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AIRTRANS URBAN TECHNOLOGY PROGRAM
PHASE II

IRAN PROGRAM
Inspect, Repair As Necessary on the AIRTRANS AGT Vehicle

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AUGUST 1978

TOPICAL REPORT

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16. Abstract

This is a report on the AIRTRANS Inspect Repair as Necessary (IRAN) project performed under the AIRTRANS Urban Technology Program, Phase II. The main objective was to critically evaluate the condition of an AGT vehicle after 268,000 miles and five years of operation and to provide a guide for the establishment of IRAN plans for future AGT systems as they are deployed in an urban environment. A program plan was developed to systematically inspect, and repair as required, the structural and other subsystems of the vehicle in operation at the Dallas/Ft. Worth Airport. The approach included Non-Destructive Tests (NDT) procedures, including radiograph, and dye penetration. The use of a high-powered magnifying lens with bright lighting conditions was also employed in the inspection procedures. The detailed inspection revealed a sound frame and chassis construction with no evidence of cracking in the welded structure. The other subsystems that were inspected, such as the suspension and drivetrain, displayed the normal wear patterns. Repairs were made on the acrylic/fiberglass exterior body panels. Subsequent followup revealed these repairs generally failed, as have previous repair attempts. Repairs were made to the vehicle roof because of a temperature related problem with the acrylic/fiberglass construction.

The result of the project indicates that the maintenance procedures developed for this system are excellent. With the exception of the exterior body panels, the vehicle appears capable of attaining the 20-year service life. A five-year IRAN program is recommended to assure continued high performance.

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SUMMARY

This report describes the Inspect Repair As Necessary (IRAN) Project, one of the Program tasks of the Vought Corporation, an LTV Company, during Phase II of the AIRTRANS Urban Technology Program (AUTP). This project evaluated the condition of a Automated Ground Transportation (AGT) vehicle after 268,000 miles and five years of operation.

In as much as AIRTRANS was a pioneering AGT project, there was no extensive data base for maintenance programs to build on, and the concept of an IRAN program was conceived, similar to programs in commercial and military aircraft as well as the trucking industry.

The objective of the program was to critically evaluate the condition of the vehicle and assure that it will provide continued availability for revenue service and operations and to provide a guide for the maintenance of all AGT systems as they enter urban environment. The inclusion of this program into the maintenance concept of AGT systems will provide intermediate support to the total service life of the vehicle.

AIRTRANS is the largest and one of the most complex AGT systems in the world. The complexity of the system is evidenced by the fact that it makes 16,212 passenger station stops per day, and with the full system operating, 92,600 switch calls per day. This translates into approximately 300 station stops and 2,000 switch calls for each vehicle each day. These vehicles provide service between four passenger terminals, two remote parking areas and a hotel. The system uses 12.8 miles of guideway at the Dallas/Fort Worth Regional Airport. Each vehicle travels approximately 200 miles each day in providing this service to passengers and employees at the airport.

An Inspect, Repair As Necessary (IRAN) program was completed on AIRTRANS passenger vehicle number 26. This vehicle was chosen for the IRAN because it was the first vehicle produced, and had accumulated over a quarter of a million miles in revenue service operations.

A preliminary IRAN plan was developed using the analytical critical inspection techniques as used by the United States Air Force. This technique is the systematic disassembly and inspection to locate hidden defects, deteriorating conditions, corrosion, fatigue and overstress. The extent of disassembly and the type and scope of the inspection is intended to reveal damage or deteriorated conditions which would not normally be discovered during normal scheduled inspections. Non-destructive testing, such as dye penetrant, and radiographic inspection was performed to provide in-depth assurance that structural defects were not present in the components or vehicle structure.

The subsystems of the vehicle were inspected according to the plan and repairs or replacements made as required.

The findings of the inspection indicate the preventive maintenance program developed for the vehicles is satisfactory. The repairs primarily centered in the steering and guidance systems, which is understandable since these systems are constantly in use in the movements of the vehicle. The suspension system repairs involved replacement of the rubber air springs which had worn areas because of rubbing on the mud flaps and some cracking and

deterioration of the exterior rubber because of age. Components of the drive train system were in good condition. The moisture extraction units of the pneumatic system were examined and considered to be only partially operational. These units were cleaned and reinstalled. The chassis and body frame alignment and condition presented no problem areas.

The vehicle body panels are constructed with an acrylic exterior surface backed by fiberglass. Swedglas was selected because of its outstanding formability, acoustical and insulation treatment and vandal resistance, but primarily for the acrylic's durability and color stability - the latter proven by the vehicle's finish after five years of service at D/FW. These panels have experienced cracking, particularly in the window radius and in the emergency door. Repair procedures were developed by the panel manufacturer and applied on numerous occasions; however, these repairs were not successful. Additional repairs were attempted prior to IRAN, using automobile body putty, and these also proved unsuccessful. Repairs made by bonding an aluminum plate to the fiberglass surface and applying an epoxy repair to the acrylic surface were monitored for three months. The repair appeared to be satisfactory; however, this repair procedure has not been effective, since cracking has reappeared. These cracks are usually surface cracks in the acrylic and do not affect operation, but affect only the aesthetics of the vehicle. The roof panels have experienced thermal deflections that result in gaps between the roof and side panels. Structural loads, thermal exposure and stress concentrations influence the panels, making repairs quite difficult. Repairs were made to the vehicle roof because of a temperature related problem with the acrylic/fiberglass construction. The end doors were sagging, partially due to the weight of the door and delayed maintenance. Repairs and adjustments were made to the hinges to realign the doors. Some corrosion was found under the door threshold, some rust on the AC/DC circuit breaker boxes, and these areas were treated to arrest further activity. The vehicle interior was meticulously cleaned and the exterior end panels repainted.

As a result of this pilot program, it is strongly recommended that an IRAN program be included in the maintenance programs of all AGT vehicles presently in service and those for future urban deployment. Additional information on IRAN is located in the Introduction. The frequency of the program will be dependent upon many factors such as, miles accumulated, environment, usage, and time. This program should be conducted at five-year intervals for the AIRTRANS vehicles to provide the intermediate support to the total service life of the vehicle. The current AIRTRANS scheduled maintenance program for the vehicles should be revised to include additional tasks for moisture ejectors and filter in the pneumatic system. End door design improvements are recommended to reduce the weight, which will also decrease the maintenance actions and cost. An undercar cleaning program should be implemented in the maintenance of the AGT vehicles. This will increase the capability of detecting problem areas during the scheduled inspections and reduce unscheduled maintenance and disruption of service operations.

1.0 INTRODUCTION

Objectives

Two objectives were deemed essential in the development of the AIRTRANS Inspect Repair As Necessary (IRAN) Program. The major objective was to assure that the vehicles would be in condition to provide continued availability for revenue service and operations. The secondary objective was to provide an in-depth inspection to evaluate the planned maintenance programs, to ascertain if the subsystems were satisfactorily maintained and to maximize the service life while minimizing the operational costs without negating vehicle safety requirements.

Background

IRAN programs for military aircraft, as well as commercial, have been in use for many years. They have been beneficial in attaining the projected service life and extending the life in many types of aircraft. In recent years flexibility has been introduced into the program, particularly with Navy aircraft. These aircraft are not necessarily on a rigid IRAN schedule, but are inducted into the program through a sampling procedure and on the basis of flying hours and calendar time.

The trucking industry follows a similar program in the maintenance of the highway trucks. There are no rigid scheduled programs for these vehicles, however, at an interval between 200,000 and 300,000 miles some fleet operators perform an inspection and repair procedure. This program involves engine, transmission or drive train, steering and brake systems, teardown and replacement of parts as necessary. This program extends the service life of the equipment and keeps most breakdown expenses within reasonable cost range.

Prior to AIRTRANS' becoming operational, maintenance concepts were established and approved for the system. Inasmuch as this system was pioneering the AGT industry, major overhaul periods were discussed. However, these were not implemented since data on this type of transportation did not exist in the depth necessary to establish documented rationale for overhaul periods. Since each of the passenger vehicles was approaching a quarter of a million miles, the IRAN concept was conceived for an AGT system. The vehicle selected for the exploratory investigation had 268,000 miles and was the first vehicle produced by Vought Corporation in 1972.

The AIRTRANS Maintenance Department selected vehicle number 26 for this project. After selection, the maintenance records of this vehicle were examined to determine what maintenance actions had been taken on the various systems identified within the scope of this program. These systems which are not addressed in this report were excluded by AIRTRANS Maintenance Department direction.

The IRAN program should not be compared directly with an overhaul program. The primary difference is the in-depth inspection of critical areas, items and components which are not normally addressed during normal scheduled preventive maintenance. These items are then evaluated, based upon engineering drawings, engineering judgment and the experience of the inspector/

quality control personnel as to whether the item is, (a) satisfactory for continued service, (b) repaired and placed into service or, (c) replaced with a new item. This process differs from an overhaul concept which removes, repairs and/or replaces items or components after a specified time, event or mileage, regardless of condition.

2.0 IRAN PROGRAM

2.1 IRAN PROGRAM PLAN

An AIRTRANS IRAN program plan was developed prior to the actual disassembly of the vehicle and was designed to provide structural (frame and chassis) system and component inspection, defect correction, modification and preventive maintenance. This plan was used as a guideline throughout the IRAN program and updated as necessary. Appendix A of this report includes the changes to the plan resulting from the experience gained with vehicle number 26. This plan used the concept of Analytical Critical Inspection (ACI) techniques, which has been successfully used in military aircraft inspection. This technique is the systematic disassembly and inspection to locate defects, deterioration, corrosion, fatigue, and overstress. The depth of disassembly and the type and scope of the inspections/tests was intended to reveal conditions which are not normally discovered during routine, scheduled inspections.

After the plan had been formalized, Work Item Instruction Sheets were developed to define each inspection or work task. These sheets indicated detailed tasks involving the removal, disassembly, inspection, and reassembly of the various components of the vehicle, as indicated in Figure 2-1. These sheets also provided the avenue for additional tasks not originally programmed. For example, within the pneumatic system, the Salem centrifugal filter was not considered in the program since it is basically a self cleaning unit. When the disassembly of the vehicle began, a column of fluid was noted in a control line connected to the filter. The filter was disassembled and oil/water sludge was found. This sludge severely reduced the filter's capability.

As the vehicle and components were disassembled, the inspector recorded conditions on the AIRTRANS Discrepancy Sheet (Figure 2-2), which lists the vehicle number, part number, nomenclature, and date. Disposition of the discrepancy was made by the engineer assigned to the program. The disposition may require repair, replacement, or may be accepted for continued service. The action to be taken was recorded, and the discrepancy sheet was completed. Each sheet was signed by the inspector and engineer as work was completed.

