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Mass Transit Management: A Handbook for Small Cities

Part 3: Operations

Third Edition
Revised
February 1988

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Prepared by
G.M. Smerk, L. Hendriksson, K. McDaniel,
D. Perrault and S. Stark
Institute for Urban Transportation
Center for Transit Research and
Management Development
825 East Eighth Street
Bloomington, Indiana 47405

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Urban Mass Transportation Administration
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Susan Hobbs
Maria Lee

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INTRODUCTION TO THE THIRD EDITION, REVISED

In most fields of transportation, management--rather than equipment, location, or operating rights--is the key to success. Urban mass transportation is no exception. Despite its importance, transit management has received surprisingly little attention, especially in terms of modern business practices. The aim of this handbook is to provide information for the management of mass transit, particularly for small-scale operations in smaller cities in the United States. For the purposes of this handbook, a small city is defined as one that operates 101 buses or fewer. This cutoff point for small transit systems is one used by the federal government. Because of the scale of transit enterprises involved, the handbook assumes that management faces two major constraints: (1) the amount of money available, and (2) the degree of specialization possible with the limited manpower of a small enterprise.

Staff members at the Institute for Urban Transportation (IUT) in Bloomington, Indiana, investigated the practices of smaller transit systems in many parts of the United States to discover firsthand some of the methods and problems of such properties. The best methods used by these properties have been included in this handbook. In addition, a modern, systematic approach to the management of transit firms has been worked into the material as an improvement on the conventional practices of the transit industry. Extensive experience in providing local and statewide technical assistance in Indiana, providing management training for the transit industry, and conducting management performance audits of transit properties has given IUT's staff substantial insight into transit management.

The consumer-oriented approach to business is strongly emphasized in this handbook. The consumer-oriented approach is the major business approach of American business firms. This marketing management technique has been in use since the end of World War II. By adopting this powerful, strategic concept, this handbook is very much a marketing-oriented document. The justifications for this approach seem compelling because the transit industry has traditionally suffered from a lack of marketing expertise and effort. Today, the transit industry still is primarily operations-oriented but it is clear that, nationwide, transit properties of all sizes are becoming more marketing-oriented.

The handbook is divided into four sections. Part I: Goals, Support, and Finance (Chapters 1-3) includes sections on establishing goals and objectives, understanding the consumer, gaining public support and public action for transit, institutionalizing transit as an integral part of the community, and financing transit. Part II: Management and Control (Chapters 4 and 5) focuses on management itself and the control and information devices needed for effective management. Part III: Operations (Chapters 6-11) covers important areas of day-to-day operation, coordinated as the product element in the marketing mix. Part IV: Marketing (Chapters 12-15) deals with the marketing program and promotional activities.

Because this handbook is intended to serve more as a reference work than a textbook, care has been taken to produce chapters that are complete in and of themselves. Some repetition is inevitable when using this technique, but every effort has been made to reduce duplication by cross-referencing and providing a detailed table of contents. Appendixes are included with some chapters to give more detail on certain subjects without interrupting the flow of the text. A short but relevant bibliography is provided at the end of each chapter.

The handbook aims to promote the concept of results-oriented management as well as marketing orientation. Early in this handbook, the need to establish goals and objectives is stressed. The concept of management by objectives (MBO) is discussed in some detail. MBO recommendations are given for policy-making bodies as well as management. A detailed explanation of how to use MBO for transit management is provided.

The critical concept of consumer orientation through marketing is reflected throughout the handbook, but perhaps most strongly in Chapters 1 and 12. Chapter 1 discusses the goals and objectives of a transit enterprise. It covers consumer behavior as it may be applied to mass transportation and recommends the development of a general marketing-management strategy for transit management. In Chapter 12, the marketing program suggested for the small transit property is developed fully. The relationship between all parts of the transit enterprise is built around a marketing-oriented firm. The marketing mix--product, price, and promotion--is the concept that shapes managerial action in meeting consumer needs. MBO is the means by which results can be attained reasonably.

Throughout this handbook, careful attention has been paid to the consumer and to gearing management thought and the service provided by the transit firm to meet the desires and needs of consumers. Service quality is a key factor with the costs carefully controlled and all aspects of the enterprise planned with specific ends in mind. The aim is to encourage, not a minimum of service at the lowest possible cost, but service that meets consumer needs and desires at a cost carefully calculated and controlled. The ideas and concepts are applicable to both private and publicly owned transit services. Most of the principal ideas are straight from the private sector.

In addition to covering broad strategic concepts of management and matters of systematic, day-to-day operation, this handbook deals with critical factors including public support, finance, and various forms of public ownership. A fair proportion of the contents, therefore, is directed not only toward transit managers, but also toward public-spirited citizens and public officials who wish to inaugurate or improve transit services through public action.

This handbook should be considered a draft, as were the first two editions. It combines the tried-and-true methods--where these appeared to be the best possible practices--with innovation, in the application of modern business techniques to transit. In a world of fast-moving managerial and technical innovation, nothing stays up to date for more than two or three years. What is contained here may be subject to fairly rapid obsolescence.

We sincerely hope that by using this handbook managers of existing smaller transit properties will find many good ideas and suggestions that they may adopt easily to serve the urban traveling public effectively and efficiently. We also wish the very best to persons working in transit, a difficult but highly rewarding field of effort.

PART III

OPERATIONS

A key idea of modern business management introduced in this handbook is the concept of the marketing mix--product, price, and promotion--as an adjustable package that management may modify to reach different segments of the market. The service provided is the transit firm's product. The chapters in this section deal with the elements involved in providing that service. The various operating functions of personnel, maintenance, equipment selection, routing and scheduling, and communications and control are treated as parts of a whole. They are interrelated, not individual, unrelated pieces. All of those functions are oriented toward serving consumers--the goal of the transit enterprise.

If all this seems more complicated than just running buses around town, it is. However, the marketing concept is not difficult and it is a rational approach. The aim is not to optimize maintenance or equipment or any one aspect of operations, but to optimize the entire package of service-related functions for the benefit of the passenger.

Chapter 6 touches on some of the current personnel issues facing transit operators. Dramatic changes have occurred in the work force since the second edition of this handbook was published; we have tried to highlight those that we see as being most relevant. Chapter 7 deals with maintenance and includes the framework of a ready-to-use manual record keeping system. The selection of equipment and fixed facilities is dealt with in Chapter 8. Chapter 9 is new to the third edition and is intended to serve as a primer on the procurement process. The key to understanding this complex subject is in accepting the notion that it changes constantly, thus any systematic approach to it must be flexible enough to adapt. We introduce a modular approach designed to do so. Chapter 10 outlines the routing and scheduling process and includes two appendixes showing detailed examples. Chapter 11 touches on supervision, communications, and control, and includes an appendix which briefly highlights the latest in radio technology.

CHAPTER 6

PERSONNEL AND LABOR RELATIONS

Personnel

Assessing Personnel Needs

Before a transit system can recruit, select, or train new employees, it must have some idea of its personnel needs. Personnel need assessments begin with the scope of the job to be done or the level of service, which leads to job analyses, and finally to a determination of personnel needs.

The strong market orientation of the small city transit system requires tasks and, subsequently, jobs designed to help achieve its mission. Bus operators are responsible for delivering the system's service to the consumer; supervisors are responsible for maintaining the quality and consistency of the service; and maintenance personnel are responsible for maintaining the image, availability, and dependability of the vehicles used to provide the service. Although their tasks differ, all employees' efforts share the objective of maximizing the consumer's benefits through use of the service.

Job analysis. The first step in assessing the system's personnel needs is to analyze the characteristics, duties, and responsibilities of specific jobs. Job analyses are used to prepare a job description for each particular job (or class of jobs) that outlines the associated duties, responsibilities, and working conditions. (Job descriptions are discussed later in this chapter.) According to the Federal Uniform Guidelines on Employee Selection Procedures, a selection instrument becomes valid only after a job analysis has been completed; therefore, the job analysis is an integral part in developing structured interviews and oral and written tests. Furthermore, a good job analysis identifies the characteristics that define successful performance, which may then be used to develop a performance-based employee incentive plan. Clearly specified success characteristics will maximize the objectivity and integrity of any incentive plan. An outline of successful performance can then be used as the basis for a training program. Finally, job analyses are useful because they clarify relationships among different jobs, help maintain an equitable salary structure, and identify potential career progressions.

