C Mechanic Training Task Analysis and The Development of An Examplary Training Module

[redacted] Final Report

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Acknowledgements

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In addition the project team would like to express their gratitude to the many operational maintenance personnel without whose assistance and patience we would know little about coach maintenance in the real world.

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SECTION I
INTRODUCTION

The maintenance resources of the Southern California Rapid Transit District (SCRTD) have become increasingly taxed in recent years by a variety of factors. These include:

- o The increasing complexity (and consequent maintenance requirements) of new transit equipment which incorporate such technology as turbochargers, electronically controlled air conditioning systems and complex engine fail safe systems.

- o The increasing demands upon SCRTD to provide more frequent and widespread service which necessitates increased numbers and availability of coaches.

- o The shortage of experienced and skilled maintenance personnel. This nationwide shortage is particularly acute in the specialized area of coach maintenance.

- o The age of much of the SCRTD equipment which creates an increase in the frequency and severity of maintenance problems.

- o Under the current system of on-the-job training (OJT) new hire mechanics are not considered "productive" for the entire first year of employment. Furthermore, their training reduces the production capacity of more experienced mechanics acting as "instructors".

In examining alternative strategies to alleviate this strain on the maintenance system, only one alternative emerges as both practical and effective. The task faced by the SCRTD becomes the provision to the maintenance system of more and better qualified maintenance personnel. This need cannot however, be satisfied easily and simply, for a variety of reasons. In the case of the SCRTD these include, but are not limited to, hiring rates, dispersed job locations and multiple shift operations. These factors, plus the variety of different vehicles, engines and other subsystems operated by the SCRTD, require that maintenance activities themselves be analyzed and defined, and the training necessary to perform this maintenance be analyzed and developed to meet the needs of the organization.

The immediate need of the SCRTD is the development of a comprehensive entry level mechanic training program to provide the necessary skills for proficient coach and subsystem repair, insure the effective delivery of such a program and to decrease the amount of time required for such training. The SCRTD's present system for diesel mechanic training relies very heavily on the initiative,teaching abilities and expertise of experienced mechanics who are assigned to instruct individual new hires. A more cost effective approach is needed to produce a high level of standardization in procedures and the progress that the district needs in order to increase its level of public service in these energy critical times. This program was the beginning of such an effort.

SECTION II

PROGRAM METHODOLOGY

The contractual agreement entered into by Canyon Research Group,Inc. (CRG) and SCRTD was to provide the SCRTD with two products:

1. A training task analysis for typical "C" mechanic tasks.

2. An exemplary training module developed from one of the task analyses.

The systems engineering of training (known by a variety of names, e.g., Instructional System Development or ISD, Systems Approach to Training, etc.), is basically the extension of the scientific approach to analysis, design and evaluation of training. It employs a series of orderly, logical, interrelated steps to produce either a discrete training module or a comprehensive training program which is efficient and effective in providing graduates with the skills, knowledge, and attitudes essential to the performance of a job. The effectiveness of this approach to training program analysis and development has been sufficiently well demonstrated so that it has been adopted in this country, Canada and Western Europe as a proven basis for instructional development. There are a variety of models which describe this approach, and a number of these are claimed to represent proprietary approaches or products. At its core, however, any systematic approach to instructional development has three phases: determining what must be taught, determining how to teach it, and determining what has been taught. The model used by Canyon is shown in Figure 1.

The training task analyses developed in this program represent the first of the training development phases. They are the basis of a complete "C" mechanic training program. Such a program could be either developed internally by the SCRTD or by a contractor using these analyses.

The exemplary module (Periodic Tune-up) will provide a baseline for the training quality and type of instructional approach which produce significant learning in SCRTD "C" mechanics. The tasks performed to develop the module and analyses are described below.

Review of Existing Materials

A review of existing materials relevant to mechanic training was conducted during the program. Materials supplied by the SCRTD were reviewed for applicable subject matter content and description of factors relating to the success/non-success of previous mechanic training programs. While little of utility was found relative to mechanic training itself, the technical manuals supplied by SCRTD proved to be extremely useful in developing the task analyses.

On Site Data Collection

On-site task analysis activities provided the majority of task analysis data. The on-site visits were made to various Divisions by project team members. Task analysis data was collected during these visits on all tasks. Data collection methodology options were examined and sorted down to two alternatives. The first of these was the direct observation and recording of tasks as they were performed. The second was the synthesis of task steps from maintenance manuals and subsequent

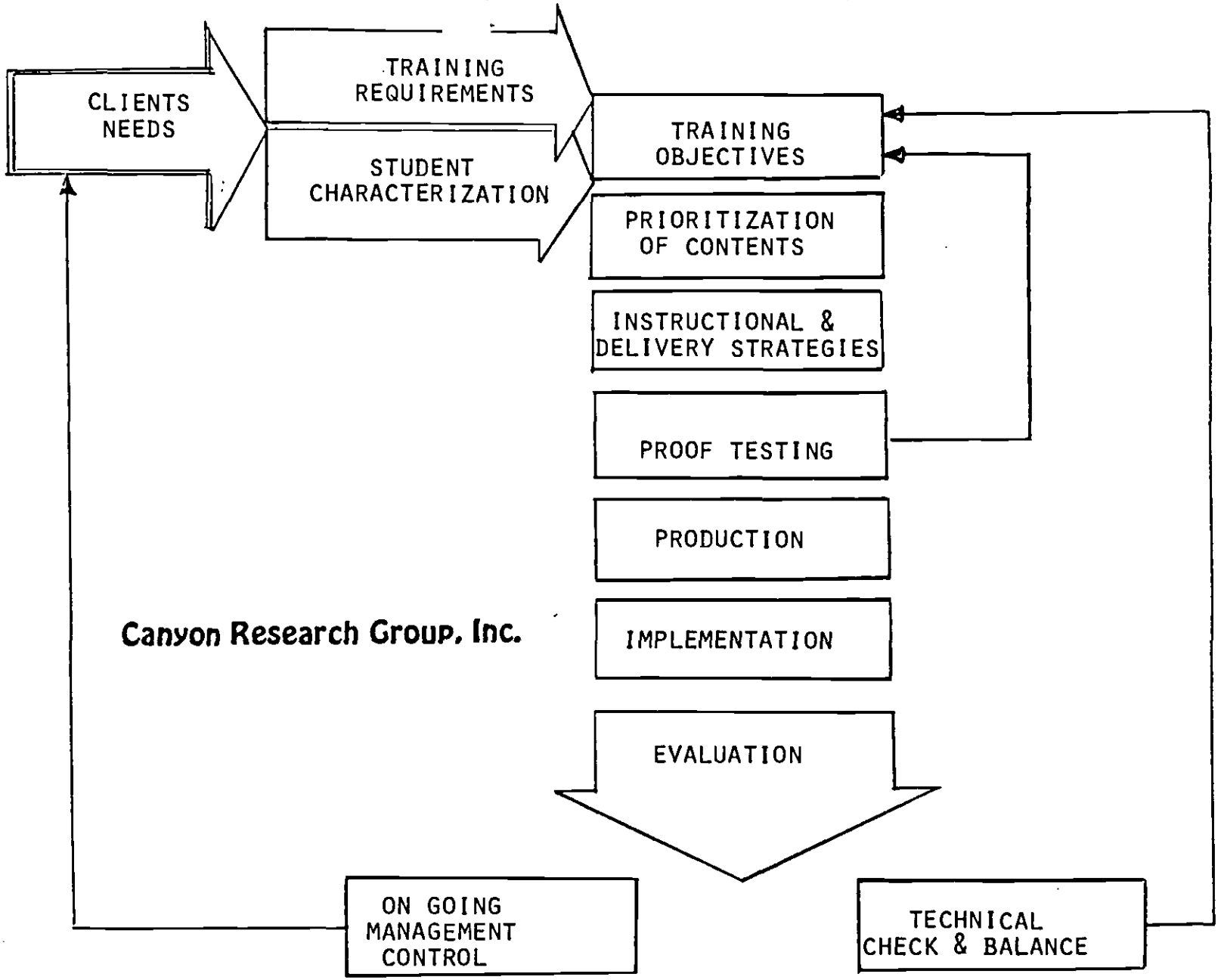


FIGURE 1. TRAINING SYSTEM DEVELOPMENT MODEL

verification/revision via direct observation. The first method was employed for the major inspection tasks due to the higher level of detail required of that analysis for direct translation into training objectives. The second method was employed on all remaining task analyses.

Review of Analyses by SCRTD Personnel

All analyses were reviewed and approved by SCRTD maintenance personnel prior to finalization of their content. Suggested revisions and clairfications were incorporated in the final analysis listings.

Technical discussions with RTD technical personnel indicated that a structuring of the analyses would result in thirteen analyses covering the following systems:

Engine -2 cycle
Engine -4 cycle
Transmission -V-drive
Transmission -Dana Spicer
Transmission and Engine Controls
Air Conditioning
Electrical System
Brakes
Suspension
Fuel System
Pressurized Systems
Major Inspection
Heating System

The task analyses for twelve of the thirteen systems are presented as Appendix A to this report. The remaining task analysis (major inspection) was immediately translated into teaching points which are presented as Appendix B to this report.

Module Development

Preliminary discussions with SCRTD contract and technical personnel lead to the decision that the example module would be for the major inspection task. After the major inspection task was translated into teaching points, and learning objectives, and pursuant to discussions with SCRTD technical representatives it was resolved that this task would require three separate modules for complete and efficient training coverage. These three modules should cover:

1. Body and interior
2. Chassis and lube
3. Tune-up

The learning objectives for this task are included as Appendix C to this report.

In conjunction with SCRTD maintenance personnel, the tune-up portion was selected for development into a complete module. This decision was based on two considerations:

1. The tune-up is the most difficult to teach.
2. A tune-up module will provide a relatively greater utility to operational personnel than would either of the other two.

In that the media of presentation was specified in the contract, instructional strategy decisions were minimized. The project team made decisions on the style of presentation (e.g. cohort explaination rather than authoritative dictum) and overall emphasis (e.g. visuals rather than workbook) based on student and content characteristics.

Based on the teaching points and learning objectives a script and pre/post tests were written covering the tune-up portion of the Major Inspection task.

A professional photographer was used to take the required slides on location at SCRTD maintenance facilities. An experienced SCRTD mechanic was used as the identifiable character in order to foster credibility and student confidence in the program.

Developmental Testing

In order to assure the technical accuracy and clarity of the program a developmental test was scheduled at SCRTD Division 7. This activity involved the administration of a rough version of the program to four SCRTD "C" mechanics

A Canyon project team member introduced the "students" to the program and the purpose of the session. Pre tests were then administered and were completed by the test subjects in eight to thirteen minutes. Test subjects were then shown the program with project team members reading the script and manually advancing the slides. Presentation time was sixteen minutes. Post tests were then administered to the test subjects and completed in four to seven minutes.

Upon completion of the post testing, a short debriefing session was then held to obtain the student's reactions to the program and suggestions for improvement. Several areas in the program were identified as vague and the pace was decidedly too fast.

After the test subjects were excused, discussions were held with SCRTD contract and technical personnel regarding program changes. Examination of pre/post test data subsequently revealed several vague and/or incorrect test items.

Validation Testing

After the identified changes were made in the pre/post test and script, fill-in visuals were obtained and the script was recorded using a professional narrator. A validation test session was then scheduled, again at Division 7.

Validation testing used essentially the same procedure as developmental testing except that the "final" version of the module was presented using the pulsed slide/tape medium. Four (different) test subjects were again used. Pre-test completion times ranged from seven to nine minutes and scores ranged from six to eight (of a possible 15) with a mean score of 6.7. Presentation time was 19 minutes 10 seconds. Post test completion times ranged from three to five minutes and scores ranged from nine to fifteen with a mean score of 12.7.

The debrief session pointed to the requirement for five minor script changes but overall acceptance was highly positive on the part of the test subjects. The highly visual nature of the presentation seemed to be of particular favor.

Final Production

The suggested changes were made in the audio and visuals and the workbooks, and administrative guide were then written to conform to the final program content. One minor change was also incorporated in the pre/post test. The pre/post test key is provided in Appendix D to this report and the Administrative Guide as Appendix E. These items have been submitted prior to or accompanying this report.

SECTION III

CONCLUSIONS AND RECOMMENDATIONS

This program has provided the SCRTD with training task analyses which will provide the basis for a complete and accurate "C" mechanic training program. This training should be geared to entry level mechanics who have some gasoline engine experience. A note of caution is that these audio visual programs cannot be expected to provide a substitute for actual hands-on experience. The nature of the mechanic's job is such that psychomotor practice is essential to learning. The audio visual programs will, however, greatly speed the psychomotor learning process. When these programs are properly developed, the overall learning time from entry level to "productive" mechanic can be expected to decline from one year to less than six months.

Based on what?

In the course of developing the analyses and example module, the project team evolved three primary recommendations which include:

- Consideration should be given to augmenting the "Periodic Tune-up" module with an engine mock-up upon which the student can practice either during or immediately after the module presentation.

- Consideration be given to translating the "Periodic Tune-up" module audio track into Spanish and other frequently occurring languages (e.g. Vietamese). This would provide bi-(poly)-lingual training capabilities at minimal cost and greatly enhance the learning performance of limited English speaking mechanic hires.

- Development of subsequent "C" mechanic training should proceed as rapidly as is practically possible. The influx of new equipment types into the SCRTD is already beginning to tax the maintenance resources. Strong consideration should be given to contracting this elementary level training out. This will off-load in house maintenance training resources to concentrate on the more critical task of training the entire maintenance department on the new generation subsystems, techniques and procedures associated with the new more complex coaches entering SCRTD service.

APPENDIX A-1

TASK ANALYSIS - AIR CONDITIONING

TASK ANALYSIS - AIR CONDITIONING

Fundamentals of Air Conditioning

Description of the System

- Compressor
- Compressor drive
  - Independent engine
  - Parasite drive from main engine
- Condenser coil
- Condenser fan
- Refrigerant - description and handling procedures
- Liquid receiver tank
- Evaporator coil
- Refrigerant expansion valve
- Refrigerant heat exchanger
- Dehydrator strainer
- Air circulation system
- Control system

Operation of the System

- System start-up
- System shutdown
- General operation
- Heating system inneraction

System Maintenance

- Refrigerant "hi-low" pressure switch
  - Test and adjust
  - Remove
  - Install

- Air conditioning control relays
  - Test
  - Remove
  - Install
- Refrigerant connections
  - Inspect (threaded and soldered)
  - Threaded
    - Connecting
    - Disconnecting
  - Soldered
    - Connecting
      - Cleaning
      - Use of flux
      - Soldering technique
  - Disconnecting
- Clutch control systems
  - Air soledonid valve
  - Test and remove
  - Remove
  - Install
  - Magnetic clutch
    - Test and inspect
    - Remove
    - Install
- Liquid refrigerant receiver tank
  - Check high pressure fuse plug
  - Remove inlet valve assembly
  - Install inlet valve assembly
  - Check for leaks
  - Remove outlet valve assembly
  - Install outlet valve assembly
  - Check for leaks
  - Remove tank
  - Install tank
  - Check for leaks

Refrigerant dehydrator-strainer

- Test strainer
- Remove strainer
- Install strainer

Refrigerant expansion valve

- Test and adjust
- Remove
- Install

Evaporator

- Inspect
- Remove
- Install
- Clean
- Straighten fins

Air filer screens

- Remove
- Install
- Clean

Under floor blowers and motors

- Inspect, Test, replace brushers
- Remove
- Install

Condenser compartment (overhead)

- Clean grilles
- Inspect door seals
- Clean screens
- Clean compartment

Condense compartment (front radiator mount)

- Clean grilles
- Clean compartment area

Condenser coil

- Test for leaks
- Visually check for leaks
- Clean
- Comb fins
- Remove
- Install

Condesner fan

- Remove
- Install
- Adjust height of blade

Condenser fan drive motor

- Check electrical connections
- Check motor speed
- Remove fan drive motor
- Install fan drive motor

Condenser fan drive alternator

- Check drive belt tension
- Check generator mounting
- Check electrical connections and output
    - Test voltage regulator
        - Test regulator and adjust
        - Remove regulator
        - Install regulator
- Check brushes, brush holders and springs
- Remove alternator
- Install alternator

Refrigerant compressor

- Test pressure, high
- Test suction, low pressure
- Check cylinder unloading control mechanism
    - Trane - hydraulic
    - Thermo King - electric
    - Frigidaire - mechanically
- Check compressor oil pump
- Check capacity control actuator
- Check for leaks
- Remove compressor
- Install compressor

Test compressor crank shaft seal for leaks
Remove clutch assembly (mechanical and electrical)
Remove fly wheel
Remove seal
Install seal
Test for leaks
Install fly wheel
Install clutch assembly

Refrigerant valves and compressor shut-off valves
Check valves for operation
Remove valves
Install valves
Test for leaks

Compressor drive
Inspect compressor and clutch drive components
Check air pressure to clutch control cyclinder
Remove clutch control cylinder
Install clutch control cylinder
Adjust clutch release fork
Remove propeller shaft
Remove clutch housing nadcover
Remove clutch drive plate
Inspect pilot bearing
Install clutch drive plate
Remove clutch release bearing
Install clutch release bearing
Install clutch cover and housing
Install properller shaft
Align propeller shaft

Servicing and Testing the System
Inactivitating the system
Inspect refrigerant valves
Test and replace condenser fan drive alternator belt
Clean dondenser coils
Check refrigerant pressure level (high and low)
Check refrigerant level
Charge the system with refrigerant

Servicing and Testing the System (Continued)

- Remove excess refrigerant
- Pump down the system
- Evacuate the system
- Check moisture indicator
- Check for air in t he system
- Chekc for superheat and adjust
- Test for refrigerant leaks
- Replace dehydrator-strainer
- Maintaining compressor oil change (level)
- Check compressor oil pressure
- Check compressor oil pump pressure
- Check compressor unloading setting
- Check compressor fan speed
- Check evaporator motors
- Check heating system

APPENDIX A-2

TASK ANALYSIS - BRAKE RELINING

TASK ANALYSIS
BRAKE RELINING

Coach Preparation

Determine wheels to be worked on (front or rear, or both).

