2A752-00-S01 1809

CDC 2A752

Nondestructive Inspection Journeyman

Change Supplement for Volume(s): 1, 2, 3 and 4

IMPORTANT: Make the corrections shown in this supplement before beginning your study of the volume(s) it affects. This supplement has both pen-and-ink changes and replacement pages. Tear out the replacement pages and insert them in your volumes.

Air Force Career Development Academy

Air University

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Changes for the Text: 2A752 01 1704, edit code 04

Pen-and-Ink Changes:

Page-Col	***Subject***	***Line(s)***	***Correction***
3-28	018	Question 7	Change “What are the two most prominent automated management systems used by the Air Force?” to “What process includes collection, storage and retrieval of data?”
3-28	018	Question 8	Change “What are the three key data elements used in MDD?” to “What is an automated system developed by Air Mobility Command (AMC) and is only used by AMC bases?”
3-28	018	Question 9	Change “Write the JCN for the 134th job on 4 January 2014.” to “What is an event-oriented system that automates aircraft history, scheduling, and aircrew debriefing processes?”
3-28	018	Questions 10-14	Delete questions
3-31	018	Answer 7	Change “The IMDS and G081” to “The MDD process.”
3-31	018	Answer 8	Change “(1) JCNs, (2) work center codes, and (3) IDs.” to G081.”
3-31	018	Answer 9	Change “140040134” to “IMDS.”
3-31	018	Answers 10-14	Delete answers
4-7- 4-8	024		Delete all of LO 024
4-10	024		Delete all STQs for LO 024
4-11	024		Delete the answers for LO 024
4-12	024	Question 57	Delete URE #57
5-20	029	Question 5	Add “5. What is the general danger zone radius of an aircraft operating radar?”
G-1	Glossary		Add “CEMS - Comprehensive Engine Management System”
G-3	Glossary		Add “REMIS - Reliability and Maintainability Information System”

Page Changes:

Remove:	*Insert:*
3-13 - 3-18	3-13 – 3-18

3–2. Maintenance Management Documentation

Management of aerospace system maintenance relies first and foremost on *complete and accurate documentation*. Documentation starts with you, the technician performing maintenance. If you fail to properly document your maintenance actions, the entire system fails.

The key to good documentation is good data. Knowing this, the Air Force has developed a system for maintenance data documentation (MDD) that standardizes how data is gathered, stored, and retrieved. MDD also standardizes common elements of data applying to all weapon systems and equipment. This standardization ensures all personnel have a common reference when documenting maintenance or researching maintenance trends. The benefit may not be apparent to you right away, but this system provides extensive savings to the Air Force through better management decisions made with sound, factual data.

018. Maintenance data documentation process

The importance and usefulness of the MDD process is essential and must be as accurate as possible. To simplify data recording and improve the accuracy of input data, the MDD process uses coded information. The use of data codes also facilitates data retrieval for reports or summaries used in maintenance management.

In this lesson we will look at the objectives, scope, key codes, and concept of the MDD process that you will need to document maintenance.

Objectives

The objectives of the MDD process are to provide a means of collecting, storing, retrieving base, depot, and contractor maintenance data. The MDD process also establishes the specific uses of data.

NOTE: At one time, MDD was used to determine manpower requirements. Although still a consideration, it is no longer the primary source for decisions. Work centers inflating maintenance repair or inspection times to justify additional manpower won't accomplish their goals and will corrupt data used for other management decisions.

Scope

The MDD process begins during the first operational tests of an equipment item and continues through the entire life of the item. MDD applies to the following:

- All maintenance functions.
- All units maintaining MDD reportable training equipment.
- Contractors (when specified in contracts).
- Depots (when accomplishing maintenance on MDD reportable equipment).
- Historical documentation.

Concept

The MDD process includes all aspects of collection, storage, and retrieval of data. Data serves an important function in MDD beyond showing what maintenance was performed, who did it, when it was completed, where it was accomplished, and how it was done. Data is used both at the site where it's collected and by the Air Force management and engineering agency, MAJCOMs, and the DOD.

Locally, data provides supervisors with feedback on maintenance operations, manpower, equipment status, workcenter taskings, and weapon system configuration information. Off base, data assists in managing Air Force and MAJCOM programs established in instructions or manuals. It's also used to identify reliability, maintainability, and availability of Air Force equipment, establish priorities for improvements, and identify safety deficiencies.

As you can see, data has an unlimited number of beneficial uses. However, without being accurate, collected data is useless.