Career paths. A career path is a progression of job classifications and responsibilities that an employee may pursue to advance within the organization. This allows employees to establish personal goals--deciding in what position they eventually want to be end up--and lets them see the steps they must take to get there (e.g., training programs, certification, development of technical or managerial skills). The job analysis, in turn, identifies the specific requirements of each step.

Figure 6.1 illustrates three hypothetical career paths. Example A shows the progression available to an entry-level bus operator. Example B shows the steps that might lead to a maintenance supervisory position. Example C shows the steps an entry-level parts clerk might take to reach a management level procurement position. Career path charts can also be developed into matrices that include the necessary training topics, or areas of expertise, for advancement. (See Source 12 at the end of this chapter for an in-depth discussion of career path charts and training matrices.)

Recruiting Candidates

Once the needs assessment has been performed, a recruitment effort is launched. First, management must decide whether to recruit from within the organization, from an external source, or both. Second, a job posting or advertisement should be produced that appeals to the audience most likely to contain the ideal candidate. The application procedure is the final step before the interview and selection process.

Recruiting source. The decision to recruit candidates internally, externally, or both depends on the nature of the position and the skills it requires. Entry-level positions, which usually require the least amount of skill, tend to be filled from outside the organization. This is also true of positions requiring proficiency in disciplines such as accounting, advertising, or equipment maintenance. However, first-line supervisory positions tend to be good positions to fill from inside the organization.

Other important factors in determining whether candidates should be sought internally, externally, or both include: the performance of the incumbent; the performance of the organization; and the abilities of other employees who are either supervised by, or depend on, whoever might fill the position being recruited. As a general rule, in mature, well-run organizations, positions other than entry level should be filled from within provided that the appropriate qualifications can be met.

A good way to monitor the potential for filling positions from within is to maintain an ability and skills record system [18]. This is an informal system that simply keeps track of the employees' education, knowledge, training, work experience, specialties, preferences, and career goals. Participation in this program should be voluntary, informal, updated frequently, and confidential. It should not be used to affect employees' positions adversely.

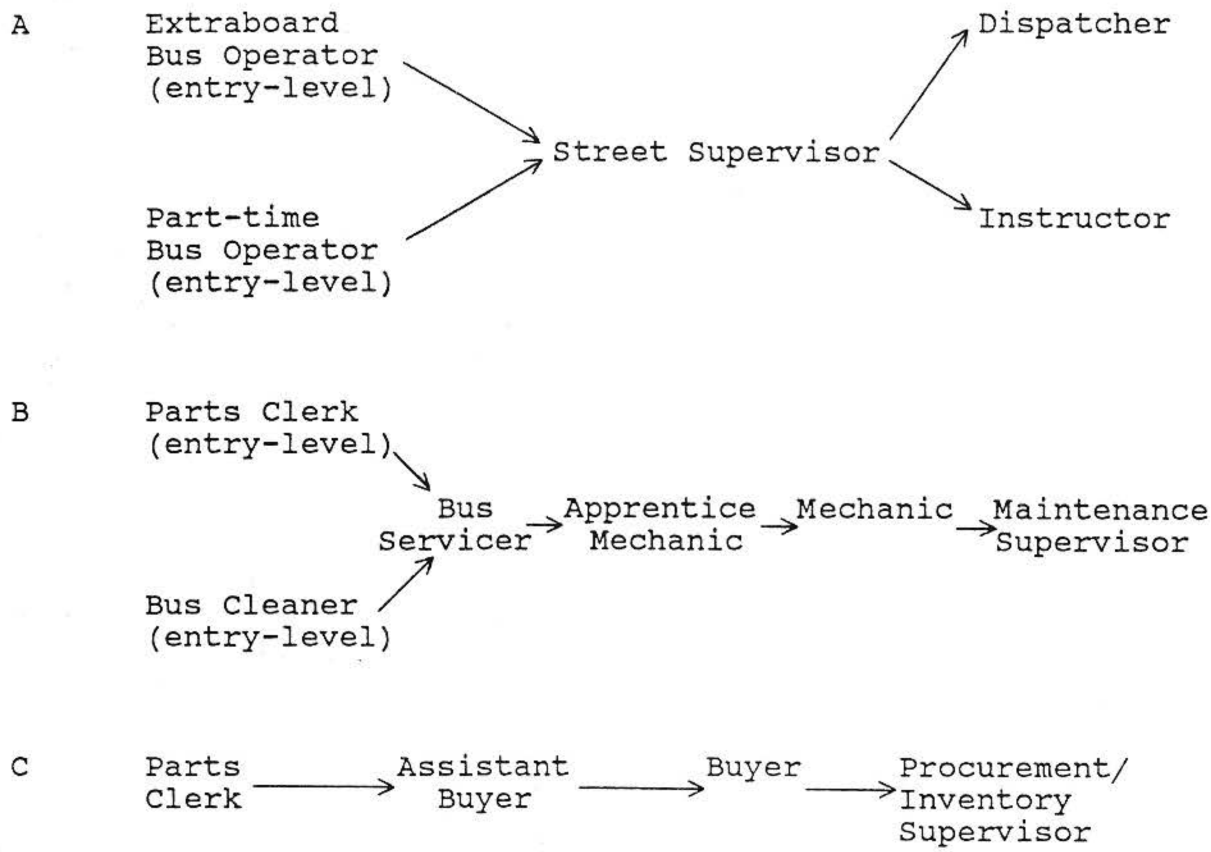

FIGURE 6.1 Examples of Career Path Charts
Source: [12]

Filling positions from inside the organization also gives management an excellent opportunity to offer a career path within the small city transit system. A better position with an increase in compensation rewards the valued employee and provides an incentive to other employees to perform well. The labor agreement may also provide guidelines on whether to fill specific key positions internally or externally. Having such a provision may be a good-faith bargaining tool; however, management must avoid being constrained by language that does not allow for discretion in filling key positions.

Job postings and position descriptions. Two additional results of a good job analysis are job postings and position descriptions. Although they are related, they are not interchangeable. Particular care must be taken in the preparation and dissemination of each.

The job posting, or job specification, is a concise listing of the traditional knowledge, skills, and abilities needed for the job. A specification should outline the criteria that potential candidates must meet. It should state how to apply for the job, where to apply, and give the application deadline. Compensation and, when possible, benefit ranges must be clearly stated. An accurate, appealing, and informative job posting helps to ensure that the system will accomplish its goal of attracting the best candidates for the job.

The job description lists tasks and responsibilities of the position. (A job description should not describe the individual worker but rather the task performed.) This description serves as the contract between the employer and employee; therefore, there must be a clear understanding of what is expected on behalf of both parties. This is a good opportunity for management to convey its goals, objectives, and performance criteria in a positive way in order to minimize any uncertainties.

Care must be taken not to confuse the specification with the description. Under no circumstances should the specification be a substitute for the description. Should this occur, management has lost its ability to expect consistent performance from its employees; the employee occupies a position simply because of qualification instead of performance. This is a good way to guarantee complacency, stagnation, and conflict in an organization.

Appendix 6B contains detailed job descriptions for a bus operator and a mechanic, based on the Factor Evaluation System developed by the federal Office of Personnel Management [17]. This system takes into account nine factors in developing a position description:

- Knowledge required
- Supervisory controls
- Guidelines
- Complexity
- Scope and effect
- Personnel contacts
- Purpose of contacts
- Physical demands
- Work environment

Culling the list of applicants. Unfortunately, there is rarely enough time to interview all applicants for a given job posting. Several techniques exist for quickly culling the most likely candidates from a group of applicants; however, these techniques are tricky, and by no means foolproof.

One good technique is for two people, managerial or supervisory, to screen the applications, and then proceed as follows:

1. Assess experience, traits, and references in terms of the organization's goals and objectives.

2. Develop a master list of all applicants that screeners chose as likely candidates. Keep a separate list of the applicants chosen by both screeners.