Record hub odomter reading (check coach numbers).

Drive coach over pit.

Set hand brake, put transmission in neutral.

With stands in place, jack coach for ground/wheel clearnance.

Block coach.

Back off on brake adjustment (increase brake shoe/drum clearance to allow easier removal of wheel).

Wheel Removal (Front) Figure 1

NOTE: Remove only the wheels to be worked on. All disassembled parts are placed in parts tray for steam cleaning.

Remove front wheel bearing retainer cap screws (6).

Remove cap -- striking the cap with a hammer will jar it loose.

Bend locing plate away from outer lock nut.

Remove outer lock nut.

Remove lock ring.

Place cradle (special wheel holding stand) under wheel anduse hydraulic jack built into the device to relieve the weight of the wheel on the spindle. Do not over-jack.

Remove adjusting nut and dowel assembly.

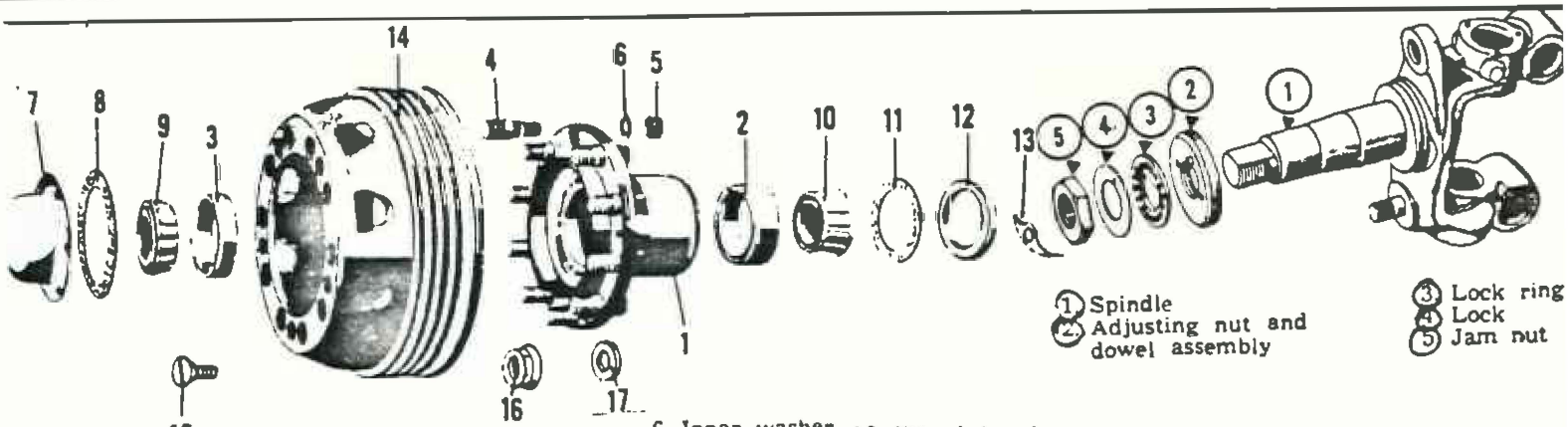
Remove outer bearing (cone only, cup remains in place unless damaged).

Pull cradle and wheel away from spindle and clear of the wheel well area.

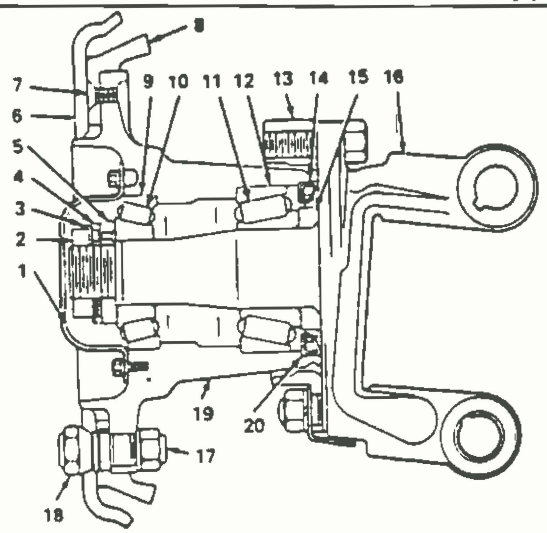
NOTE: If wheel is difficult to remove, it may be necessary to provide more brake shoe/drum clearance by again backing off on the brake adjustment.

Inspect wheel rim for cracks, nicks, chips, or other visible damage.

Remove inner bearing oil seal for hub assembly. Use a soft (brass) drift punch for removal.



1. Hub, cup and stud assembly
2. Inner cup
3. Outer cup
4. Stud
5. Inner nut
6. Inner washer
7. Hub cap
8. Cap gasket
9. Outer cone
10. Inner cone
11. Washer
12. Oil seal
13. Wheel bearing grease slinger
14. Brake drum
15. Drum to hub screw
16. Nut
17. Washer



1. Hub Cap
2. Lock Nut
3. Nut Lock
4. Adjusting Nut Lock Ring
5. Bearing Adjusting Nut
6. Wheel
7. Brake Drum Retaining Screw
8. Brake Drum
9. Outer Bearing Cup
10. Outer Bearing Cone and Roller Assembly
11. Inner Bearing Cone and Roller Assembly
12. Inner Bearing Cup
13. Brake Spider
14. Oil Seal
15. Bearing Spacer
16. Steering Knuckle
17. Wheel Stud
18. Wheel Nut
19. Hub
20. Oil Seal Washer

Figure 1 - Front Wheel Brake and Spindle Assemblies

Remove inner bearing (cone only, cup remains in place unless damaged).

Tie bearings together, tag right side and mark with coach number.

Write coach number on inside edge of brake drum.

Measure drum wear. A special inside micrometer is used for this measurement. Measurement is made at point of deepest wear (deepest groove). Drum must remain within tolerance after resurfacing.

NOTE: This is a decision point. Should the drum be resurfaced or not? Various visual checks are used in addition to the drum measurements. Look for evidence of heat stress, warpage, cracks and deep grooves.

Set wheel aside for steam cleaning. The wheel is to be steam cleaned whether or not it is to be resurfaced.

Brake Shoe Removal (Front) Figure 2

NOTE: All disassembled parts are placed in the parts tray for steam cleaning.

Rotate slack adjuster nut until brake shoe rollers are at the lowest point on the S-type cam. This minimizes return spring tension.

Remove anchor pin lock bolt.

Remove lock plate from grooves in anchor pins.

Remove anchor pins from brake shoe and spider. Anchor pins are driven out with soft drift punch. Return spring will hold shoes in place.

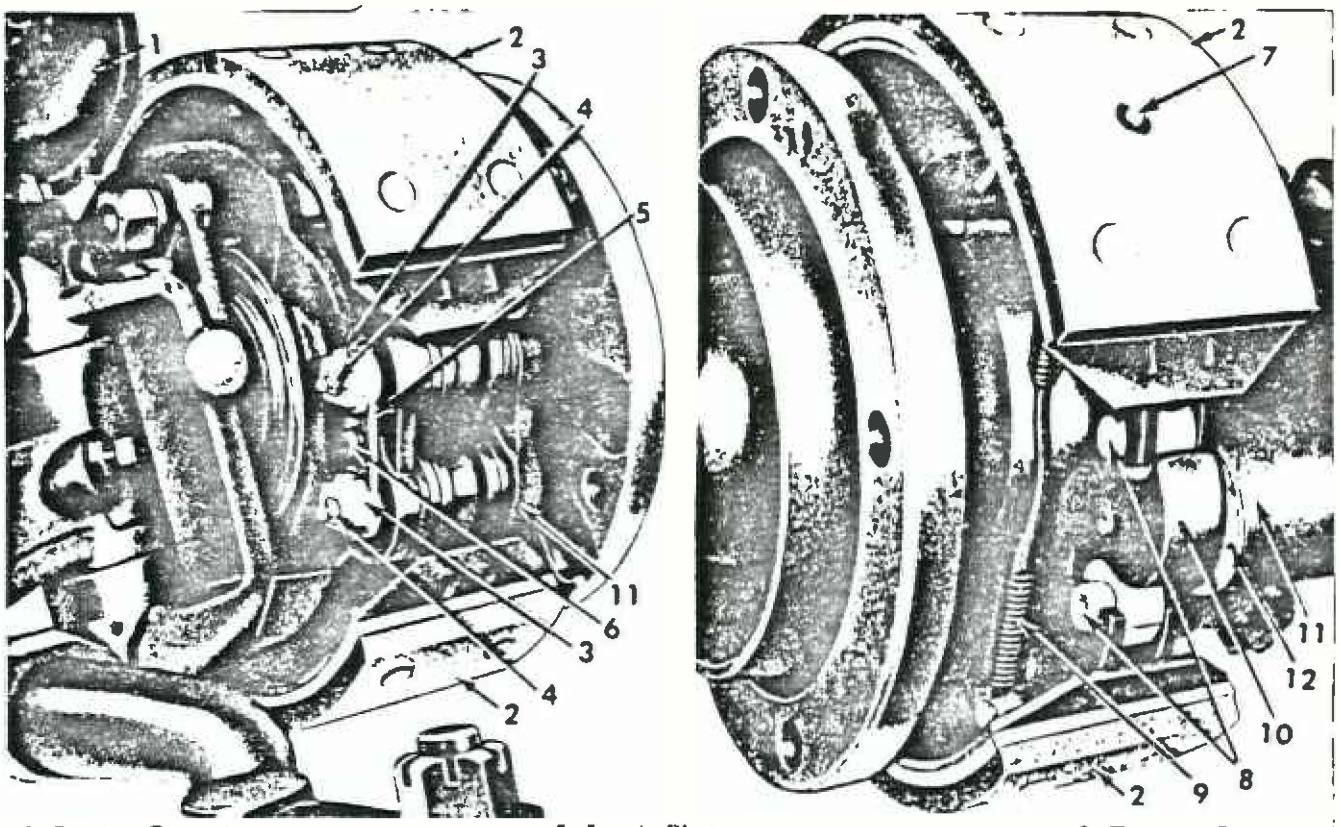
Remove lower brake shoe. This is done by forcing the lower brake shoe down and away from the spider bracket and pulling it outward to disengage return spring.

NOTE: When removing upper and lower brake shoes, brass shims will fall free from the assembly. These shims are to be discarded.

Remove return spring from upper shoe.

Remove upper shoe.

NOTE: Brake shoes should <u>not</u> be identified with coach number at this point.



1. Brake Chamber
2 Brake Shoe and Lining Assy.
3 Anchor Pins
4 Lubrication Fittings
5 Lock Plate
6 Lock Bolt
7 Return Spring Access Hole
8 Rollers
9 Return Spring
10 Camshaft
11 Brake Spider
12 Washers T-7179

Figure 2 - Front Brake Shoe Assembly

Slack Adjuster Removal (Front) Figure 3

Remove cotter pin from brake chamber push rod clevis (yoke) pin.

Remove clevis (yoke) pin.

Rotate slack adjuster arm to clear the clevis.

Remove snap ring from cam shaft (opposite end from the cam).

Remove spacing washers.

Remove slack adjuster from splines.

Pull cam shaft from brake spider.

Prepare all removed parts and aasemblies for steam cleaning.

Clean brake spider and axle assemblies with approved solvent. Use a stiff brush to aid in cleaning hardened grease and inaccessible places.

NOTE: Special attension should be given to the cam bushings in the spider bore. These areas need to be absolutely clean to provide the best possible check for cam shaft wear.

Wheel Removal (Rear) Figure 4

Check that hub odometer reading has been recorded.

NOTE: Remove only the wheels to be worked on. All disassembled parts are placed in parts tray for steam cleaning.

Remove rear wheel axle shaft cap screws (6).

Remove axle shaft.

Remove outer lock nut.

Remove lock ring.

Place wheel cradle under wheel assembly and jack cradle to relieve load on axle.

Remove bearing adjusting nut.

Remove wheel and drum assembly -- pull crade clear of rear wheel well.

Identify wheel and drum assembly with coach number on the inner drum flange.

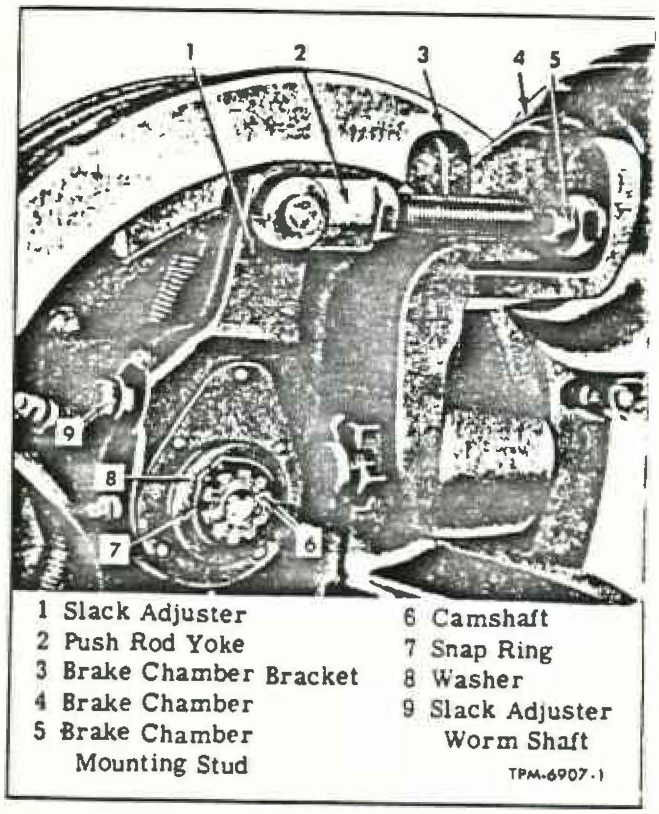
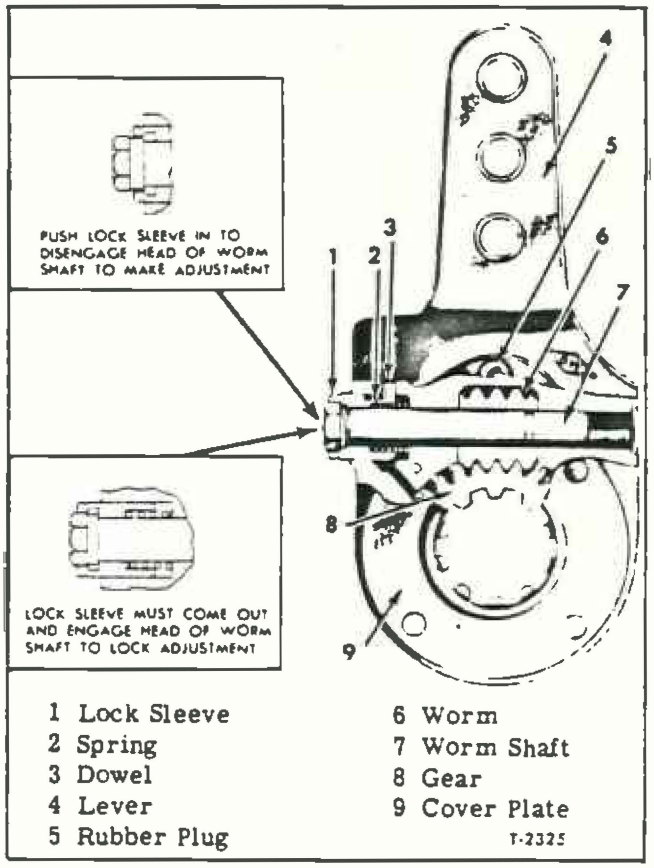
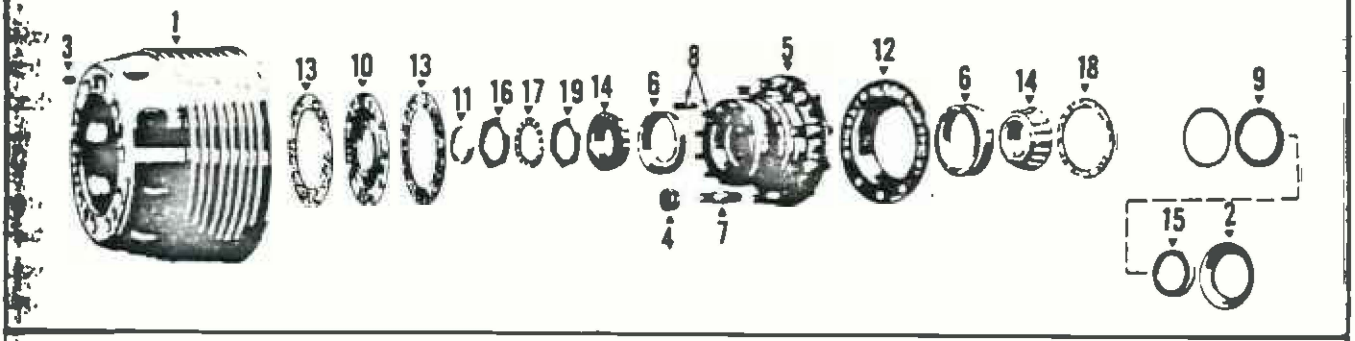