2.2 IRAN PROGRAM PROCEDURE

The vehicle was disassembled in the following sequence:

a) Guidebars and Power Collectors
b) Steering/Guidance
c) Axles
d) Suspension
e) Pneumatic Storage Tanks
f) Seats
g) Windows
h) Interior Panels and Stanchions
i) Interior Light Fixtures

The propulsion motor, motor controller and air conditioners, previously removed by AIRTRANS Maintenance and refurbished on a scheduled program, were excluded from this effort. With the above items removed, the underside of the chassis was available for detailed inspection.

AIRTRANS IRAN WORK ITEM INSTRUCTION	
VEHICLE NO. 26	DATE April 14 NO. 26A
ORIGINATED BY: D. L. Hawkes	[x] REMOVE ☐ INSPECT ☐ REPAIR

Suspension System.

Separate the 240-25003 Axle hanger assembly and the 90515229 Equalizer Beam Assy by removing the inner and outer 90001002 Bushings.

Inspect the Equalizer Beam for corrosion and condition in the area of the joint. Use boroscope if necessary.

Inspect the weld with dye penetrant or X-Ray.

Inspect the welds in the area where the transverse beam attaches to the equalizer beam with dye penetrant or X-Ray.

ACCEPT/REJECT CRITERIA

Figure 2–1 AIRTRANS IRAN WORK ITEM INSTRUCTION

MODEL AIRTRANS	AIRTRANS DISCREPANCY SHEET	SHEET NO. 23X
VEH. NO. #26		DATE 4/18/78
PART NO. ABWT 8V		PART NAME Bearing

DISCREPANCY

Bearing in 240-26044-104 Support Assy has excessive play and has moved in casting.

INSPECTOR D M Johnson

DISPOSITION

Replace bearing.

ENGINEER	DATE
Van W. Hall	4/19/78

Figure 2–2 AIRTRANS DISCREPANCY SHEET

The inside furnishings of the car were removed and stored, providing complete access to the upper-frame structure, roof and exterior panel attachments.

The disassembly inspection of the components was accomplished using blueprints and AIRTRANS Engineering Directives to verify the correct dimensions. Accurate measurements were made on all wear areas and variations recorded. Dial-bore Gages, Inside and Outside Micrometers, Vernier calipers, and a calibrated surface plate were used for these measurements.

The interiors of the suspension system tanks and the pneumatic system storage tanks were inspected using a borescope. This instrument provided the capability to critically inspect the interiors of the tanks.

2.3 IRAN FINDINGS BY SYSTEM/COMPONENT

2.3.1 Vehicle Structure

2.3.1.1 Vehicle Frame

The upper frame structure, which supports the roof, side and end panels, was cleaned at the weld areas and visually inspected. The welds at the corners and door openings were cleaned and inspected with dye penetrant. No evidence of corrosion or weld cracks/separation was found.

The upper frame was measured to ascertain if there had been any creep or shifting of the structure. Measurements were taken from end to end and diagonally from top to bottom. The same technique was used for side-to-side measurements. These measurements were taken at each end and at the center door opening of the vehicle. There were no deviations from the as-built dimensions.

2.3.1.2 Vehicle Chassis

The chassis was completely inspected for any abnormalities. Accessible welds were inspected visually. All welds for the suspension-system brackets were inspected using dye penetrant for structural integrity. Each of these inspections revealed no structural deformities or problem areas.

2.3.1.3 Vehicle Floor

The vehicle floor is marine-type plywood which has been treated with an undercoating on the bottom side. A sharp pointed pick was inserted into the floor at several areas, particularly around the vehicle door areas. This technique is standard procedure for determining dry rot and termite damage in wood and is not harmful to the structure when used prudently. No evidence of deterioration of the plywood floor was found.

2.3.1.4 Door Threshold

The bi-parting door threshold was removed primarily for the excessive wear in the slot for the lower guide of the door. This wear occurred in four places along the slot, particularly in the door closed portion where the round teflon buttons attached to the door contact. The worn areas were welded using Heliarc equipment, and the slot was machined to the proper dimension.

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To prevent additional wear of the threshold, the teflon buttons were removed and replaced with flat rectangular strips of teflon. These rectangular strips, having a greater surface area, should minimize the localized wear.

On removal of the threshold, an area was discovered near the aft door post on the underside that had moderate to heavy corrosion. The threshold rests on the plywood floor and there is no contact with the steel post in this area which precludes electrolysis. The corrosion was removed, the threshold treated with aladine solution, and two coats of zinc chromate primer were applied to the underside of the threshold.

2.3.2 Drive Axle System

The drive axle disassembly and inspection began at the planetary hubs and worked progressively to the differential. Measurements were obtained at the wear points. The wheel-bearing inspection did not show any appreciable wear; however, these were replaced as a precautionary measure and to eliminate additional maintenance at a later date.

2.3.2.1 Differential Assembly

The differential ring and pinion-gear assembly was removed, cleaned and inspected. The ring and pinion gear wear pattern was normal when compared to the manufacturer's maintenance manual photographs of normal and abnormal gear wear patterns. Additional expertise was solicited from an independent repair facility specializing in this axle. The remaining components were in good condition. The lubricant was inspected and found free from foreign matter. No metal chips were found in the systems or on the magnetic drain plug.

2.3.2.2 Drive Axle Assembly

The drive axles were removed, cleaned and inspected with radiographic equipment. The inspection revealed no latent defects in either the long or short axles. An excessive amount of grease/universal joint lubricant was found in the cavity of the axle housing. High pressure lubrication of this joint can damage the bearing seals. The universal joint was inspected, greased and reassembled since no apparent wear was detected.

2.3.2.3 Axle Housing

There have been numerous occurrences on other vehicles where the upper quadrant of the differential bowl has developed a crack in the weld and allowed the gear lubricant to leak out. As a result, the exterior surfaces of the axle housing were thoroughly cleaned, particularly in the differential bowl area. This area was visually inspected with a high-intensity light and a seven-power lens. A second inspection, using NDT dye penetrant procedures was made of the same area. No defects surfaced from either of these examinations.

The axle-housing bearings and seals (inside the housing) which supports the drive axle and retains the lubricant were inspected for condition. The bearings did not indicate any eccentricity and the seals did not show any wear or damage.

2.3.2.4 Steering Knuckles

These components attach to each end of the axle housing through the kingpins and bearings. The left and right knuckles are interconnected by a tie rod and provides steering geometry for the vehicle. This first production vehicle had marginal clearance for the tie rod movement between the equalizer beams on the suspension system. In this configuration, the tie rod mounted to the steering knuckle arm from the bottom. To provide added clearance a steering knuckle modification was made in which the tie rod mounted to the top of the knuckle arm. The configuration change of the steering knuckle created a reconfigured offset tie rod because of the mounting change. This modification of the steering knuckles updates this vehicle to the subsequently produced vehicles.

The steering knuckle and kingpins were removed, and the kingpins and bushings were inspected, revealing moderate wear. The kingpins and bushings were replaced and the modified steering knuckle and tie rod were installed.

2.3.3 Steering System

The steering system had the most wear of all systems examined. This can be anticipated since it is a relatively complex system, required because all wheels are steerable and the vehicle is capable of travel in either direction. Additionally, steering is required when the vehicle is removed from the guideway for maintenance. Figure 2-3 shows the steering system arrangement. Each of the components within the system will be addressed individually.

2.3.3.1 Coupler/Towing Attachment Assembly

This assembly is composed of a vertical pin mounted to the vehicle chassis, a fitting which has provisions to accept a bar to couple vehicles, and a bellcrank to attach a tow bar that inputs steering commands. The bellcrank bearing had a few vertical scores (one considered moderate); some rust and radial scratches were noted. These conditions were cleaned up and considered acceptable for reinstallation. The acceptability of these parts is a matter of judgment by the inspectors and the engineers which is based upon experience.

A grease fitting was installed on the boss of the bellcrank to lubricate the bearing and reduce the wear and rust. The rod end which attaches to the bellcrank from the axle steering was replaced because it was badly worn and corroded.

2.3.3.2 Guide Bar Assembly

One guidebar was cleaned using a grit blast process. This cleaning was not continued because a possible defect could be masked or camouflaged and hinder the dye penetrant and zyglo inspection methods. The cleaning procedure used for all other components was pressure-sprayed safety solvent or tricloroethane degreasing solvent.

The guide bar, after being properly cleaned, was inspected visually using a high-intensity light and a seven-power lens. All welded areas were checked using the dye penetrant NDT technique. No weld cracks were found.