Documentation categories

All MDD can be grouped into two categories: on-equipment and off-equipment.

On-equipment MDD

Any data documented to describe maintenance performed on an end item piece of equipment is called on-equipment MDD. An end item is any complete, operational piece of equipment. An example of an on-equipment item is an inspection on an aircraft or an engine component.

Off-equipment MDD

Generally, data documented to describe maintenance on assemblies, subassemblies, or components removed from an end item of equipment is called off-equipment MDD. An example of an off-equipment item is a wheel assembly, torque tubes, or any part of an aircraft component that has been removed.

Data is usually required to be entered into a database in one of four cases.

1. A discrepancy is discovered during scheduled maintenance.
2. Unscheduled events are discovered and entered as discrepancies as they occur.
3. A discrepancy may be discovered as a result of a specific aircraft flight during debriefing.
4. Discrepancies may be discovered by on-board recording devices.

Documentation rules

Support of the MDD process requires rules to ensure documentation is accomplished consistently. The rules are in place to specify data formats and when to use which data codes. Specific rules are found in the following sources:

- 00–20 series TOs.
- Aircraft maintenance manuals.
- Air Force, MAJCOM, or local instructions.

Now we look at the key data elements and codes you need to know to provide accurate and standardized data to the MDD process.

Maintenance information systems

To this point, we have not specifically covered the automated systems used by the Air Force to manage data. Although computer advancements have made data storage and retrieval far more efficient than only a few years ago, one basic premise is that the basic process of MDD does not change, regardless of the system you are using to store data. New systems are being evaluated by the Air Force while those systems currently in use are continuously upgraded. Your installation is responsible for providing detailed training on the particular systems you will use.

Maintenance information systems (MIS) refers to automated maintenance information systems that support and enable maintenance business processes. MIS is used to document maintenance actions and track fleet health. The information entered into the MIS is accomplished IAW TO 00–20–2, *Maintenance Data Documentation* and matches the content of the aircraft forms. MIS data entries do not have to be accomplished by the same individual who documented the aircraft forms, but employee numbers/man numbers/USERIDs of individuals accomplishing the actual work are entered into the MIS.

The MDD process includes collection, storage and retrieval. The process provides for the data collection and monitoring of maintenance discrepancies. Rules and regulations govern the operations of each process. There are, however, several systems that are utilized for the input of MDD data. While each of these systems must follow the basic rules for the composition of the data elements and data entrees, the procedures for data entry and operation of the following systems are contained in their user manuals and related documents:

- G081 Integrated Maintenance Data System (IMDS).
- G105 IMDS.
- G099 Reliability and Maintainability Information System (REMIS).
- D042 Comprehensive Engine Management System (CEMS).

NOTE: GO81 is an automated system developed by Air Mobility Command (AMC) and is only used by AMC bases.

G081

G081 provides both a maintenance management system and a logistics command and control system for the C-40, C-5, C-130, KC-10. KC-135, and C-17 fleets. It provides base maintenance managers the ability to track each aircraft and determine what maintenance is required to get the aircraft available for generation. It provides the following:

- Fleet-wide visibility of status and location of aircraft.
- Discrepancy history.
- Time compliance technical order status.
- MDD historical records.
- Personnel.
- Back shop production control.
- Training.
- Support equipment.

G105

The G105 IMDS Central Data Base data is the primary, production-oriented, base-level automated MIS. This system supports all aircraft, spacelift assets, support equipment maintenance activities at worldwide bases, Guard and Reserve sites, and North Atlantic Treaty Organization (NATO) locations.

G105 is an event-oriented system that automates aircraft history, scheduling, and aircrew debriefing processes which provides an interface for entering base-level maintenance data into other logistic systems. This data base updates the database, retrieves information, and reports data required by higher headquarters.

G099

G099 is the AF Maintenance Enterprise System providing organizational, intermediate, and depot-level operational authoritative information for all AF weapon systems, satellite, missile, trainer, mine resistant and ambush protected vehicles that support world-wide operating bases.

This system will provide accurate, near-real-time data accessibility to all levels of management. This is the official AF system of record for:

- Weapon system master inventory.
- Weapon system maintenance data.
- Master validation tables.
- Inventory assignment.
- Capability status.
- Flying hours.

- Time compliance technical order status.
- Chief financial office reporting.

D042

D042 is the data system that has been identified by Congress as the AF standard data system for the tracking of engine status, accountability, and critical parts life tracking. It provides on-line real-time data accessibility to all levels of management.

