When investigating damage to an aircraft, it is necessary to make an extensive inspection of the structure. When any component or group of components has been damaged, it is essential that both the damaged members and the attaching structure be investigated, since the damaging force may have been transmitted over a large area, sometimes quite remote from the point of original damage. Wrinkled skin, elongated or damaged bolt or rivet holes, or distortion of members usually appears in the immediate area of such damage, and any one of these conditions calls for a close inspection of the adjacent area. Check all skin, dents, and wrinkles for any cracks or abrasions.

Nondestructive inspection methods (NDI) are used as required when inspecting damage. NDI methods serve as tools of prevention that allow defects to be detected before they develop into serious or hazardous failures. A trained and experienced technician can detect flaws or defects with a high degree of accuracy and reliability. Some of the defects found by NDI include corrosion, pitting, heat/stress cracks, and discontinuity of metals.

When investigating damage, proceed as follows:

- Remove all dirt, grease, and paint from the damaged and surrounding areas to determine the exact condition of each rivet, bolt, and weld.
- Inspect skin for wrinkles throughout a large area.
- Check the operation of all movable parts in the area.
- Determine if repair would be the best procedure.

In any aircraft sheet metal repair, it is critical to:

- Maintain original strength,
- Maintain original contour, and
- Minimize weight.

Maintaining Original Strength

Certain fundamental rules must be observed if the original strength of the structure is to be maintained.

Ensure that the cross-sectional area of a splice or patch is at least equal to or greater than that of the damaged part. Avoid abrupt changes in cross-sectional area. Eliminate dangerous stress concentration by tapering splices. To reduce the possibility of cracks starting from the corners of cutouts, try to make cutouts either circular or oval in shape. Where it is necessary to use a rectangular cutout, make the radius of curvature at each corner no smaller than ½-inch. If the member is subjected to compression or bending loads, the patch should be placed on the outside of the member to obtain a higher resistance to such loads. If the patch cannot be placed there, material one gauge thicker than the original shall be used for the repair.

Replace buckled or bent members or reinforce them by attaching a splice over the affected area. A buckled part of the structure shall not be depended upon to carry its load again, no matter how well the part may be strengthened.

The material used in all replacements or reinforcements must be similar to that used in the original structure. If an alloy weaker than the original must be substituted for it, a heavier thickness must be used to give equivalent cross-sectional strength. A material that is stronger, but thinner, cannot be substituted for the original because one material can have greater tensile strength but less compressive strength than another, or vice versa. Also, the buckling and torsional strength of many sheet metal and tubular parts depends primarily on the thickness of the material rather than its allowable compressive and shear strengths. The manufacturer's SRM often indicates what material can be used as a substitution and how much thicker the material needs to be. *Figure 4-169* is an example of a substitution table found in an SRM.

Care must be taken when forming. Heat-treated and cold-worked aluminum alloys stand very little bending without cracking. On the other hand, soft alloys are easily formed, but they are not strong enough for primary structure. Strong alloys can be formed in their annealed (heated and allowed to cool slowly) condition, and heat treated before assembling to develop their strength.

The size of rivets for any repair can be determined by referring to the rivets used by the manufacturer in the next parallel rivet row inboard on the wing or forward on the fuselage. Another method of determining the size of rivets to be used is to multiply the thickness of the skin by three and use the next larger size rivet corresponding to that figure. For example, if the skin thickness is 0.040-inch, multiply 0.040-inch by 3, which equals 0.120-inch; use the next larger size rivet, ⅛-inch (0.125-inch). The number of rivets to be used for a repair can be found in tables in manufacturer's SRMs or in Advisory Circular (AC) 43.13-1 (as revised), Acceptable Methods, Techniques, and Practices—Aircraft Inspection and Repair. *Figure 4-170* is a table from AC 43.13-1 that is used to calculate the number of rivets required for a repair.

Extensive repairs that are made too strong can be as undesirable as repairs weaker than the original structure. All aircraft structure must flex slightly to withstand the forces imposed during takeoff, flight, and landing. If a repaired area is too strong, excessive flexing occurs at the edge of the completed repair, causing acceleration of metal fatigue.