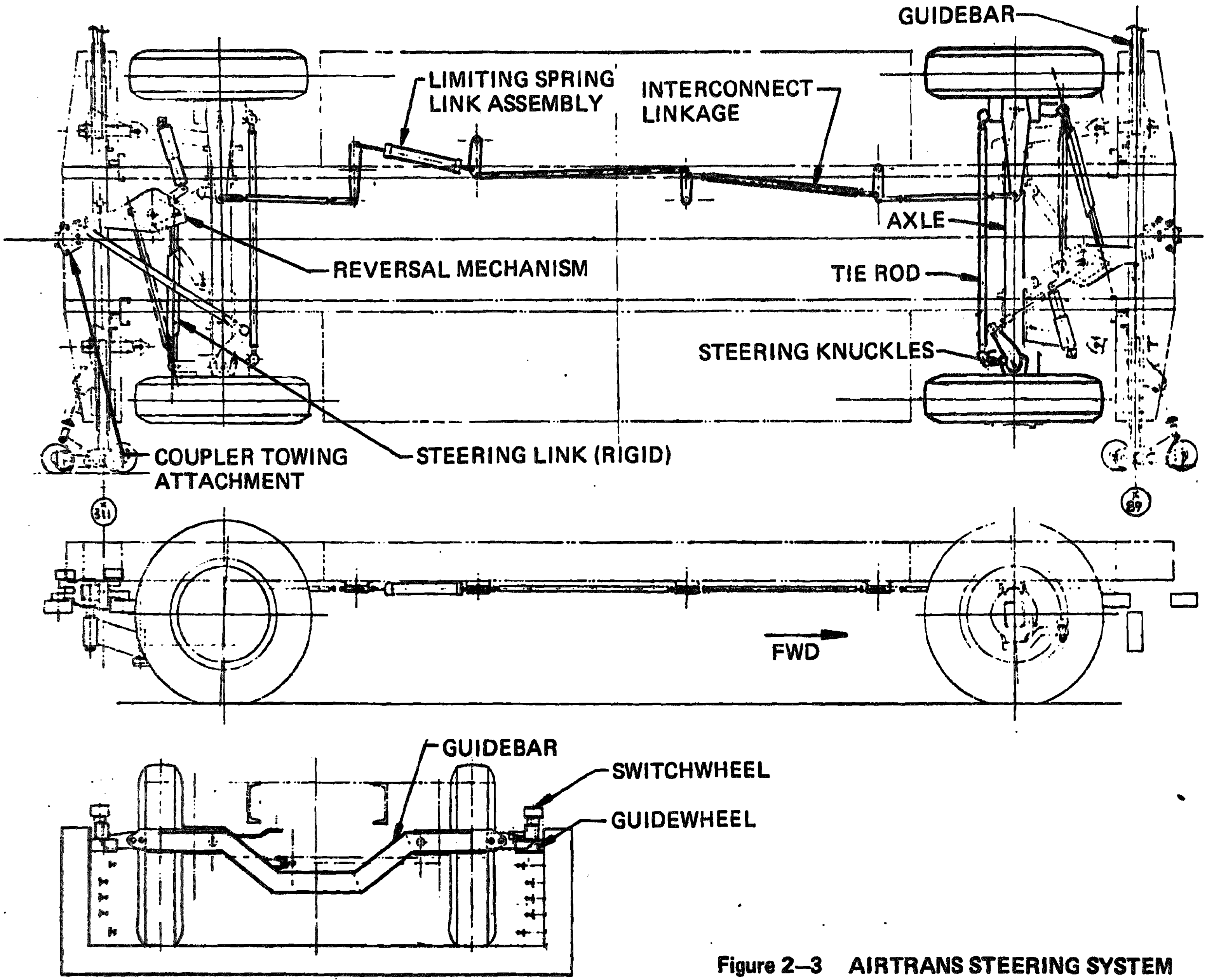

Figure 2–3 AIRTRANS STEERING SYSTEM

A sealant was applied to two areas in which water could collect and cause corrosion.

The guidebar bushing which interfaces with the left-hand pivot fitting of the hanger assembly exceeded the wear tolerances, and was replaced.

The guide bars, after being repaired, were phosphate treated, primed and painted.

2.3.3.3 Guidebar Hanger Assemblies

The hanger assemblies displayed the most wear of the components inspected. This wear was primarily associated with the bearings, which were rough and rusted. The lower bearings had more severe wear than the upper bearings. All bearings and shafts were replaced. Excessive high pressure lubrication of these bearings has the potential to damage the seals associated with the bearings. As seal damage occurs, water and moisture are allowed to penetrate the bearings and cause rust and wear.

2.3.3.4 Steering Reversal Actuator

The preliminary inspection of the actuator revealed moderate looseness and wear. The actuator was disassembled for a detailed inspection.

The steering-rod-end bearing within the actuator was loose within the rod end. Investigation revealed that the staking points had broken. The bearing was restaked, which eliminated the looseness.

The steering reversal actuator lug was worn, and the sleeve insert was loose. The lug hole was slightly elongated. A repair was made by line reaming the hole to eliminate the elongation and press fitting a steel bushing into the hole. The bushing hole diameter was then reamed to the correct size.

The lock, ring arm and key parts were worn to the extent that the actuator would not lock into position. These parts were removed and replaced with new parts.

2.3.3.5 Steering Interconnecting Linkage

All of the push rods, bell crank assemblies, yoke ends, and bearings were inspected for corrosion and wear condition. Each of the push rods was inspected using a dye penetrant test for cracking.

The limiting spring link assembly was removed and disassembled. This unit showed no sign of wear or corrosion and was regreased and reassembled.

2.3.4 Suspension System

The suspension system was disassembled and each component inspected. Figure 2-4 illustrates the suspension system arrangement.

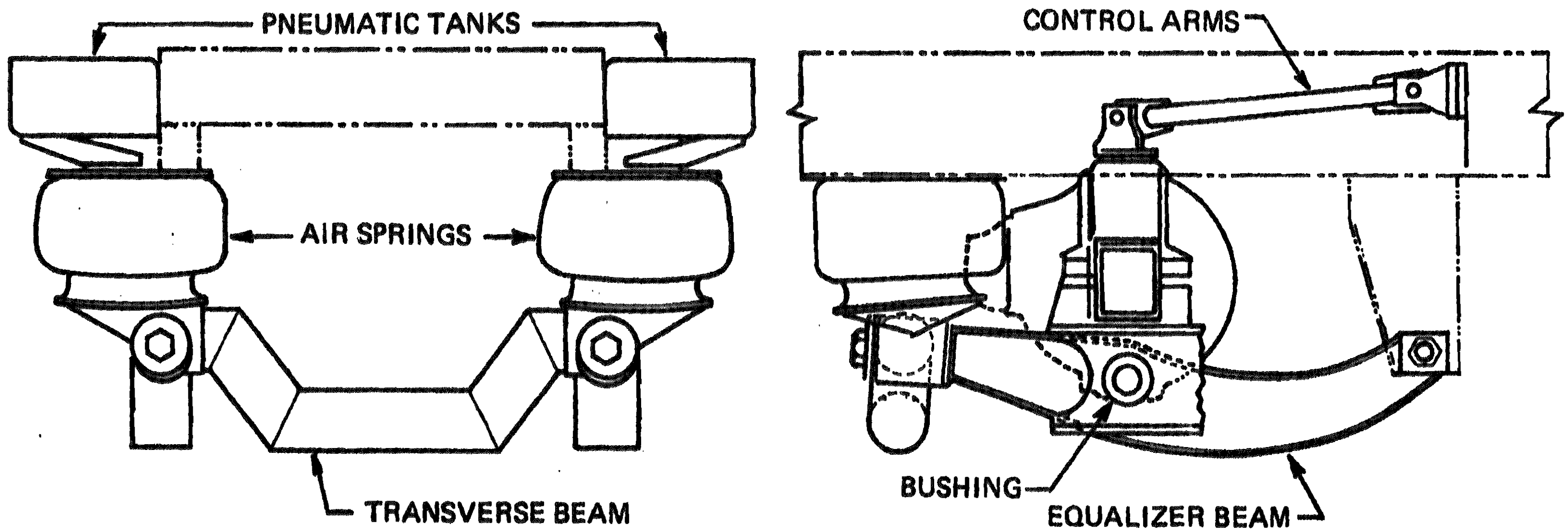

Figure 2—4 SUSPENSION SYSTEM DIAGRAM

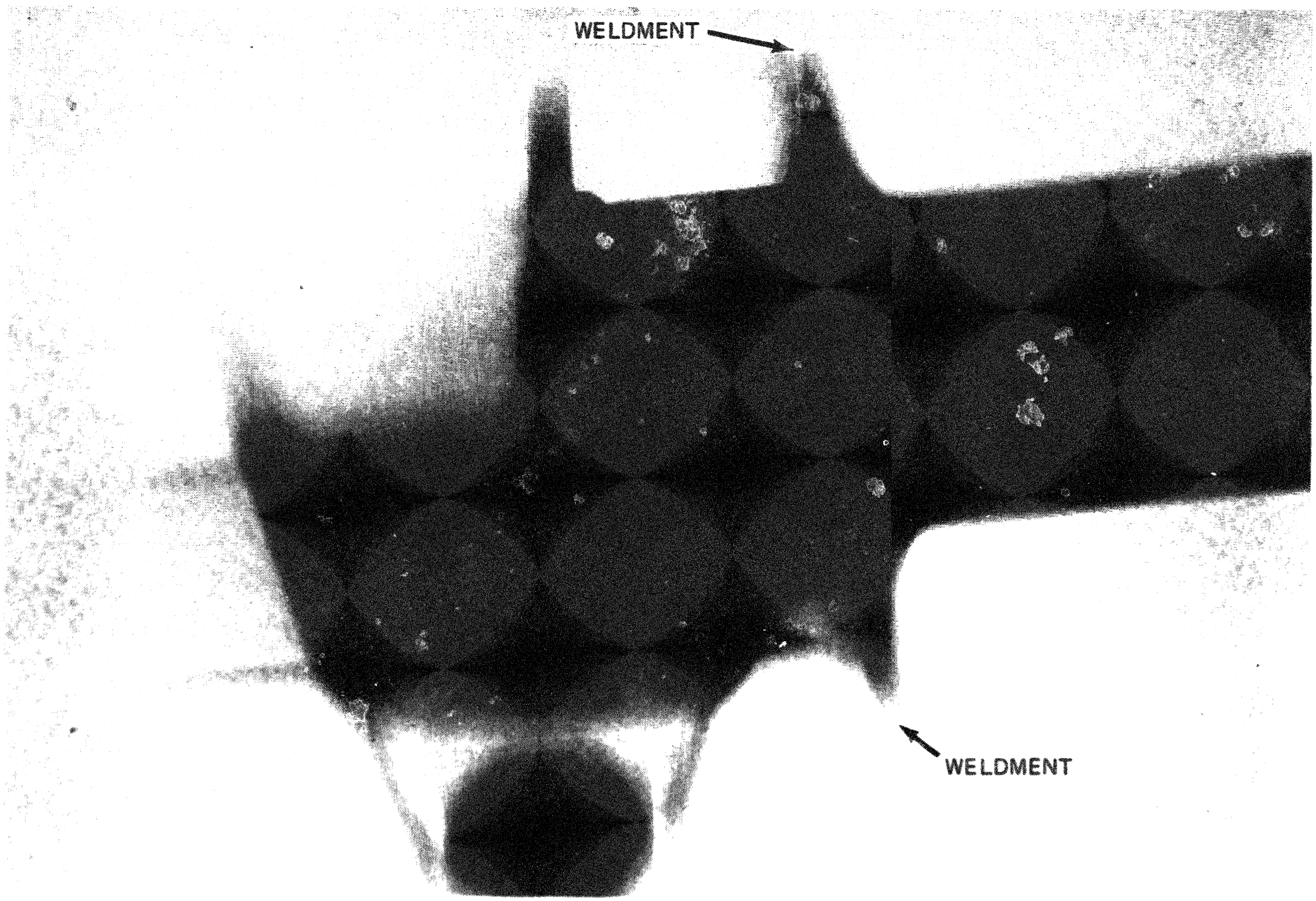

Figure 2—5 EQUALIZER BEAM X-RAY

2.3.4.1 Equalizer Beams

The equalizer beam assemblies were disassembled and examined for condition. There was moderate to heavy corrosion on the steel bushing within the rubber bushing. This condition is not hazardous or considered dangerous. The design of the assembly allows moisture to enter the area between the inner and outer rubber bushings to form rust. The bushings were cleaned and a zinc chromate primer applied to prevent the corrosion. The beams were inspected visually and with dye penetrant process to locate any cracking within the welds. No evidence of cracks was found. This process has been successfully used to determine cracks in the structure on other vehicles. One beam, selected at random, was subjected to a radiographic inspection. Each end and the center section were x-rayed to verify the other inspection procedures. Figure 2-5 shows an x-ray view of one end of the beam which attaches to the transverse beam. This area is of particular interest since a few beams have experienced some cracks.