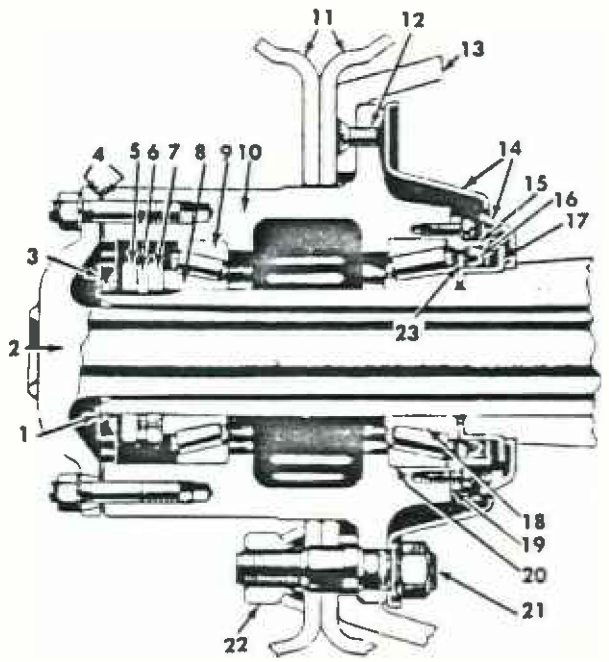
Figure 3 – Brake Chamber Bracket and Slack Adjuster Mounted on Front Axle



– Slack Adjuster



1. Brake drum
2. Oil slinger
3. Hub screw
4. Hub and wheel stud nut
5. Hub, cup and stud assembly
6. Inner and outer cup
7. Wheel stud
8. Axle shaft stud
9. Oil seal and retainer assembly—inner
10. Oil seal assembly —outer
11. Wiper assembly —outer
12. Oil slinger
13. Axle shaft gasket
14. Inner and outer wheel bearing cone
15. Inner wiper assembly
16. Outer wheel bearing nut
17. Washer
18. Gasket
19. Adjusting nut and dowel assembly



1 Oil Seal Wiper and Cork Assembly
2 Axle Shaft
3 Outer Oil Seal Assembly
4 Gaskets
5 Lock Nut
6 Lock Ring
7 Bearing Adjusting Nut
8 Outer Bearing Cone and Roller Assembly
9 Outer Bearing Cup
10 Hub
11 Wheels
12 Brake Drum Retaining Screw
13 Brake Drum
14 Oil Slinger
15 Oil Seal Retainer
16 Inner Oil Seal
17 Oil Seal Wiper Sleeve
18 Inner Bearing Cone and Roller Assembly
19 Gasket
20 Inner Bearing Cup
21 Wheel Stud
22 Wheel Nut
23 Oil Seal Washer T.175

Figure 4—Rear Hub and Bearings (Typical)

Remove inner bearing seal retainer. Six (6) screws hold this retainer in place. The screws are not reused. Discard them to avoid reuse.

Remove bearing assembly and seals -- bearing cups remain in place.

Brake Shoe Removal (Rear) Figure 5

Rotate slack adjuster nut until brake shoe rollers rest on lowest part of cam. This reduces tension on the return spring. Cut safety wire on brake shoe anchor pin lock bolts.

Remove lock bolts and plate.

Remove snap rings from anchor pins.

Remove anchor pins from brake shoe and spider. Anchor pins are driven out with soft drift punch. Return spring will hold shoes in place.

Remove lower brake shoe. This is done by forcing the lower shoe down and away from the load tube and spider bracket and pulling it outward to disengage the return spring.

NOTE: When removing and lowering brake shoes, brass shims will fall free from the assembly. These shims are discarded.

Remove upper shoe and disengage return spring.

NOTE: Brake shoes should <u>not</u> be identified with coach number at this point.

Slack Adjuster Removal (Rear) Figure 6

The procedures for the removal of the rear slack adjuster are the same as for the front.

Cleaning Parts (Front and Rear).

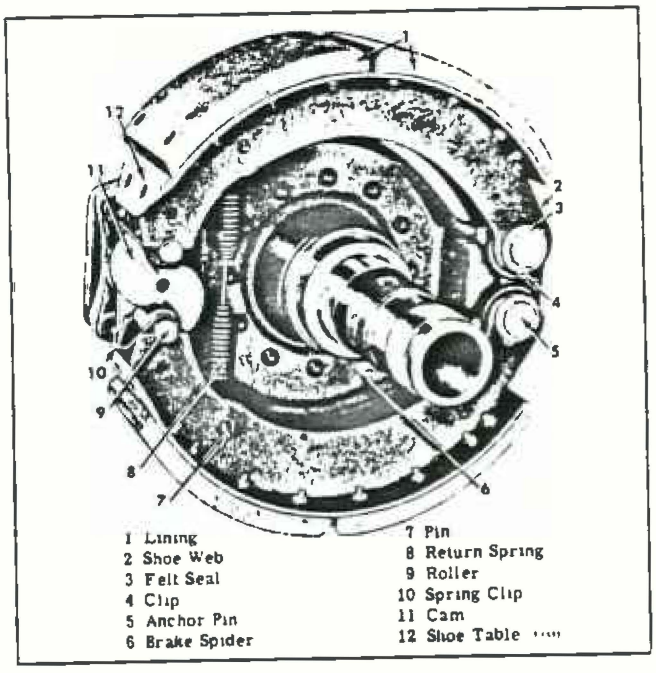
All reusable parts are carefully and completely cleaned before inspection and reassembly. The disassembled parts are steam cleaned in a special cleaning area. Parts remaing on the coach are cleaned with an approved solvent and brushes.

This approved cleaning solvent is _____.

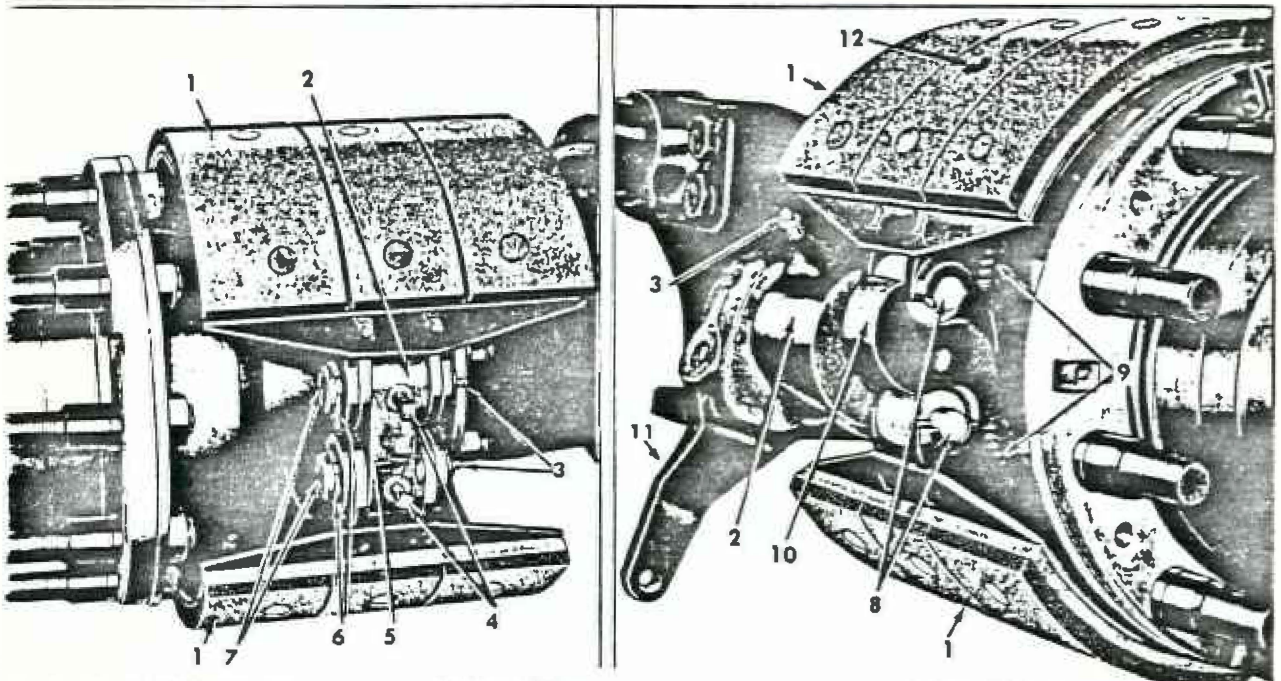
Steam Cleaning.

Steam cleaning is a straightforward task if the parts to be cleaned are prepared properly when removed from the coach.

Safety in using steam cleaning equipment has to be stressed. There is the possibility of serious personal injury if safe procedures are not followed.



1 Lining
2 Shoe Web
3 Felt Seal
4 Clip
5 Anchor Pin
6 Brake Spider
7 Pin
8 Return Spring
9 Roller
10 Spring Clip
11 Cam
12 Shoe Table



1 Brake Shoe and Lining Assy.
2 Brake Spider
3 Lubrication Fittings
4 Lock Bolts
5. Lock Wire
6. Anchor Pin Lock
7. Anchor Pins
8. Rollers
9. Return Spring
10. Camshaft
11. Slack Adjuster
12. Return Spring Access Hole

Figure 5 -- Rear Brake Shoes Installed

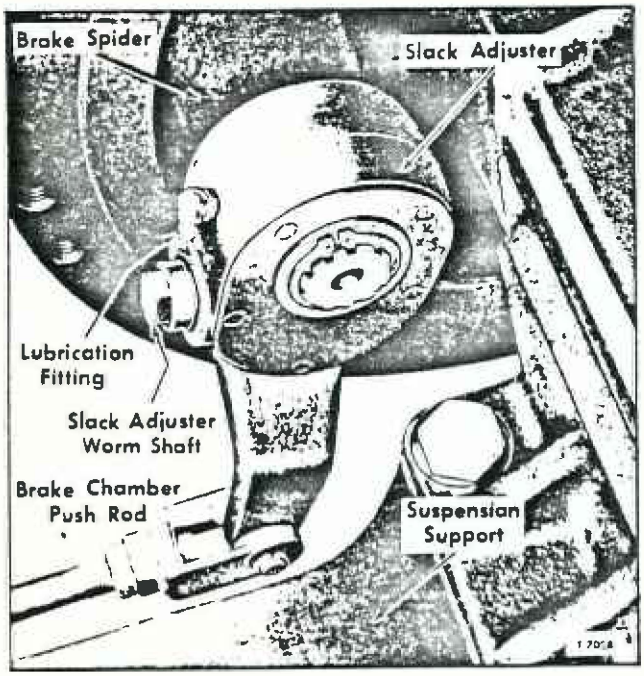
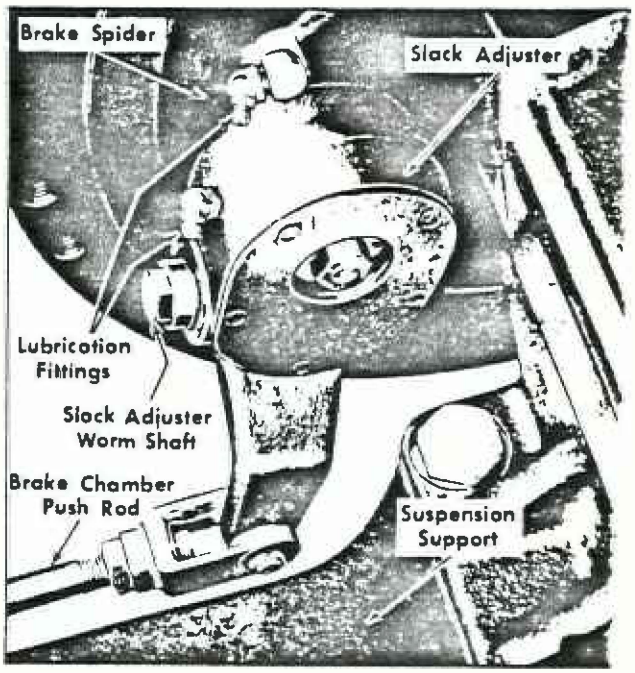


Figure 6 —Slack Adjuster and Camshaft Mounted on Rear Axle – Snap ring retainer



Slack Adjuster and Camshaft Mounted on Rear Axle – washer and nut retainer

Immediately after steam cleaning parts, the parts are inspected and given a light coat of oil to prevent rusting. Bearings are inspected, packed in grease and wrapped to prevent collecting dirt.

Cleaned and treated parts that are serviceable are returned to the wheel well area of the coach from which they were taken.

Inspecting Parts

All moving parts and bearing surfaces are checked for evidence of damage or wear.

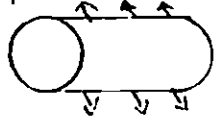
Nicks, chips, burns, distortions, etc., are visible evidence of damage. Identification of such problems requires experience.

Wear is not necessarily visible. Some parts must be measured to determine if they are within acceptable tolerances. Various measurement techniques are used. Actual measurements are taken using micrometers, rulers or feeler gauges. Some measurements involve mating parts and making judgments of fit.

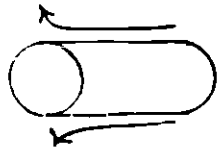
Brake Cam Busings (Front and Rear) Figure 7. The cam shaft bore bushings are thoroughly cleaned and checked for damage.

A lightly oiled cam shaft is inserted into the bore bushings and the bushings are checked for wear. (The camshaft used for this operation must be free from cracks, chips or nicks and this camshaft must be within manufacturer's tolerances for new or reusable parts).

Two axes of the camshaft are checked for movement: the radial axis (movement of the pin from side to side throughout the length



of the busings) and the pivotal axis (movement of the pin on one end only).



Movement along the radial axis means the bushings are worn. Movement along the pivotal axis can mean bushing wear or, in some cases, a looseness of the spider attaching bolts. Replace bushings if movement occurs.

Anchor Pins (Front and Rear) - Check for grooves, nicks, chips and evidence of textural or color differences on the hardened surfaces. Wear must be within manufacturer's tolerance for new or unusable parts.

Brake Spider (Front and Rear) - Insert anchor pin and check bushings (or bore if bushings are not used) for radial movement. The same procedures are used here as for the camshaft bushings. Replace if movement occurs.

Front Spindle (Axle assembly) - Check bearing surfaces for grooves, nicks, chips, and hardened surface wear-through (evidenced by textural and color changes). General practice is to slip inner and outer bearing race over the shaft and feel how the race slides on the spindle.

Load Tube (Rear counterpart of the front spindle) - Check for grooving.

Seal Wipes (Front and Rear) - Check for nicks, grooves and burns.

Manual Slack Adjuster - Check splines for wear and distortion (twisting and bending). Check clevis pinhole for wear (out-of-round). Check adjusting nut for rounded edges. Lock sleeve should be free to move in and out (in to allow nut access for adjusting; out for protecting nut from inadverted movement and damage).

Automatic Slack Adjusters - Procedures not checked at Division 2 because of missing jigs and tools.

Wheel Bearings (Front and Rear) - Inspect rollers for cracks, chips, nicks and roughness. Check inner bearing race for roughness and pitting. This is accomplished by holding race up to a light source and checking the evenness of the reflected light. Bearing cups are checked for pits, cracks, roughness or chips.

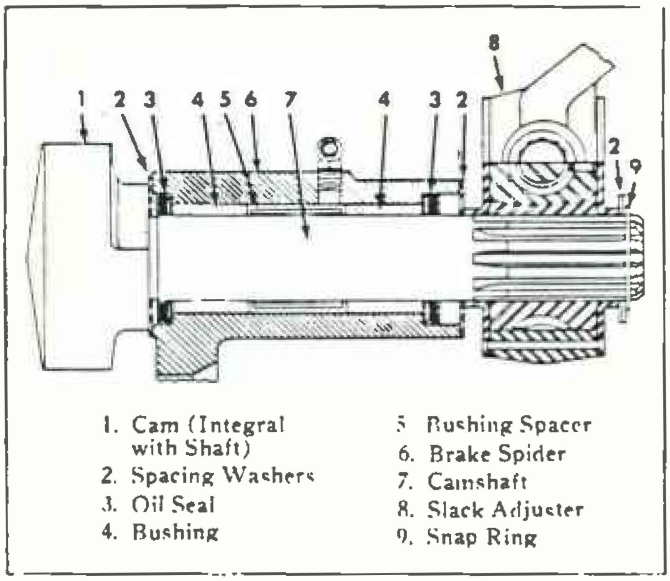


Figure 7 Typical Brake Camshaft and Slack Adjuster Mounting

Return Springs - General practice is to replace all return springs when brakes are relined.