3. Discuss the reasons for choosing the respective candidates. Screeners should reach a consensus on the rank order of candidates in terms of desirable qualities.

4. Eliminate the lowest ranking candidates until a number is reached that fits the interviewing time frame.

Assessing experience. A candidate's qualities should be consistent with the organization's goals and objectives. In the consumer-oriented transit environment, desirable qualities in a bus operator include experience in working with the public. Persons with a track record of handling stress well are often excellent candidates. The neatness of the application is a good indicator of the applicant's seriousness toward the position. Educational experience may also be helpful.

Interviewing the candidates. Once the likely candidates have been screened, initial interviews may be arranged. The goal of the initial interview is to learn as much about the candidate and his or her qualifications as quickly as possible. Each candidate should be interviewed under the same guidelines, which should be consistent with the Equal Employment Opportunity Commission (EEOC) guidelines. This maximizes the objectivity of the interviewing process which, in turn, allows for valid comparisons among the candidates. The most promising candidates should be invited back for a second, much longer interview.

Using structured interviews. Promising candidates identified in the initial interview should be interviewed more thoroughly in the second interview. A structured interview can be used to provide more data for assessing the candidate. The structured interview is designed to put candidates "on the spot" so that their reactions and approaches to different situations can be observed. Appendix 6C gives a brief sample of the types of questions that might be used in structured interviews for bus operators.

Using validated tests. A more sophisticated method of selecting employees is through use of validated tests. A test is validated if it can be shown that it has no adverse impact on any specific group of applicants such as women or minorities. Although tests are useful tools in assessing applicants, they should not be used as the sole criterion for selection. At least one firm offers a battery of tests specifically designed for selecting bus operators. These tests include measures of experience and background, skills and abilities, and emotional health.

Selecting an alternate candidate. It is a good idea to select an alternate qualified candidate who could fill the position or at least be available for future openings. By maintaining a pool of alternate candidates who have already been screened and interviewed, the system can fill subsequent vacancies faster. There are other reasons for maintaining a qualified applicant pool. The candidate you choose may have received other offers of employment or may be using your offer to negotiate a promotion in his or her current job. Or, the successful candidate might accept the offer, then discover during the training process or later on that he or she really does not like the position.

Selecting an alternate candidate may or may not be directly addressed in a small city transit system's personnel hiring policy. Personnel policies and procedures of the small city transit system are often molded after the policy and procedures of the municipality in which they operate. In very small systems, these policies and procedures may be the same. It is often common for waiting lists, or pools, to be maintained for police officers, fire fighters, and teachers so that vacancies can be filled quickly. A consumer-oriented small city transit system plays a vital role in its own way, and should attempt to maintain an alternate selection process.

The feasibility of such a process will depend upon the local economy. Where there is a high local unemployment rate, the transit system may be able to maintain a large pool of candidates for bus operators and mechanics. Conversely where the local unemployment rate is low, a pool will not be feasible. Because the skills involved in operating and maintaining small city transit vehicles are specialized, it is likely that second-level positions will be filled from within the system. It is therefore feasible to maintain internal pools of candidates for street supervisors and higher-rated mechanics.

There is one caveat to maintaining pools. If a substantial period of time has elapsed between the need to fill vacancies, and if operating conditions have changed significantly, then there may be no advantage in filling vacancies from a pool of candidates who were identified using previous selection criteria. They simply may be wrong for the job.

Extending a job offer. The successful candidate should be notified, in writing, of the offer of the position, subject to meeting any preemployment conditions such as a physical exam. In the letter, stress that you are pleased to offer the position to the successful candidate because he or she met your rigorous assessment standards. Thank the candidate for his or her time and participation in the process. It is important to state a firm response deadline and starting date. Inform the candidate of any further preemployment conditions such as a physical examination, drug testing, training, skill attainment levels, and probation periods.

Remember that the objective has been to identify, recruit, and train a candidate to fill a position with the hope that he or she will become a valuable, contributing employee. The job offer only marks the half-way point in this process. It takes two to three years for a bus operator in a small city to mature into a valuable operating employee; in larger cities, the estimate is five years. Therefore, new employees should be viewed as candidates until they mature into contributing members of the organization.

Checking past employment. Candidates are usually selective in what they reveal during interviews. It is important to understand why they changed jobs in the past. People usually change jobs because of conflict over the derived benefits, their performance, or their personality. Where there is conflict in either personality or performance, it is essential to get a clear understanding of the circumstances. Caution must be exercised, however, because in many states, the applicant's references can be verified only after written permission is given. The applicant should be informed at the beginning of the employment process that references will be checked. (Note: personal references generally have little value except when the applicant has little or no prior working experience.)

At a minimum, check with the former employer of the candidate. A telephone call or a personal visit are generally the best methods. A telephone call has the advantage of being both cheaper and faster. Figure 6.2 is a sample telephone information questionnaire. Be particularly careful when asking any questions concerning a job candidate because there may be strict legal guidelines on the type of information to which a prospective employer is entitled. This is also true when someone is seeking information about a candidate who was once, or still is, your employee. In either case, check with the legal staff for appropriate guidelines, and review any questionnaire or outline with them before using or responding to a questionnaire.

PREVIOUS EMPLOYMENT REFERENCE CHECK

Checker's initials ____________

Date ______________

Name of Applicant: ____

Previously Employed by: ______________________ Phone #: _______

Former Supervisor: ___________________________ Title: _________

1. ____________________ has applied for employment with us and I would like to verify some of the information he/she gave us. Would you please tell me when ___________ worked for you?

   From: _________________________ To: ______________________

2. What was _________________'s job when he/she:

   started? ______________________ left? ____________________

3. What did you think of ________________'s productivity and

   quality of work? ____

   ____.

   Attendance? ____

   Working relationship with others? __________________________

   ____

4. ___________________ claims past earnings of $ ______________

   per _______________. Is that correct?

FIGURE 6.2 Previous Employment Reference Check
(Continued on following page.)

5. Has ________________ ever had any accidents? If so, please explain. ____

6. Why did ________________ leave your company? __________

____

7. Would you hire ____________ in the future?

_______ yes. ______ no, because: ________________________

____

8. In your opinion, what are ________________'s strengths?

____

____

Weaknesses? ____

____

Additional comments: ______________________________________

____

____

FIGURE 6.2 Continued.

Management should also undertake a complete investigation of the applicant's personal history. Many transit operators take fingerprints of all applicants. State and local police departments, as well as motor vehicle departments, are excellent sources of accident and moving violation records. However, be absolutely certain that all information gathered bears a direct relationship to the skills identified during the job analysis, and that the process is legal.

A complete credit check on the applicant can give an indication of responsibility; however, it may not be legal to drop a candidate from the selection process because of either a poor credit rating or garnishment of wages. Garnished wages may indicate a candidate's need to take on additional employment outside the transit organization, which might make it difficult to do the transit job properly. This is especially applicable to new bus operators who are likely to start out on the extraboard, and not know from day to day what their commitment will be to the system; the pressure to make up garnished wages will therefore remain.

<u>Requiring a physical examination</u>. The purpose of a physical examination is to determine whether the applicant has any physical impairments that would render him unable to do the job. Upon accepting the offer of employment, the candidate's physical abilities will need to be assessed against the physical requirements identified during the job analysis. Only those candidates who have accepted the job offer should undergo this phase of the selection process because of the time and expense involved. Particular attention should be directed to previous heart or back ailments, high blood pressure, and vision, especially color and depth perception.

It is becoming common to test transit job candidates for drug use, typically by means of urinalysis. This must be done with the cooperation of a physician who should have the analysis done by a competent laboratory. Such a test is a major safeguard to service reliability and passenger safety. EEOC guidelines strictly prohibit requirements that discriminate against women and minorities, unless such requirements are related directly to job performance.

<u>Why spend so much time recruiting</u>? Hiring a regular full-time employee is a long-term investment, and like any other investment involves taking on risk. Over 90% of a bus operator's daily work is unmonitored; therefore, much trust is placed on the employee to perform properly. With the competitiveness inherent in a service industry and the subsequent demands for increases in productivity, transit employees make (or break) the system. Moreover, because most of transit's expense goes for salaries and wages, care in selecting employees is the best way to ensure that the money is well spent.