2.3.4.2 Transverse Beam

The transverse beams were cleaned and visually inspected for condition. The weld areas were also inspected using dye penetrant to detect any cracks. The beams were checked for torsional deformation by placing the flat circular plates, which normally attach to the air springs, on a calibrated surface plate and measuring for any deflection. These beams were properly aligned and displayed no cracks in the welds.

2.3.4.3 Air Springs

The air springs were inspected visually for cracking and deterioration. These air springs which are cylindrical in form and constructed of rubber did display a moderate amount of cracking and deterioration, particularly on the lower end where the attachment to the transverse beam is located. Further examination revealed a wear area on the side of the spring. This wear, a vertical line approximately three (3) inches long and one-fourth (1/4) inch wide, cut a groove in the spring through the fabric and into the second ply of the construction. This wear was created by the vehicle tire mud flap rubbing with the spring. As the vehicle moved vertically up and down to accommodate loads and station alignment, the wear would occur. The mud flaps were secured to the vertical structure of the pneumatic compressor/alternator compartment and the AC/DC panel boxes. The other two mud flaps were cut and trimmed locally to preclude the interaction of the air spring and flap. The wear on the air spring is shown in Figure 2-6. All air springs were replaced to preclude an air spring failure.

2.3.4.4 Air Tank Assembly

All suspension air tanks were removed and inspected using a boroscope for the detailed inner tank examination. A pressure test was not considered a requirement for this inspection, since the tanks are low pressure (under 100 psi) and each tank is equipped with a safety valve. There was no corrosion or sediment in any of the tanks. All tanks were flushed, dried and reinstalled.

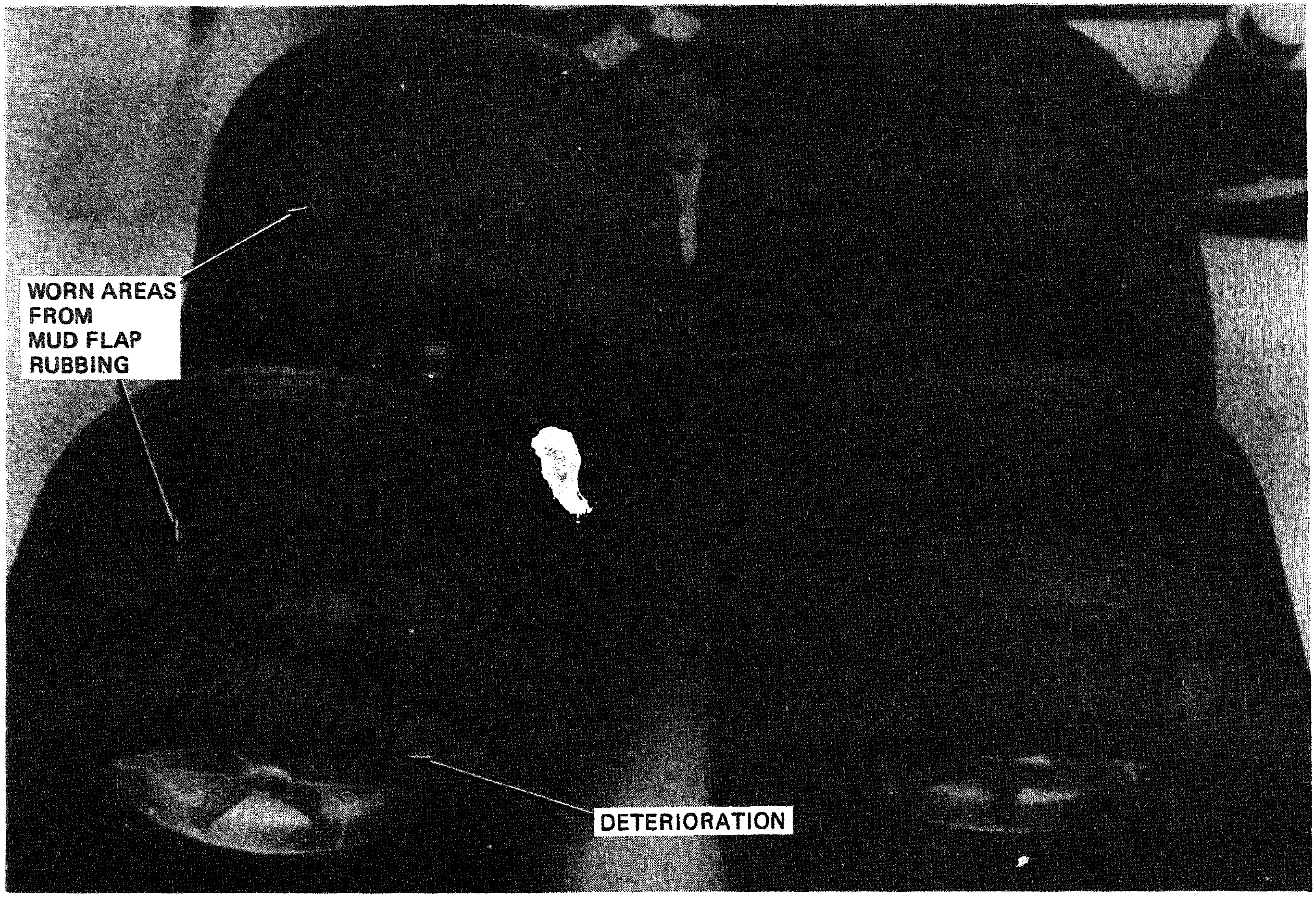

Figure 2–6 AIR SPRINGS

2.3.4.5 Control Arms

The control arms were removed and inspected. bearing wear was apparent due to considerable fore- and aft-movement. Also, the pins were worn four to five-thousandths of an inch, which contributed to the motion. All control arms and pins were replaced.

2.3.5 Electrical System

The electrical system of the vehicle was thoroughly inspected. The AC and DC systems were examined for corrosion (particularly at the connectors), chafing and fraying insulation. None was found. A dielectric withstand test was applied to the 480 VAC system, and no evidence of insulation breakdown was found.

2.3.5.1 AC Power Panel

The AC power panel is a rectangular metal box with a hinged door, mounted to structure from the bottom of the box. A space exists between the structure and the bottom of the box which is approximately 0.125 inch.

The wiring and components of the panel revealed no corrosion, wear or chafing. However, the panel was removed; and moderate to severe rust was found on the bottom exterior of the panel. This was attributed to the periodic washing of the vehicle and the environment in which the vehicle is operated. The corrosion was removed, and the exterior was treated with zinc chromate primer paint and sprayed with polyurethane paint.

2.3.5.2 DC Power Panel

The DC electrical system was inspected visually, and the wiring was considered satisfactory. Most of the wiring is environmentally protected, and as all of the system is low voltage, a dielectric withstand test did not seem warranted under this program.

The same conditions found on the AC panel were noted internally and externally on the DC panel. This panel received the same preventive maintenance procedure as applied to the AC panel.

2.3.5.3 Interior Lighting

The interior, florescent light fixtures were inspected and examined for condition. The two center fixtures were cracked along the end seams and slightly deformed. This condition was attributed to improper shimming during previous removal and installation operations. The two forward fixtures also displayed distortion to the extent that the florescent bulbs were loose in the sockets.

Arcing was noted in the bulb sockets. This arcing was moderate to severe in several of the fixtures. All of the bulb sockets were replaced, using a new type of socket with a positive locking feature. Each socket was installed to allow no more than 0.10 inch total lateral travel of the bulb. This assured a positive engagement which should eliminate arcing problems. This modification was incorporated in an Engineering Directive at AIRTRANS Maintenance.