Wheel and Brake Drum Preparation for Turning (Front and Rear)

Remove worn blocks from shoes, discard brass screws.

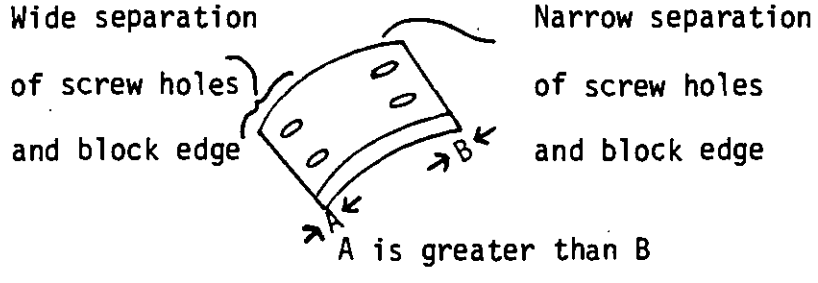
Inspect shoe for warpage or being out-of-round in special jig designed for this purpose.

Inspect rollers and anchor pin bushings for nicks, cracks, chips, or flat spots. Make sure rollers are well seated.

Determine block size for fit with brake drum diameter. (Use X, XX, or XXX blocks according to specifications.)

Attach blocks to shoes using brass screws and lock washers. Washers are bottomed out at approximately 28 ft. lbs. torque.

NOTE: Blocks are supplied in pairs. One of the blocks is blue color coded on its edges, the other is natural. The blue block goes on the leading end of the shoe (toward the cam). Also, the distance from the screw holes to the edge of the block is different. On one edge the distance is narrow, on the other the distance is wider. The narrow distances on the blocks butt each other when installed on the shoe. Two blocks per shoe are used for the front, four blocks per shoe are used for the rear.



Mark prepared shoe with the coach number of the wheel and drum with which it is to be matched and machined.

Drum and Shoe Turning

Attach wheel and drum to lathe spindle using hoist. Secure wheel and drum with retaining nut (left-hand thread).

Determine depth of resurfacing cut to be made. Measure depth of deepest groove. Measure highest point - difference plus 0.005" is cut depth. Fill in inspection sheet.

NOTE: If a lip at the outer edge of the drum will create the need for a final run-out cut greater than 0.050", it may be desirable to remove the lip with a preliminary cut before proceeding with the resurfacing cut.

Attach shoes (upper and lower) to lathe. Shoes are attached the same as they would be on the coach, but instead of a return spring, a special rigid retaining rod is connected between the return spring mounting pins and tightened to hold the shoes firmly in place while turning.

Set drum turning cutting tool to desired depth using feed handle micrometer (cut taken will be twice that indicated on micrometer).

NOTE: The lathe will automatically feed in one direction only. It is necessary to manually run the cutting tool into the inner shoulder of the drum before setting the desired cut depth.

Set shoe cutting tool to provide a matching cut across the shoes by aligning the bench marks between the drum cutting tool feed attachment and the shoe cutting tool feed attachment.

Safety NOTE: Because asbestos is used in the brake blocks, a respirator should be worn during this operation. The vacuum system provided with the lathe is seldom working at maximum efficiency and does not remove all the drum and shoe dust from the air.

Wheels and drums and matching shoes are removed from the lathe and returned to the wheel well area of the coach on which they are to be installed. Wheel cradles are used for transporting and holding the wheels.

Slack Adjuster Installation (Front) Figure 8 (same as 6)

Assemble cam shaft -Figure 9 (same as 7)

Replace camshaft seals in brake spider cam shaft bore.

NOTE: Cam shaft seals have a tapered inner surface. The seals are installed with the taper facing the cam end of the cam shaft. This allows the shaft to be inserted without damaging the seals.

Spacing washer is slipped on cam shaft and rests against cam shoulder.

Cam shaft is inserted through seals.

Second spacing washer is installed over cam shaft and against spider inner shoulder.

Slack adjuster is slipped onto splines on the end of the cam shaft.

Snap ring is temporarily installed on cam shaft and the correct thickness of washer to be used is determined by measuring gap between slack adjuster shoulder and snap ring. (Various thicknesses of washers are held together and inserted in the gap to get the best fit.)

Snap ring is removed, washers installed and snap ring replaced.

Push rod is connected to slack adjuster by inserting clevis pin through holes in the clevis and the hole in the lever arm of the slack adjuster. The pin is secured in place with a cotter pin.

Push rod length is measured from brake chamber shoulder through which the push rod travels to the center of the clevis pin. This length should be . If not, the lock nut on the clevis is loosened and the push rod is adjusted to its proper length.

Brake Shoe Installation (Front) Figure 10 (same as 2)

Check coach number against numbers on brake drum and brake shoes.

Set upper shoe in place and insert temporary anchor pin. (This is a special pin used for aligning shims in spider and shoe bores.)

Rotate the cam until the roller of the brake shoe rests on the lowest part of the cam.

Slide temporary anchor pin through spider bushings far enough to allow shims to be inserted between spider bore and brake shoe bore. Shims are inserted until all free play between brake shoe and spider is eliminated.

Realign all shims by reinserting temporary anchor pin.

With temporary anchor pin still in place, insert permanent anchor pin. (Gently drive the temporary pin out with the permanent one.)

Attach return spring to upper shoe return spring pin.

Attach return spring to lower brake shoe and set roller in lowest part of the cam.

Push down and in on the lower brake shoe and mate with spider.

Insert temporary anchor pin and repeat shimming procedures to remove free play from lower shoe.

Insert permanent pin to replace temporary pin.

Orient grooves in anchor pins to accept lock plate.

Insert lock plate.

Install lock bolt.

Drum and Wheel Installation (Front) Figure (same as Figure 1)

Check coach number with number on wheel and drum assembly.

Inspect inner and outer bearing cups for dirt, damage, and proper seating (if these parts were not removed from the hub during disassembly process). If cups were removed, they should be reinstalled at this point.

Grease inner and outer cups and insert inner bearing cone in hub assembly. Bearing cone should be packed with grease.

Install washer.

Install oil seal.

Move wheel and drum into position near the spindle and jack wheel to height and angle to slip on the spindle.

Push wheel and drum onto spindle until inner bearing is seated.

Install outer bearing cone. Bearing cone should be packed with grease.

Install adjusting nut and dowel.

Remove cradle.

Adjust wheel bearings.

NOTE: Wheel bearing adjustment should be carefully checked during the installation procedure. While slowly rotating the wheel, the adjustment nut should be tightened until wheel binds. Back off on the adjusting nut one-sixth (1/6) of a turn, or move, if necessary, to allow the wheel to rotate freely but without movement along the spindle.

Install lock ring. Make sure the dowel on the lock nut is aligned with a hole in the lock ring.

Install lock washer.

Install jam nut.

Bend lock washer over one flat side of the jam nut.

Install hub cap gasket.

Install hub cap.

Slack Adjuster Installation (Rear) Figure 12 (same as 6)

Assemble cam shaft Figure 13 (same as 7)

Replace cam shaft seals in brake spider cam shaft bore.

NOTE: Cam shaft seals have a tapered inner surface. The seals are installed with the taper facing the cam end of the cam shaft. This allows the shaft to be inserted without damaging the seals.

Slip spacing washer on cam shaft until it rests against cam shoulder.

Insert cam shaft through seals.

Install second spacing washer over cam shaft and against spider inner shoulder.

Mount slack adjuster onto the splines on the end of the cam shaft.

One of two methods is used to retain slack adjuster on cam shaft:

1. Snap ring method - Snap ring is temporarily installed on the cam shaft and the correct thickness of washer to be used is determined by measuring the gap between the slack adjuster shoulder and the snap ring. (Various thicknesses of washers are held together and inserted in the gap to get the best fit.) Snap ring is removed, the washers are installed, and the snap ring is replaced.

2. Bolt and washer method - The slack adjuster is mounted on the splines of the cam shaft and retained by a bolt threaded into the end of the shaft.

Connect the push rod to the slack adjuster by inserting the clevis pin through the holes in the clevis and the hole in the lever arm of the slack adjuster.

Measure the push rod length from the brake chamber shoulder through which the push rod travels to the center of the clevis pin. This length should be . If not, the lock nut on the push rod (at the clevis) is loosened and the push rod adjusted to its proper length. The lock nut is then retightened.

Brake Shoe Installation (Rear) Figure 14 (same as 5)

Check coach number against numbers on brake drum and brake shoes.

Set upper shoe in place and insert temporary anchor pin. (This is a special pin used for aligning shims in spider and shoe bores.)

Rotate cam until the roller of the shoe rests on the lowest part of the cam.

Slide temporary anchor pin through spider bushings far enough to allow shims to be inserted between spider bore and brake shoe bores. Shims are inserted until all free play between brake shoe and spider is eliminated.

Realign all shims by reinserting temporary anchor pin.

With temporary anchor pin still in place, insert permanent anchor pin by gently driving out the temporary pin with the permanent one.

Attach return spring to upper shoe return spring pin.

Attach return spring to lower brake shoe and set roller in lowest part of the cam.

Push down and in on the lower brake shoe and mate with spider.

Insert temporary anchor pin and repeat shimming procedure to remove free play from lower shoe.

Insert permanent pin to replace temporary pin.

Orient holes in spider with holes in anchor pins.

Install lock bolts to secure both upper and lower anchor pins in spider and brake shoe bores.

Install safety lock wire between lock bolts.

Install washers and snap rings on upper and lower anchor pins.

Drum and Wheel Installation (Rear) Figure 15 (same as 4)

Check coach number with number on wheel and drum assembly.

Inspect inner and outer bearing cups for dirt, damage, and proper seating (if these parts were not removed during the disassembly process; if the cups were removed, they should be reinstalled at this point).

Grease inner and outer cups.

Insert inner bearing cone into hub assembly. Bearing cone should be packed with grease.

Install gasket.

Install inner oil seal and retainer assembly.

Install inner seal wiper assembly.

Install oil slinger.

Move wheel and drum assembly into position near the rear axle load tube and jack wheel to height and angle necessary for installation on the load tube.

Push wheel and drum onto load tube until inner bearing assembly is seated.

Install outer bearing cone. Bearing cone should be packed with grease.

Install adjusting nut and dowel assembly.

Remove cradle.

Adjust wheel bearings.

NOTE: Wheel bearing adjustment should be carefully checked during the installation procedures. While slowly rotating the wheel, the adjustment nut should be tightened until the wheel binds. Back off on the

adjusting nut one-sixth (1/6) of a turn, or more, if necessary, to allow the wheel to rotate freely but without movement along the load tube.

Install outer wheel bearing nut.

Install outer wiper assembly.

Install axle shaft gasket.

Install outer oil seal assembly.

Install axle shaft gasket.

Install axle shaft.

Lower cradle and remove from wheel well.

Brake Relining (objectives outline)

- Area Preparation
- Tools Preparation
- Coach Preparation
- Wheel and Drum Removal (Front)
- Brake Shoe Removal (Front)
- Slack Adjuster Removal (Front)
- Wheel and Drum Removal (Rear)
- Brake Shoe Removal (Rear)
- Slack Adjuster Removal (Rear)
- Steam Cleaning Parts
- Solvent Cleaning Parts
- Inspecting Parts
- Brake Shoe Preparation for Turning
- Wheel and Brake Drum Preparation for Turning
- Drum and Shoe Turning
- Wheel Well Areas and Parts Preparation for Installation
- Slack Adjuster Installation (Front)
- Brake Shoe Installation (Front)
- Drum and Wheel Installation (Front)
- Slack Adjuster Installation (Rear)
- Brake Shoe Installation (Rear)
- Drum and Wheel Installation (Rear)

Additional Elements of the Braking System that may be Performed During Brake Relining Procedures.

Brake Chamber Removal (Front)

Brake Chamber Removal (Rear)

Brake Chamber Repair (Front and Rear)

Brake Chamber Installation (Front)

Brake Chamber Installation (Rear)

Brake Application Valve Removal

Brake Application Valve Repair

Brake Application Valve Installation

Rear Brake Relay Valve Removal

Rear Brake Relay Valve Repair

Rear Brake Relay Valve Installation

APPENDIX A-3

TASK ANALYSIS - ELECTRICAL SYSTEM

TASK ANALYSIS - ELECTRICAL SYSTEM

General Description

Circuit Diagrams

Test Equipment

Electrical Components

- Wires
- Switches
- Fuses
- Circuit breakers
- Meters
- Solenoids
- Relays
- Lights (incandescent and fluorescent)
- Batteries
- Voltage regulators
- Generators
- Alternators
- Starter motors
- Junction blocks
- Resistors
- Diodes
- Rectifiers
- Rheostat
- Wiring harness and connectors

Driver's Control Panel

- Test master switch circuit
- Replace master switch circuit component
- Test panel components
- Replace panel components

Driver's Control Panel Junction

Approximately 90 circuits are controlled through this junction box. The principles of fault isolation and repair apply to each circuit. Some circuits are more complex than others and involve unique pieces of equipment. Only these circuits will be dealt with in the task analysis.

Driver's Circuit Breaker Control Panel

Test circuits

Test components in circuits

Replace faulty components

Engine Compartment Apparatus Box

Test junctions

Test circuit breakers

Test electrical components

Replace faulty components

Regulator and Blower Control Circuits

Test voltage regulator

Test blower control relay

Test water pump circuit breaker

Test regulator sensing control relay

Replace faulty components

Entrance Door Circuits

Test circuits

Isolate faults

Replace components

Exit Door Circuits

Test circuits

Isolate faults

Replace components

Flasher and Foot Switch Circuits

Test circuits

Isolate faults

Replace components

- Battery Circuits
  - Inspect terminals
  - Test circuits
  - Isolate faults
  - Replace parts
- Tell-Tale Alarm System
  - Test light circuits
    - Hot engine
    - Low oil
    - Exit door
    - Stop lamp
    - Hi beam
    - Directional signal
    - Air conditioning stop
    - Brakes applied
  - Test alarm buzzer and rectifier assembly
  - Test passenger signal chime
  - Isolate faults
  - Replace faulty components
- Electric speedometer
  - Test circuits
  - Test components
  - Isolate faults
  - Replace components
- Battery Maintenance
  - Check electrolyte level
  - Fill batteries to proper electrolyte level
  - Clean batteries
  - Inspect battery:
    - Cables
    - Clamps
    - Hold downs
  - Charging battery:
    - Standard charge rate
    - Emergency boost charging (road call)
  - Test specific gravity
  - Replace faulty battery

Starting System
- Starter operation
  - Driver's compartment
  - Engine compartment
- Test starter
  - Perform no-load test
  - Test solenoid
- Remove starter
- Install starter

Generating System
- Test generating system output
  - Voltmeter check
  - Ammeter check
- Test alternator control relay

Voltage Regulator
- Test regulator setting
- Replace regulator
- Adjust regulator

Exter-or Lighting System
- Test circuits for:
  - Headlights (high beam and low beam)
  - Stop lights
  - Backup lights
  - Directional lights
  - Hazard warning lights
  - Markerand destination lights
- Isolate faults
- Replace faulty components
- Aim (align) headlights

Interior Lighting System
- Test circuits for:
  - Gauge a nd tell-tale lights
  - Front and rear step well lights
  - Engine compartment lights
  - Dome lights
  - Fluorescent lighting system

APPENDIX A-4

TASK ANALYSIS - FUEL SYSTEM

TASK ANALYSIS - FUEL SYSTEM

- System Description
  - Component parts
    - Fuel tanks
    - Fuel pump
    - Fuel lines
    - Fuel filters
    - Air cleaners
    - Pressure relief valves
    - Check valves
    - Anti-spill alarm
    - Air controlled throttle
      - Treadle valve assembly
      - Throttle control assembly
- System Operation
- System Maintenance
  - Remove fuel tanks
    - Drain fuel tanks
    - Disconnect fuel lines and whistle alarm vent tubes (if used)
    - Remove mounting straps from tanks
    - Remove tanks
  - Install fuel tanks
    - Position tanks under coach
    - Install mounting straps
    - Connect fuel lines and vent tubes
    - Fill tanks
    - Inspect for leaks with engine running
- Fuel lines
  - Remove fuel lines and fittings
  - Inspect fuel lines and fittings
  - Install fuel lines and fittings

Fuel filters (primary and secondary)
- Remove fuel filter
- Remove fuel filter elements
- Install fuel filter elements
- Install fuel filter
- Inspect fuel filter

Fuel pump
- Inspect fuel pump
- Test fuel pump
- Remove fuel pump
- Install fuel pump

Air cleaner
- Inspect air cleaner for air inlet restriction
- Remove and replace filter element or service oil bath tank
- Remove filter housing
- Install filter housing
- Inspect and reset restriction indicator (if used)

Pressure relief valve
- Inspect pressure relief valve
- Adjust pressure relief valve
- Remove pressure relief valve
- Install pressure relief valve

Anti-spill alarm
- Inspect anti-spill alarm
- Remove anti-spill alarm
- Install anti-spill alarm

Air throttled control
- Treadle valve
    - Inspect treadle valve assembly
    - Remove treadle valve
    - Install treadle valve
    - Test treadle valve
- Throttle control assembly
    - Inspect throttle control assembly
    - Remove throttle control assembly
    - Install throttle control assembly
    - Adjust throttle control assembly

APPENDIX A-5

TASK ANALYSIS - HEATING AND VENTILATION

TASK ANALYSIS - HEATING AND VENTILATION

Description of System

Operation of System

General Maintenance

Flush heating system.

