in the taper bore would be scraped out with the small aluminum rod. The aluminum rod would not scrape the taper bore; but with about one in five propeller blades, it would leave some scratches up to 0.003 inches deep that could be blended out. Prior to the release of PS960, he said he did not remove lead wool from the taper bore. He had been trained to remove the lead wool, but was not qualified to do so.

The tapered steel rods, which were used with the air hammer to remove the lead wool, would "mushroom" at the tip from use over a period of time. He had been taught not to use any tapered rods that were mushroomed or damaged. If the tips of the rods were mushroomed or damaged, he was permitted to grind the tips of the rods to restore the geometry which he had done once or twice. He said the damage that he observed on the rods would not have been a result of removing the lead wool from the taper bore.

After the lead wool was removed, they would soak the blade with methyl ethyl ketone (MEK) to remove the glue used to secure the cork in the taper bore. They would take a rag on a stick, swirl it around to loosen it up, and then remove it.

The next step was to grit blast the taper bore to remove any remaining glue. When grit blasting the taper bore, the major caution was to avoid scratching the propeller blade butt as it was being put into the fixture. He had to ensure he taped up the propeller blade butt, blade pin, and the inside of the snap ring groove with electrical or duct tape. He said he would make three to four passes into the taper bore with the grit blasting nozzle rod. He had to use caution not to push the grit blasting nozzle rod all the way into the taper bore or up against the wall. He would use a flashlight to see if all of the glue was removed and if any remained, he would repeat the process. They would also use flashlights to look into the taper bore when removing the lead wool and after the water rinse to ensure it was dry. For the visual inspections of the taper bore, the borescopes that were used had an integral light source.

Following the grit blasting, Mr. Bender would do a visual inspection, using a borescope, of the taper bore for any remaining damage or pitting in accordance with the PS960A instructions. If there was any question about what was observed in the taper bore, he would go to either Mr. Carter or Mr. James Seipel, Manager of Quality Control at Hamilton Standard, Rock Hill for their opinion or determination. If any damage was found in the taper bore, he would blend it out. The blending limits, which are published in the CMM, for the propeller blade taper bore permit 0.010 inches on the face side and 0.020 inches on all other surfaces. He believed that Engineering in Connecticut had done some tests and found that these limits were acceptable. He would make another visual inspection of the taper bore to ensure all of the damage or pitting had been repaired and taper bore wall had the required RMS surface finish. The RMS surface finish was verified by using a dowel or a borescope with the surface comparator. Mr. Bender did not use a profilometer to check the taper bore surface finish. After the visual inspection was completed; he thought, but was not sure, that they would grit blast the taper bore again. They would then do either another visual inspection of the taper bore or an ultrasonic (UT) inspection. Mr. Bender said most of the time the damage observed in the bore is not picked up by the ultrasonic inspection unless the damage is deep. In September 1994, the revision to the 04 section of the CMM required a FPI type inspection for the taper bore instead of the visual inspection.

There is another technician, Mr. David Smith, who works with Mr. Bender. Messrs. Smith and Bender are the only two individuals in the shop qualified to do the taper bore blending, visual and FPI inspections. They share the work and their usual procedure is the person who blends out the taper bore typically does not do the visual inspection, and definitely does not do the FPI inspection. If the other person is unavailable, then Mr. Sabatello will do the inspection. There have been occasions when one person has done all of the work including the inspection, but Mr. Bender thought that had happened about 5 percent of the time. When he did work alone and had any questions about a blade, he would hold the blade over to the next day in order to get the second opinion. He thought he had to done this with about 15 blades, sometimes getting Mr. Carter, Mr. Sabatello, or Mr. Smith to check the blade. On occasion, Mr. Bender had been asked to look at a blade that someone else had questioned. He and Mr. Smith would both have to agree about some minor pitting and whether it could be repaired further.

Following the UT inspection; he thought, but was not certain, that the procedure was to clean the taper bore with MEK prior to the Alodine treatment of the bore. They would fill up the taper bore to the snap ring with Alodine 600 and let it stand for the required time, he thought about 3 minutes. They would then remove the Alodine with a mechanical pump, rinse the bore out with water, and let it dry. The Alodine surface treatment was the last of the processes that he was qualified to perform and he would then hand off the propeller blade to someone else.