Strong competition for well-paying jobs has resulted in techniques for making the individual job hunter more competitive in the market. Some candidates are more adept at these techniques than others; however, there is not necessarily a positive correlation between mastering job-search techniques and performing well in a given job. Some candidates who excel at various job-search techniques may be poor on-the-job performers. Others may do poorly during the selection process but may be excellent on-the-job performers. Unfortunately, both are difficult to identify. Spending more time during the selection process simply provides more opportunity to sense either possibility. A good method of identifying the former is to duplicate some of the criteria in different parts of the selection process. A good way to identify the latter is to rely heavily on the candidate's previous employers, who have firsthand knowledge about the candidate's capabilities. However, neither of these methods is guaranteed.

In general, the more time spent with candidates during the selection process, the more they will come to know you and the organization. This gives the sincere candidate better information to be used in developing a commitment to the transit system. The ideal candidate is productive, can be trusted to work virtually unsupervised (particularly in the case of bus operators), will support the goals and values of the system, and does not have outside interests or responsibilities that continually conflict with what is expected on the job.

A good reason to spend enough time during the recruitment process is that it is very difficult to discharge an employee who has attained "regular" status. This is particularly true of union-eligible employees who, even if clearly deserving of termination or discipline, will be vigorously represented by union officials. Even with a strong case, management can expect to become involved in a time-consuming grievance procedure and, probably, a time-consuming and costly arbitration proceeding. The time invested in a rigorous employee search may be far less than the time, effort, and resources needed to defend management's position in an arbitration proceeding. Even if a case goes to arbitration, management stands a 40% chance of losing and the system usually will end up paying for the process. (Based upon our analysis of grievance-arbitration data released by APTA covering the period June 1982 through April 1984.)

Institutionalizing the New Employee through Training

Having learned about the candidate and his values, the next step is to acquaint him fully with the transit system including its history, goals, and current policies and operating procedures. This last point is crucial because most of the operating employee's time is spent unsupervised. A qualifications procedure is applied at the end of the formal training period. However, the true test of an employee's value comes in observing, without his knowledge, the employee's actual behavior within the first hours on the job.

The training process is crucial to the candidate's ability to become a valuable employee. The candidate must understand the system's goals and objectives, and the candidate's role as both an individual and member of a team working to accomplish said goals. Operating techniques, report procedures, administrative policies, and guidelines on what to do in situations not specifically addressed must be presented to the candidate in a clear, precise manner. Turnover in potentially valuable employees can be directly attributed to the candidate's inability to adjust to the organization. The effective training program takes this into consideration and thoroughly indoctrinates the candidate into the organization. Candidates must receive all necessary information when assuming their positions and responsibilities, together with the confidence and attributes that will make them a valuable team member in the future. For these reasons, the orientation acts as the planned and guided adjustment of the candidate to both the employer and the job.

Management should establish goals for this indoctrination process, and then bolster them with the appropriate guidelines. Goals frequently found in training programs include:

1. The transit system must be sold to the candidate to establish a set of favorable attitudes about the system and its role with the consumer.

2. Candidates must be made to feel that they belong to the organization, and that they are valuable, contributing members.

3. Candidates must be given the necessary assurance and confidence to be relaxed, and to absorb the goals, objectives, operating procedures, and training materials. Removing their fears and uncertainties will aid the learning and adjustment process.

More specific goals might be:

1. Reduce the turnover rate of employees whom management considers valuable to the system.

2. Reduce costs associated with the selection process.

3. Provide a thorough and proper explanation of the fundamentals to ensure grievances are minimized.

Training must not be regarded as a cure-all for the system's problems, and will probably be a poor investment if it is used to:

- Compensate for poor organization and planning.

- Substitute for low hiring standards.

- Make up for inadequate employee compensation, poor facilities, poor supervision, or aging equipment.

- Force employees to learn. Training only provides the means for learning. Unless candidates are properly motivated, they will not learn anything.

New bus operator training programs. A sample training program for bus operators is in Appendix 6D. The following steps are a proven method of presenting new material to trainees:

1. Prepare the trainees; put them at ease.

2. Present the tasks of the job stressing key points; do not overload trainees with new material.

3. Give the trainees a chance to see how well they can perform.

4. Review what has been presented.

5. Gradually decrease the amount of instruction as the trainees' performance and attitudes improve.

In most small city transit systems, an experienced bus operator does most of the training of candidates for new bus operator positions. Because the instructor has a crucial part in shaping trainees' attitudes and performance, instructors should be adequately briefed on what the trainees have already been told, what they need to be told and, most important, what will be the instructor's role in the remaining parts of the training process. When experienced operators are used to train new candidates, they should be encouraged to participate in setting up the training program. The experiences of such operators will aid them in designing a training program that conveys the actual knowledge and finer details the candidate will need to know. Through their participation in the training process, experienced operators become personally involved in the progress of new employees and will ultimately have a better understanding and acceptance of the program. It should be noted that not every experienced driver will do well as an instructor. Some lack the commitment or the ability to convey their knowledge to others.

Some transit properties may have a training supervisor whose major responsibility is training new operating employees, observing performance of older operators, and retraining when necessary. Training supervisors usually work with a small team of experienced operators in carrying out the training effort.

Ongoing training programs. Situations often arise where experienced employees, particularly drivers, may require additional skills or training. Training is an ongoing process that does not end after the initial indoctrination-training program, but must be supplemented for various reasons. For example, additional skills may be needed because of changes in equipment. Long-time employees may also require additional training because of inadequacies in the previous training program. Some employees may have developed poor attitudes, work habits, or skills that need correction. When these problems arise, the company may want to retrain or upgrade some of its operators.

Retraining for drivers is especially valuable in the areas of safety and customer relations. Safety training is a challenging area because safety is not a skill but a state of mind. The safe driver is one who has a proper attitude as well as mental alertness. To promote safety, many transit systems use a form of training that includes visual aids, contests, and periodic observation of the employees. In the ideal situation, when an employee has repeated difficulty in adhering to safety procedures, his supervisor will discuss the employee's problems with him and may assign him to one or two days of retraining with an appropriate instructor.

Customer relations for employees who meet the public or deal with them on the telephone is another important area that must be evaluated continually. Training on the proper use of the telephone is usually available at no charge from the telephone company providing service. Several complaints about a particular driver may necessitate a conference with his supervisor. Many transit companies have "charm schools," in which a competent instructor periodically reviews the importance of courtesy to the customer. Usually, some attention is devoted to dealing with "problem passengers" because they can spoil a driver's trip and adversely affect his attitude toward the other passengers.

Maintenance employees need constant upgrading of skills and knowledge as technology changes. New buses are more complex than those available a decade ago. Manufacturers of buses and components offer training programs as part of the purchase package. Transit properties should take full advantage of these training schools. Some training is available at the property and so is virtually cost free. It is especially important to take advantage of training while the warranties are in effect.

Reviewing progress. Measurement and feedback are central to the entire training program because they motivate the employee and provide an objective basis for self-review of performance. Recognizing this, the instructor should review the trainee's progress at various stages of the training program.

The appraisals should be conducted objectively by the instructor. To maximize objectivity, the transit system may want to use readily available tests such as the "Road Test Checklist," available from the American Automobile Association (AAA), or management may use a test of its own design. In either case, the test should reflect the materials presented in the training program. Figure 6.3 provides an example of a generic roadtest checklist.

To achieve the maximum benefit from any evaluation, the results need to be conveyed to the trainee. Accordingly, review sessions between each trainee and the instructor should be held to discuss:

- The test results and their significance
- The trainee's performance
- Any problems encountered
- The trainee's strengths
- Areas needing improvement

While the testing procedure evaluates the trainee, the review sessions should be perceived as counseling or helping sessions. If the review sessions are threatening, they will not help the trainee but will merely waste time. To achieve any benefit from the review session, it should be conducted in a frank and open manner. At the close of the session, the instructor should briefly summarize the discussion and emphasize the progress that the trainee has made since the last conversation.

At the close of the formal training program, each trainee should be made aware that training is continuous, and that good drivers (and mechanics) are not made in weeks but in years. Recognizing this fact, most transit agencies have established a 90-day minimum probation period for the new driver. During this period, the new driver can be dismissed if references were falsified or if there have been serious problems in adjusting to the job. (Probation is discussed in the next section.)