Examine heater pipe joints and fittings.

Check heater cores for leakage.

Clean heater cores.

Check operation of:

heater blower motors

blower motor relays

Clean or replace underfloor air filters

Drain heating system

Fill heating system

Remove heating system water pump and motor.

Replace heating system water pump motor brushes.

Install heating system water pump and motor.

Adjust switch at water modulation valve.

Test and adjust Grad-U-Stat.

Remove Grad-U-Stat.

Install Grad-U-Stat

Check adjustable heat control with Grad-U-Stat (if used).

Check Thermostatic Heat Control (when used).

Check operation of water solenoid valve.

Remove water solenoid valve.

Install water solenoid valve.

Check operation of water modulation valve.

Remove water modulation valve.

Install water modulation valve.

Inspect air pressure regulator valve.

Remove air pressure regulator valve.

Install air pressure regulator valve.

Remove underfloor heater core unit.

Install underfloor heater core unit.

Remove underfloor blowers and motors.

Install underfloor blowers and motors.

Inspect and test components of heating system controls and wiring (circuit breakers, switches, relays, etc.).

Remove components of heating system controls and wiring.

Install components of heating system controls and wiring.

Test defroster heater.

Remove defroster heater.

- Remove air filters
- Remove heater core
- Remove fan motor and wheel

Install defroster heater.

- Install fan motor and wheel
- Install heater core
- Install air filters

Check manual ventilation.

- Operator's window opens
- Forward fresh air vents can be opened
- Passenger windows open

APPPENDIX A-6

TASK ANALYSIS - PRESSURIZED SYSTEMS

Task Analysis - Pressurized Systems

Note: Maintenance for some parts of this system has been described within other systems. In these cases only a reference to another task analysis will be provided. All component parts are listed here for clarity.

Operation of the System

Description of the System

System Components

- Air compressor
- Air compressor governor
- Air storage and supply reservoirs (tanks)
  - Primary service tank
  - Secondary service tank
  - Supply tank
  - Park tank
  - Accessory tank
  - Ping tank
- Air manifold
- Air cylinder valve
- Check valves
- Pressure protection valve
- Engine shutdown solenoid and air cylinder
- Clutch air cylinder
- Clutch solenoid valve
- Air shift cylinder

System Components (continued)

Braking System

- Dual brake valve
- Manual parking control valve
- Stand-by valve (TR-3)
- Service interlock valve
- Double check valve
- Stop light switch
- Modulators (front and rear)
- Brake chambers (front and rear)
- Relay valve (R-6)
- Parking valve assembly (DD-3)
- Parking activator (DD-3)
- Accelerator interlock

Suspension System

- Air springs (bellows), front and rear
- Height valves, (front and rear)

Heating, Ventilating and Air Condidioning System

- Air operated water valve
- Grad-u-stat
- Pressure limiting valve
- Air separator

Door Control System

- Door control valve
- Door air shut-off valve
- Entrance door engine
- Flow control valve
- Air magnet valve
- Rear door cylinder

Windshield Wiper System

- Wiper control valves
- Washer control valves
- Washer reservoir
- Wiper motors

Air Seat

System Maintenance

- Air Compressor
  - Inspect main discharge air lines
  - Remove main discharge air lines
  - Install main discharge air lines
  - Remove discharge valve cap nut
  - Clean carbon from discharge valve area
  - Inspect discharge valve
  - Install discharge valve and cap nut
  - Inspect unloader assembly
  - Remove unloader assembly
  - Clean, visually inspect, replace valves
  - Install unloader assembly
  - Inspect air compressor for pumping excessive oil

Air Compressor (continued)

- Remove air compressor
- Install air compressor
- Test air compressor and inspect for leaks

Air Compressor Governor

- Inspect for leaks
- Test governor
- Adjust governor
- Remove governor
- Install governor

Air Storage Tanks (general for all tanks)

- Inspect tank mounting
- Drain moisture from tanks
- Inspect petcock
- Remove and replace petcock
- Steam clean air tanks and lines
- Remove air tanks
- Install air tanks

Clutch Air Cylinder

- Inspect for leaks
- Remove clutch air cylinder
- Rebuild clutch air cylinder
- Install clutch air cylinder
- Adjust clutch air cylinder

Air Shift Cylinder

Inspect for leaks

Test electrical connection

Remove air shift cylinder

Repair and replace parts

Install air shift cylinder

Adjust air shift cylinder

Brake System

Note: The elements of the brake air system are covered under the task analysis for relining brakes and in air pressure system description and will not be repeated here.

Heating and Ventilating

Note: The elements

Door Control System

Test air supply to door control system

Inspect and check door handle for operation

Remove door handle valve

Inspect and repair door handle valve

Install door handle valve

Inspect door engine

Remove door engine

Install door engine

Adjust door engine linkage

Windshield Wiper System

- Test wiper motor control valve
- Adjust
- Remove control valve
- Install control valve
- Test wiper motor
- Remove wiper motor
- Install wiper motor
- Test washer operation control valve
- Remove washer control valve
- Install washer control valve
- Test washer pump
- Remove washer pump
- Install washer pump
- Inspect and clean lines and nozzles
- Repair or replace lines and nozzles

APPENDIX A-7

TASK ANALYSIS - SUSPENSION SYSTEM

TASK ANALYSIS - SUSPENSION SYSTEM

System Description
- Suspension supports
- Air bellows
- Height control valves
- Radius rods
- Shock absorbers
- Pressure protection valve

System Operation
- Compressed air source
- Height control
  - Loading
  - Unloading

System Maintenance
- Test and inspection
  - Test air tanks for leaks
  - Inspect bellows
  - Examine mounting assembly for loose nuts and bolts
  - Torque mounting nuts and bolts
  - Clean bellows
  - Check height adjustment
  - Adjust height

Remove front axle and front suspension
- Raise coach (front axle must be supported)
- Block coach
- Remove wheels and tires
- Disconnect steering drive
- Disconnect height control valve link
- Bleed bellows
- Disconnect air hoses to bellows and brake chambers
- Disconnect radius rods
- Remove shock absorbers
- Remove axle assembly

Install front axle and suspension

- Install suspension support on axle
- Attach radius rod bracket to axle
- Install bellows on suspension supports
- Position axle and hoist into place
- Connect radius rods
- Install shock absorbers
- Connect height control valve
- Correct steering gear drive
- Connect air hoses to brake chambers and bellows
- Connect sensor cables to brake modulator valve
- Install wheels

Remove rear axle and suspension

- Raise coach (support axle)
- Block coach
- Remove wheels
- Disconnect propeller shaft
- Disconnect parking brake control rod
- Disconnect height control valve from overtravel lever
- Bleed air from bellows
- Disconnect air hoses
- Disconnect bellows from upper supports
- Disconnect stabilizer bar
- Remove radius rods
- Remove shock absorbers
- Remove axle assembly
- Remove bellows assembly from suspension supports
- Remove air side beam from rear axle assembly

Install rear axle and suspension

- Position suspension assembly under coach on jacks
- Raise suspension assembly into place for attaching to coach frame
- Align plates on bellows assemblies and beams
- Install nuts and bolts in plates and torque to specifications
- Connect air hoses
- Install shock absorbers
- Connect radius rods
- Adjust axle clearance to normal ride height
- Torque radius rod cap screws and anchor bolt lock nuts
- Connect height control valve linkage
- Connect propeller shaft
- Connect parking brake linkage
- Install stabilizer bar and linkage
- Remove jacks
- Install wheels
- Lower vehicle
- Build up air pressure to normal operating pressure
- Check clearance between axle bumpers and axle
- Adjust overtravel lever on each height control valve to achieve desired clearance
- Check system for air leakage

Remove height control valve

- Disconnect overtravel lever from valve link
- Disconnect air supply lines
- Disconnect bellows air supply lines
- Remove attaching nuts and bolts
- Remove valve assembly

Remove shock absorbers front and rear

- Remove nuts and bolts attaching shocks to frame
- Remove mounting stud on lower end
- Remove shock absorber assembly

Install shock absorbers (front and rear)

- Assemble rubber bushings and anchor pins
- Install shocks on mounting plates
- Install shock absorber assembly
- Torque attachment bolts

TASK ANALYSIS - Steering System (Mechanical)

System Description

System Operation

System Components

- Steering Wheel
- Steering Column and Bevel Gear
- Steering Propeller Shaft and Pitman Arm
- Steering Drag Link
- Steering Tie Rod and Steering Arm
- Steering Gear Assembly

System Maintenance

- Remove steering wheel
- Install steering wheel
- Remove steering column and bevel gear
- Install steering column and bevel gear
- Remove steering propeller shaft and Pitman arm
- Install steering propeller shaft and Pitman arm
- Remove steering drag link
- Install steering drag link
- Remove steering tie rod and steering arm
- Install steering tie rod and steering arm
- Remove steering gear assembly
- Install steering gear assembly

System Adjustments

- Adjust worm bearing
- Adjust Pitman Shaft Lash

TASK ANALYSIS - Steering System (Power)

System Description

System Operation

System Components

NOTE: The Power Steering system is a conventional steering with a hydraulic power boost. Only those components unique to the power steering part of the system will be presented and discussed here.

Power Steering Booster Cylinder

Booster Cylinder Extension and End Socket

Booster Cylinder Piston Rod End Socket

Power Steering Drag Link

Power Steering Hydraulic Pump

Power Steering Fluid Revervoir and Filter

System Maintenance

Remove booster cylinder

Install booster cylinder

Remove booster cylinder extension and end socket

Install booster cylinder extension and end socket

Remove booster cylinder piston rod end socket

Install booster cylinder piston rod end socket

Remove drag link

Install drag link

Adjust drag link

Remove drag link end socket

Install drag link end socket

System Maintenance (continued)

Remove hydraulic pump

Install hydraulic pump

Remove fluid reservoir and filter

Install fluid reservoir and filter

Test hydraulic pressure

Adjust timing angle

Bleed power steering hydraulic system

APPENDIX A-8

TASK ANALYSIS - TOP OVERHAUL - CUMMINS 903, 4 CYCLE

TASK ANALYSIS - TOP OVERHAUL - CUMMINS 903, 4 CYCLE

Engine Description

- Four cycle vs two cycle engines
- Fuel injection principle
- Engine accessories

Coach Preparation

- Steam clean engine compartment
- Steam clean engine
- Hoist coach
- Drain oil and water

Engine Tear-down

- Remove engine accessories

  Note: Techniques for removing, cleaning, inspecting, and testing accessories, pieces and parts are essentially the same as for 2 cycle engines. The functions, locations, and specifications vary with each engine type.

  - Disconnect air cleaner piping
  - Remove air cleaner
  - Disconnect electrical wiring
  - Remove fuel lines
  - Remove engine accessories
    - Remove drive belts from alternator
    - Remove front idler pulley
    - Remove alternator
    - Remove water manifold
    - Remove water pump

Remove cam shaft cover plate

Remove intake manifold (both sides)

Remove fuel pump

Remove valve covers

Remove rocker arm assembly

Remove push rods

Remove push tube cavity cover

Disconnect header pipes

Remove head bolts

Lift off head (both sides)

Remove tappet guide plate

Remove cam followers

Remove oil pan

Remove oil filter

Remove oil cooler

Remove starter

Remove water header plates

Remove baffle plate and oil pumps

Remove connecting rod caps

Remove pistons

Remove liners (special tool used - Liner Puller)

Note: At this point, flush block with solvent and remove any corrosion from water jacket.

Remove main bearings (four bolts for each, two on caps, two at side of block)

Clean, inspect, and replace main bearings

Test, inspect, measure, and replace all parts for tolerances to specifications

Engine Rebuild

Install main bearings

Torque all bolts to specification

Meaure crank shaft end play for thrust washer size

Install thrust washers

Note: Plastigauge each bearing during installation. Techniques is the same as for two stroke engines

Install liners

Install "O" rings (specifications change and should be checked)

Lubricate "O" rings with special lubricant

Insert liners (special tool required)

Align liners with bench mark on block and liner

Measure liner protrusion at top of block

Install pistons - (Build up at South Park)

Pistons, rods, caps, are all numbered for use in a specific cylinder

Install piston and rod assembly in cylinder

Install rod caps and bearings

Plastigauge rod bearings for fit

Note: Proper torque on cap bolts must be used when fitting caps.

Install new or rebuilt oil pump

Install baffle plate

Install cam followers (called Tappet Rollers in manual)

Install tappet guide plate (inspected as installed)

Install head gasket and "O" rings

Install exhaust manifold on head

Install head - (head is built up at South Park - all to specs)

Install push rods

Install rocker arm assembly

Install water header plates

Install starter

Install oil cooler

Install oil filter housing and new element

Install push rod cavity covers

Install fuel pump

Reconnect fuel lines

Install intake manifolds

Install water pump

Reconnect water lines and replace thermostats

Install cam shaft cover plate

Install idler pully

Install alternator

Install drive belts

Install fuel injector and time

Adjust valves (intake and exhaust)

Replace fuel filter and pressure check system for leaks

Change by-pass oil filter element
Install pan
Reconnect electric wires
Reconnect air filter
Install valve covers
Fill with oil
Fill with water

Engine Run-in

Start engine
Run at low RPM (1000) for 1/2 hour to 45 minutes
Check for leaks
Check for oil pressure
Reset valves (hot)
Set idle

APPENDIX A-9

TASK ANALYSIS - TOP ENGINE OVERHAUL - TWO CYCLE

TASK ANALYSIS - TOP ENGINE OVERHAUL - TWO CYCLE

Tranverse engine V71 series

Top overhaul includes: Pistons, liners, rods and mains, cylinder heads. Heads are not reworked at the Division level. Removed and replaced by new ones or rebuilt ones from South Park.

Complete overhaul includes: All of the above plus removing the crank shaft and timing train.

Coach preparation:

Steam clean engine

Hoist coach to required height or drive over pit

Drain oil and water

Remove engine assessories:

NOTE: All parts removed from the engine are collected in trays for steam cleaning.

Remove air filter assy

Fresh air supply hose

Blower horn

Remove valve covers

Remove throttle linkage

Remove governor cover

Remove fuel rods

Disconnect electrical connectors to:

Soft-shift micro switch

Damper shutdown switch

Temp. sending unit

Disconnect fuel lines

Remove water lines

Remove fuel filter assy

Remove engine rack assy

Remove cross-over fuel lines

Remove cylinder head bolts

Remove blower assy - This includes blower, governor, and fuel pump.

This unit is disassembled on the bench later and the blower itself is replaced, depending on mileage.

Remove cylinder heads - the technique for lifting the cylinder heads away from the block varies with engine type.

Hoist coach

Remove pan

Remove flow through filter (one of two filters)

Remove angle adapter

Loosen (do not remove) main bearing cap bolts (this is to allow for additional oil drainage)

Remove oil relief valve

Remove oil pressure regulator

Remove oil pickup tube

Lower coach

Remove radiator

Remove fan (blade)

Remove air conditioner drive shaft

Remove Torus Fan assembly

Remove Torus Drive Flex plate (puller required)

Jack Engine - Remove weight to remove front moter mount

Remove front motor mount assembly

Remove engine oil pump assembly

Remove oil cooler

Remove water pump

Remove piston

Remove piston sleeves (liners)

Remove rod cap

Remove piston out of cylinder

Remove piston from top

Remove piston ring inspection plates (for steam cleaning) "Hand hole cover"

Replace front motor mount temporarily so that coach can be moved to steam rack.

Steam clean engine block and compartment

This is a very important step - must be done correctly and thoroughly.

Return coach to work area (hoist)

Dry compartment (air gun)

Visually inspect all parts

Especially: Cam lobes (also check for end play of shaft)

Crank shaft

Engine Rebuilding

Block preparation

Use solvent and wet n dry sandpaper to prepare surfaces not thoroughly steamed. Generally takes several hours to sand down and clean sufficiently for reassembly.

Flush everything well with solvent to remove any sandpaper residue.

Fit cylinder liners

Install liners and fire ring in each cylinder

Check wall clearance

Check deck height

Check main bearings

Drop middle (#2) main bearing cap and install shim support

Replace cap and torque cap bolts

Plastic gauge each bearing

Replace bearings that are out of tolerance

NOTE: Thrust washers are installed with rear main bearing cap - end play checked.