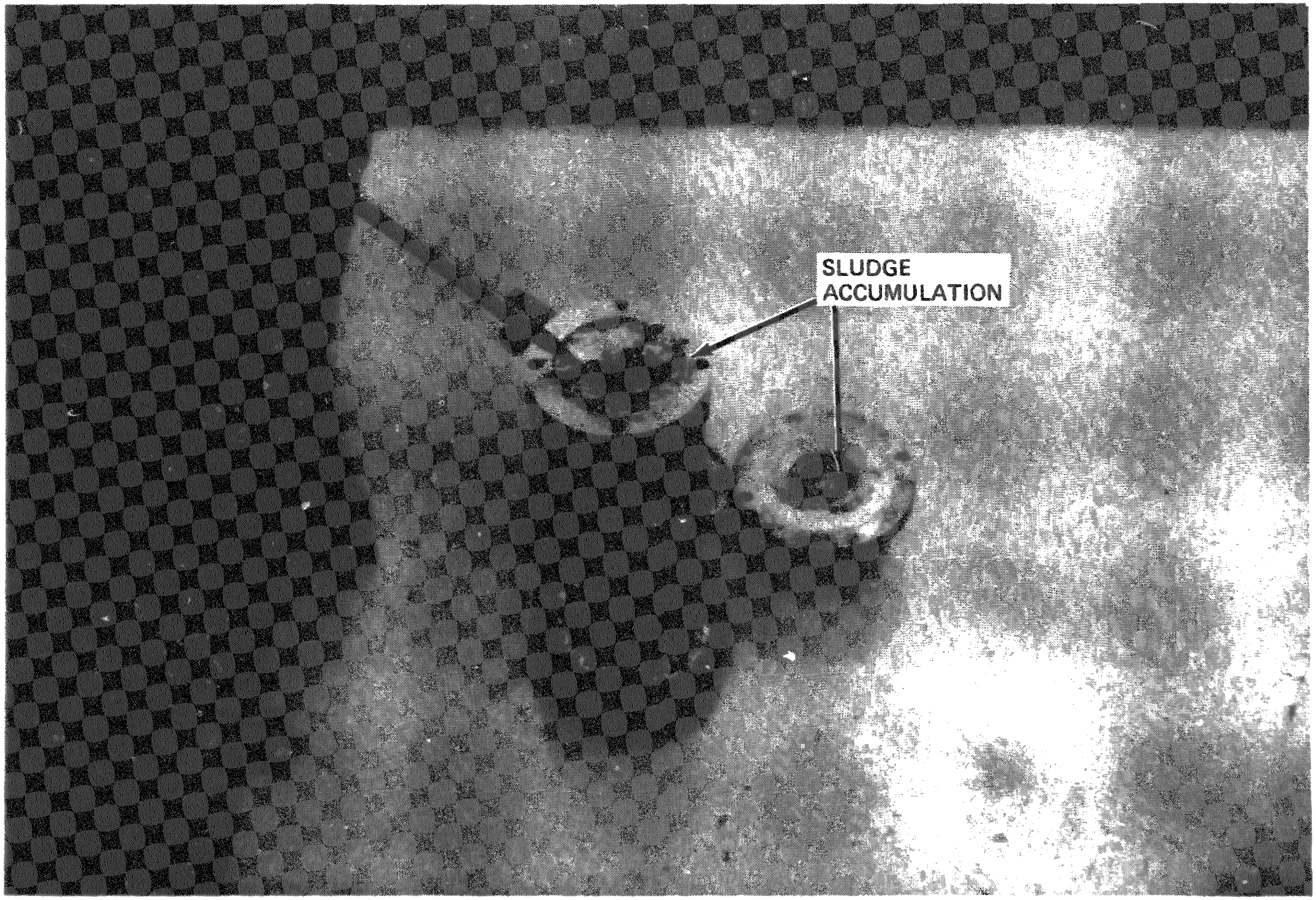

Figure 2–7 PNEUMATIC SYSTEM MOISTURE EJECTOR

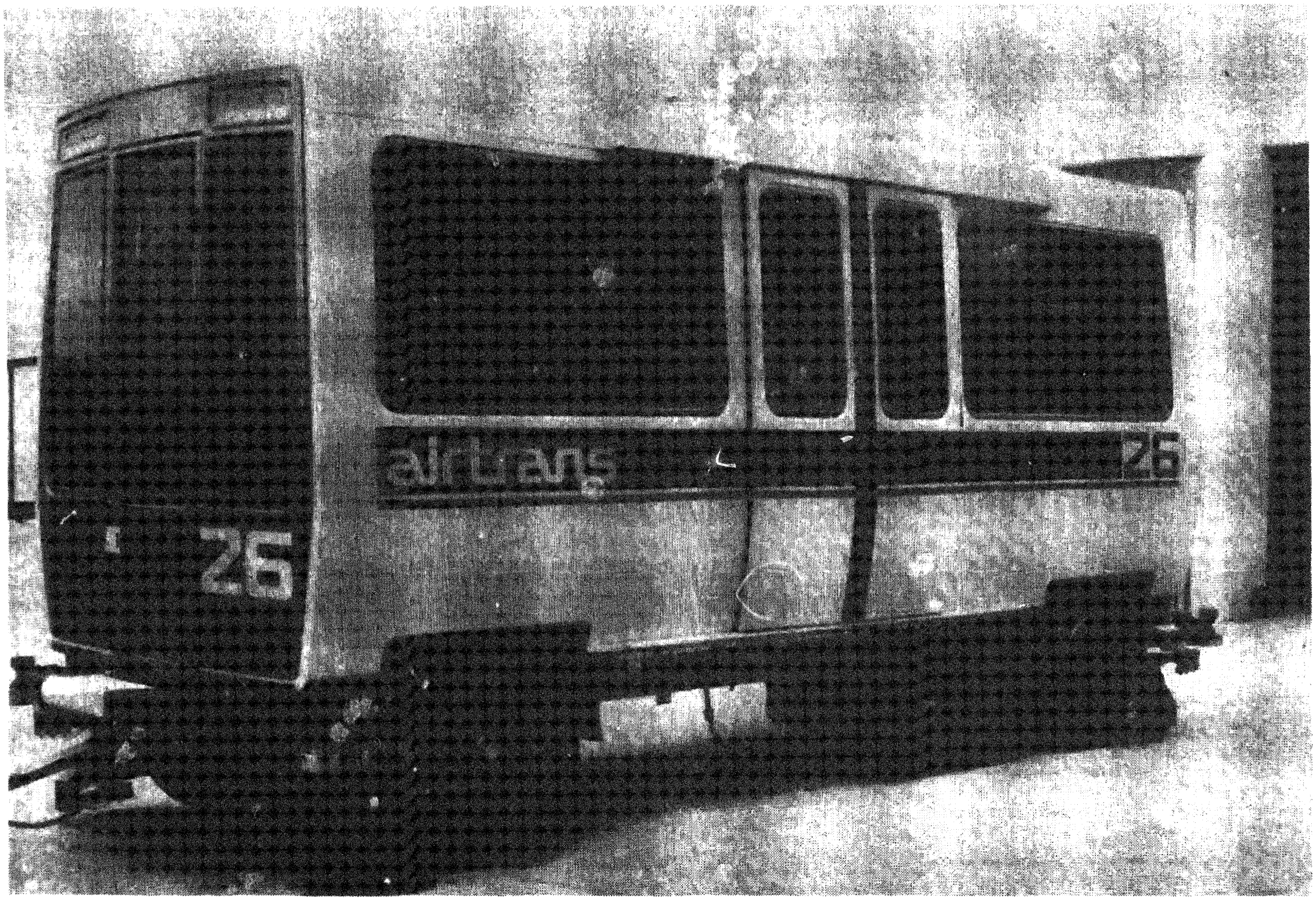

Figure 2–13 VEHICLE AFTER IRAN PROGRAM

4.0 RECOMMENDATIONS

The IRAN program performed on this vehicle represents a very small sample of the condition of the total passenger vehicle population (one out of fifty-one). A larger sampling might have provided different results and the discovery of additional problem areas; however, based upon the current sample, certain observations are considered warranted.

In all AGT systems, it is recommended that the vehicles be subjected to an IRAN program and that such a program be considered for inclusion in the maintenance concept and planning. This will provide the operator with a measure of the effectiveness of the preventive maintenance program. It will provide information that will allow anticipation of areas of wear and corrosion, leading to early repair. It will also reduce incidents caused by unexpected failures.

A program of this type can be flexible. There are certain areas of this inspection which are considered mandatory in the interest of safety. There are other areas which will preclude failures and provide improved availability. Other areas may be omitted later, since the original purpose did not materialize.

The frequency of this effort will depend upon several factors, including mileage, environment, usage, failures, loading and elapsed time. It is recommended that the AIRTRANS vehicles be processed through the IRAN Program when the vehicle mileage is at least 250,000 miles (approximately 5 years). This frequency is at present a judgment based upon numerous years of experience in the field of maintenance. To remove the judgment factor, it is recommended that a study be made which will include the failure rate data, maintenance actions, maintenance costs and the effect upon the availability of the vehicle.

The mechanical systems have experienced thousands of miles of operation, and although the preventive maintenance programs are effective, an in-depth inspection and repair is definitely required to properly sustain the vehicle. Electrical insulation deterioration is a function of time, environmental exposure and electrical operating characteristics. Periodic examination and testing will assure the capability of continued service. During this program, refurbishment of the interior seat cushion fabrics and the carpet can be done at minimum expense, since these items have faded and deteriorated from exposure, cleaning and wear. Refurbishment of these items give the vehicle a fresh new look and improved appearance.

Approximately 3,000 manhours were involved in the total IRAN program for vehicle number 26. These hours included plan development, supervision, engineering support and the actual teardown, inspection and reassembly. Also involved was detailed probing into all areas, including cosmetics and interior panel cleaning, which is considered normal routine maintenance. Future programs, excluding the nonrecuring hours, should not exceed 1,000 hours.

In the course of the disassembly, inspection and reassembly of the vehicle, areas were found in which the operating and maintenance costs may be reduced through hardware design changes.

With respect to the bi-parting doors, three design changes are recommended. First, the present doors should be evaluated to reduce the weight and to maintain a constant contour which is compatible with the body panels. This will eliminate maintenance actions for door adjustments when variations in the temperature and weather occur. Second, the teflon strips which replaced the round buttons in the guide for the threshold slot should be evaluated and incorporated to improve door operation and reduce the localized wear in the threshold. Third, the touch stop door edge design and the door edge seals should be reviewed to provide a better weatherproof seal. A misaligned door seal will allow rain or water from the washing cycle to enter the vehicle and damage the carpet. Each of the above items require maintenance actions, and if improvements are made, a reduction in cost is obtained.

The end doors should also be evaluated for a weight reduction. The weight of the door appears to be directly related to the sagging conditions, and the upper hinge separation from the door jamb. The end door latch keeper attached to the door jamb presently is not adjustable to accommodate any sagging of the latch. An adjustable keeper would compensate for variations in the body system and simplify the maintenance task which, in turn, reduces the maintenance costs.

Within the pneumatic system, the moisture ejectors are essentially maintenance-free units and are examined, for visual or audible operation at each 15,000-mile inspection. It is recommended these units be disassembled at one of the scheduled inspections such as the 45,000-mile (semi-annual) inspections. This will minimize the accumulation of sludge.

Although the centrifugal filter is listed on the 45,000-mile (semi-annual) inspection, this particular unit did not appear to have been serviced in some time, as indicated by the amount of sludge, water and oil accumulation. Rigid adherence to the scheduled maintenance programs is strongly recommended to minimize maintenance costs and extend component life.

On the boss of the bellcrank in the coupler/towing attachment assembly a grease fitting was installed to lubricate the bearing and reduce the wear and rust accumulation. It is recommended this installation be included on all AIRTRANS vehicles at one of the scheduled inspections or induction into IRAN.

The kingpin bushing design of the axle and differential assembly develop wear patterns which increase the maintenance requirements of the vehicle. It is recommended that consideration be given to modifying the kingpin assembly and replacing the upper bushing with needle bearings and the lower bushing with roller bearings. This improvement has been demonstrated in Phase I of the AUTP program. The antifriction kingpin bearings does reduce the steering forces and improve the overall steering system life.

The undervehicle components are susceptible to the collection of dirt and dust. This collection combines with grease and grime over a period of time and reduces the effectiveness of any inspection. It is recommended that the 45,000-mile (semi-annual) inspection be revised to include an undervehicle cleaning, including the steering and guidance components. This will minimize the accumulation of grime, improve visual inspection capabilities and reduce the possibility of overlooking an impending failure condition.

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APPENDIX A

AIRTRANS IRAN PROGRAM PLAN

INTRODUCTION

The IRAN (Inspect Repair As Necessary) program plan has been designed to provide for structural (frame/chassis), system and component inspection, defect correction, modification (when directed), and preventive maintenance. The objective of this plan, when implemented, will be to assure the vehicles will provide continued availability for revenue service and operations. The IRAN requirements for the vehicles subject to this process will be the minimum needed to ensure reliability and operational availability. The plan also provides intermediate support of the total service life, with safety requirements and reasonable economic considerations.