The situation is somewhat different with mechanics because supervision is easier in the maintenance area. Supervisors can work much more closely with new maintenance employees. Moreover, if effective apprenticeship programs are available, new employees may already have been taught most of the skills needed. Proper supervision should see that new maintenance employees receive the necessary experience. Training is apt to be a problem when unskilled servicing employees advance to maintenance positions. If possible an arrangement should be made with a local technical high school to provide basic skills.

STUDENT OPERATOR BREAK-IN REPORT

Operator____________________________ Line ______________________________
Date ___________________ On _______________________ Off____________________

Student ________________________________ is breaking in as an operator. Please cooperate by checking off the steps as he progresses.

BE SURE YOU KNOW THAT THEY KNOW:

(Check one of the following)	Good	Fair	Poor	Remarks
Driving ability				
Handling equipment				
Safety and handling passengers				
Route				
Stops				
Time points				
Transfers				
Transfer points				
Fare box				
Copies schedules correctly				

IS FAMILIAR WITH:

(Check one of the following)	Good	Fair	Poor	Remarks
Pull out and pull in instructions				
Location of schedule information				
Bulletin boards				

Attitude ____

Student drove coach _______Hrs. ________Min.

Additional information regarding student:______________________________

____

____

FIGURE 6.3 Road Test Checklist

Using Probation to Extend the Interview Process

Employment probation. The probation period is perhaps the most critical time period in the relationship between the candidate and the organization. Note that although the new person has been referred to as a "candidate" up to this point, he is likely to have been on the payroll since the training period began. The terminology was chosen very carefully. In most public service settings, employees must first complete a probation period ranging between 90 days to one year. The objective of the probation period is for management to assess the candidate in the actual job environment.

For the well-motivated and hardworking candidate, the probation period will be spent practicing and developing skills introduced during training. For the candidate who has been successful in masquerading bad habits or traits, the probation period is likely to present a sense of false security, during which these traits will probably surface. Management has several strategies for assessing the probationary employee. If the perception of the candidate was favorable both before and during the probation period, management should congratulate the candidate and may want to recommend that he or she commence regular full-time or part-time work. If the perception is favorable but performance is questionable (possibly through no fault of the candidate), then the strategy might be to extend the probation period, provided this option is legally available. On the other hand, if performance shows any hint of poor judgment or poor attitude, then the proper strategy is to terminate the candidate. Again, as in all previous phases of the selection process, consult legal counsel before taking action.

Unfortunately, management often finds itself in the awkward position of terminating a candidate who has successfully progressed through, or fooled, the selection process up to this point. The tendency is to suspect the process; unfortunately, it is easier to fool the system than to identify who is fooling it. Terminating a candidate during the probation period usually leaves the candidate with little, or no, recourse. Not terminating during this period usually leaves management with little, or no, recourse during the new employee's tenure. Note that the new employee has mastered "the game" extremely well and is likely to continue doing so to his own advantage throughout the course of employment.

Performance probation. Performance probation is particularly applicable to small city transit systems in which employees from other city departments, within the same bargaining (or policy) unit, are permitted to bid on jobs within other seniority units. The application of performance probation is essentially the same as in employment probation; however, instead of being terminated, the candidate reverts back to his original position. This can be a valuable tool for both management and the candidate because it provides an incentive to fill positions from within the organization. Management can offer the candidate an opportunity to advance, with the safety of an adequate fall-back option should the candidate not work out. The candidate has an incentive to try to climb the ladder, knowing that his employment is not at stake during the effort.

Evaluating Employees

There are two basic reasons for performance evaluations. First, human resources are an investment and performance should be monitored to determine if the investment was a wise one. Second, good employees will want feedback on their efforts because they have a strong desire to perform well. Evaluations can either rank employees among themselves or compare them against previously determined standards. Careful consideration must be taken when using any evaluation system to avoid conflict with EEOC guidelines.

Performance evaluations can be a powerful tool in enhancing the organization's investment in a valued employee and the employee's investment in the organization. Good evaluations motivate achievers to perform while constructively critical evaluations help them to improve. To ensure the evaluation is constructive, feedback should be accurately weighed against a previously defined, and achievable, objective.

Some absolute standards are attributes, behaviors, and objectives [14]. However, these will vary depending on the position. Attributes include attendance, job knowledge, and performance. Behavior includes specific examples of attribute performance. Objectives include the rate of accomplishment in the employee's work plans. To evaluate an employee effectively, specific levels of attainment and both acceptable and unacceptable attributes and behavior characteristics must be clearly defined.

Performance evaluations should be carried out in two stages: evaluation and development [5]. The evaluation stage makes the employee aware of the assessment. Management reviews specific employee attributes, behavior and, if appropriate, attainment of objectives. The development stage becomes a constructive, give-and-take session to help the employee maintain adequate performance as well as improve performance. Reaching a consensus in the first stage helps ensure the success of the recommended course of action set out in the development stage. It is also beneficial to carry out each stage separately because each has a different objective. A short period of time between the evaluation and future development stages gives motivated employees a chance to develop their own input toward an effective course of future action.

Evaluation and development interviews should be done in a neutral setting to put the employee at ease. Good settings include a picnic table in a park on a nice day and a secluded table in a restaurant over a cup of coffee. The interviews should never be done in the evaluator's office.

As in the employment selection process, the evaluation must directly relate to the desirable skills defined in the job analysis. Evaluations can be used to identify upwardly mobile candidates. Consistency in achieving goals and adherence to the directions recommended in the development stage are good signs of the employee's willingness and ability to take on responsibility. Such abilities, combined with the incentive of the performance probation period, make the employee an excellent candidate for promotion, provided the appropriate skill level is met.

Managers should also pay particular attention to performance that does not meet their criteria. It is important to identify the most likely reason, which might be the evaluation criteria, the training process, the employee, or conditions inherent in the operation of the system. It is unreasonable to expect an employee to perform adequately if he lacks the appropriate tools and environment in which to do so. Management should ensure that:

1. Performance criteria have a direct relationship to the skills identified in the job analysis and developed in the training program.

2. The training program is designed to convey the objectives clearly.

3. The operation of the evaluation system is consistent with its goals and objectives, the desirable employee skills, and the ideals conveyed by the training program.

Managers should be realistic and note that the evaluation process is neither well-developed nor exact. There is bound to be error in human evaluation, which makes it impossible to design a performance appraisal system that is absolutely safe from litigation [7]. Several organizational policies have been suggested to increase the accuracy and appropriateness of performance appraisal procedures and to decrease the probability of legal action [7]:

1. Analyze the job to determine the characteristics important to successful performance.

2. Incorporate these characteristics into a rating instrument.

3. Communicate performance standards to employees.

4. Train supervisors to use the rating system.

5. Document evaluations and reasons for subsequent personnel action.

6. Monitor the performance appraisal system.

The Role of Career Development

Not only is the employee an investment to the system, but the system is also an investment to the employee. It is unreasonable to expect employees to strive to meet the system's objectives unless they receive a benefit other than wages. Career development can be formal or informal; it can be costly and considered part of the wage package, or it can be virtually free. Simple efforts include help with resumes, letters of recommendation, and informal counseling by supervisors.

The presence of a career development program, formal or informal, should be a policy decision based on the system's goals and objectives, operating environment, labor climate, and the relative condition of the local economy. Whether formal or informal, a good career development program requires substantial time, effort, and resources. If the transit system is performing well in meeting its goals and objectives, then there is probably sufficient time to devote to a career development program. It is also likely that in being able to meet its objectives, the transit system and its employees operate in a mature environment which is essential to the acceptance of any program designed for further development. If the transit system is not meeting its objectives, then any career development effort merely robs management of precious time.

The system's turnover status will also be a determining factor. If turnover is favorable--that is, the transit system is losing employees it does not want--then career development efforts might be limited to the employees that management wishes to retain. If turnover is unfavorable--the system is losing employees it wants to keep--then efforts might be increased toward development both within those job classifications and within the organization itself. In a strong local economy, the employment package may need to be made more attractive by career development opportunities. In a weak economy, it may be wisest to concentrate on opportunities within the organization, and then adopt an overall strategy designed to minimize continuing unfavorable turnover.