Clean crank shaft again (rod journals are dressed with crocus cloth and cleaned with solvent)

Remove liners and mark with cylinder numbers

Piston and Liner Installation

Install piston in liner - Connecting rod and bearing cap are stamped

with number to indicate the cylinder in which piston is to be installed. Direction of installation is critical and is stamped on rod also.

A special tool is used for installing (tapered tube) pistons in liners.

Install upper connecting rod bearing

Install lower connecting rod bearing in rod cap

Paint cylinder with "key paste" as sealer just below air box opening.

Insert liner and piston assy from the top of the block. (Two mean are usually used for this step, one installing liners and pistons at the top; one guiding the connecting rods onto the crankshaft and installing the bearing caps underneath.)

Install liner retainer - Each installed liner is locked in place because the crankshaft must be rotated to place the connecting rod journal at its lowest point for installing the piston.

Plastigauge connecting rod bearing (replace bearings as needed)

Torque connecting rod cap bolts

Replace oil cooler core and gaskets (on the bench)

Install oil cooler assy

Install new oil pump (or rebuilt one)

Install flex plate

Install Tórus fan and air conditioning drive

Install water pump

Install radiator

Build-up cycliner heads (cylinder heads are nearly complete when received from rework facility)

Install theromstats (2)

Prepare block for accepting heads

Install seal, "O" rings, top fire ring

Install right bank cylinder head

Torque cylinder head bolts in proper sequence

Repeat the procedure for the left cylinder head

Install new injectors

Build-up blower (on bench)

Install new governor

Install new fuel rings

Install blower on engine

Replace blower drive shaft

Reconnect all water hoses

Reconnect all fuel lines

Install cross-over fuel lines

Install rack assembly with fuel roads

Adjust valves

Adjust injector timing

Adjust governor

Set rack (injectors are delivering same amount of fuel)

Install fuel filter (primed when installed)

Pressure check system (external pressure applied)

Fuel pump must be bypassed during check and return fuel line blocked.

Reconnect Electrical connections to: soft-shift micro switch, damper shutdown solenoid, temperature sending unit

Reconnect throttle linkage

Fill with water and check for leaks

Reassemble lower engine

Install oil regulator and pressure relief valves

Install oil pickup tube

Install angle adapter

Install oil pan

Install new oil filters

Install motor oil (over fill to accommodate the extra oil needed to cling to new and unoiled surfaces)

Engine Run In

Start engine - run for oil pressure check, check for leaks, shut down after four or five minutes

Install valve cover

Run engine at about 1500 rpm for 1/2 hr. to 45 mins.

Set governor

Idle and buffer screw

Wide open (free speed)

Stall speed (load)

Check oil (level and pressure)

Road check

APPENDIX A-1D

TASK ANALYSIS - TRANSMISSION - DANA SPICER 184 TURBO-MATIC

TASK ANALYSIS - TRANSMISSION - DANA SPICER 184 TURBO-MATIC

System Description

System Operation

Transmission Removal

- Drain torque converter
- Disconnect oil cooler lines from converter
- Disconnect wiring harness
- Disconnect hand brake control rod
- Disconnect forward and reverse control rod
- Remove propeller shaft
- Remove emergency brake drum
- Remove dipstick
- Disconnect extension tube and oil filter tube
- Disconnect speedometer cable
- Attach hoist and suspend converter unit weight
- Remove clutch housing bolts
- Remove torque converter from engine compartment
- Seal fluid inlet and outlet openings
- Steam clean unit

Transmission Installation

- Position converter in line and square with engine flywheel bell housing
- Engage input drive gear hub splines with engine flywheel flange
- Install and torque bolts in clutch housing/bell housing
- Install emergency brake drum
- Install propeller shaft
- Install forward and reverse control rods and levers

Transmission Installation (continued)

- Adjust forward and reverse shift levers
- Reconnect wiring harness
- Reconnect speedometer cable
- Install dipstick extension tube
- Install converter oil filler tube
- Reconnect oil cooler fluid lines
- Install drain plugs
- Add converter fluid
- Idle test system:
  - Check fluid piping connections
  - Check electric connections
  - Check case gaskets for leaks
  - Check linkage adjustments
  - Check mounting hardware
- Test shift lever operation
- Adjust shift lever operation

APPENDIX A-11

TASK ANALYSIS - FLUID DRIVE TRANSMISSION

TASK ANALYSIS - FLUID DRIVE TRANSMISSION

General Operation

- Stall speed test
  - High stall speed
  - Low stall speed
- Drain and refill transmission
- Heat exchangers (air and water)
- Shift control
- Air shift cylinder
- Air shift solenoid valve
- Control valve adjustment (spool valve)

Transmission Removal

- Remove engine compartment panels
- Steam clean external parts of transmission and immediate area
- Drain engine cooling system
- Drain transmission
- Disconnect water lines (upper and lower) from heat exchangers
- Disconnect oil lines between heat exchanger and converter
- Disconnect oil lines between heat exchanger and converter filters
- Remove bypass oil filter assembly
- Remove ground strap
- Remove speedometer adapter
- Remove governor
- Remove overdrive valve body
- Disconnect electric write from control valve solenoid
- Disconnect shift solenoid plugs from air shift cylinder
- Disconnect air shift cylinder linkage from clevis
- Remove air shift assembly from transmission
- Disconnect propeller shaft
- Position transmission dolly
- Attach adapter to transmission
- Remove transmission attachment bolts (to engine) Upper and lower bolts
- Remove transmission assembly

Transmission Installation

- Mount transmission on dolly
- Install planetary gear assembly into transmission
- Move transmission into place and align hub and input shaft splines
- Install engine attachment bolts in proper sequence and tighten alternately to proper torque
- Install overdrive valve body
- Remove adapter and dolly
- Install propeller shaft
- Install air shift cylinder
- Install ground strap
- Install governor
- Install speedometer adapter
- Connect solenoid wires
- Install heat exchanger
- Install heat exchanger oil filter
- Install converter oil filter
- Reconnect oil lines between converter and heat exchanger oil filters
- Reconnect water lines
- Install bypass oil filter

Transmission Adjustments

- Adjust transmission linkage at air shift cylinder
- Fill transmission
- Fill cooling system
- Perform stall speed test
- Perform oil pressure test
- Test for leaks
- Check neutral solenoid
- Check transmission control relay
- Adjust soft-shift switch

APPENDIX A-12

TASK ANALYSIS - TRANSMISSION AND ENGINE CONTROLS

TASK ANALYSIS - TRANSMISSION AND ENGINE CONTROLS

SYSTEM OPERATION

DESCRIPTION OF THE SYSTEM

- Control operation
  - Manual shift into gear
  - Operating in hydraulic drive
  - Shifting automatically into direct-drive
  - Operating in direct drive
- System components
  - Accelerator pedal
  - Forward and reverse shift assembly and cable
  - Throttle air cylinder
  - Throttle control magnet valve
  - Throttle control relay
  - Air pressure regulating valve
  - Clutch air cylinder
  - Clutch control solenoid (neutral stop solenoid)
- Clutch magnet valve
- Air strainer
- Scavange valve
- Electric transmission govenor

System maintenance

- Inspect accelerator pedal and linkage
- Adjust pedal movement dimensions to specifications
- Remove pedal
- Install pedal
- Inspect forward and reverse shift assembly and cable
- Clean forward and reverse shift assembly and cable
- Adjust forward and reverse shift assembly and cable
- Remove shift assembly and cable
- Install shift assembly and cable
- Inspect throttle air cylinder
- Test throttle air cylinder for leaks
- Adjust throttle air cylinder rod
- Remove throttle air cylinder
- Install throttle air cylinder

Inspect throttle control magnet valve

Test throttle control magnet valve

Remove throttle control magnet valve

Install throttle control magnet valve

Inspect air pressure regulating valve

Test air pressure regulating valve for leaks

Remove air pressure regulating valve

Rebuild air pressure regulating valve

Install air pressure regulating valve

Adjust air pressure regulating valve

Inspect clutch air cylinder

Remove clutch air cylinder

Rebuild clutch air cylinder

Install clutch air cylinder

Adjust clutch air cylinder

Test clutch control solenoid (neutral stop solenoid)

Remove clutch control solenoid (neutral stop solenoid)

Adjust clutch control solenoid (neutral stop solenoid)

Remove air strainer

Clean air strainer

Install air strainer

Inspect scavange valve

Test scavange valve for leaks

Remove scavange valve

Rebuild scavange valve

Install scavange valve

Remove electric transmission governor

Install electric transmission governor

Note: The procedures for adjusting the engine governor and rack are covered under top overhaul.

APPENDIX B

TEACHING POINTS: MAJOR INSPECTION

1.0 Preparation

1.1 Obtain checklist and repair documentation cards.

1.2 Obtain the following tools from your tool box: standard screwdriver, Phillipshead screwdriver, flashlight, gauges for working rear door deflection, stopwatch, tape measure, 3/8 drive ratchet with a long extension and any required sockets, an assortment of light bulbs and sheet metal screws, and torque wrench and sockets for wheel lugs and axle flanges.

1.3 Take a position in the driver's seat.

2.0 Interior Inspection

2.1 Visually inspect the windshield and areas surrounding the driver's seat. Look for cracked glass and/or other damage. Insure by touch that all items such as the fare box are mounted securely. Report repair or replace as necessary. Activate the windshield wipers and windshield washer if applicable. Visually inspect the condition of the wiper blades and operation of the wipers and washers to ensure proper operation. Make any necessary repairs or adjustments. Check steering free-play by turning the wheel to one direction until resistance is felt. Mark that position, then turn the wheel to the other direction until resistance is felt and measure the distance the wheel rim has traveled. This distance should be less than:

2.75 " for a 22 " diameter wheel, and

2.50 " for a 20 " diameter wheel, and

2.25 " for a 18 " diameter wheel.

2.2 Check the driver's heater compartment for worn, broken or cracked hoses or accumulation of trash. To check hose condition, insert a flat screwdriver between the hose end and heater fixture to which the hose is clamped. Gently twist screwdriver. If the hose shows cracking in that area, it is bad and requires replacement.

2.3 Pull down the driver's curtain. Make sure the curtain is in good condition and operates properly. Replace if necessary.

2.4 Remove the fire extinguisher from its brackets. Check the gauge to be sure that the extinguisher is fully charged and record the extinguisher number on the major inspection report. Replace the extinguisher if not fully charged. Put the fire extinguisher back into position and secure in the mounting brackets. Start the engine.

2.5 Cycle the front door and check the cycle time with the stopwatch. Cycle time should be approximately 1½ seconds for push-type doors and 2½ to 3½ seconds for other door types. Repair and/or make any necessary adjustments.

2.6 Cycle the rear door and check cycle times with the stopwatch. Cycle times should be approximately 1½ seconds for push-type doors and 2½ to 3½ seconds for other door types. Repair and/or make any necessary adjustments.

2.7 Activate the right turn signal. Flashing of the turn signal indicator on the dash indicates proper operation. Activate the left turn signal, again looking for the flashing light on the dash panel. Repair, replace or report as necessary.

2.8 Activate all exterior lights including high beams and running lights. Activate all interior lights including the driver's map light, the head sign light and fare box lights. Activate the road flashers and the emergency flashers, taking care not to activate the emergency radio signal circuit also on the emergency flasher switch. The emergency flasher switch should be activated only halfway. Activate ventilation blowers and air conditioner.

2.9 Cycle the driver's seat to its full forward, then to its full rearward position. Sticking or uneven movement indicates that adjustment or lubrication is required. Repair, replace, record or lubricate as necessary.

2.10 Activate the rear door interlock and move to the right front side of the bus.

2.11 Open the front door motor cover over the front door. Cycle the door and check all door motor components for proper operation. Note: Pay particular attention to the primary pivot pin, looking for wear. Repair, replace, record and lubricate as necessary. Close the front door motor cover when finished with inspection.

2.12 Moving down the right side of the coach, perform a visual inspection of the right side, looking for cracked windows, loose side panels and torn seats. Document all cracked windows, tighten all loose side panels and remove, replace and document all torn seats. Note: Seats and windows are numbered consecutively beginning with the right front-most and moving clockwise down the right side, across the back, and up the left side to the left front. These numbers are to be used when either maintenance is performed or maintenance is required. Concurrent with the visual inspection, check seat and stanchion mounting for looseness by hitting gently with the palm of the hand each seat back and stanchion. Replace and/or tighten loose screws as necessary.

2.13 Upon reaching the back door, open the back door motor cover and cycle the door observing motor components for proper operation. Pay particular attention to the primary pivot pin, looking for wear. Check the operation of the treadle mat microswitches one at a time by stepping in each corner of each treadle mat, causing the door to open and release the corner, causing the door to close. Using the appropriate gauge checks the activation of sensitive edges both high and low on the door. Sensitive edges should activate when displaced less than 1.5 inches. Where applicable, check the operation of the

rear door push bars. Activation time with this system should be less than 1.5 seconds. Repair, replace, report and lubricate as necessary then close and secure the rear door motor cover.

2.14 Proceed to the rear of the coach again checking windows, seats, stanchions and side panels as before. Remove the rear seat cushions, insulation pad, and engine access panel. Visually inspect the engine compartment for leaks of oil, water, or fuel. Pay particular attention to the back of the water pump for rust stains which indicate water leakage from the water pump seal. Visually inspect the battery cable for cracked and missing insulation. Record any defects which are discovered.

2.15 Place the insulation pad from under the rear seat over the engine exhaust manifold and carefully inspect the starter motor brushes for wear. When the starter motor brushes are worn to the point where the top of the brush is even with the top of the brush guide, either replace the starter motor brushes or record the defect. Visually inspect the back of the starter solenoid to assure the presence of the solenoid plug. Record all defects and work done.

2.16 Proceed up the left side of the bus inspecting all windows, seats, stanchions, and side panels as before. Include a visual inspection of all interior lights replacing burned out bulbs as necessary.

2.17 Open and close any emergency doors or hatches. Ensure that applicable emergency door activation warning systems are operating at the driver's compartment. Lube and/or repair and/or report as necessary.

2.18 On the majority of coaches, approximately mid-coach, on the left side, there are bulges in the floor under which are the ventilation blowers. Place your hand directly on each of these bulges. The presence of a vibration indicates the blowers are functioning. If there is no vibration, report the blower motor(s) as needing repair.

2.19 Continue up the left side of the coach inspecting the windows, seats, stanchions, side panels, and lights as before. Upon returning to the driver's seat, turn off all interior lights and check the horn operation.

2.20 Remove the brake pedal, clean and lubricate as necessary, and replace.

2.21 Apply the parking brake. Listen for the release of air as the brake is applied. Using the stopwatch and the parking brake indicator on the dash, time the release of the parking brake. This release should take less than three seconds.

2.22 Release the head sign cover and check the operation and condition of the head sign by operating the sign in both directions. Lubricate, repair and replace as necessary.

3.0 Exterior Inspection

3.1 Visually inspect the stairwell for loose mat edges and burned out light bulbs. Replace burned out light bulbs as necessary, and report loose mat edges as in need of repair. Torque the right front wheel lugs to 350 foot-lbs.

3.2 Check the bottom hinges on the front door by gently pushing and pulling at the bottom of the door. Any free play in the bottom hinges is indicative of bad bushings. Document this condition where encountered.

3.3 Move toward the rear of the bus visually inspecting the body panels, window glass, the advertising sign for damage or missing components. Check to be sure that the side lights are operating properly. Replace bulbs as necessary. Document damage for required repairs as necessary.

3.4 Open the fuel door and the fuel filler cap. Check the seals to ensure that they are not damaged or cracked. Replace damaged or cracked seals.

3.5 Check the ventilation ducts to ensure the intake of air by placing the hand in front of the duct to feel an air flow. Document the lack of air flow as necessary.

3.6 Move to the rear door area. Check the condition of the rollers, hinges and tracks, lubricate as necessary, and document any defective or broken parts. Check lower hinges on the front door.

3.7 Continue to the rear of the bus checking body panels, glass, and lights as before. Torque the right rear wheel lugs to 350 foot-lbs.

3.8 Open the transmission door. Visually inspect the transmission compartment for oil leaks, worn or damaged lines and cables. Document or replace as necessary.

3.9 Check for current to the shift govenor and neutral shift solenoid where applicable.

3.10 Visually inspect the lights on the engine door to ensure proper operation. Replace burned out bulbs as necessary. Open the door and turn on the engine compartment lights. Inspect these lights for proper operation and replace burned out bulbs as necessary.

3.11 Check the engine compartment door hinges for abnormal wear and visually inspect the wiring harness for cracked or missing insulation and broken or unconnected wiring. Repair, replace or report as necessary.

3.12 Check filter restriction with a water vacume gauge. Hook up tachometer. If vacume exceeds 18" at 2100 RPM filter must be changed. Replace as necessary.

3.13 Check exhaust back pressure with a pressure gauge. If back pressure exceeds 1.6" of mercury at 2100 RPM the muffler must be replaced. Replace or repair as necessary.

3.14 Check blower pressure or turbo boost pressure on turbo charged engines. If the pressure exceeds _____ psi on normally aspirated or _____ psi on turbo charged engines, further maintenance will be required. Replace, repair, or document as necessary.