In most cases; when he hands off a propeller blade, then he is finished with that particular blade. But since he can also do fiberglass repair, there have been occasions when he was helping out in the fiberglass shop that he would work on a propeller blade that he had previously worked on and handed off. When the propeller blade is finished, it goes to the final inspection bench at flow center 8. A repairman checks all of the work and an the inspector makes the final sign off.

Mr. Bender said he had never seen a propeller blade with a crack in the taper bore. He also was not aware of any blade with a crack in it having ever come through the Rock Hill shop. Of the blades that did come through the shop, some were repaired and returned to service and some were sent to Hamilton Standard Engineering in Connecticut for further evaluation of the damage and determination of what could be done with them. He was not authorized to scrap a propeller blade.

Mr. Bender stated that when PS960 and 960A first started around April 1994, he was working between 10 and 12 hours per day, five days a week plus an additional five or six hours on Saturday, depending on how much work they had in the shop at the time. He maintained this work schedule lasted from the beginning of PS960 to about July 1994, when the work started to slack off and they went back to 9 or 10 hour days. That work schedule was required because they were being trained and there was the influx of blades that had been sent in by customers at that time because of the AD for the taper bore, which had to be completed within 90 days, had just come out. He recalled he was working around 60 to 65 hours a week, from about 6 a.m. to about 6 p.m. The latest he would stay to work was about 7 p.m. At Hamilton Standard, any work over 40 hours a week is overtime, paid at time and a half.

The technicians plan their own work each day. Mr. Bender said that at the time of the interview, he was working on an average of between 8 and 10 propeller blades a day. The number varied depending on the number of propeller blades that had been sent in for repair. Hamilton Standard has a one piece flow system, which means they work on one piece of hardware at a time until they could go no further with it. On some days, he would finish propeller blades that he had not completed the previous night which would increase the numbers of completed propeller blades. If they ever run out of work, they will try to help somebody else in the shop.

When Mr. Bender first started working on the taper bore inspection and repair, he said it would take about three hours to complete the process on one blade. Because the process has changed; the water jet to remove the lead wool and the caustic etch (acid in the tanks) that gets the taper bore cleaner, faster, and he is more familiar with the process; he now spends about an hour on each blade.

He said he does not have any contact with the people in Connecticut. If he had questions for the people in Connecticut, he would ask Mr. Carter who would get back to him.

Mr. Bender stated that he has had contact with an airline customer on only one occasion when he went to Atlantic Southeast Airlines (ASA), Macon, Georgia, to assist ASA with a propeller blade inspection. Mr. Tatro accompanied him to Macon. Two other technicians in the shop were also qualified to perform the inspection, but only he was asked to go.

He has seen customers come through the shops; sometimes a lot, sometimes less, depending on who was conducting the audit. He is made aware of when an audit will occur. He said he would be told when a customer was coming and to give them the correct information. He said when customers were coming in, they would always do extra clean up work before hand.

Mr. Bender said they do see the Federal Aviation Administration (FAA) people occasionally. The FAA comes in whenever they have a new repair line or process. Mr. William Neely, the FAA Principal Maintenance Inspector (PMI) from the Columbia, S.C. Flight Standards District Office (FSDO) has come in numerous times as well as other FAA people. The technicians are told in advance when the FAA is coming in. The instructions and preparation were the same as for the airline customers.

He said when the FAA or an airline customer has come in for an audit or a visit, Mr. Seipel is usually accompanying them through the shop area. And when they are observing the work, it is usually the work of one of the technicians.

He said there are some propeller blades returned from the final inspection area, about 5 percent of the time. The returns can be because of paperwork problems or the teflon gets damaged on the line. Occasionally, the fiberglass has a mark on it that was missed during the earlier inspections. He was not aware of any kickback that had occurred because of something that he has missed. When he is inspecting the taper bore surface with the borescope, he cannot tell what is underneath the shot peened surface.