Abilities and skills record system. A more sophisticated and relatively inexpensive approach to career development is maintenance of an abilities and skills record system. This system should be completely voluntary and is simply an updatable file of skills, interests, and career objectives.

Leaves of absence. Another method is to grant unpaid leaves of absence to employees who wish to leave the system temporarily to try something new. This is similar to granting an internal performance probation period. The feasibility of leaves depends entirely on the organization's ability and management's willingness to deal with the resulting variability in manpower planning.

Training and education. A costlier method includes subsidizing outside formal education, developing comprehensive internal training programs, and establishing a formal assessment center. A large management corporation may intentionally take on uneconomical, small jobs with greater responsibilities in order to challenge its employees. Although this may not be feasible in a small city transit system, there are probably tasks in the organization that have both a low probability of failure and a minimal negative effect if not carried out properly, which can be assigned to potentially upwardly mobile employees, Examples include: gathering data for routine managerial reports; updating bus stop, vendor, and ridership databases; and coordinating a fund drive for a social service agency in conjunction with the transit system. The array of projects and potential candidates is limited only by management's imagination and the negotiated labor agreement.

As in all other personnel strategies, the feasibility of this effort is defined by the maturity of the system, management's success in meeting defined goals and objectives, labor-management relations, and the current turnover rate.

The Value of Employee Assistance Programs

Employee assistance programs (EAPs) are designed to help the employee on a personal rather than a professional level. Most EAPs are in the form of referral services to community-based help organizations specializing in counseling. A 1984 study showed that the most prevalent form of EAP is referral services to alcohol and drug facilities, medical facilities, mental health and social agencies, psychiatrists and psychologists, and self-help groups [11]. Only a large transit property could afford such specialists in-house, but even a small property can take advantage of community services. Given the effort put into recruiting, training, and developing employees, it makes good sense for the small transit system help maintain and enhance their value to the organization.

Employee assistance programs help the employee to take responsibility for his or her behavior, thereby reducing the negative effects of personal problems on the workplace. The program also focuses attention on problems caused by the work environment [15]. The client-counselor relationship should be a cooperative one; both individuals should work together to assess the problem and to define the proper treatment (or service). The counselor offers professional expertise in the assessment of the client's strengths, weaknesses, and needs. The client makes the final choice about whether or not to follow the course of treatment. Ongoing treatment for the identified problem(s) occurs outside the EAP after diagnosis, pretreatment, counseling, and referral [15].

The overall goal of the EAP is to reduce the incidence of terminations, disability retirements, and reduced work performance caused by employees' personal problems, including those related to alcohol and substance abuse [15]. Often this will mean offering help through supervisory or union referrals before disciplinary action is taken by the transit property. In other cases, help will be offered to employees who refer themselves for help before their problems become severe enough to affect job performance. A 1984 study found that the most common methods of getting employees to seek help are referrals of supervisors, the employee's own effort, and co-workers calling management or supervisory attention to the problem [11].

A system need not have lengthy and elaborate disciplinary processes in order to convince an employee to change. Employees can simply be made aware of the problem, be told of the consequences should it continue, be given options that might help them reach a solution, and be advised that they will be held accountable for satisfactory performance in the future.

When screening providers of EAP service, transit management should consider the following [9]:

- Reputation in the community
- Personal and organizational considerations
- Treatment orientation
- Fees
- Policy on communications with staff
- License and other qualifications

As in all other personnel matters, management should get sound legal advice before implementing any personnel program or taking action based on a perception of unsatisfactory performance.

EAPs are beneficial in cutting costs arising from low productivity, low morale, chronic absenteeism, increased accidents, and excessive use of medical and disability benefits [16]. For example, the first year of an EAP at General Motors (GM) resulted in a 40% reduction in lost time, a 60% decrease in accident benefits, and a 50% decrease in grievances. GM estimates that it received an average of $2 in benefits for every $1 spent on the program [8].

Administering EEO and Affirmative Action Programs

After the Civil Rights Act of 1964, the federal government set up administrative machinery to provide equal employment opportunities (EEO) for everyone. Employees may not be discriminated against on the basis of their creed, race, religion, or sex. In addition, through executive orders, the federal government requires many organizations to take affirmative action to avoid discrimination in the future, often demanding action to compensate protected classes of citizens for the results of past discrimination.

While it is not within the scope of this handbook to describe these programs in detail, one of the tasks of the personnel function is to administer them. Therefore, each transit system must know and comply with the applicable federal, state, and local laws and regulations. One of the first organizations management should contact is the federal Equal Employment Opportunity Commission (EEOC). The bases for assessing or developing job analyses, new employee selection criteria, promotions, job descriptions, and operating procedures can be found in "Uniform Guidelines on Employee Selection Procedures," issued by EEOC.

Administering Health and Safety Programs

Just as there has been increased federal, state, and local interest in equal employment opportunity and affirmative action, employee health and safety have recently become the subjects of governmental attention. Again, the administration of such governmental programs is the responsibility of the personnel function. One of the first organizations management should contact is the federal Occupational Safety and Health Administration (OSHA), which will help find the relevant laws and regulations, and advise as to their compliance.

Wellness education. More of American enterprise is discovering that it makes better sense to help employees stay well than to deal with illness; hence the trend toward wellness education. Compared to the expensive, reactive, traditional health insurance and sick leave plans, it is more cost-effective to take a proactive position in maintaining the health of employees. Absenteeism probably affects transit systems more adversely than it does other industries because there is a published level of service that must be met. Transit properties with paid sick leave programs are likely to pay twice for a scheduled bus-operator shift when the regular operator calls in sick: once for the sick leave benefit, and again to pay someone else to cover the shift.

Promoting wellness can take many forms, including: stop-smoking clinics, stress management seminars, and health maintenance organizations. Some systems have set up physical fitness facilities on the property to give employees an outlet for stress and frustration, while promoting better physical condition and health. A person in good health is better able to handle stress and other problems of the workplace.

Safety. A good safety program is an ongoing process that seeks to minimize human and property damage through:

- Sound practices and procedures translated into an effective training program.
- Sound accident investigation procedures combined with a comprehensive database of pertinent facts.
- Routine managerial monitoring of accident trends and conditions.
- Revision of existing, or implementation of new practices and procedures in response to trends or new information.

A comprehensive safety database serves two other functions. First, under UMTA's Section 15, transit systems are required to provide information about the nature and frequency of accidents involving revenue vehicles. Second, a complete accident and claims system can be a significant aid in determining a property's casualty and liability exposure, and thus, its insurance premium.

For an example of a safety records system, refer to Reference [6] at the end of this chapter. Help in designing a practical safety program for a small transit property is available from:

Department of Transportation
Transportation Safety Institute
6500 S. MacArthur Boulevard
Oklahoma City, Oklahoma 73125

Bus roadeos. The bus roadeo, which is designed to assess the skills of top qualifying operators at various transit systems, has been cited as a means of improving driver pride and performance, and of reducing the number of accidents [2]. Similar events have also been developed at some transit properties for top qualifying maintenance personnel. To qualify for entering either of these competitions, an employee usually must meet certain criteria. For drivers, a major criterion is to have no chargeable accidents during a previously defined time period, usually a year.

Getting the Job Done: The Mystery of Motivation

Considerable research has been done on the effectiveness of compensation on employee productivity. Can a transit system elicit anything from an employee other than a fixed level of output? If so, then how, without having the employee adjust output in another area? If not, then how can management expect any form of productivity gain? What motivates employees? Is it only money? Are productivity gains possible?

Persons coming to maturity in the 1930s, 1940s, and 1950s were strongly influenced by the Protestant work ethic and were willing to work under a top-down, order-oriented management style. By the 1960s, the transit work force had changed to one that was better educated and which, thanks to Affirmative Action programs, included Blacks, Hispanics, and women. Conflict often arose when older employees became supervisors and managers and found that the order-oriented style of management simply did not work [13]. Because the values and work ethics of the several generations were markedly different, a clash was inevitable. Funding restraints of the late 1970s and early 1980s brought an end to the "growth" mode. Productivity and morale declined while absenteeism and other problems increased. The managerial style of the older employee was not fit to deal with those circumstances effectively.