019. Maintenance forms

There are literally thousands of forms in the maintenance community. Some forms you need to become familiar with because of their importance and the time you will spend filling them out. First let's look at the repair cycle and how maintenance is tracked

Repair cycle system

A basic Air Force concept is to perform repairs at the lowest level of maintenance, to the greatest extent possible, consistent with good management practices. In addition, troubleshooting and repairs are extended to the lowest possible component or part. Repairs are not limited to the procedures found in equipment technical orders. Unless specifically prohibited, the procedures in general maintenance technical orders and common sense maintenance actions should be used to aggressively pursue local repair options. Defective Air Force components are replaced with a like item, repaired in place, or removed, repaired, and reinstalled.

Due to their critical nature, repair cycle assets are those items requiring a one-for-one swap before they can be issued from supply. Some examples of repair cycle assets might include the following:

- Aircraft flight controls, skin panels, or other components.
- Missile components.
- Munitions handling, storage, or transportation equipment.
- Any assets with supply shortages, high value, or sensitive nature that are designated.

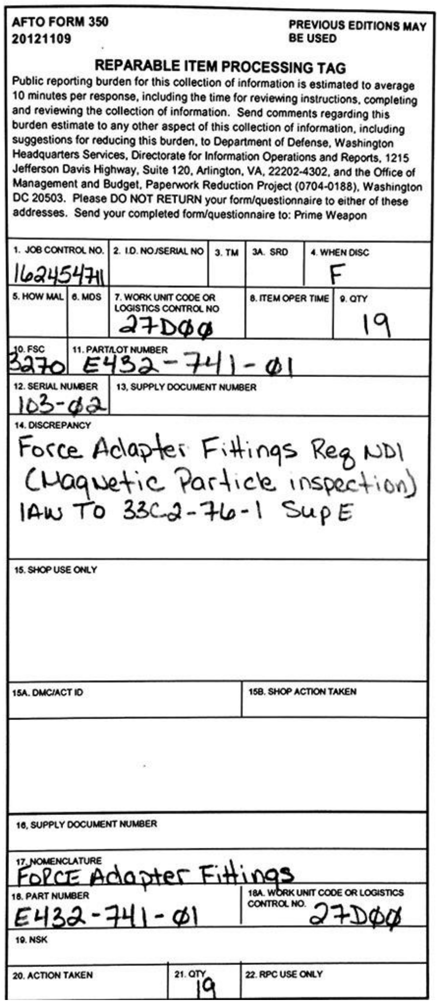
When repair cycle assets are removed for maintenance work, they enter the repair cycle system. The particular layout of the repair cycle system on each base will vary depending on the MAJCOM, organizational layout, and weapon systems supported. Centralized repair processing or control centers should be physically located near the center of the maintenance complex surrounded by the supporting shops performing the various repair and inspection actions.

Tracking and processing repair cycle assets

Whenever you receive a component in the NDI laboratory, whether it is a repair cycle asset or a generic part, you track it using an AFTO Form 350, Repairable Property Processing Tag (fig. 3–2). This two-part form is used to identify an item, tell you where the item originated from, and provide data needed to properly document shop actions into MDD systems. Part I of the form is the repair cycle processing tag. Part II serves as a production-scheduling document to track maintenance actions. Some base organizations may bring you parts to be inspected without an AFTO Form 350. Normally, this will only apply to organizations not part of the maintenance complex such as civil engineering, the base fire department, base services facilities, or contractors. Local procedures should be developed to track and document maintenance on these components.

Depending on the organizational structure at your base, personnel in a designated central office continuously monitor the location of repair cycle assets, their status, and when they may be returned to serviceable condition. Your job, as an NDI technician, is to inspect the asset as quickly as possible and properly document your actions in the applicable MDD system. Once you've done that, the item can be returned to the owning workcenter, repair cycle center, or next shop in the maintenance chain.

All personnel routinely dealing with a repair cycle system should be familiar with detailed requirements outlined in TO 00–20–3, *Maintenance Processing of Reparable Property and the Repair Cycle Asset Control System*, as well as MAJCOM and local guidance.