The plan has been developed using the concept of Analytical Critical Inspection (ACI) techniques. This technique is the systematic disassembly and inspection to locate hidden defects, deteriorating conditions, corrosion, fatigue, and overstress. The extend of disassembly and the type and scope of the inspections and tests are intended to reveal damage or deteriorated conditions which would not be discovered during the normal scheduled inspections.

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1.0 SCOPE

1.1 AIRTRANS IRAN Program

The AIRTRANS IRAN (Inspect Repair As Necessary) program has been developed to assure continued service for vehicles with high usage and mileage. This plan delineates the requirements for the IRAN of the passenger vehicles of the Dallas/Fort Worth Airport.

1.2 Task Control Panel

A Task Control Panel shall be established to review discrepancies which require tasks or actions (i.e., disassembly or replacement of major components) beyond the scope of the plan. The Task Control Panel shall consist of representatives of the contractor and representatives from AIRTRANS Maintenance Department Engineering Staff. The Task Control Panel shall be responsible specifically for the following:

a) Disassembly beyond that required for established repairs when records or inspection indicate further structural damage.

b) Repairs found necessary as a result of vehicle logbook review, incoming inspection or processing inspection.

All decisions of the Task Control Panel shall be recorded in a master workbook maintained for each vehicle.

1.3 Replacement Parts (Hardware, Bin Stock & Materials)

The replacement parts (hardware, bin stock and materials) required for the IRAN shall be supplied by the AIRTRANS Maintenance Department.

1.4 Equipment Removals

The AIRTRANS Maintenance Department will remove the motor, motor controller, air conditioners, seats, and all electronic equipment.

2.0 REQUIREMENTS

2.1 General Instructions and Limitations

2.1.1 The requirements defined herein provide for structure, systems and component inspection, defect correction and preventive maintenance. These requirements include, but are not limited to:

a) A thorough and comprehensive inspection of the vehicle structure, systems and components by visual and appropriate non-destructive inspection methods; with repair as required.

b) Replacement of limited life components as directed by the customer.

2.1.2 Adjustments, checks, tests, repairs, inspections, component rework, and preventive maintenance, and the rework procedures coincidental thereto, shall be accomplished in accordance with the documents specified herein.

2.2 General Instructions and Requirements

2.2.1 Vehicle Records

2.2.1.1 The logbook and records of the vehicle undergoing IRAN will accompany the vehicle to the IRAN facility.

2.2.1.2 Upon completion of the IRAN, a logbook entry shall be made stating compliance with the requirements of this plan.

2.2.1.3 All modifications accomplished during the IRAN shall be properly recorded in the appropriate section of the logbook.

2.2.2 Test equipment shall, where required, bear current calibration stickers from authorized/recognized calibration organizations.

2.2.3 A workbook shall be prepared and maintained for each individual vehicle to plan, document, establish, and account for the tasks to be accomplished. Items in addition to those of the established standard may be added by the Task Control Panel.

2.2.4 A quality assurance program shall be provided for the IRAN process. The inspectors will document the findings and results of the inspection process.

2.2.5 Inspection criteria and standards of acceptance shall be consistent with those established by the owner/operator for equipment applicable to programs of automated ground transportation vehicles. Appearance reflecting previous usage will not be cause for rejection of a serviceable part.

2.3 Detail Requirements

2.3.1 Unscheduled maintenance requirements are those which are discovered as a result of one or more of the following: (1) review of the vehicle logbooks and records, (2) the operational/functional testing of systems, (3) the visual examination of the vehicle and its components, or (4) normal vehicle usage.

2.3.2 Initial Preparation

2.3.2.1 A preliminary examination shall be performed on each vehicle to validate reported discrepancies and to aid in the determination of unscheduled maintenance. The scope of the examination shall be of sufficient depth to logically sequence any unscheduled work. This induction inspection will be performed prior to acceptance into the program. Photographs of the vehicle interior and exterior conditions are very desirable.

2.3.2.2 All discrepancies revealed during vehicle checks shall be documented.

2.3.2.3 Work items not listed in the plan will be considered exceptions, or extra work, and will be referred to the Task Control Panel for authorization to proceed. These items will be negotiated separately.

2.3.3 Surface Conditioning

2.3.3.1 Cleaning

a) Metal Surfaces - External metal surfaces, including those on the underside of the vehicle, shall be cleaned using a 1,1,1, trichloroethane solvent, a safety solvent or a dry cleaning solvent, P-D-680 Type II with a pressure spray hose.

b) Cleaning may be done with hot water and high detergent spray but direct spray on propulsion motor, motor controller and compressor belts should be avoided.

c) Grit blast procedures will not be used in the cleaning process.

2.3.3.2 Finish from external metal surfaces shall be stripped only as required for removal of corrosion and treatment of affected areas and for specific inspection requirements.

2.3.3.3 Corrosion

a) Removal, Treatment and Repair

   1) Corrosion removal and resulting treatment/repairs of affected areas shall be in accordance with AIRTRANS Maintenance Depart-ment procedures.

   2) All corrosion damage exceeding established limits shall be referred to the Task Control Panel for action.

2.3.3.4 If the vehicle has been stripped in the areas where sealant was present, sealant shall be reapplied.

2.3.3.5 The exterior painted surfaces will be touched up or refinished on the partially stripped metal surfaces in accordance with established practices.

2.3.3.6 This plan does not address the cosmetics of the vehicle. The items or areas will be addressed by the Task Control Panel and will be treated as exceptions. Tasks developing from the Task Control Panel decisions will be negotiated separately and individually to the basic plan.

2.3.4 Disassembly

a) The vehicle shall be disassembled to the extend necessary to accomplish the scheduled examination, restoration and testing established by the IRAN plan.

b) Whenever any pneumatic line or fitting is disconnected, both halves of the connection shall be capped.

2.3.4.1 Specific Disassembly

a) The following components shall be removed.

1) Interior seats

2) Ceiling and wall panels

3) Windows

4) Stanchions and garment bag hangar bar

5) Baggage rack

6) Dead and drive axle assemblies - See 2.3.7.1(c)

7) Suspension system (excluding lines and valves)

8) Pneumatic tanks

9) Steering system (excluding inter-connect linkage)

10) Air conditioner units

11) Propulsion motor and motor controller

12) Battery

b) Adequate storage facilities shall be provided for the removed items to preclude damage. Window glass will have padded racks and protection from the environment. Interior panels will be stored to prevent twisting and further damage.

2.3.4.2 Examination During Disassembly

a) During disassembly, the vehicle shall be examined for obvious defects, specifically for the following: damage, cracks, corrosion, excessively worn attach fittings, bearings, bushings and bolts, distortion and elongation of bolt holes and any other condition that may require further investigation, inspection and disassembly. Any questionable items will be referred to the Task Control Panel.

b) If corrosion damage is evident or suspected at body joints, the problem shall be reported to the Task Control Panel for further direction.

2.3.5 Structure Group

2.3.5.1 Vehicle Frame

a) All accessible structures shall be examined for cracks, corrosion, deformation, weldments and loose or missing fasteners, especially vertical members and associated weldments on the front, rear and door side of the vehicle.

b) All clips shall be inspected for cracking and deformation. Fiberglass structure in the immediate area of the clips shall be checked for structural integrity.

c) The frame will be measured top to bottom diagonally, end to end and side to side to determine any alignment distortion.

2.3.5.2 Vehicle Chassis

a) All accessible structures shall be examined for cracks, corrosion, deformation and loose or missing fasteners. All welds shall be inspected for structural integrity, especially at the support brackets for the following:

1) Suspension system

2) Steering interconnect linkage

3) Propulsion motor

4) Motor controller

5) Air compressor and alternator equipment structure

6) A.C. - D.C. - Battery structure

7) Bumper shock absorbers

8) HVAC units

2.3.5.3 Exterior Body Panels

a) All body panels (acrylic/fiberglass) shall be examined for cracking, deformation and missing or loose fasteners.

b) Repair of the damage should be done according to the instructions of the supplier, or with an epoxy compound compatible with acrylic material. The repair should be reinforced on the rear side with fiberglass. Severe damage may require a metal (aluminum) reinforcement bonded to the fiberglass backing.

c) The repaired surface should be prepared for painting by using the techniques necessary to conceal the damaged surface.

d) The repaired surface should be painted, blending the painted surface as required in good commercial practice.

2.3.5.4 Interior Panels

a) All interior panels (ABS) shall be examined for cracking and damage.

b) The panels should be repaired as necessary. Bonding of the surfaces may be obtained by the solvent cementing process.

c) The interior panels should be cleaned with a warm water detergent. A scouring cleanser (Ajax or equal) and a stiff brush should be used to remove dirt from the hairlines in the surface, then rinsed with clear water and dried.

2.3.6 Drive Axle System

2.3.6.1 General

a) Whenever any air lines have been disconnected, both halves of the connection shall be capped.

b) Removed components shall be cleaned as required for the depth of examination and inspection needed.

c) A kingpin bushing wear test shall be performed prior to disassembly from vehicle and the data recorded.

2.3.6.2 Drive Axle

a) Planetary Steering Assembly

1) The tire and wheel assembly, planetary drive system and hub assembly shall be removed/disassembled.

2) Components (gears, seals, bearings, bushings) shall be examined for wear, tolerances, deterioration and condition.

b) Drive Axles

1) Drive axles shall be removed from the differential assembly.

2) The long and short axles shall be inspected for condition using Non-Destructive Inspection (NDI) Radiographic procedures.

3) The universal joint shall be inspected for condition, lubricated and reassembled.

c) Differential Assembly

1) The carrier shall be disassembled and gear thrust washers shall be inspected for tolerances, wear and condition.

2) The carrier assembly shall be reassembled but not installed until inspection of drive system component is complete.

d) Housing

1) Exterior surfaces of the housing shall be examined for cracks, corrosion and condition of welds with dye penetrant or suitable non-descructive methods and repaired if necessary.

2) Concentricity and wear limits of inner and outer axle bearings shall be verified.

e) Steering Knuckles (Kingpins)

1) Kingpins and bushings shall be disassembled and inspected for condition and wear.

2) Upper and lower kingpin bushing areas shall be examined for cracks on deformation using visual and Non-Destructive Testing (NDT) methods.

3) Discrepancies will be corrected, and the knuckles will be re-assembled.

f) The drive axle assembly will be re-assembled and lubricated in accordance with maintenance manual instructions.

2.3.7 Steering Axle System

2.3.7.1 General

a) Whenever any air lines have been disconnected, both halves of the connection will be capped.

b) Removed components will be cleaned as required for the depth of examination and inspection required.

c) The kingpin bushing wear test will be performed prior to removal from vehicle and the data recorded.