In an attempt to understand this dilemma, the Metropolitan Transit Commission in Minneapolis, St. Paul, undertook a study which understand the dilemma revealed that morale of supervisory and nonsupervisory personnel was generally low [13]. Within the supervisory group, pay was not a significant problem. The problem, derived from the top-down communication flow and the perceived lack of participation in the decision making process. Additional concerns of supervisors were the lack of feedback on their performance, their inability to deal with poor performers, and management's failure to back them up in dealing with inadequate employee performance. What supervisors seemed to lack, and desire, was training in communication and other "people" skills. Moreover, older-generation supervisors tended to take the success, or failure, of the organization personally.

The nonsupervisory group felt that they did not receive enough positive recognition and, instead, got only negative feedback from their direct supervisors. Other concerns included the frustration with the top-down communication flow, the lack of adequate supplies, equipment, and facilities to do the job well and, surprisingly, management's inadequate dealings with poor performers. The key conclusion drawn from the nonsupervisory group was that they wanted supervisors to motivate them and were unsatisfied with what was currently being done.

The most frustrating conclusion of the study was that supervisors desired to become more skilled in communication and in dealing with people, whereas employees desired to be motivated by their supervisors--leaving no apparent way to bridge the gap. Accordingly, training programs for managers and supervisors were recommended. Supervisory training was to include such topics as praise and recognition, effective disciplinary procedures, and interpersonal communications. Management training was to include planning, setting objectives, effective performance appraisals, and executive decision making. For nonsupervisors, two kinds of participative management programs were recommended: one to improve the quality of work life and performance, and a second to enhance interdepartmental, as well as bottom-up, communication.

An awards program that would balance outstanding performance with the penalty system was also recommended. The study found that rank and file employees wanted incentive programs to be located at the work site and to be primarily in the hands of their foremen and supervisors. In this way, there could be immediate, positive reinforcement. Several incentives were developed that included cash awards based on attendance and customer commendations [13].

Incentives in General

Although public transit has come a long way in recognizing the value of incentives, there is still room for improvement in timing the reward to coincide with the desired behavior. Three common incentives, along with advantages and disadvantages, follow [1]:

1. Annual percentage pay increase or merit pay if performance standards are met.

   - Advantage: appropriate behavior is rewarded.

   - Disadvantage: reward not immediate. Should performance decline after the award, the employee is actually being rewarded for poor performance, in the form of a higher paycheck.

2. Cash in a percentage of accumulated sick leave after a specified period of time.

   - Advantage: rewards good attendance.

   - Disadvantage: the economical choice for the employee is to be sick.

3. Graduated lump-sum payments after each year with no rule violations.

   - Advantages: encourages desired performance, is easy to monitor and document, begins each time period with a clean record.

   - Disadvantage: performance period is too long. Should the employee be disqualified early in the period, there is no incentive to attempt improvement during the rest of the year.

To be meaningful, incentive programs must be both timely and accurate in addressing behavior. They should be structured so that everyone in the targeted classification can compete. For the program to have credibility, desired performance must be clearly defined, easily measured, and directly related to operational objectives. Appendix 6E presents three incentive plans, one each for bus operators, mechanics, and support staff.

The Recent Revolution: Participative Management

Traditional line-and-staff organizational structures are beginning to give way to the newer participative style of management. Participative management stresses "we" instead of "us vs. them." Various forms of participative management are being applied in medium and larger sized transit systems, which are adaptable to small transit properties. The theory is that performance is optimized when employees have a meaningful stake in the outcome of their efforts.

A study done at the University of North Florida, published in June 1985, found that several forms of participative management or labor-management cooperation were being used at seven transit systems chosen for the project. Most of the section is taken directly from this report [15]. The study examined:

- The opportunities and problems which cooperative ventures offer.
- What conditions must be present for successful cooperative interactions.
- What transit managements and unions can accomplish through cooperation.
- Solutions and techniques which will tend to maximize the potential for success of cooperation.

Common participative management initiatives were grouped into four categories:

1. Employee input programs
    - quality circles
    - labor-management boards and committees
2. Safety programs
    - accident review boards
    - employee assistance programs

3. Performance incentive programs

   - attendance based
   - productivity based

4. Training

The study found that one essential ingredient in cooperative efforts was a training program in problem solving. Common training topics included: brainstorming, graph and chart construction, basic cause-and-effect analysis, process cause-and-effect analysis, and presentation skills. Common problems with cooperative efforts included: lack of commitment by participants, lack of clearly defined problems, and intragroup difficulties.

The study resulted in three major conclusions [15]. First, the line between labor-management cooperation and the labor agreement is thin. Therefore, precautions must be taken to ensure that cooperative activities will not disrupt the labor organization or the labor agreement. Second, there is a direct relationship between mutually successful collective bargaining efforts and mutually successful labor-management cooperative efforts. Third, each program is unique; no two are exactly alike.

Labor Relations

Negotiating and Implementing a Labor Contract

Although labor relations is too comprehensive a topic to deal with effectively in a small section of this handbook, it is useful to point out some interesting recent trends in negotiating and implementing labor contracts. Preparing for negotiations and deciding priorities are essential to the successful negotiation of a labor contract. Gaining useful contract provisions, in terms of resources and objectives, is a necessity.

The recent trend has been the development of productivity-related labor contracts that are based on an emerging labor-management realization that labor, as well as management, must play a significant role in maintaining the competitiveness of the organization. Although most efficiency and incentive plans are currently based on attendance, there are several interesting plans based on performance or proficiency that include:

- Bonuses based on systemwide on-time performance

- Bonuses based on miles between road calls

- Bonuses based on accidents per 100,000 vehicle miles

- Hourly pay increases based on ridership goals

Other examples include [10]:

- Wages for service workers related to the number of buses fueled and cleaned

- Mechanics' wages related to the percentage of the fleet available for service

- Use of part-time operators in peak periods

- Operators' wages related to the farebox recovery ratio

- Mechanics' wages related to miles between road calls

- Cash incentives for good safety and attendance records

The American Public Transit Association (APTA) publishes an excellent guide: "Preparing for Negotiations, Implementing the Contract, and Contract Administration," which recognizes that despite recent trends found in contracts and provisions, each system will want to enter into an agreement and, subsequently, progress at its own pace [4]. It suggests step-by-step directions for techniques which may be used to: (1) prepare for collective bargaining, (2) implement the labor contract, and (3) administer the labor contract.

Grievance-Arbitration Proceedings

Assuming that labor and management have reached mutual agreement it is unrealistic to assume that such agreement can address all unforeseen circumstances that might arise within its duration. Recognizing this, the grievance-arbitration process prescribes a systematic approach for resolving conflicts. APTA publishes a handbook entitled, "The Grievance-Arbitration Process," which is an excellent guide for managerial personnel involved in the process [3]. The APTA handbook includes: an introduction to the process, grievance-arbitration administration, the grievance process, the arbitration process, and results of the process.

The grievance process is the prescribed manner in which a member of the labor force, who feels wronged by a managerial policy or action, appeals to management for an in-depth review of his or her claim. There are usually three or four levels of appeal in the process depending on what was agreed to in the labor contract. A typical process is shown in Figure 6.4. This process is also meant to serve as a substitute for court litigation. Unfortunately the process is sometimes used for political purposes, such as posturing before contract negotiations.

APTA also provides its members with an ongoing summary of transit related grievance-arbitration proceedings. Again, as in all personnel matters, be sure to get sound legal advice before taking action.

