

BLADER FUEL CELL

REPAIR

Introduction

- Fuel Cells have a service life that is affected by many factors such as flight hours, removal and replacement cycles and environmental conditions. Most of the aircraft flying today have long exceeded their original expected life. Many of these aircraft have been through one or more airframe or avionics modifications programs. However the service life of fuel cell is often not considered, as there is no mention of this in the various government publications, aircraft manuals or aircraft TO's.
- Fuel Cell Manufacturers have become aware of this in late 1995 and has made an in depth study of older fuel cells in the field and cell returned here for repair. This study was completed late in 2001 and we now have a clear understanding of the life cycle of these products.

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Manufacture's Recommendation

- Flight hours, environmental conditions and removal and reinstallation cycles vary greatly from fleet to fleet. Therefore it is not possible to fix a firm service life of fuel cells. However we can state that any fuel cell older than 15 years should be considered a candidate for replacement. This is especially important when the aircraft is involved in any major modification program that requires removing the cell.
- It should be noted that the US forces have determined that the average service life should be considered to be 10 to 12 years depending on the aircraft program.
- Generally it is false economy to effect major repairs on any fuel cell that is older than 12 years and is expected to be kept in service any longer than 12 months.

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What are new Fuel Cells

- Fuel cells cannot be remanufactured, rebuilt, or overhauled. Fuel cells that are represented as such are incorrect
- New Fuel Cells
- A fuel cell is considered new for 24 months from the original date of manufacture, while in storage at Amfuel. Warranty applies from the date of the original shipment from Amfuel

New (unused) cells that have a manufacture date on shipping containers showing that the cell is over two (2) years old but less than four (4) years old and has never been inspected since time of receipt should be returned to an authorized service center for inspection.

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New Surplus Fuel Cells

- Fuel cells that have a manufacturing date of more than 6 years must have the paper work inspected to be sure that the proper storage procedures have been followed. If there is no evidence of proper storage per QB No 152 then these fuel cells should be considered not flight worthy until reinspected and fuel tested by the OEM.

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Why replace an older Fuel Cell

- Nitrile by its nature is the longest life type of fuel cell material. However as the fuel cells age they become more difficult to repair due to the effects of time and the environment on the material. Much of this aging process takes place on the between plies of the fuel cell and are not visible by visual inspection.
- Repairs made to fuel cells older than 15 years are not as long lasting as repairs made to new fuel cells. As these cells age they become less flexible and become more difficult to remove and reinstall.
- The removal and reinstallation most often require that the fuel cell be folded and maneuvered into confined spaces. This action will often damage an older fuel cell in areas, which cannot be seen, resulting in new leaks that are not discovered until after the installation process.

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- Repair
- Responsibility: Normal fuel cell maintenance and repair are primarily the responsibility of field maintenance organizations. Specialized repairs may be accomplished under the supervision and/or direction an Aircraft Services Bladder Shop

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- Safety Precautions
- Personnel: Personnel handling or working with potentially hazardous materials and equipment used in repair of fuel cells should adhere strictly to the safety standards and regulations of their company.
- Caution: Extreme caution should be exercised by personnel to avoid contact with fuels, extensive inhalation of fuel vapors and splashing or spilling of fuel, which may possibly involve eye contamination

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- Safety Precautions
- Protection: Protective clothing of non-static cotton should be worn by personnel in a fuel cell repair area. All tools and electrical equipment should be approved as "explosion-proof" or "non-sparking."
- Wetted Fuel Cells: Personnel entering a wetted fuel cell should wear a full-face air- supplied respirator or have some type of uncontaminated air supply flowing into the cell.

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- **General Handling Precautions for All Fuel Cells**
- Avoid contact with sharp or abrasive objects such as edges of metal, metal shavings, concrete floor, etc. Remove shoes and all tools or metal objects from pockets before entering a cell. Take only the necessary tools inside of the cell when installing or servicing the cell.
- Upon entering a cell, do not step on creases or folds, but first smooth out this area to protect the liner against injury. On entering, leaving, and/or handling a cell, do not stand on any fitting. If it is necessary to work in the fitting area, the fitting should be supported. Do not lift the cell by its fittings.

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- **General Handling Precautions for All Fuel Cells**
- Thoroughly clean and reinspect the interior of the cell before closing the access opening.
- Store cells in a clean, cool, and dry place in their shipping containers in the position indicated on the containers.