Mr. Bender said his manager is Mr. Dennis Mayhew, who is the Production Manager and who works for Mr. Sebastiaan (Bas) Demarteau who is the Director. Their workload does pile up sometimes. When that happens, they adjust their schedules accordingly by increasing their hours and moving people around the shop to help. The other people would not do any blending, but would do whatever work they could, under his guidance, to help out. He said he always tries to work to the best of his ability and as efficiently as possible. Mr. Mayhew has never asked him to speed up or work faster. He has been asked to stay an hour or two later, but has never been told or asked to work faster. Mr. Carter has the final word about the parts on engineering hold. There are other individuals, such as Mr. Mayhew who could make a determination about parts on engineering hold, but Mr. Bender said he would not do that without consulting with Mr. Carter. He had never been questioned on the number of items that he has put on engineering hold. He also said he has never been pressured to accept something that he would not have otherwise accepted. If he did not feel comfortable with something, he would turn it over to engineering hold. He had not been criticized for missing something.

3.2 Randal Carter, Engineering Manager

Mr. Carter requested he be represented by Mr. Sebastiaan Demarteau, Director of Hamilton Standard Rock Hill Operations.

Mr. Carter's position at Rock Hill is Engineering Manager. Mr. Carter has been employed by Hamilton Standard since 1980. He started working in the Automotive Test Equipment division. In 1989, he moved to the Aviation side of the business. From 1989 to 1993, he was an Operations Engineer on regional propeller systems in overhaul and repair in Connecticut. In August, 1993, he transferred to Rock Hill, South Carolina.

As Engineering Manager, his responsibilities are to set up repair processes, put the repair process in place, implement new processes, do a limited amount of repair development, implement the hardware flow systems used, maintain the Technical Document Library, work with the Design group in Connecticut, and provide input to the Engineering and Design groups in Connecticut about the condition of service hardware that is being received for repair. He had worked on other blade and propeller applications in Connecticut. Mr. Carter's job functions at Rock Hill are broader and more extensive than his previous position in Connecticut. He felt his assignment at Rock Hill was more managing than working.

He is responsible for maintaining and updating all of the maintenance manuals. He said there is a master copy for each of the maintenance manuals. There is a technical librarian who maintains the master copy and files the changes as they are received. The librarian then makes copies of the changes and distributes them to each technician who has an individual copy of the manual. The technical librarian also does the audits of the individual copies of the manual. The audits are conducted about twice a week to the manuals of two technicians. On a yearly basis, a complete page by page audit of each individual's copy of the manual is conducted. Hamilton Standard has strict compliance requirements about maintaining a complete and up to date maintenance manual. If any deviations are found, the individual will be given a written warning. The penalty for having a maintenance manual which is incomplete or not up to date is not just limited to a written warning; but can theoretically range from time off without pay up to termination. There have been some cases of people being suspended without pay, but no terminations, because of a problem with an individual's copy of the maintenance manual.

When the Rock Hill repair facility was getting started, he was initially responsible to set up the training program. He is presently not the primary source for training, but he had been involved in training in the past. For the initial training for PS960, he took the written procedures, which he thought lacked detail, and made sure the technicians understood the procedures and how to apply the instructions. He, personally, had not done PS960 prior to it being released. He took the PS960 instructions and put them into place so the technicians could use them. He had done similar types of work in Connecticut in the previous four or five years. He was not certain about the requirement for repair training for the technicians. Mr. Carter had provided the training, but Mr. Mayhew maintains the technicians' training records. Mr. Carter said he had trained two technicians, Messrs. Bender and Smith, when PS960 initially began. After the initial training was accomplished, the training function was turned over to Production. He was not certain how many people were currently trained to do the taper bore repair and said Mr. Mayhew would have information about any additional people trained for PS960 and 960A.

When he would set up a repair process, he would take the existing technical data and lay it out in a manner that was usable for the technicians. He would put the process into finer detail. He felt some areas of the CMM go into detail, and some do not. The routers are a primary example of laying out the instructions in a more detailed manner. The shotpeening operation is an example of establishing the procedures, pressures, and equipment required.

The PS960 taper bore repair was developed and written by Hamilton Standard Engineering in Connecticut. Messrs. Carter and Bender did not participate in the development of the PS960 repair process. He was not sure what the most difficult part of developing the repair since it was done in Connecticut. After the repair was developed and prior to it being released, Mr. Carter did have the opportunity to review the repair and provided some feedback to Connecticut regarding a particular taper bore. If a change had been required, they could have gotten Connecticut to make the change. PS960 was considered a major repair and had to be approved by a Hamilton Standard Service Engineer and then signed off by Quality and a Designated Engineering Representative (DER) prior to being submitted to the FAA at Burlington, Massachusetts for approval.