AFTO FORM 350 20121109 — PREVIOUS EDITIONS MAY BE USED

REPARABLE ITEM PROCESSING TAG

Public reporting burden for this collection of information is estimated to average 10 minutes per response, including the time for reviewing instructions, completing and reviewing the collection of information. Send comments regarding this burden estimate to any other aspect of this collection of information, including suggestions for reducing this burden, to Department of Defense, Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 120, Arlington, VA, 22202-4302, and the Office of Management and Budget, Paperwork Reduction Project (0704-0188), Washington DC 20503. Please DO NOT RETURN your form/questionnaire to either of these addresses. Send your completed form/questionnaire to: Prime Weapon

1. JOB CONTROL NO.	2. I.D. NO./SERIAL NO	3. TM	3A. SRD	4. WHEN DISC
1624547H				F

5. HOW MAL	6. MDS	7. WORK UNIT CODE OR LOGISTICS CONTROL NO	8. ITEM OPER TIME	9. QTY
		27DØØ		19

10. FSC: 3270 — 11. PART/LOT NUMBER: E432-741-Ø1

12. SERIAL NUMBER: 103-Ø2 — 13. SUPPLY DOCUMENT NUMBER:

14. DISCREPANCY: Force Adapter Fittings Req NDI (Magnetic Particle inspection) IAW TO 33C2-76-1 SupE

15. SHOP USE ONLY

15A. DMC/ACT ID — 15B. SHOP ACTION TAKEN

16. SUPPLY DOCUMENT NUMBER

17. NOMENCLATURE: FORCE Adapter Fittings

18. PART NUMBER: E432-741-Ø1 — 18A. WORK UNIT CODE OR LOGISTICS CONTROL NO. 27DØØ

19. NSK

20. ACTION TAKEN — 21. QTY 19 — 22. RPC USE ONLY

Figure 3–2. AFTO Form 350, front.

Inspection of repair cycle assets

As part of the Air Force QA program, maintenance and supply functions designate certain representatives to serve as inspectors. Maintenance inspectors include QA inspectors, production inspectors, and designated maintenance supervisors. These folks verify the quality of all asset maintenance including repair, overhaul, modification, local manufacture, or restoration to serviceable condition for all materials and equipment at USAF facilities. Designated maintenance inspectors will also determine the final

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Changes for the Text: 2A752 02 1703, edit code 04

Pen-and-Ink Changes:

Page-Col	***Subject***	***Line(s)***	***Correction***
1-5	202	Line 1	Change “[psi]]” to “[psi]”
1-14	201	Question 14	Change “What is the form of metallic structure?” to “What is the physical form of metals?”
1-35	205	Answer 11	Add “and casting” after “processing”
2-17	212	Question 8	Change “documenting you” to “documenting your”
4-13	216	Question 5	Change “penetrants” to “penetrates”
4-15	218	Question 2	Add “during Method C?” after “inspection process”
4-31	221	Question 17	Change “resides” to “residues”
5-30	228	Question 4	Add “be” after “typically”
5-64	236	Answer 14	Delete “Pick or brush all residues from the holes along its length.”
5-64	236	Answer 15	Add “Pick or brush all residues from the holes along its length.” after “agitator pipe.”

Changes for the Text: 2A752 03 1706, edit code 04

Pen-and-Ink Changes:

Page-Col	***Subject***	***Line(s)***	***Correction***
1-54	409	Question 8	Change “rise?” to “rises?”
3-12	421	Question 4	Change “What is the most common application of bonded structures in aircraft construction?” to “What is the most common design of a sandwich structure?”
3-22	427	Line 9	Add “.” after “impedance analysis (MIA)”
3-23	427	Fig 3-15	Delete “at right” in figure A after “laminate shown”
3-29	425	Question 4	Change “posable” to “possible”
3-31	421	Answer 4	Remove “panels.”

Page Changes:

Remove:	***Insert:***
3-1 - 3-4	3-1 – 3-4

Unit 3. Bond Testing

AN ADHESIVE IS A SUBSTANCE that adheres to two materials and bonds them together. Forms of adhesive bonding have been around for centuries. For example, adhesives obtained from bitumen (a type of asphalt) and from tar pits were used as a type of mortar by the builders of the Tower of Babel. In another application, the ancient Egyptians used adhesives made from eggs and tree resin.

Metal bonding was slow to progress and there were few advances in adhesive metal bonding technology until World War II. At that time, military needs resulted in great technological progress. Following World War II, lightweight aircraft designs using metal and honeycomb construction required the development of new methods to join and fasten structural members. One of the first developments was the formulation of adhesive from phenolic resin and neoprene rubber. Today, these adhesives join load-bearing components on aircraft. This has a great advantage of reducing concentrated stress, such as around rivets. Fatigue crack formation around conventional fasteners has been eliminated and adhesives have replaced fasteners.

The use of adhesives is now common in the manufacture of everything from toys to residential building materials to modern spacecraft.