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- **Design and Function of Non Self-Sealing Fuel Cells**
- **Layers:** The general construction of the non-self-sealing “Line-A-Cell” fuel cell consists of three primary layers of material.
- Innerliner (Inside Ply)
- Nylon Film (Barrier)
- Outerply

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- **Design and Function of Non Self-Sealing Fuel Cells**
- **Innerliner:** May consist of Nitrile rubber material or Nitrile coated square woven fabric. The purpose of the innerliner is to contain the fuel and to provide internal protection for the nylon film (barrier). Construction numbers E-1104-1, E-1367-1, E-1367-2, E-1367-3, E-1622-1, E-1622-2 and E-1389 have a rubber innerliner. Construction numbers E-1074-5, E-1105-3, NR-1549-1A and -1B, E-1620, E-1622-3, E-1622-5 and E-1669 have fabric innerliners. Construction numbers US538N, US543N, US543N-1, US570N, US570N-1, US588, US588L, US943, and US965 have gum innerliners. All other US constructions have fabric innerliners.

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- **Design and Function of Non Self-Sealing Fuel Cells**
- **Nylon:** The purpose of the nylon film barrier is to keep the fuel from diffusing through the cell wall.
- **Outerply:** The outerply consists of one or more plies of Nitrile coated square woven fabric. The purpose of the outerply is to lend strength to the fuel cell and provide external protection to the nylon barrier.

Fuel Cell Installation

- **Non-Self-Sealing Fuel Cell Installation**
- For detailed information as to the operation and maintenance instructions, refer to
- U.S.A.F.T.O. No. 1-1-3, and NAVAIR 01-1A-35.
- Installation and Assembly
- Do not remove the cell from the shipping container until the cavity has been made ready for cell installation. Inspect the cavity for cleanliness and absence of sharp metal edges.

Fuel Cell Installation

- **Non-Self-Sealing Fuel Cell Installation**
- Use extreme caution in collapsing the cell for installation and assembly. During installation, never allow the cells to remain completely collapsed for a long period of time.
- Do not allow cells to remain in direct rays of the sun, particularly when cells are collapsed.
- Powder the outer surface of the cell with talc or soapstone.

Fuel Cell Installation

Non-Self-Sealing Fuel Cell Installation

- Make all fitting connections, and install all internal accessories after the cell is installed.
- Wipe or vacuum the cell clean of all dirt and foreign particles. Reinspect for cleanliness.

Maintenance and Servicing of Cells

- Maintenance and Servicing of Cells:
- For detailed instructions, refer to U.S.A.F.T.O. No. 1-1-3, titled "Repair, Handling, and Inspection Instructions - Integral and Removable Metal Tanks, Rubber and Nylon Fuel, Oil, Water-Alcohol Cells," or NAVWEPS TO. O No. 03-10-513.

Maintenance and Servicing of Cells

- Service Life:
- Any fuel cell which has been stored for an extended period of time, either at Depot Level or in the aircraft, be inspected closely.
- Fuel cells in the aircraft older than fifteen (15) years, may be considered for replacement when the aircraft is in for major depot level maintenance or involved in any major upgrade program. This will greatly reduce aircraft down time and maintenance requirements.

Maintenance and Servicing of Cells

- Note: Use explosion-proof lights.
- Failure or Leakage of Cells:
- If there is any evidence of failure or leakage of the fuel cell upon inspection, the cell should be removed from the airframe cavity for a thorough check.

Maintenance and Servicing of Cells

- Repair Materials
- Note: Repair on the constructions designated “high strength” is for installations requiring a high level of strength. Repairs to the interior or exterior of these cells may be made in the field. Damage which results in breakage of the exterior reinforcing fabric of these constructions should be referred to the Amfuel factory.
- Note: All repair materials must be fully cured unless otherwise specified.

Maintenance and Servicing of Cells

- Fittings, loops, tabs, hanger fittings, and other accessory parts should be ordered per aircraft company drawings.

Preparation of Cells for Repair

- Preparation:
- Refer to Section 3, "General Handling Precautions." All cells must be clean and dry before starting to repair. If moisture is present, the cell must be thoroughly dried at room temperature or in circulating, hot air at 160°F for 8 - 12 hours.