Mr. Carter explained that PSs are generated by Hamilton Standard for major repairs. The PS stands for Propulsion System, which is the division that manufactures propeller blades. A DER is a generic term used for minor repairs that are developed at the repair facilities such as Rock Hill and approved by a DER, who is a Designated Engineering Representative. The Designated Engineering Representative reviews and approves of minor repairs on behalf of the FAA. Mr. Jorge Laires, who is an employee of Hamilton Standard, is also Hamilton Standard's DER. The minor repairs that are approved by the DER are forwarded to the FAA on an FAA Form 8110, which is a transmittal sheet and lists the repair and the applicability of the repair.

The taper bore repair was initially accomplished in Connecticut. Mr. Carter developed and had fabricated the tooling that was required to accomplish the repair. He originated the paperwork to put the process in place at Rock Hill. He reported that there were daily phone calls between Rock Hill, Connecticut, and the other Hamilton Standard repair centers to coordinate the start of the process, the resources required, and any problems any that may have occurred. When Rock Hill started doing the repair, they used the same procedures that were used in Connecticut. There was no streamlining or modification of the process because they just wanted to get the repair process in place as soon as possible. He had never done the PS960 taper bore repair process previously since this was a new procedure and this was the first time it was performed at Rock Hill. He had done similar blending repairs, but on the outside surfaces of the yoke and shank. He validated the repair process to ensure there were no problems and then turned it over to Production.

Mr. Carter did not think there were any real major problems related to the introduction of PS960. He thought the biggest problem to accomplishing the repair was removing the lead wool from the taper bore. They experimented with various approaches to remove the lead wool to avoid the ergonomic hazard to the technicians. At the present time, they require the technicians to rotate in and out of the process, provide gloves, use plugs to blend through, and support the tools with counterbalance systems. He said there were several generations of methods to remove the lead wool from the taper bore. It was believed the mechanical damage that was seen in the taper bores was being caused by the tapered rods used to remove the lead wool. That resulted in the use of the new tooling to try to eliminate the damage done to the taper bore. Prior to PS960, there was no requirement to remove the lead wool except as required for major inspections. The release of the PS960 and 960A repairs required all of the lead wool be removed. He did not think the problems associated with removing the lead wool from the taper bore were out of the ordinary because he had never introduced a new process that did not have some implementation problems due to the myriad of conditions that can exist with service parts.

The purpose of the visual inspection of the taper bore was to look for any pitting and surface damage, to look for anything that was abnormal. The typical damage the technicians found was pitting and mechanical damage. The technicians had been told it was permissible to blend out any mechanical damage. The blend limits that were established with the repair were 0.010 inches on the face side and 0.020 inches on all other surfaces. The CMM taper bore repair now permits any damage less than 0.005 inches deep to remain. With the PS960A repair; if the technicians observed anything other than mechanical damage in the taper bore, they had been instructed to send the blade to Connecticut for further evaluation. With the taper bore repair in the CMM, they do not have to send the propeller blades to Connecticut and can scrap them locally. He said the number of blades scraped was less than one percent. He did not know the percentage of blades that had been rejected that had previously been repaired. He thought the data existed, but he was not sure of the numbers or the percentage of the times that the defects were confirmed. If a crack had been observed, he would have made a note of it and the technicians would not have been permitted to blend out the crack. He had not seen a crack in the taper bore; but prior to the PS960 repair and the taper bore cracks, there had been little work done in the taper bore. He did not think he could see a crack with the borescope and he was relying on the ultrasonic inspection to find any cracks.

He said there were no problems associated with balancing the propeller blades, it was a straight forward process.

Mr. Carter explained the oversight of the shop falls between himself and the Quality and Production Managers. He talks to the technicians daily and the rest of the staff is also encouraged to talk to the technicians. The Quality Department is responsible to conduct the audits. The technicians are told to hold the work if they are unsure about something.