3.15 Check crankcase pressure at the dipstick. If pressure exceeds _____, further maintenance will be required. Repair or document as necessary.

3.16 Lubricate the speedometer sender, the engine governor mechanism, air conditioning, alternator bearings, and all bell cranks as necessary. Check for excess play or bad bearings or shims in each of the above. Replace, repair or report as necessary.

3.17 Hook a jumper wire from the hot engine alarm stat to ground.

3.18 Check heater pump operation.

3.19 Visually inspect the hoses, water pump and radiator for leaking water or rust indicating small leaks.

3.20 Bleed off the coolant pressure by opening the petcock on the coolant filler neck. When the pressure has been bled off completely open the coolant filler cap with your head placed to the side. Close the coolant pressure relief petcock. Do not check water level at this time as an overheating engine may suddenly spurt hot water or steam.

3.21 Check the soluble oil mixture. Torque the left rear wheel lugs to 350 foot/lbs. and axle flange nuts to 75 foot/lbs.

3.22 Visually check the floor in the engine compartment of oil leaks. Locate the source of any leaks and document as necessary.

3.23 Check and record the oil pressure at idle. This pressure should be 10 to 15 psi. Check the oil pressure at maximum rpm. This pressure should be 50 to 70 psi.

3.24 Visually inspect the coolant level in the surge tank. Add coolant as necessary and close the filler cap. Inspect the filler cap for cracked or missing seals. Replace seals as necessary. Close cap.

3.25 Set the throttle to 1/3.

3.26 Take air conditioning alternator amperage and voltage readings at the alternator using a volt-ammeter. If the voltage reading is not 35 volts, adjust at the air conditioning voltage regulator or report the condition as necessary.

3.27 Reset the throttle to idle.

3.28 Recheck the air conditioning alternator voltage and amperage as before. If the voltage reading falls below 35 volts, change the alternator brushes or document the condition as require.

3.29 Open the radiator door and check for airflow and hinge conditions. Document defects and repairs required as necessary. Close the door.

3.30 Open the air conditioning compressor compartment door and visually inspect the operation of the air conditioning compressor. Listen for grinding noises which would indicate bad bearings or shims. Mark the position of the air conditioning compressor clutch throw out arm on the compressor case with chalk. Document required repairs as necessary.

3.31 Check the forward and the left compressor mounts with a pry bar by lifting the compressor at each of the mounting points. Document broken compressor mounts as required.

3.32 Open the battery case door and slide out the batteries.

3.33 Open each cell cap and check the hydraulic reading of each cell using the hydrometer. Replace any batteries in which the cell solution is unacceptable according to the hydromoter test. Fill all cells using distilled water to the proper levels.

3.34 Using a volt-ammeter check the voltage from the positive to negative terminals for each battery. This reading should be approximately 13.5 volts. If the reading is below 12 volts, replace the battery. Check the voltage drop from the positive terminal of each battery to ground chassis source. There should be no greater than two volts difference between this reading and the reading taken from positive to negative terminals on the battery. The difference of greater than two volts indicates a bad grounding somewhere in the system which must be located and repaired.

3.35 Using the volt-ammeter check the voltage of each individual cell within each battery. Each cell voltage is to be between 2.0 and 2.2 volts. Any battery containing a cell which has a voltage of under 2.0 volts is to be replaced.

3.36 Change the bolts, nuts and washers at each battery terminals.

3.37 Add paste to all battery terminals.

3.38 Check the battery tray, battery cables and battery hold-down boards for corrosion and/or breakage. Replace as necessary.

3.39 Lubricate the follers and slides as necessary, slide the batteries in and close the door.

3.40 Open the door for the air conditioning receiver sight glass and turn on the light (where applicable). Check the Freon level in the sight glass to ensure that the level is between ½ and ¾ of the way up the sight glass. Check the operation of the compartment light and replace burned out bulbs where necessary. Repair, replace or report as necessary.

3.41 Continue up the left front side of the coach checking the panel condition, glass condition, and the left corner of the left driver's mirror to ensure that it is tight and in good condition. Note any defects and report as necessary. Torque the left front wheel lugs to 350 foot/lbs.

3.42 Check the operation of all front lights, the condition of the front bumper. If the coach is equipped with water bags top off each bag with water. Check the front windshield and body panels for cracks and damage. Tighten and lubricate the right sideview mirror as necessary. Install the curb feeler where applicable. Fill the windshield washer bottle. Report required repairs as necessary.

3.43 Enter the coach and check all alarm stats to ensure activation. Replace burned out light bulbs as necessary. Turn off all lights, accessories, flashers and signals. Turn off air conditioning systems. Then shut down the engine.

3.44 Release the parking brake. Move to the rear of the bus and remove the jumper from the hot engine alarm stat.

4.0 Undercarriage and Chassis Inspection.

4.1 Obtain the following tools: tread depth gauge, air tank bleeder wrench, large flat screwdriver, chalk, tape measure, hand grease gun, pneumatic grease gun, wrenches to fit engine and transmission drain plugs and slack adjusters, a .020" feeler gauge.

4.2 Raise the coach to working height on the lift (where appropriate).

4.3 Move the engine oil drain plug and let the oil drain into the catch tank.

4.4 Remove the transmission oil drain plugs (2) and let the oil drain into the catch tank.

4.5 Inspect all nuts, bolts and supports under the engine and transmission. Check and tighten as needed.

4.6 Check the right rear tread depth. Minimum tread depth is 6/32 of an inch. Document as necessary.

4.7 Measure with a tape measure the brake lining thickness. The minimum thickness is 7/16 inches. Document as necessary.

4.8 Visually inspect the activation cam. If the cam is within one inch of top dead center, it will require replacement. Document as necessary.

4.9 Using a feeler gauge, check the drum to shoe clearance. Proper clearance is 21/1,000 of an inch. Where necessary, adjust the slack adjuster to achieve the 21/1,000 clearance. Using chalk, mark the position of the brake rod.

4.10 Lube the bottom door bushings, emergency brake linkage, the right rear slack adjuster, and the main shaft universal joints. Wipe lubrication points with a rag before and after lubrication.

4.11 Visually inspect the bottom back door step well for cracks or other damage.

4.12 Check the right rear radius rod bushings by attempting to move the rod ends laterally with a large flat screwdriver. If movement is possible, the bushings will require replacement. Document as necessary.

4.13 Visually inspect the levellers, bellows, radius rods, tomahawk, sway bar, and other suspension components for cracks and other damage. Check the shock absorbers for an accumulation of grease indicating leakage. Document as necessary.

4.14 Visually inspect the junction box and battery cables looking for cracked and missing insulation. Document as necessary.

4.15 Remove the plug from the rear brake valve and hook up the air pressure gauge line to the rear brake valve.

4.16 Check the differential grease level. Fill as necessary.

4.17 Check the left rear tread depth. Minimum acceptable tread depth is 6/32 of an inch. Document as necessary.

4.18 Measure with a tape measure the brake lining thickness. Minimum thickness is 7/16 inches. Document as necessary.

4.19 Visually inspect the activation cam. If the cam is rotated into one inch of top dead center it will require replacement. Document as necessary.

4.20 Using a feeler gauge, check the drum to shoe clearance. Proper clearance is 21/1000 of an inch. Adjust the slack adjuster to achieve this clearance. Using chalk, mark the position of the brake rod.

4.21 Lubricate the emergency brake

4.22 Visually inspect the shock absorbers for accumulation of grease on the outside. This indicates a leaking shock which will require replacement. Document as necessary.

4.23 Check the left rear radius rod bushings by attempting to move the rod ends laterally. with a large, flat screwdriver. If movement is possible the bushings won't require replacement. Document as necessary.

4.24 Visually inspect the levellers, bellows, radius rods, tomahawk, sway bar, and other suspension components for cracks or other damage. Document as necessary.

4.25 Remove the sheet metal under the air conditioning compressor compartment.

4.26 Check for cracks in the angle iron structural members of the compartment.

4.27 Using the hand grease gun, lubricate the universal joints in the compressor shaft & lubricate the speedometer cable.

4.28 Check the right (innermost) compressor mount using a large, flat screwdriver. If the mount is broken it will require replacement. Document as necessary.

4.29 Check the grommet on the main air discharge line at the bulkhead. Cracked or missing grommet will require replacement, Document as necessary.

4.30 Replace the air conditioning compartment with sheet metal.

4.31 Move forward toward the air tanks visually inspecting the frame and hoses for cracks or other damage. Document as necessary.

4.32 Drain the water from all air tanks using the special tool provided for that purpose.

4.33 Visually inspect the brushes on the blower motors. If the top of the brush is even with or below the top of the brush guide, the brushes will require replacement. Document or replace as necessary.

4.34 Open the ventilation screen box.

4.35 Remove the ventilation screens and blow the compartment out using compressed air.

4.36 Spray clean filters with "filter coat."

4.37 Place the clean screens in the ventilation screen box and close the compartment.

4.38 Move to the right front corner of the coach. Inspect the tie rod ends, drag links, and other suspension components for cracks or abnormal wear. Check the shock absorber for grease buildup indicating leakage. Document as necessary.

4.39 Lubricate the tie rod ends, drag links, king pins and bushings, front slack adjuster, and bottom bushings of the front door.

4.40 Check the drum to shoe clearance on the right front brake. Proper clearance is 21/1000 of an inch. Adjust the slack adjuster as necessary to achieve this proper clearance.

4.41 Check the right front tire tread depth. A minimum of 6/32 tread is required. Document as necessary.

4.42 Measure with a tape measure the brake lining thickness. Minimum thickness is 7/16 inches. Document as necessary. Visually inspect the brake activation cam. If the cam is within one inch of top dead center it will require replacement. Document as necessary.

4.43 Visually inspect the tie rod ends, drag links and other suspension components for cracks or abnormal wear. Visually inspect the shock absorbers and steering box for grease buildup on the outside indicating leakage. Document as necessary.

4.44 Lubricate the tie rod ends, drag links, king pin and busings, front slack adjuster and steering shaft universal joints. Fill the steering box with 140 weight grease as necessary.

4.45 Check the brake drum to shoe clearance with a feeler gauage. Twenty-one thousandths of an inch is proper adjustment. Adjust the slack adjuster as necessary to achieve this clearance.

4.46 Check the left front tread depth. A minimum of 6/32 of tread is required or the tire will have to be replaced. Document as necessary.

4.47 Measure with a tape measure the brake lining thickness. Minimum thickness is 7/16 inches. Visually inspect the activation cam. If this cam is within one inch of dead center it will require replacement. Document as necessary.

4.48 Replace the drain plugs in the engine and transmission. Torque the engine plug to 25-30 foot-lbs and the transmission plug to 15-20 foot-lbs.

4.49 Lower the coach (where appropriate) to an intermediate position.

4.50 Remove the lines from the engine bypass filter. Remove the filter housing and disassemble the housing, removing the bypass filter. Clean the housing, replace the filter, o-ring and seal, and replace the assembly and reconnect all lines.

4.51 Remove and replace the transmission primary, intermediate, and secondary filters.

4.52 Fill the engine and transmission with appropriate lubricants. V-8 engines require 35 quarts of engine oil. Transmissions in these assemblies will require 32 quarts of fluid. All 6 cylinder engines require 25 quarts of engine oil. Transmissions in 6 cylinder coaches will require 23 quarts of transmission fluid.

4.53 Place the engine controls in the front run position. Move to the front of the coach, place the brake pressure gauge in the driver's compartment. Start the engine and build up air pressure at a high idle.

4.54 Apply the brakes and hold.

4.55 Have an assistant measure the brake rod travel at each wheel. Maximum allowable travel is one inch for the front brakes and 1.5 inches for the rear brakes. Travel in excess of these specifications will require brake work. Document as necessary.

4.56 Check the maximum pressure on the gauge with the brakes applied. Maximum pressure should be greater than or equal to 115 psi. If pressure is below 115 psi, adjustments should be made at the air pressure regulator. Document as necessary.

4.57 Return the ending to a low idle.

4.58 Release the brakes.

4.59 Apply the brakes again, hard! Pressure readings should indicate between 90 and 150 psi. Readings outside of this range will require additional brake work. Document as necessary. Release the brake.

4.60 Apply the rear door throttle interlock. Air pressure readings should indicate between 30 and 40 psi. If this reading is not attained, adjust air pressure in front as necessary.

4.61 Shut down the engine, then lower the coach to the floor.

5.0 Tuneup

5.1 Place engine controls in the "off position".

5.2 Visually inspect the outer edges of the fan blades for nicks or grooves. Nicks or grooves indicate a bad trunion mount which will need to be replaced. Document as necessary.

5.3 Visually inspect the radiator mounts and hose condition. Hose condition is checked by inserting a screwdriver between the hose edge and the hose mounting fixture. The screwdriver is then turned gently and the hose observed. Should cracks appear under these conditions the hose will require replacement. Document as necessary.

5.4 Remove the hoses connecting the blower cover and the air cleaner and the hoses connecting the blower cover and the air compressor.

5.5 Remove the transmission shift microswitch and place it aside.

5.6 Remove the emergency fuel shutdown cylinder.

5.6.1 Remove the plunger.

5.6.2 Remove scratches, burrs, etc. from the switch plunder using No. 400 sandpaper.

5.6.3 Reassemble the plunder and switch assembly.

5.6.4 Replace the entire assembly.

5.7 Remove the emergency air shutdown cylinder (where applicable) and place it aside.

5.8 Remove the blower cover, place a new screen over the blower intake and loosely secure the screen with two bolts.

5.9 Remove the valve covers.

5.10 Visually inspect the valve train and injectors for rust. Rust will indicate water leaks which must be corrected. Document as necessary.

5.11 With a clean rag wipe off all excess oil and grease from the valve train.

5.12 With the fingers, feel each valve spring for breaks or looseness. Collapsed or broken springs will have to be replaced. Document as necessary.

5.13 Using the engine pulley wrench, rotate the engine until one cylinder has the injector rocker arm completely depressed.

5.14 Adjust the valves on the cylinder with the depressed rocker arm.

5.14.1 Obtain the appropriate go/no feeler gauge. For 2 valve heads use an 11/13 gauge, and for 4 valve heads use a 13/15 gauge.

5.14.2 Insert the small end of the gauge between the valve and rocker arm.

5.14.3 The go part should slide easily between the rocker arm and the valve, the no go part should not fit unless forced. Do not force.

5.14.4 To adjust, backoff the locknut on the push rod.

5.14.5 Adjust the rod length to specification.

5.14.6 Retighten the locknut.

5.14.7 Mark the rocker arm with chalk.

5.14.8 Repeat the same sequence on the second valve of the same cylinder.

5.15 Adjust the injector on the proper cylinder.

5.15.1 Locate the cylinder for which both valves are depressed.

5.15.2 Select the proper injector gauge.

5.15.3 Place the injector gauge in the alignment hole in the cylinder head.

5.15.4 Spin the gauge so its shoulder passes over the injected spring cap.

5.15.5 The gauge shoulder should lightly contact the spring cap.

5.15.6 To adjust, break the locknut on the push rod.

5.15.7 Adjust the rod to specification.

5.15.8 Retighten the locknut.

5.15.9 Mark the injector arm with chalk.

5.16 Rotate the engine until the next pair of cylinders is in position for adjustment.

5.17 Repeat the above adjustment sequences on the cylinders which are in proper position.

5.18 Continue this process until all valves and injectors are in proper adjustment.

5.19 Unlock the idle adjustment and adjust back all the way. Back out the buffer screw approximately 5/8".

5.20 Disconnect the throttle air cylinder, throttle return spring and/or any other throttle linkage.

5.21 Loosen the throttle delay cylinder.

5.22 Check for free play on the clevis pins at the end of each rack tube. Loose or binding pins will require replacement. Document as necessary.

5.23 Adjust the fuel injector racks.

5.23.1 Loosen all of the inner and outer injector rack control lever adjusting screws (older engines) or adjusting screw and lock nut (newer engines) on both cylinder heads. Be sure all of the injector rack control levers are free on the injector control tubes.

5.23.2 Remove the clevis pin from the right tack tube.

5.23.3 With light finder pressure, hold the throttle in full fuel position.

5.23.4 Tighten the rack adjusting screw of the No. 11 rack until the rack clevis begins to roll up or an increase in effort to turn the screwdriver is noted. On the newer engine single screw racks, tighten the screw approximately 1/8 of a turn more and lock securely with the adjusting screw lock nut. On the older two screw racks, turn down the outer adjusting screw until it bottoms lightly on the injector control tube. Then alternately tighten both the inner and outer adjusting screws.

5.23.5 To be sure of proper rack adjustment, hold the throttle lever in the full fuel position and press down on the injector rack with a screw driver or finger tip and note the "rotating" movement. The rack should tilt downward and when the pressure of the screw driver is released, the control rack should "spring" back upward.

If the rack does not return to its original position, it is too loose. To correct this condition on newer engines, loosen the lock nut and turn the adjusting screw clockwise a slight amount and retighten the lock nut. On older engines, back off the outer adjusting screw slightly and tighten the inner adjusting screw slightly.