Preparation of Cells for Repair

- Cleaning of Wet (Fueled) Cells:
- After the cell has been de-fueled and completely drained, prepare a solution of Turco #3252 and water (approximately 1 pint of Turco to 25 gallons of water), and partially fill the cell with the cleaning solution. Close all cell fitting openings, sloshing the interior of the cell with the cleaning solution to thoroughly clean the interior surfaces, or use the fresh air purging procedure, in accordance with applicable technical orders, to aerate the cell. After purging, check the fuel/air concentrations with a company approved vapor analyzer.

Preparation of Cells for Repair

- General Information
- Punctures, Small Cuts, or Damage through Cell Wall:
- If there are rough or jagged edges at the injury, carefully trim away to an even or rounded contour to ensure a satisfactory repair.

Preparation of Cells for Repair

- Buffing Operation:
- Buff, or roughen, the damaged surface by using a power buffer or by hand sanding. Buff very lightly in all directions beyond the edge of the damaged area, extending the buffed area 1-1½'' beyond the injury, if at all possible. Prepare and buff the downside of a patch of the proper size and material. Care should be taken to avoid damage to any fabric that will not be removed from the cell during the repair.
- Reference SK-A3806 and SK-A3807 for the size of the area to be buffed.

Preparation of Cells for Repair

- Cleaning Buffed Areas:
- All surfaces must be cleaned with a clean cloth or swab moistened with 22-20595 solvent. Wash until all grit and buffing dust is removed. Allow the solvent to evaporate before proceeding.
- Note: 22-20595 solvent may be used wherever “solvent” is specified.

Preparation of Cells for Repair

- Bonding Cements:
- Whenever cements are applied, always use two coats of cement on all surfaces to be repaired, and observe the specified drying times. Brush-coat the cell area and repair material with an even coat of the specified cement. Allow the cement to dry a minimum of 45 minutes or until completely dry. Do not cement beyond the buffed area. Repaint the cell area and repair material with a second coat of the specified cement; let it dry a minimum of 45 minutes or until completely dry. After both coats of cement have completely dried, moisten a cloth or swab with the specified solvent, and lightly wash both cemented areas (cell wall and repair material).

Preparation of Cells for Repair

- Bonding Cements:

Allow the solvent 22-20595 to evaporate for approximately 10 to 20 seconds (at approximately 80°F room temperature), or until the cemented areas are “tacky.”

- Note: To determine if the cemented areas are “tacky” enough, test by pressing a knuckle gently against the cemented surfaces. If the area feels tacky, the surface is ready for application of the repair material.

Preparation of Cells for Repair

Applying the Repair Material or Patch:

- To obtain the best results in applying a patch, the surface to be repaired must be backed up by a firm surface such as a table or floor. The “down” side of the patch is to be buffed as described in Paragraph 7.4.2. All corners of the patch should be rounded to avoid loose edges. Apply the patch and stitch well (with a 1/4” metal stitcher) to the cell wall - do not let the patch overlap the uncemented area. After the patch has set for 30 minutes to an hour, check the patch for looseness. Seal the patch and patch edge with one coat of bonding cement, allowing it to dry for 10 - 15 minutes, and then restitch the patch.

Preparation of Cells for Repair

- WHEN USING THE AIR CURE METHOD OF REPAIR, ALLOW THE CELL TO SET A MINIMUM OF 24 HOURS BEFORE BEING INSTALLED IN THE CAVITY OR BEING FILLED WITH FUEL. IF PATCHES ARE VULCANIZED THE CELL MAY BE INSTALLED OR FUELED AFTER TWO HOURS.

Preparation of Cells for Repair

- Repair Adhesives
- Repair adhesives are shipped as a kit consisting of two components. Parts. Stir each component well before mixing. To provide an air curing repair adhesive, the two parts must be mixed together and thoroughly blended as follows: 90% of 22-20556-1 (master batch) to 10% of 22-20555-1 (catalyst) by weight. Stir the mixture for 10 - 15 minutes. The cement now should be labeled "PU459." The maximum shelf life after mixing is 6 hours.
- This adhesive is flammable and should be kept away from any ignition source. Materials should be kept tightly sealed in individual containers in a cool, dry place. The shelf life of 22-20556-1 is 6 months and the shelf life of 22-20555-1 is 12 months.

Preparation of Cells for Repair

- Repair Adhesives
- The areas to be repaired should be lightly buffed or sanded to provide an appropriate surface for the bonding of the repair adhesive. After buffing, the surface should be cleaned with solvent. Allow the solvent to evaporate before the application of repair adhesive.