He said he was very comfortable with the quality of the new hires at Rock Hill when they started going into production. The new hires came four nights per week before they were hired for training. They had some experienced people from Connecticut and U.S. Navy to train the new people using about 20 scrap propeller blades to practice the repairs. Hamilton Standard had received over 500 applications for 20 open positions. The initial review of the applications reduced the list to about 150 people asked to come in for interviews. They then used a high performance work team assessment methodology to see how they would react to different situations to select 25 people to come in for night training. The group making the selections was Messrs. Demarteau, Thomas Shaw, Mayhew, Seipel, and Carter. He said most of the trainees were offered jobs, some were asked to leave. Mr. Bender was selected because of his automotive background, he was very capable, had a good demeanor, and was there to do a job. Mr. Carter said he felt very good about Mr. Bender early on.

He said they tried to create a different culture for morale by creating ties. They would hold meetings with the technicians, the feedback from the meetings with the technicians involved changes, and to get the technicians involved with the changes. They were trying to set up high performance work teams. He thought the working conditions were similar environmentally. A normal schedule is worked although it was sometimes necessary for a technician to work overtime with an inspector. Mr. Carter said there were times the technicians had to work longer hours to keep up with the PS960A propeller blades that were going through the shop. Most of the technicians were not as keen to working overtime as they were in New England, but it depended upon the individual. When they opened the Rock Hill facility, the starting pay was $9.00 per hour. The pay of East Windsor, Connecticut employees was around $16 - 17. Some other industrial plants have moved into the area which has forced them to increase the pay to $11.00 to keep up with the market demand. The turnover rate was very low. They had two or three people quit and some had to be let go due to problems. Of those let go, one was belligerent and the other did not come up to the expected standards.

Mr. Carter said the time it took for a technician to become proficient depended on the individual and the job. Initially, the technicians were not fast, but they were proficient. They did not push the technicians to work faster. He thought it took about four to six months for the technicians to become proficient to do normal speed work. He wasn't sure how long it would have taken a full craftsman to become fully proficient. In Connecticut, the work is segmented and the workers had one to three skills because there was very little cross training. The PS960 and 960A taper bore repair was a new process for everyone, he thought the Connecticut craftsmen might not have been able to catch on any faster to do the repair than the people at Rock Hill. Mr. Bender was chosen to do the taper bore repair because he was available. The area he was working in at the time had over capacity. He thought Mr. Bender was an intelligent person and he had a lot of confidence in him.

Mr. Carter said since the start of operations at Rock Hill, there had been some management turnover with four managers leaving. One individual transferred to Connecticut, one left Hamilton Standard to go to the FAA, and a finance manager went to another company. A human resource manager left to go to Otis Elevator. He explained the managers going to other United Technologies divisions was because the corporation was looking for managers who had start up experience. He did not know why the other managers had left the company.

Of his coworkers, Mr. Carter thought Mr. Mayhew's strengths were he was personable, a people person, fair, and he had been a supervisor in Connecticut. He thought Mr. Demarteau had taught them to take action, not to get wrapped up in limits, and to get the resources necessary to get something accomplished. Mr. Demarteau had taught the Connecticut culture people accustomed to a large company structure to streamline the decision making process.

3.3 Dennis Mayhew, Production Manager

Mr. Mayhew requested he be represented by Mr. Randal Carter, Engineering Manager of Hamilton Standard Rock Hill Operations.

The PS960 propeller blade taper bore repair was initiated after the service bulletin was issued following the first propeller blade separation incident. For Mr. Mayhew as Production Manager, the hardest part of incorporating PS960 and 960A was to redesign the parts flow through the shop. The shop flow is intricate and it is difficult to get it under control and then to keep it under control.

Mr. Bender was selected for the PS960 taper bore repair because the shop where he was working at the time was overstaffed and he was available. Mr. Mayhew thought Mr. Bender's strong points were he is extremely conscientious, he can follow technical instructions, he is respected by his coworkers, and his work ethic is also respected by his coworkers.

Mr. Mayhew thought the number of propeller blades that were scrapped as a result of PS960 and 960A was not very high at all, probably very low. He said Mr. Bender had recommended to Mr. Carter that some propeller blades be scrapped, but he did not know the number.

He said there were two technicians who were trained and doing the taper bore repair. There was one other individual who had been trained, but he was not doing the taper bore repair at the time. He said the time it took for a technician to become proficient at a particular task was dependent upon the individual and the different skills required for that task. With Mr. Bender and PS960, it took about 89 hours of training before he was proficient to do the taper bore repair. He did not know, even in general, how long it took for the technicians to become trained at various tasks and recommended the training records be reviewed to determine the time required.