NDI focuses on inspection of the adhesive bond itself, usually after the part has been in service for some time. The purpose of this unit of instruction is to introduce you to bonded structures, familiarize you with the various NDI bond-testing methods, and provide you with knowledge regarding the equipment you will use to perform bond inspection methods.

3–1. Principles and Standards of Bond/Composite Testing

A composite or bonded structure is one consisting of two or more material components adhesively bonded together. The individual components may be metallic or nonmetallic and contain honeycomb or other lightweight core material. Carbon/epoxy composites are bonded structures although the layers are only a few thousandths of an inch thick and lose their individual identity as the materials cure together. Delaminations or separations between individual layers can occur and be detected ultrasonically.

In this section, we will present the terminology and principles involved in bonding and bond testing, use of standards and typical defects. We will also introduce a new NDI technique called shearography used for inspecting bonded structures. Your understanding of the material we present could directly affect your ability to perform bond testing correctly.

421. Bonded structures

There are vast numbers of bonded structures and configurations used in the Air Force today. To enable you to describe disbonds, delaminations, or other discontinuities to repair technicians, you will need to understand each part of the bonded structure.

NOTE: It is beyond the scope of this career development course (CDC) to cover every known method of bond testing. Because of this, we only cover the general and specific tests you are likely to use.

Bonded structures

A bonded structure is one consisting of two or more components adhesively bonded together. The structure can be all metallic or nonmetallic, or it can consist of both types of material. A bonded structure can contain honeycomb or other type of lightweight core. Sheets of metal or nonmetal can be bonded together to provide the appropriate thickness. Carbon/epoxy composites are bonded structures although the individual layers are only a few thousands of an inch thick, and essentially lose their individual identity in the curing process. Delaminations do occur between these layers because of external impacts with foreign objects. We present some of the common bonded structural features in the following paragraphs. The features you will look at are as follows:

- Lap joint.
- Multiple laminate.
- Sandwich structure.
- Composite materials.
- Doubler.

Lap joint

The lap joint is the simplest structure that uses an adhesive application. As figure 3–1 shows, the lap joint consists of two materials held together by an adhesive. The adhesive in any assembly is *normally* referred to as the *glue line* or *bond line*. Lap joints are structures used in edge treatment for sandwich panel construction, doubler installation, laminations, and other applications where the objective is to bond two or more flat surfaces together.

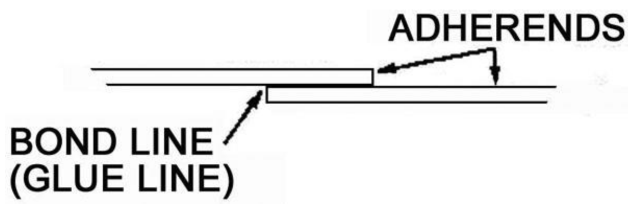

Figure 3–1. Lap joint.

Multiple laminate

Laminate structures may be in the form of a sheet or bar, composed of two or more metal layers bonded together using heat, adhesive, and pressure. The laminated metals form a structural member. This is demonstrated in figure 3–2. A good example of a multiple laminate is plywood. However, by modern aircraft standards, the strength to weight ratio of plywood is *not* very good and you will *not* likely encounter plywood as part of an aircraft.

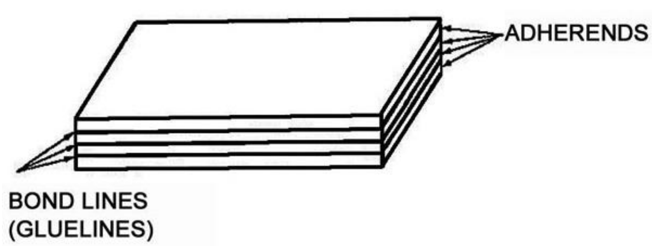

Figure 3–2. Aluminum and adhesive multiple laminate.

As you might expect, a laminate is a stack of lamina or plies built up using precise ply orientation. A better example of a multiple laminate is fiberglass. Many modern aircraft use fiberglass for the construction of radomes. In this type of construction, fiberglass is molded in multiple layers with the glass cloth strands in each adjoining layer running in different directions for added strength. Multiple laminates are normally used as face sheets, or the outside portions or skins of sandwich construction.

Sandwich structure

A sandwich structure consists of two face skins separated by a lightweight core material, and has the highest strength to weight and rigidity to weight ratios.

The *most common* design of a sandwich structure is honeycomb. Honeycomb is a light, rigid structure that is often found in wing, empennage, and control surface components.