2.3.7.2 Hub Assembly

a) The wheel and tire assembly will be removed; the hub will be disassembled; and inner and outer bearings, cups and cones will be inspected for condition and wear.

NOTE: Bearings, cones and cups will require special protection while disassembled.

2.3.7.3 Steering Knuckles (Kingpins)

a) Kingpins and bushings will be disassembled and inspected for wear and condition.

b) The upper and lower kingpin bushing area will be examined for cracks or deformation using visual and NDT inspection methods.

c) The steering knuckles will then be reassembled.

2.3.7.4 housing

a) The exterior surfaces of the housing will be examined for cracks, corrosion and condition of welds using dye penetrant or suitable NDT methods; and necessary repairs will be made.

1) The steering axle assembly will be reassembled and lubricated in accordance with maintenance manual instructions.

2.3.8 Steering System

2.3.8.1 Components of the steering system will be cleaned as required for the depth of examination and inspection needed.

2.3.8.2 Coupler Assembly

a) The structure will be examined for cracks, corrosion, missing fasteners, and wear.

b) The 240-24002-109 lug, the 240-24002-111 pin and the 240-24002-146/147 bellcrank assemblies will be inspected for cracks, deformation and hole elongation.

On suspect areas, dye penetrant inspection will be accomplished. The 240-26002-101/102 rod and rod ends will be inspected for condition and wear.

2.3.8.3 Guidebar Assembly

a) The bar assembly will be examined for cracks, corrosion and hole elongation.

b) All welds and suspected areas will be inspected by a dye penetrant technique for cracks.

c) The spring-loaded strut assemblies and brackets will be inspected for corrosion, wear and deformation.

d) The support assemblies will be examined for bearing wear and deformation.

e) The assembly will be repaired as necessary and reassembled.

2.3.8.4 Guidebar Hangar Assembly

a) The guidebar hangar assembly will be disassembled and inspected.

b) Bearings and shafts will be examined using the dye penetrant method.

c) The assembly will be repaired as required and re-assembled.

2.3.8.5 Steering Reversal Actuator

a) The actuator will be examined for structural integrity, obvious wear and corrosion, then disassembled.

b) The cam follower assembly will be examined for wear points.

c) The steering reversal mechanism lug will be inspected for condition and wear limit.

d) The lock, arm and ring will be inspected for wear and engagement.

e) All bearings, rod end assembly, clevis assembly, screw and nut will be checked for wear.

f) Necessary repair and lubrication will be accomplished, and the steering actuator reassembled.

2.3.8.6 Steering Actuator Support (Steering Yoke)

a) Attaching bolts and nuts will be removed and examined for cracks, stress, corrosion, wear, and distortion. Other hardware will be subjected to X-ray and possibly chemical analysis, magnetic particle inspection and Rockwell hardness test. The bearing will be inspected for condition.

b) The support will be inspected by NDT processes for cracks, particularly in the area of the mounting holes. The supports will be examined for hole elongation or deformation.

c) The steering yoke will be reassembled and installed.

2.3.8.7 Steering Interconnecting Linkage

a) Push rods, bellcrank assemblies, yoke ends and bearings will be visually inspected for condition, corrosion and wear.

b) The link assembly, limiting spring will be removed and disassembled. The assembly and interior cylinder will be inspected for corrosion and condition. Chassis lubricant (EP with molydisulphide) will be applied to the cylinder interior and the mechanism re-assembled.

2.3.8.8 Steering Rod Assembly

a) All steering rod and tie rod assemblies will be examined for wear, condition, corrosion, and fit using NDT processes and necessary repair/replacement accomplished.

2.3.9 Suspension System

2.3.9.1 General

a) Whenever any pneumatic lines or fittings are disconnected, both halves of the connection will be capped.

b) All hoses and lines will be examined for condition, abrasion, protection, and security.

c) When all pneumatic lines and components are assembled, an air leakage test will be performed on the system.

2.3.9.2 Equalizer Beams

a) The equalizer beam assemblies will be examined for cracks, corrosion and condition; and the bushings will be examined for condition, weather checking and wear.

b) Using NDT methods, the equalizer beams will be inspected for cracks with emphasis on weld areas and attachment points.

c) After necessary repairs, the mechanism will be reassembled.

2.3.9.3 Transverse Beam

a) The beam will be examined for general condition and corrosion, and welded areas will be inspected by the dye penetrant process.

2.3.9.4 Air Spring

a) Air springs will be removed and visually examined for weather checking, condition and cracking. Special attention will be given to the area adjacent to the wheel mud flap area for wear caused by rubbing as the air spring actuates.

2.3.9.5 Air Tank Assembly

a) Air tanks will be removed and visually examined on the interior surfaces for condition and corrosion.

b) Dye penetrant process will be used to inspect the attach points and air spring area.

c) Deficiencies will be corrected, corrosion removed and corrosion preventive material applied where required.

2.3.9.6 Control Arms

a) The arms will be examined for condition and wear.

b) Each bearing will be inspected for end play.

c) Necessary repair/replacement will be accomplished.

2.3.10 Door System

2.3.10.1 General

a) The bi-parting door system will be examined for obvious defects and wear, but the door operator will not be removed from the vehicle unless required to repair discrepancies.

b) In the event the door operator requires repair, the Task Control Panel will be contacted for authorization to proceed with said repairs. Same will be negotiated separately.

2.3.10.2 Door Operator

a) The door operator will be examined for obvious wear, corrosion and damage and the Task Control Panel consulted for direction in case of needed repair.

2.3.10.3 Door Assemblies

a) Each door will be examined for condition, chafing and corrosion.

b) The touch stop edge will be visually inspected for cracking and deterioration.

c) The door and body seals will be checked for condition, cracking and deterioration. Both seal tolerances will be inspected in the open and closed positions.

d) The bottom door guide will be examined for condition and wear. The guide will be inspected for the proper engagement in the threshold slot and proper clearance between the bottom of the guide and the bottom of the threshold slot with the doors in the open and closed positions.

2.3.10.4 Door Hanger Assemblies

a) Hangers will be checked for condition, wear, cracking and corrosion.

b) The anti-rise roller assembly will be inspected for gap (.02 to .04 inches) to be measured between the cam roller and the V-103R-2 door operator housing surface.

2.3.10.5 Door Threshold

a) The threshold will be removed and examined for corrosion and condition.

b) The threshold slot will be measured for wear.

c) Same will be repaired as necessary.

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2.3.11 Electrical System

2.3.11.1 General

a) Wiring and wiring components of the AIRTRANS vehicle will be inspected for condition and security.

b) Whenever any electrical connectors are disconnected, both halves of the connector will be capped.

2.3.11.2 Collector Assembly

a) Collector assemblies will be examined for wear, corrosion and general condition.

b) Wire and connections will be examined for chafing, corrosion, damage, and fraying.

c) Wiring insulation will be visually examined for deterioration, cracking and general condition.

d) Collector arm assemblies will be inspected for wear and vertical movement. Signal arm should not exceed 0.5 inch and power arm should not exceed 0.25 inch vertical movement when checked in accordance with the maintenance manual procedure.

2.3.11.3 AC Power Panel

a) The panel enclosure will be examined for security, condition and corrosion.

b) Internal wiring and connectors will be examined for security, corrosion, fraying, and general condition.

c) Wire leads into and from the panel will be checked for security, wear, chafing, fraying and condition and the insulation for deterioration.

2.3.11.4 D.C. Power Panel

a) The panel enclosure will be examined for security, condition and corrosion.

b) Internal wiring and connectors will be examined for security, fraying, corrosion, and general condition.

c) Wire leads into and from the panel will be examined for security, wear, chafing, and fraying and the insulation for deterioration.

2.3.11.5 Vehicle 480 Volt Wiring

A hi-pot/megger test will be conducted on the vehicle 480-volt wiring to determine the condition of the wiring. Care will be exercised not to damage any components during this test/examination.

2.3.11.6 Interior Lighting

a) Each fixture will be examined for structural cracks and deformation. Repairs will be accomplished as required.

b) Fluorescent bulb holders will be inspected for arcing, corrosion and wear.

c) Inspection for excessive lateral movement of the fluorescent bulb within the holders will take place. Repair by shimming will be accomplished as required.

2.3.12 Pneumatic System

2.3.12.1 General

a) Whenever any pneumatic lines or fittings are disconnected, both halves of the connection will be capped.

b) All hoses and lines will be examined for condition, abrasion, protection and security.

c) When all pneumatic lines and components are assembled, an air leakage test will be performed on the system.

2.3.12.2 Reservoirs

a) The reservoirs will be removed and examined internally and externally for damage, corrosion and condition. A boroscope will be used for the internal inspection.

2.3.12.3 Moisture Ejectors

a) The moisture ejectors will be removed, disassembled and examined for condition and corrosion.

b) After inspection and necessary repairs, the mechanism will be reassembled.

2.3.12.4 Centrifugal Filter Assembly

a) The centrifugal filter assembly will be removed, disassembled and inspected for sludge, corrosion and condition.

b) After inspection and necessary repairs, the filter will be reassembled.

GLOSSARY

The terms in this glossary are defined in the context of their usage as applied to the requirements of this specification.

ACCESSIBLE - Areas exposed by the removal of access doors, panels, fairings, etc., and such other disassembly necessitated by the maintenance requirements and not involving destructive disassembly.

CALIBRATE - To repair, check or correct the graduations or indices of measuring devices or to repair, adjust and align equipment so that it functions within assigned tolerances.

CHECK - An inspection or analysis to validate specified values, conditions and limits.

CLEANLINESS - The state of being free from impurities, impediments and foreign material not specified to be applied to the surface in question.

DETERIORATION - The breakup, eating away or decomposition of a substance by the action of wear, corrosive material or other environmental condition.

DISTORTION - Any disfigurement or change in form or shape from the intended design configuration.

EXAMINE - (EXAMINATION) - A visual or non-destructive inspection to determine the presence of defects (if non-destructive state type), or conversely, to verify the absence of defects. Determination of condition and/or work to be performed.

EXTERIOR SURFACE - That part of the vehicle exposed to the elements when in the operational configuration. Does include wheel wells and wheel and tire assemblies.

FUNCTIONAL TEST - The testing of installed vehicle, accessories and equipage to determine proper functioning, particularly with respect to the applicable system.

GENERAL ELECTRICAL/ELECTRONICS EXAMINATION - A visual examination of installed electrical/electronics components, wiring and wiring components, for corrosion, proper bonding, security, evidence of overheating, proper routing, kinking, condition of insulation and potting, corroded or high-resistance connections, broken connector pins, terminals and lock wiring, damaged wiring harnesses, condition or junction boxes and conduits, and legibility of essential markings.