In comparing the Rock Hill facility to Connecticut, he thought the morale was better at Rock Hill and that they had a "can do" attitude. The work force was more focused on the customer and what it took to be in the overhaul and repair business than Connecticut. He thought the quality of the Rock Hill technicians and their productivity was equal to Connecticut. He said the company benefits at Rock Hill were equal to those in Connecticut.

With regards to his coworkers, Mr. Mayhew thought Mr. Demarteau's strengths were his aggressiveness to get the job done. He thought Mr. Carter's key points were that he was a perfectionist, organized, and was good at explaining things.

4.0 Interviews, October 19, 1995

Three Hamilton Standard Customer Support Center employees: Messrs. Chris Bender, Randal Carter, and Dennis Mayhew; were interviewed by the Group on October 19, 1995. All three of these individuals had previously been interviewed by the Group at the Hamilton Standard Rock Hill facility on August 30 and 31, 1995. Participating in the interviews on October 19, 1995, were Jim Hookey, NTSB; Cee Smallwood, ASA; Stuart Browning, Hamilton Standard, William Neely, FAA; and Manuel Monteiro, Embraer.

4.1 Chris Bender, Technician

Mr. Bender requested he be represented by Mr. Randal Carter, Engineering Manager of Hamilton Standard Rock Hill Operations.

Mr. Bender said his training on the taper bore evaluation and blending was provided by Mr. Carter. Mr. Sabatello provided the training on visual inspection and use of the borescope. And Mr. Marcos Robles also provided the training on how to blend in the taper bore. The training with Mr. Carter consisted of the two of them looking at the taper bores together and Mr. Carter would show him what to look for in the taper bore. He said the training he received on the taper bore repair before he actually started working on propeller blades was for some period of time, but he could not recall how long the training lasted. When he first began working on the propeller taper bores, he was being supervised and someone would check his work after he had finished. If he saw anything that he did not know or recognize, he would ask Mr. Carter to look at it and explain what he was seeing. He could not remember the number of weeks his work was reviewed before he could work on his own and sign off his own work.

He said any propeller blade that was found to have mechanical damage in the taper bore would have been blended. Those propeller blades that were found with pitting in the taper bore had to be evaluated and were usually sent to Connecticut. Most of the blades he saw had mechanical damage. He had seen a few blades with pits in the taper bore that he rejected and would then show the damage to Mr. Carter who would then handle the disposition of the blade. If they did not find any damage or flaws in the taper bore, the taper bore would be grit blasted, receive another visual inspection, an ultrasonic inspection, and then the Alodine coating. He said the taper bore repair has changed from what was originally done in PS960 to what is done today. PS960 was an interim repair for the propeller blades after they had been rejected during the ultrasonic inspection or due to mechanical damage. All of the propeller blades were now having the taper bore inspected regardless of whether it had been previously rejected in an ultrasonic inspection. The new repair process came out in the maintenance manual revision in September 1994. Those propeller blades marked (+A) had no previous damage or pitting and were shotpeened, if that was not done previously, and then fluorescent penetrant inspected. Those blades marked (+B) had damage which had been previously blended and shotpeened. Propeller blades marked (+C) had damage which was over the blendable limits and had been previously reamed and shotpeened.

He said it was common to get ultrasonic indications when inspecting a propeller blade that had the taper bore shotpeened and not find any visual damage. He had been told in the beginning of his training for PS960 with Mr. Carter that the taper bore surface finish could cause an ultrasonic reject indication. The individual who did the ultrasonic inspections had also told him the taper bore surface finish could cause a reject indication. It was not very common to get an ultrasonic indication on propeller blades which did not have a shotpeened taper bore. On those blades which had not been shotpeened, but did have an ultrasonic indication, he usually saw mechanical damage or a ridge that was caused by the reamer in the taper bore. But he also said they would occasionally get propeller blades which had not been shotpeened in the taper bore, but had an ultrasonic indication and there was no visible damage in the taper bore. He said he had not seen this condition on many propeller blades. He wasn't sure of the exact number, but he thought it might have been with about 10 blades.