A typical honeycomb sandwich cross-section is shown in figure 3–3. The face and back sheets are *normally* made from aluminum or composite materials. Core material can be made from almost any lightweight material with good compressive strength. The following materials are typically used for the core:

- Balsa wood.
- Foam.
- Aluminum.
- Nomex paper.
- Plastic.
- Composite materials.
- Phenolics.

Honeycomb skins carry loads from one structure to the other substructures and the core transfers loads from one skin to the other skin. This distributes the stresses throughout the structure.

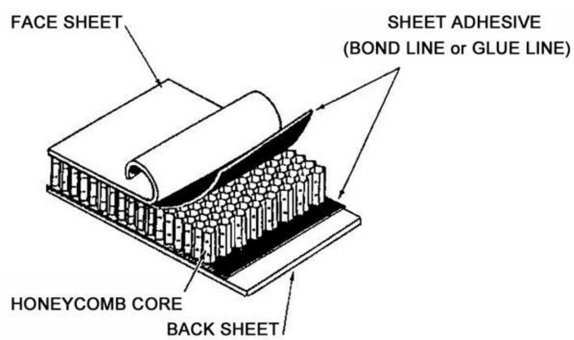

Figure 3–3. Honeycomb sandwich.

Composite materials

An advanced composite material is made of a fibrous material *embedded* in a resin matrix, generally laminated with fibers oriented in alternating directions to give the material strength and stiffness. The next lesson describes advanced composites more in detail.

Doubler

A doubler is a reinforcement structure and can be part of an original bonded structure, as shown in figure 3–4. When you are inspecting an original bonded structure, you will normally experience a doubler. By being aware of it, your testing will not produce confusing inspection results.

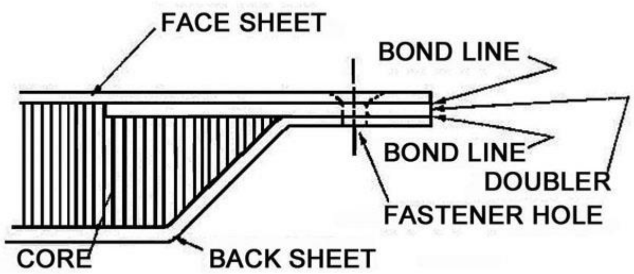

Figure 3–4. Honeycomb panel edge close out doubler.

The repair of a severe dent or a puncture involves the removal and replacement of the damaged material. Often, the repair involves adding a doubler to the structure to ensure that the strength of the honeycomb sandwich is not compromised. Adding a doubler may affect the continuity of the part and will produce varying indications when inspected. For this reason, you need to ask the aircraft structural repair technician if they know if alterations have been made to the part. This will prevent confusing inspection results, especially if a doubler is in the repair of a components back surface. Figure 3–5 shows a doubler not visible to the inspector.

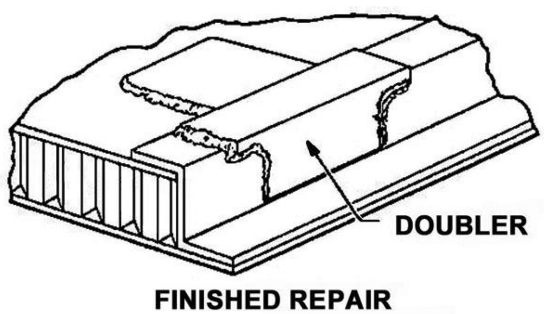

Figure 3–5. Honeycomb panel edge close out doubler.

422. Advanced composite materials

As stated before, an advanced composite is made of fibrous material embedded in a matrix. The term “advanced” applies to composites using fibers of superior stiffness and strength. Plies of this fibrous material are generally oriented in various directions to give the structure strength and stiffness superior to the fibers or matrix alone; however, fibers are chopped and spread throughout a matrix without a pattern or orientation. A good example of this is castings or moldings.

Advanced composites can present some unique problems to the NDI technician. They are a combination of two or more materials acting as one unit, but the materials retain their separate identities. It is common that the heterogeneous mass of an advanced composite is harder to inspect than a homogeneous part. In this lesson, you will study the following advanced composite subjects:

- Matrix.
- Fibers.

Changes for the Text: 2A752 04 1706, edit code 04

Pen-and-Ink Changes:

Page-Col	***Subject***	***Line(s)***	***Correction***
3-7	617.	14 from the bottom	Delete “to” after “engine was considered”

Student Notes

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