Preparation of Cells for Repair

- Repair Adhesives
- Immediately after the surface preparation, apply one brush-coat of adhesive to both of the surfaces to be bonded. Dry the cement for 20 - 60 minutes. Apply a second brush-coat of adhesive to both surfaces. Dry the cement for 20 - 60 minutes. Before joining, lightly swab the coated surfaces with 22-20595. External forces, such as clamps and weights, may be applied to the repair area. Allow the repair to remain undisturbed for a minimum of 8 hours. Allow a minimum of 24 hours before exposing the repair to fuel. Discard all excess mixed cement.

Repair of Bladder Fuel Cells

- All fuel cells must be repaired in accordance with the aircraft maintenance manual and/or the manufacturers repair manuals

Inspection of Repaired Cell

- Each repaired cell should be carefully inspected by an approved inspector for any additional repairs, which might have been overlooked, or possible damage when removing the cell from the air frame cavity. Repair areas should be carefully inspected for proper workmanship.

Testing Procedure

Air Soap Test

- Seal all openings on the cell. Apply an internal pressure of $\frac{1}{2}$ psi and hold for 15 minutes. Cover the cell with a soapy water solution (any standard dish detergent can be used). Leaks will be indicated by the presence of air bubbles forming in the soap water solution. Any leaks should be marked and repaired using an approved repair procedure. After leaks are repaired another air soap test shall be administered. If no leaks are found then the cell shall be washed off using clean water. Cell shall be dry before performing any other subsequent operations.

Testing Procedure

- Chemical Test
 - Seal all openings on the cell except the access door
 - Install inlet fittings and tighten the cover
 - Pore ammonium hydroxide on an absorbent cloth and place the cloth in the tank.
 - Install the access cover and inflate the cell in accordance with the manual instructions.
 - Maintain air pressure for 6 to 8 hrs

Testing Procedure

- Chemical Test (cont.)
- Prepare leak detection mixture in accordance with the maintenance manual instructions.
- Soak a large white cloth in the solution, thoroughly wring out the cloth of excess solution.
- Spread the cloth over the cell and smooth down to ensure detection of minute leaks. Leave the cloth in place for a minimum of 5 min.
- Check for red spots. Due to a chemical reaction the moistened cloth will develop red spots when in contact with the ammonium. Red spots can be removed by re-soaking the cloth.

Testing Procedure

- Chemical Test (cont)
- Mark leaks as necessary
- Move the cloth and repeat procedure to check the entire surface of the fuel cell

Lacquer Finish Coat

- An exterior lacquer finish coat is optional except when specified by the aircraft operator or specific maintenance manuals.

Lacquer Finish Coat

- Procedures
 - Clean and dry all surfaces of the fuel cell that is to be coated
 - Apply a moderately thin coat of lacquer to the external surface of the fuel cell. Apply one coat by brush and allow to dry
 - DO NOT APPLY LACQUER TO FUEL CELL FITTINGS

Fuel Cell Temporary Storage

- Preservation:
- If cells which have contained fuel are to remain without fuel for a period of five (5) days or longer, apply a thin coating of Mil-O-6081 non-additive or equivalent oil to the innerliner to prevent it from drying out and possibly cracking.
- If storage conditions have not been ideal, fuel cells that have been stored for some time can shrink, which will make installation difficult. Cells found in this condition may be restored to their approximate proper dimensions by soaking in water at 100°F (120°F maximum) for four (4) hours or longer, depending on the condition of the cell.

Fuel Cell Temporary Storage

- Packaging and Packing:
- After the cell interior has been coated with oil, all openings should be covered with paper, cardboard, or equivalent and secured with tape. Fold the cell, keeping folds to a minimum. No sharp creases should be permitted in the folded cell. Wrap the cell in moisture-proof paper, or put it in a plastic bag. Put the cell in its original shipping box or a box of the correct dimensions.

Fuel Cell Temporary Storage

- Storage:
- A permanent building in which the temperature is maintained at 20° to 100°F should be provided for the storage of serviceable or repairable cells.

Fuel Cell Temporary Storage

- Inspection of New Cells in Storage:
- New cells that have been boxed or crated and stored for two or more years should be removed from the box and inspected for any visual evidence of deterioration or damage. The manufacturer recommends that the fuel cell innerliner be given a light coat of oil after inspection if the cell will be re-boxed and stored for additional time. Fuel cells should always be stored in a cool and dry location away from direct sunlight and any heat source. Cells should also remain in their sealed plastic bag and box during storage