He would then go in and blend the taper bore to remove the indication. He had been told during his training or as a result of a question that he could blend the taper bore for an ultrasonic indication per PS960 or 960A even though the PS960 and 960A repair was only intended to blend out any mechanical damage. On non-shotpeened blades which had an ultrasonic indication without any visible damage, he would occasionally have to blend the taper bore more than once to make the indication go away. He would blend the taper bore to bring the surface finish down to a 63 rms finish even on shotpeened blades. After he had blended the taper bore, he would check the finish of the blended surface by comparing it to a surface finish comparator which he called a "Baptist board" using either a wood stick or borescope. When he would blend a taper bore to eliminate an ultrasonic indication, the indications would sometimes disappear. He said he tried to not let any blade go that had a recordable indication, which was anything greater than 40 percent full scale height (fsh) on the ultrasonic display screen. Sometimes he would have a blade which had been shotpeened and would have a 40 percent fsh indication, but he usually could get a flat screen which meant there were no peak indications above 20 or 30 percent.

4.2 Randal Carter, Engineering Manager

Mr. Carter requested he be represented by Mr. Dennis Mayhew, Production Manager of Hamilton Standard Rock Hill Operations.

Mr. Carter did not agree with the number of hours of training, about 90 hours, that was listed for Chris Bender on the taper bore evaluation and blending. He said the actual training for the taper bore evaluation and blending repair process took about four or five hours to explain. He thought a lot of the training that was spent on taper bores was on-the-job training (OJT). Mr. Mayhew, who was representing Mr. Carter, interjected that the difference in the four or five hours to explain the repair process and the approximately 90 hours which was listed on Mr. Bender's training record is that most of the time was probably OJT. When Mr. Carter would provide training on a procedure, he would review the document with the technicians and then have them practice the procedure. He would then review the procedure with the technicians and ask them questions. He would show the procedure once and then have the technicians repeat the procedure for him. When he was conducting the training for PS960, he showed how to determine the depth and position of the mechanical damage in the taper bore. He also demonstrated the 50:1 width to depth blend ratio and how to have a smooth surface radius and transition from the blended to unblended areas. He showed how to determine the surface finish in the taper bore by using a surface finish comparator. He and Mr. Sabatello showed the technicians how to use a borescope to determine the surface finish by comparing the indications in the taper bore to the surface finish comparator. He went through the process having the technicians using a number of scrap blades before they moved on to actual blades. The technicians then began the OJT with them assisting and answering questions as they became more proficient with the process. They had to demonstrate how to determine the depth of damage, how to blend the damage in the taper bore, and how to do the Alodine surface treatment coating. The taper bore blending was a simple repair and he had prior experience on similar repairs. The taper bore blend repair did not take a substantial amount of training to become proficient. The actual explanation of the repair was simple because it was not a technically difficult repair.

PS960 was developed to repair any blade which was found to have mechanical damage in the taper bore. If any corrosion was observed in the taper bore, the propeller blade was removed from the repair process and sent to Connecticut for further evaluation. At the time when PS960 was issued, Hamilton Standard in Windsor Locks, Connecticut was trying to understand the nature of the corrosion problems to correlate the extent of damage and determine what could be done to repair those propeller blades. For those propeller blades that were found to have mechanical damage in the taper bore, the technicians could blend away up to 0.010 inches on the face side and up to 0.020 inches from all other areas of the taper bore including the camber side. Even though there had been two events of propeller blade fractures, there was no process other than the ultrasonic inspection to identify cracks and result in the blade being removed from service. The router's inspection section did state to check for cracks, but he said they had listed cracks in that section to ensure the technicians looked for everything and they did not want to limit the rejectable criteria to just mechanical damage. If a large crack was found, they wanted to make sure the propeller blade would be removed from the repair process. He thought with the equipment that was being used, the chances of finding a crack were minimal and that the technicians would probably not see it unless it was visible to the naked eye. The white light which was used to inspect the taper bore was not designed to find any cracks. An FPI inspection or something of that type would be needed to detect cracks, but they were not doing FPI at that time.