GENERAL ELECTRICAL/ELECTRONICS WIRING CIRCUITRY VERIFICATION - A test of system wiring and wiring components to verify the ability of the vehicle wiring to perform its intended function when mated to a set of operational black boxes. Wiring circuitry verification may be accomplished by either of the following procedures.

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a) By operational test of the system using installed black boxes or slave units. Operational test shall be limited to the depth required to demonstrate the adequacy of the wiring and normally shall be required only once during the rework process provided the wiring is not disturbed by modification subsequent to the initial operational test.

b) By a suitable method of continuity checks.

GROUP - A collection of units, assemblies or subassemblies which is a subdivision of a set or system, but which is not capable of performing a complete operational function (See System).

INSPECT - To perform a critical investigation of an item, unit, component or frame and chassis through the visual, auditory, olfactory and tactile senses utilizing simple manipulation, gauging and measurements, as required, for the specific intent of determining its conformance to the assigned specifications within the tolerances permitted; may require partial disassembly of such items.

INSPECT AND REPAIR AS NECESSARY - A minimum level of rework processing applicable to items determined defective on a conditional basis and not otherwise subject to prescribed rework procedures. The level of rework is restricted to only those functions necessary to correct the removal discrepancy and return the item to operational serviceability.

OPERATIONAL TEST - The subjection of the vehicle, accessories, equipment, and equipage to normal conditions of usage in its normal usage environment to ensure proper operation within its normal usage parameters as established in the applicable operating manual.

OVERHAUL - Standard rework performed on a component subject to established service periods and reworked as a direct function thereof. Includes disassembly sufficient to inspect all constituent parts, followed by cleaning, repair, replacement of consumables and defective parts as required, servicing, reassembly, and check/tests in accordance with applicable overhaul specifications, instructions and procedures.

REFINISH - To restore an existing surface finish without removal of all the existing finish. The process of refinishing includes cleaning of the affected area to remove all loose and scaling paint or other finish material, soil and contaminants; feather edging the remaining original finish to a smooth surface; application of new finish coatings (including chemical conversion coatings) as required to provide protection from corrosion and to provide a like-new appearance.

REMOVE/INSTALL - The routine procedures employed to remove or install components of the vehicle.

REPAIR - Necessary preparation, fault isolation, disassembly, inspection, replacement of parts, adjustment, reassembly, calibration, and tests accomplished in restoring items to serviceable status.

REPAIR AS REQUIRED - As used herein, directs the unscheduled repair of items which have been determined to be discrepant, based on authorizing directives or inspections and tests when repair is technically feasible and economically justified.

REPLACE - To install a new or overhauled like item in place of the removed item.

REPLACE AS REQUIRED - Directs the unscheduled replacement of items which have been determined to be discrepant based on authorizing directives or inspections and tests with like serviceable items when repair is not technically feasible or economically justified.

SERVICE - The performance of any act (other than corrective maintenance) required to keep an item of equipment in operating condition, such as lubricating, oiling, cleaning, etc., but does not include periodic replacement of parts for any corrective maintenance task.

SERVICEABLE - The condition of an item in which all requirements of repair, check/test, rework or modification have been accomplished making it capable of performing the function or requirements for which originally designed.

SYSTEM - A combination of parts, assemblies and sets joined together to perform a specific operational function or functions.

TEST - To subject a vehicle, accessory, equipment and equipage to prescribed conditions to determine function in accordance with predetermined requirements and to ensure proper function in accordance with applicable directives.

TEST, FUNCTIONAL - System, sub-system or component tests to verify proper functioning of every mode inherent in the design of the equipment applicable to its specific application in the vehicle. Proper functioning demonstrates the ability of equipment to perform its intended purpose.

TEST, OPERATIONAL - System, sub-system or component tests to verify proper operation of every mode inherent in the design of the equipment applicable to its specific application in the vehicle. Proper operation demonstrates the ability of equipment to perform its intended purpose without resort to actual specified measurements.

WIRING AND WIRING COMPONENTS - Wiring includes all electical and electronics cable assemblies, individual wires and bonding/grounding straps, which are an integral part of the electronics systems. Wiring components include any item, other than wiring, constituting a part of the vehicle electronics systems. Examples of wiring components are terminal strips, junction boxes, switches, and circuit breakers.

APPENDIX B

NONDESTRUCTIVE INSPECTION METHODS

GENERAL

The detection of defects without damage to or destruction of the item being inspected is commonly referred to as nondestructive inspection (NDI). NDI can be used to discover defects or failures in both structural parts and mechanical parts. Methods of NDI are available which may be applied to an assembly or component to determine the integrity, composition, physical, electrical, or thermal properties and dimensions of the material without causing change in any of the materials characteristics. These methods include:

a. Liquid penetrant methods

  (1) Visible dye penetrant

  (2) Flourescent dye penetrants

b. Magnetic particle methods

c. Electromagnetic methods

  (1) Eddy current

  (2) Magnetic field

d. Ultrasonic Methods

e. Penetrating Radiation

  (1) X-radiation

Of these available methods only the liquid penetrant and Penetrating Radiation (X-Ray) methods were used. These will be briefly discussed to provide an overview to the reader.

Liquid Penetrants

Penetrant inspection is basically a very simple process. First a liquid penetrant is applied to the surface of the part. It is allowed to remain on the surface for a period of time, during which it penetrates into any open defects in the surface. After the penetrating period, the excess penetrant is removed from the surface. A light colored, absorbent powdered material called a developer is applied. This developer acts as a blotter and draws out a portion of the penetrant which had previously seeped into the surface opening. As the penetrant is drawn out, it diffuses the coating of the developer, forming indications that are much wider than the surface openings with which they are associated. The inspector observes the part and looks for the colored indication against the background of the developer powder.

Almost any liquid will penetrate certain sizes of defects and nearly any light colored powder can be used as a developer. However, to achieve the desired sensitivity, a liquid with deep penetrating ability and potent colored dyes is essential to locate minute defects. These are visible under white light or while fluorescing under black or ultraviolet light. The penetrant inspection can detect surface defects as cracks, porosity, fatigue cracks, heat cracks and seams. This method has a rather wide capability in the non-destructive inspection field.

X-Ray

The X-ray is a type of non-destructive inspection that consists of allowing the X-ray beam generated by the X-ray tube to pass through an object and expose a photographic plate placed on the opposite side of the object. When the photographic plate is processed, a permanent radiograph or shadow picture of the object is available. Since a greater amount of radiation will pass through the object where it is thin or where there is a space or void (crack) parallel to the X-ray beam, the corresponding area on the X-ray film will be darker. The X-ray film is interpreted by comparing it with the known nature of the object.

Radiographic (X-ray) techniques can be used for periodic inspections such as IRAN for X-ray detectable damage of the axles, and drive train, suspension system/components and guidance/steering systems. When the X-ray method of NDI is to be used in such a program, qualified personnel are required for the making and interpreting of the radiographs.

APPENDIX C

VEHICLE TECHNICAL DATA

C-1 VEHICLE IRAN MEASUREMENTS

Within the scope of the IRAN program, the wear points were measured and compared with either the original drawing measurements or the AIRTRANS Engineering Directives. These measurements were noted along with the allowable tolerances to determine the action required. In many cases, wear was insignificant; and the part continued in service. Other parts displayed wear patterns which were beyond the tolerance listed and were either replaced or repaired. This data has been accumulated from the Discrepancy Sheets and recorded in this appendix. The drawing nomenclature and number has been listed for each component.

C-2 SUB-SYSTEM MEASUREMENTS

1) Steering System

(a) **Beam Assembly** 240-26017-120

The bearing installation holes should have been 1.6770" $^{+.0007''}_{-.0000}$. Hole measurement was 1.6795", which as a loose fit (not a pressed fit). Two of the 6008-2RS bearings had two rollers which had rusted and become rough. One bearing was missing a retainer. Two Fafnir 9108PP bearings were installed in place of the 6008-2RS bearings. All bearings were replaced and installed with prime.

(b) **Support Assembly** 240-26044-103-104

The upper bushing, 240-26046-101, in the -103 assembly should have been 1.751" maximum. The measured hole was 1.7543" to 1.7550". The lower bushing measured hole was 1.7542" to 1.7545" and also had a maximum of 1.751".

(c) **Axle** 240-26003-117 -113 Assembly

The axle, 240-26003-117, in the -103 assembly had two minor grooves near the casting entry approximately 0.0015" in depth plus a few shallow wear grooves.

(d) **Axle** 240-26003-117 -104 Assembly

The axle, 240-26003-117, in the -104 assembly had several grooves approximately .002" in depth and showed corrosive wear through the finish.

(e) Guidebar Assembly 240-26003 (Drive Axle)

The bushing (240-26003-141) hole had a 1.701" $^{+.004"}_{-.000}$ measurement originally which measured 1.708" to 1.710" along with moderate rust. A new bushing was installed and reamed to the correct dimension.

(f) Guidebar Hangar Assembly Shaft L.H. 240-26017-111

The upper land area dimension, 1.5742" $^{+0000}_{-0008}$", was worn to 1.5520" and corroded. This part was replaced.

(g) Guidebar Hangar Assembly Shaft R.H. 240-26017-112

The lower land area dimension, 1.5742" $^{+0000}_{-0008}$", was worn to 1.5721" with the upper land area worn to 1.5710" with corrosion at both bearing wear points. This part was replaced.

(h) Cam Follower Assembly of the Reversing Actuator Assembly

The clevis, 240-26012-119, had considerable wear in the upper and lower surfaces. The hole size should have been 1.8130" $^{+.002"}_{-.001}$. The hole measured 1.8150" to 1.8170".

2) <u>Axle and Differential Assembly</u> <u>PS 50RSAX-1</u>

(a) Kingpin bushings 1825-X-232

The kingpin bushings (1825-X-232) were measured, and all were exceeding the 1.7535" measurement on the dead axle. The measurements of the bushings were as follows, viewed from where the drive shaft end of the assembly would be located:

Left Upper	1.7641" to 1.7629"
Left Lower	1.7580" to 1.7562"
Right Upper	1.7662" to 1.7660"
Right Lower	1.7588" to 1.7582"

The wear was in the left/right direction within the bushings. Some bellmouth existed from top to bottom of the bushing.

(b) Kingpin Bushings 1825-X-232

The kingpin bushings (1825-X-232) on the drive axle all exceeded the 1.7535" wear limit. The measurements of the bushings were as follows, viewed from the drive shaft end of the assembly:

Left Upper	1.7683" to 1.7678"
Left Lower	1.7620" to 1.7601"
Right Upper	1.7721" to 1.7700"
Right Lower	1.7668" to 1.7662"