The setting is too tight if when moving the throttle from the idle to the full fuel position, the injector rack becomes tight before the throttle lever reaches the end of its travel. This will result in a step-up in effort required to move the throttle to the end of its travel. To correct this condition on newer engines, loosen the lock nut and turn the adjusting screw counterclockwise a slight amount and retighten the nut. On older engines, back out the inner adjusting screw slightly and tighten the outer adjusting screw slightly.

5.23.6 Remove the clevis pin from the fuel rod and the left bank injector control tube lever.

5.23.7 Replace the clevis pin in the right rack tube lever and adjust the No. 1R injector rack as previously outlined in Step 6 for the No. 1L injector rack control lever.

Insert the clevis pin in the fuel rod at the left bank injector control tube lever to verify the adjustments for the No. 1L and 1R injector racks are equal. Move the throttle to the full fuel position. Rotate the clevis pins on both racks and note the drag or resistance to rotate the pins. This resistance or drag should be equal for both pins. If the drag is not equal, adjust the No. 1R injector rack adjusting screw (inner screw, former engines) clockwise to increase drag on the right bank clevis pin or counterclockwise to decrease the pin drag. Adjust No. 1R adjusting screw and lock (inner screw, older engines) securely to ensure equal drag for both clevis pins.

5.23.8 Place a spring to hold the throttle in the full fuel position.

5.23.9 Adjust the No. 2L rack according to procedures outlined before for the No. 1L rack. Cycle the throttle linkage and recheck the spring back of the No. 1L rack. Readjust No. 1L rack if No. 1L rack is no longer in adjustment. Match all left bank racks to the No. 1L rack in this manner. When finished with the left bank cycle the throttle linkage and recheck all racks.

5.23.10 Adjust all right racks to match the No. 1R rack as described for the left bank racks above.

5.24 When rack adjustment is complete, recycle and recheck adjustments. Make sure the throttle linkage is free of binding or obstructions.

5.25 Remove the spring holding the throttle open.

5.26 Re-set idle adjustment and buffer screw to approximate previous setting.

5.27 Replace throttle return spring.

5.28 Cycle the throttle open and place the throttle delay gauge in its position in the right rack.

5.29 Adjust the throttle delay cylinder for alignment.

5.30 Remove the throttle delay gauge.

5.31 Set the idle adjustment to approximate the previous setting.

5.32 Replace the valve cover gasket in the valve covers. Ensure that all old gasket material is removed.

5.33 Replace the valve covers on the engine.

5.34 Remove the old primary and secondary fuel filters.

5.35 Fill to the top each new filter with clean diesel fuel.

5.36 Place in position and hand tighten both primary and secondary fuel filters.

5.37 Remove the plug from the turbine pressure line and screw in the turbine pressure gauge.

5.38 Remove the bolts holding the blower gasket place it on the blower cover. Ensure that the blower cover surfaces are clean.

5.39 Replace the blower cover over the blower and secure all bolts, using a screwdriver to ensure proper gasket alignment.

5.40 Reconnect the hoses from the blower cover to the compressor and from the blower cover to the air filter.

5.41 Replace the emergency air shutdown cylinder.

5.42 Replace the transmission microswitch.

5.43 Start the engine.

5.44 Adjust the idel to specification using the tach reading.

5.45 Adjust the buffer screw until the engine rpms increase, then backoff one complete revolution.

5.46 Accelerate the engine to full throttle.

5.47 Adjust the engine full speed to specification using the tach reading.

5.48 Check the turbine pressure with the engine at idle and warm. This pressure should in 18 to 25 psi. Turbine pressures out of this range will necessitate transmission repair. Document as necessary.

5.49 Shut the engine off, and place engine controls in the "normal run" position.

5.50 Check the accelerator air cylinder (when applicable).

5.50.1 Put the appropriate air pressure gauge in the accelerator air line.

5.50.2 Have an assistant turn on the switch at the driver's seat.

5.50.3 Have the assistant put the accelerator to the floor.

5.50.4 Adjust the throttle linkage to line up with the extended air cylinder.

5.50.5 Air pressure gauge should read approximately 60 psi. Pressure readings deviating significantly from this figure will require air cylinder replacement and/or further repair. Document as necessary.

5.51 Have the assistant release the accelerator and turn off the switch.

5.52 Reconnect the air cylinder and/or other throttle linkage.

5.53 Replace the cover on the idle/govenor adjustment screws.

5.54 Get help to start the engine and then place the engine in high idle.

5.55 Check the turbine pressure at 2150 rpm. This pressure should be 45-90 psi. Pressures significantly deviating from this figure will require turbine maintenance. Document as necessary. When this check is complete return the engine to idle.

5.56 Have an assistant apply the brakes firmly, put the transmission in low gear, and then apply the full throttle, this is known as a "stall" condition.

5.57 Check stall speed according to the tachometer. This speed should be 1300-1450 rpm. Significant deviations from this figure will require further maintenance. Document as necessary.

5.58 Check the turbine pressure at stall. This pressure should be between 55 and 80 psi. Significant deviations from these figures will require further maintenance. Document as necessary.

5.59 Check engine oil pressure at stall. This pressure should be approximately 60 psi. Readings differing significantly from this figure will require further engine maintenance. Document as necessary.

5.60 Have the assistant release the accelerator and place the transmission in neutral.

5.61 Shut down the engine.

5.62 Remove the tachometer and replace the tachometer cover.

5.63 Remove the turbine pressure gauge and replace the plug.

5.64 Check all electrical wiring in the engine compartment for cracked or missing insulation. Replace or document as necessary.

5.65 Reset engine control switches to the front operating mode.

APPENDIX C

LEARNING OBJECTIVES FOR PROGRAM 1, "INSPECTION"

LEARNING OBJECTIVES FOR PROGRAM 1, "INSPECTION"

1.0 PREPARATION

1. Given a list of 15 items, the trainee will identify 10 that should be included as tools used during the inspection. (1.1; 1.2)

2.0 INTERIOR INSPECTION

1. Given four possible front door cycle times, the trainee will identify the correct cycle time for a push-type door. (2.5)
2. The trainee will describe the correct way to check the emergency flasher so as not to activate the emergency radio signal circuit. (2.6)
3. Given a plan diagram of a bus interior the trainee will correctly state the number of a seat marked on the plan as needing maintenance.
4. The trainee will describe the steps in checking the back door and its motor and switches. (2.13)
5. The trainee will select the maximum allowable displacement in inches of the sensitive edges to activate the rear door and the maximum time in seconds. (2.13)
6. The trainee will state how to check for a leaking water pump. (2.14)
7. Given example diagrams of a starter motor, the trainee will identify which brushes should be replaced. (2.15)
8. The trainee shall describe how to check the ventilation blowers. (2.18)
9. Given a selection of three possible release times, the trainee shall select the correct time for the release of the parking brakes. (2.21)

3.0 EXTERIOR INSPECTION

1. The trainee will describe the correct procedure to check the bottom hinges of the front door. (3.2)
2. The trainee will describe the correct procedure for checking air intake of the ventilation ducts. (3.5)

3. Given a series of possible oil pressures, the trainee will identify the correct pressure at (1) idle and at (2) maximum rpm. (3.19)
4. The trainee will state the steps in testing the air conditioning alternator amperage and voltage readings. (3.22 - 3.25)
5. The trainee will describe how to check the forward and left compressor mounts. (3.28)

4.0 UNDERCARRIAGE AND CHASSIS INSPECTION

1. Given a list of tools, the trainee will identify those needed for this inspection. (4.1)
2. Given four tread depths, the trainee will select the minimum tread depth allowable. (4.6; 4.17)
3. Trainee will state how to determine brake lining thickness and the minimum allowable thickness. (4.7; 4.18)
4. Trainee will state when an activation cam should be replaced. (4.8)
5. Trainee will describe how to check drum shoe clearance, what this clearance is and how to mark the position of the brake rod. (4.9; 4.45)
6. Given an incomplete list of points to be lubed, the trainee will complete the list. (4.10)
7. Trainee will describe how to check the right rear radius rod bushings. (4.12; 4.23)
8. Trainee will describe how to check the right (innermost) air conditioning compressor mounts. (4.28)
9. Trainee will state when brushes should be replaced on blower motors. (4.33)
10. Trainee will describe how to clean filters. (4.36)
11. Given a selection of the quantities of engine oil and transmission fluid, the trainee will identify the correct quantities. (4.52)

12. The trainee will describe how to check the brakes. (4.55)
13. Given a series of brake pressures, the trainee will select the correct minimum pressure at a high idle and low idle.
14. The trainee will state the correct air pressure reading with the rear door throttle interlock applied.

5.0 TUNEUP

1. Trainee will state the indication of a bad trunion mount. (5.1)
2. Trainee will describe how to inspect radiator hose conditions. (5.2)
3. Trainee will state the meaning of rust on an injector. (5.4)
4. Trainee will describe how to inspect valve springs for breaks or looseness. (5.10)
5. Trainee will describe the use of the go/no-go feeler gauge. (5.13)
6. Given an incomplete list of the steps involved in adjusting an injector, the trainee will complete the list. (5.14)
7. Trainee will describe how to adjust the rack. (5.20-26)
8. Trainee will state how tight fuel filters should be. (5.36)
9. Given a selection of turbine pressures, trainee will select correct pressure range at idle (5.45), and at full speed. (5.58)
10. Trainee will describe steps in checking the accelerator air cylinder. (5.47 - 5.48)
11. Trainee will state engine pressure at stall. (5.62)
12. Trainee will state the approximate acceptable stall speed for a given engine/transmission combination. (5.60)

APPENDIX D

PRE/POST TEST ANSWER KEY

PRE/POST TEST

1. A bad trunion mount will be shown by:

___ a. Rust on the valves
___ b. Squeaking
✓ ___ c. Nicks and groves on the fan
___ d. All of the above

2. The radiator hose is inspected by:

___ a. Bending with both hands
✓ ___ b. Inserting a screwdriver at the edge and turning gently
___ c. Squeezing with vise-grips
___ d. Visually looking for leaks

3. An indication of a water leak in the head is:

___ a. Rust on injectors and/or valves
___ b. Water dripping out of the valve cover
___ c. Thinning of the oil
✓ ___ d. Both A and B are correct

4. Scratches and burrs on the switch plunger of the emergency fuel shutdown cylinder are removed by:

___ a. Wiping with a clean rag
✓ ___ b. Rubbing with No. 400 sandpaper
___ c. Clean with recommended solvent
___ d. Replacing the plunger is all that can be done

5. The valves are adjusted with the injector or arm depressed and:

___ a. The valve rocker arms depressed
___ b. A phillips head screwdriver
✓ ___ c. A go/no-go feeler guage
___ d. Either A or B

6. After adjusting a set of valves:

___ a. The cover is replaced
✓ ___ b. The rocker arms are marked with chaulk
___ c. The locknuts are backed off
___ d. Both B and C are correct

7. To adjust the injector on a specific cylinder:

___ a. Both valves should be depressed

___ b. The injector arm should be depressed

___ c. The injector gauge should slide easily over the shoulder of the injector cap

✓ ___ d. Both A and C are correct

8. When adjusting a rack on the new single screw racks, the adjusting screws should be tightened until resistance is felt in turning the screwdriver:

___ a. Only

✓ ___ b. And then tightened an additional 1/8 of a turn

___ c. Tightened an additional full turn

___ d. Backed off 1/8 of a turn

9. The correct turbine pressure with the engine at idle and the transmission in neutral is:

___ a. 12 - 18 psi

✓ ___ b. 18 - 25 psi

___ c. 25 - 38 psi

___ d. None of the above

10. The throttle air cylinder should be checked for leaks:

___ a. By listening

✓ ___ b. By feeling around the seals

___ c. By throwing water on the cylinder and looking for bubbles

___ d. None of the above

11. The correct turbine pressure at full engine speed is:

___ a. 18 - 25 psi

✓ ___ b. 45 - 90 psi

___ c. 65 - 120 psi

___ d. None of the above

12. To check the stall speed, have an assistant apply the break, put the transmission in low gear, and apply full throttle. The stall speed, according to the tachometer, should be approximately:

___ a. 600 - 800 rpm

___ b. 1000 - 1100 rpm

✓ ___ c. 1300 - 1450 rpm

___ d. None of the above

13. The turbine pressure at stall should be approximately:

___ a. 30 - 40 psi

✓ ___ b. 55 - 80 psi

___ c. 80 - 90 psi

___ d. 100 - 120 psi

14. Vavle springs are checked for breaks or looseness:

✓ ___ a. Feeling it with your finger

___ b. With a compression tester

___ c. By removing each spring and testing on the bench spring depressor

___ d. None of the above

15. The turbine pressure should be checked under three conditions. One of them is when:

___ a. The engine is cold

___ b. The transmission is in reverse

✓ ___ c. The engine is at idle

___ d. The bus is moving at least 10 miles per hour

APPENDIX E

THE PERIODIC TUNE-UP
Administrator's Guide

Southern California
Rapid Transit District

THE PERIODIC TUNE-UP

Administrator's Guide

Produced for:
Employee Education, Training and Development Division
and
Maintenance and Equipment Department.
By:
Canyon Research Group,
Westlake Village, California.

THE SCRTD PERIODIC TUNE-UP MODULE
ADMINISTRATIVE RECOMMENDATIONS

The Periodic Tune-up Training Program is one of several SCRTD modules using a combination audio tape/slide presentation. Since its effectiveness depends to a great extent on its administration, the following recommendations are offered.

DESIGN OBJECTIVES

This training program has been designed with the objective of improving the learning rate for entry level personnel not familiar with SCRTD maintenance tasks. It has been designed for use in a small group or for self-study.

GROUP SIZE

For the program to be effective, a maximum of five participants is recommended. More than five participants would inhibit personal participation and questioning at the end of the presentation. These questions are valuable in the learning process.

SUGGESTED SCHEDULE

The program has been designed so that it can be administered in a single session. It is recommended that where possible, the slide/tape presentation be followed as soon as practically possible by actual hands-on practice. This promotes maximum retention of the program's technical content.

ADMINISTRATION

The administration of the program is critical to its success. It is recommended that all administrators be given the opportunity to participate in a session of the course before they administer it. The following introductory pages are a guide in preparing for program administration.

PREPARATION CHECKLIST

In preparation for the training session, consider the following. Check off items as they have been attended to:

- ___ Review this Administrator's Guide.
- ___ Set up cassette tape recorder/slide projector
- ___ Preview the program
- ___ Set the schedule for the program administration (including required coordination at the Division level).
- ___ Prepare participant materials (pre and post tests, workbook and pencils).
- ___ Make a list of participant names for yourself.

Introduce the program by telling the participants that they are about to see a slide/tape program on the periodic tune-up of diesel bus engines.

Say: "The slide/tape program you are about to see will introduce you to the steps in performing the periodic tune-up of our diesel bus engines. This program will not be the only instruction you will get on tune-ups. You will also get hands on experience under the guidance of an experienced mechanic. But, this program will outline the steps involved in the tune-up and where the various components are located, how they are removed, tested and adjusted, and how they are replaced".

"Before you look at the slide/tape presentation, we want you to take a short test. This test will also be given after the slide/tape presentation. The purpose of the test is to determine how effective the program has been".

Pass out the pre-tests.

Say: "Please put your name on the test in the upper right hand corner. Begin the test now. Don't be too concerned if you can't answer some of the questions. You'll find the answers in the slide/tape presentation. But do the best you can".

Allow about 10 minutes for the pre-test. When they are finished, collect the test.

Show the slide/tape presentation which will take 19 minutes.

After the slide/tape presentation, pass out the post/tests.

Say: "This is the same test you took before the slide/tape presentation. It will tell us how effective the presentation has been. Please put your name in the upper right hand corner".

Allow about 10 minutes for the post test. When they are finished, collect the test.

YOUR ROLE AS COURSE ADMINISTRATOR

If you have been selected to administer this training program, you will find your role a challenge, but you were chosen in the belief that you could handle that challenge. You deserve to be congratulated.

Your first step should be to become thoroughly familiar with the program. The best way to do this is to watch the program. Go through the entire program and complete the test.

Allow time for discussion following the slide/tape presentation. You should maintain an open, friendly attitude toward the participants. Use your expertise and experience to relate the materials to the participants, but don't allow yourself to become the "expert" lecturer.

As administrator of this course, you should attempt to:

- Direct any discussion toward the heart of the subject matter, and keep the group from wandering off onto related but unproductive subjects.
- Clarify comments by extracting and restating the key words, ideas, or thoughts.
- Expand the content by drawing on your experiences and those of the participants.
- Relate discussions to the mechanic's job.

Keep the following points in mind as you conduct the course:

1. Learning is an active experience.
2. The purpose of this learning experience is to develop a needed skill and to add knowledge for a specific purpose, i.e., being able to tune a diesel engine.
3. People learn and retain more if they become actively involved, rather than if they are being passively exposed to material. Discussions after the presentation can be highly beneficial.
4. In general, people do not resist learning if the learning seems useful and practical. Under these circumstances, they would rather learn than not learn.

In summary, your major tasks are to show the program, stimulate group discussions, and to handle the program logistics.