Mr. Carter said he was not sure why the router for propeller blade SN 861398 was marked "No visible faults found, blend rejected area." When PS960 was first issued, there was a period of time, about four or five months, when there were daily phone calls between Connecticut and the Hamilton Standard repair shops, including Rock Hill, to disseminate information on the repair. It was during one of those phone calls that Connecticut brought up the issue about propeller blades which had ultrasonic indications and no visible indications. Connecticut said the blades were being rejected because of the taper bore shotpeening. The repair shops were told during the phone call they could remove the ultrasonic indications caused by the shotpeening by blending the taper bore in accordance with PS960A. Mr. Carter provided a copy of a memo, dated April 27, 1994 written by Mr. R. Rutz of Hamilton Standard in Connecticut, that Mr. Carter said was issued to permit the blending of the taper bore to remove ultrasonic indications caused by the shotpeening. A review of the memo (A copy is of the memo attached) did not show any specific reference to blending the taper bore to remove an indication because of shotpeening. Mr. Carter said he was never aware that there were unshotpeened propeller blades being found with ultrasonic indications in the taper bore that did not have visible damage. Mr. Carter did not think that there was any reason to have to blend the taper bore of a blade that had not been shotpeened, unless it had some mechanical damage. The possibility of having unshotpeened propeller blades with ultrasonic indications and no visible damage was not considered or questioned. He said he had told the technicians they could blend any areas with ultrasonic indications on blades which had been shotpeened because the shotpeening could cause the ultrasonic indication. If there was no visible damage, he thought that it was always propeller blades that had been shotpeened that were being found with the ultrasonic indications that the technicians were blending. He said that at that time, the shop was pumping out hundreds of blades per month and he was not always aware of everything that happened and not everything was brought to his attention. He said he did try to stay involved and would emphasize that to the technicians so they would point anything out to him. However, Mr. Carter said he did ask Mr. Rutz if the April 27, 1995, memo to permit blending to remove an ultrasonic indication was applicable to peened and well as unpeened blades and Mr. Rutz had responded that both the peened and unpeened blades could be blended. He said Mr. Rutz had also stated that blades which had previously been peened did not need to be repeened after blending because it was thought the benefits of peening extended into the subsurface areas which were now exposed due to the blending. Although Mr. Carter had questioned and been told the memo to permit blending to remove an ultrasonic indication was applicable to both peened and unpeened blades, he said he told the technicians they could only blend the shotpeened blades. He said he was curious how Mr. Bender knew he could blend out the ultrasonic indication of a taper bore which had not been shotpeened.

He said when the PS960A repair was finished, the final inspection accomplished was dependent upon what had been found during the repair. If there had been an ultrasonic indication, then the blade would definitely have to receive another ultrasonic inspection before leaving and the inspection results must be below the allowable limits.

4.3 Dennis Mayhew, Production Manager

Mr. Mayhew requested he be represented by Mr. Randal Carter, Engineering Manager of Hamilton Standard Rock Hill Operations.

With the PS960A repair, the only damage that could be worked would be mechanical damage which could be repaired. He thought the technicians' instructions for PS960 were only for surface imperfections which they would have repaired. Any pitting or corrosion in the taper bore was not a repairable condition. If any pitting or corrosion was found, it would have been communicated through Randy up to Connecticut on what they were seeing. For the fractured blade which had no visible faults but was blended, he thought that it might be a possible surface finish issue.

5.0 Mr. Chris Bender's Work Schedule

Hamilton Standard provided copies of Mr. Bender's payroll records for the time period around when propeller blade SN 861398 was repaired at the Rock Hill facility. The time cards include the three weeks prior to the repair (No. 1 - 3), the week of the repair (No. 4) and the following week (No. 5). (A copy of Mr. Bender's payroll records is attached.) Propeller blade SN 861398 had the taper bore blend repaired and inspected on June 4, 1994, which was a Saturday.

Mr. Chris Bender's Work Schedule

No.	Week Ending	Reg Hrs	O/T Hrs	Total Hours
1	May 15, 1994	40.0	11.0	51.0
2	May 22, 1994	40.0	22.7	62.7
3	May 29, 1994	40.0	26.7	66.7
4	June 5, 1994	27.0	8.0	35.0
5	June 12, 1994	40.0	12.9	52.9

[redacted]
Gordon J. Hookey
Propeller Maintenance Group Chairman
[illegible] 12/18/95