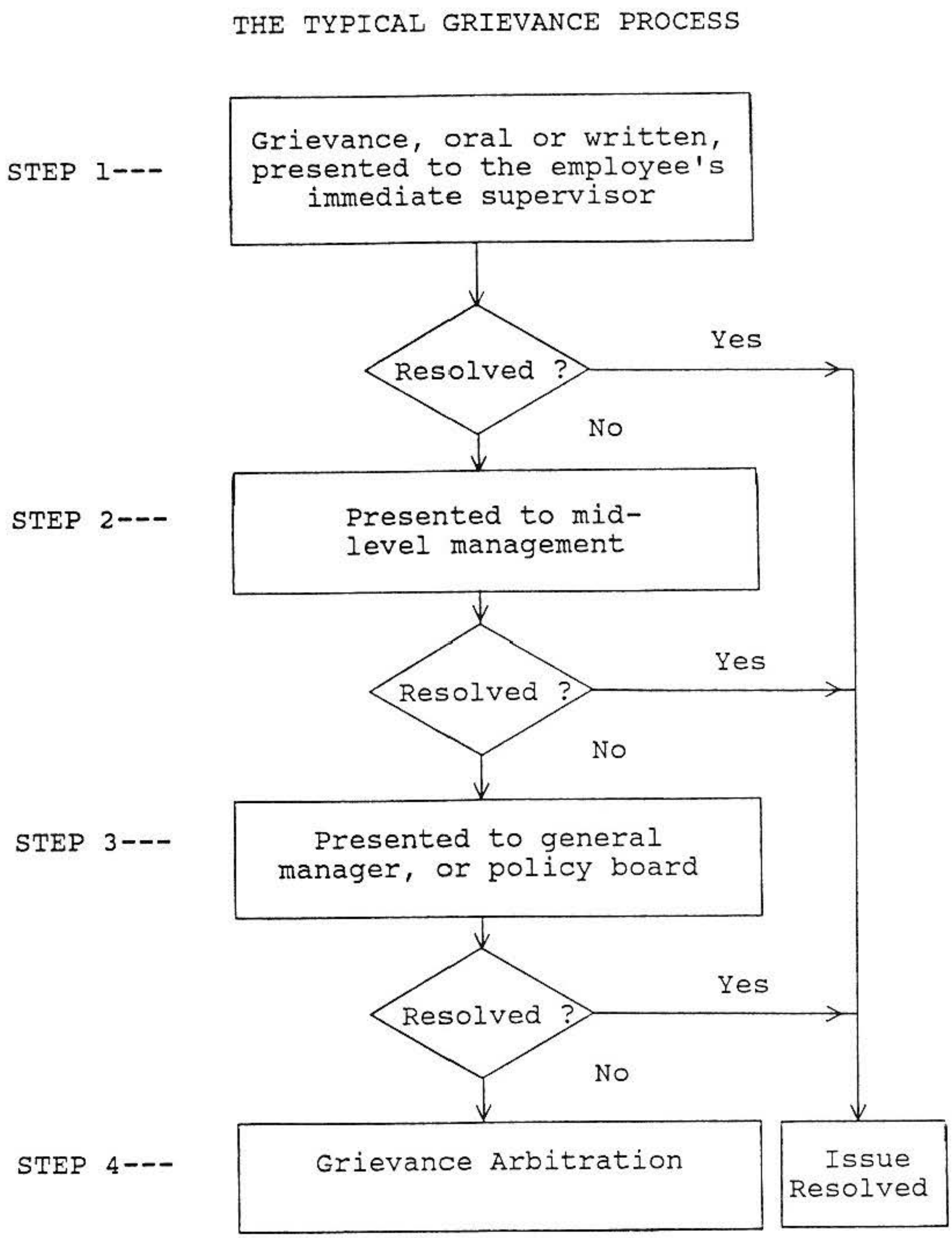

FIGURE 6.4 The Typical Grievance Process
Source: [3]

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APPENDIX 6A

DETERMINING BUS OPERATOR NEEDS

This appendix presents two simple bus operator forecasting techniques that are sensitive to the level of service offered by the system. The first example requires more detailed input than the second example, which is based on a bus-to-operator ratio.

Example 1

Assumptions

1. The system has 50 employees who are (or will be) bus operators at the start of the planning period.

2. There is a 5% operator termination rate based on deaths, promotions, transfers, firings, and voluntary terminations.

3. Other operators will retire during this period; these figures can be obtained directly from the employee files each year.

4. Every vacant position will be filled, in addition to any new position that may be necessary.

5. Over the next two years, there will be a 10% growth in service.

Calculations

A rough estimate of the number of operators needed to cover the schedule is calculated using revenue-vehicle hours, plus a factor of 20% for check-in and check-out time, miss-outs, vacations, and so on, then dividing by 40 hours per week. In this example, there are 86,684 revenue-vehicle-hours of service in the first year, or 1,667 hours per week. Therefore:

1,667 hours + 20% = 2,000 hours
2,000 hours/40 hours per week = 50 bus operators

The number of bus operators needed to fill both turnover and new positions also can be estimated assuming a 10% rate of growth in service over the next three years, with a 5% termination rate and known retirement rate. Table 6A.1 shows that a total of 28 turnovers and 17 new positions will have to be filled during the planning period. This information is valuable in developing year-to-year operating budgets and identifying annual recruitment, selection, orientation, and training needs.

TABLE 6A.1 Personnel Planning: Operators Needed

	1987	1988	1989	1990	Totals
Level of Service:					
Revenue Vehicle hrs./wk.	1,667	1,834	2,017	2,219	
Operators					
Current Number (a)	50	55	61	67	
Losses					
Terminations (5%/yr)	3	3	3	3	
Retirement (known)	2	4	6	4	
Total	5	7	9	7	28
New Positions (b)	0	5	6	6	17
New Operators Needed (c)	5	12	15	13	45

(a) Number at the beginning of the planning year.

(b) Increase in revenue vehicle hrs. + 20%, divided by 40 hrs. per week.

(c) New positions + losses for the year.

Example 2

The second planning technique assumes a constant operator-to-bus ratio throughout the planning period; it does not take turnover directly into account. The number of buses needed, which is actually a surrogate of the level of service, is used to estimate the number of new bus operator positions for increases in service. The formula follows:

$$\text{Operators (after)} = \frac{\text{Operators (before)} \times \text{Buses (after)}}{\text{Buses (before)}}$$

For example, where:

current operators	=	18
current buses	=	9
new buses	=	15

Substituting: operators (after) $= \frac{18 \times 15}{9}$

$= 30$ operators

APPENDIX 6B

DEVELOPING JOB DESCRIPTIONS

The Factor Evaluation System

Although job descriptions and postings may vary substantially in format, there is a simple way of outlining the basic duties and responsibilities of a position. Once outlined, these characteristics can be shaped into whatever format is required. The federal government's Office of Personnel Management publishes a guide on writing position descriptions using what they call the Factor Evaluation System (FES) [1]. This system outlines nine factors to assess when developing position descriptions, as follows:

1. Knowledge required by the position
   - kind or nature of knowledge and skills needed
   - how the knowledge and skills are used in doing the work
2. Supervisory controls
   - how work is assigned
   - employee's responsibility for carrying out the work
   - how the work is reviewed
3. Guidelines
   - nature of the guidelines for performing the work
   - judgment needed to apply the guidelines or develop new guidelines
4. Complexity
   - nature of the assignment
   - difficulty in identifying what needs to be done
   - difficulty and ability involved in performing the work

5. Scope and effect

   - purpose of the work

   - impact of the work product or service

6. Personal contacts

   - people and conditions under which contacts are made, excluding supervisors

7. Purpose of contacts

   - reasons for contacts in factor 6

   - skill needed to accomplish work through person-to-person activities

8. Physical demands

   - nature, frequency, and intensity of physical activity

9. Work environment

   - risks and discomforts imposed by physical surroundings and the safety precautions necessary to avoid accidents or discomfort

Although it contains an excellent procedure for developing position descriptions, this technique cannot be used as a formal job analysis by itself. It can, however, supplement the process. As in all other personnel issues, be sure to get sound legal advice before taking action.

Sample Transit Job Descriptions Using the FES

Three sample job descriptions developed under the FES follow. These hypothetical descriptions are in the FES format, but the information is readily adaptable to whatever format your system, or municipality, uses.

Job Description for Bus Operators

Knowledge required. Thorough knowledge of the city of Yourtown, its bus routes, and timetables and fare structure of the Yourtown Transit System (YTS) is necessary for both the satisfactory provision of transit service and the ability to respond to customer inquiries about the city or the transit system. Upon completion of the training program, operators must demonstrate proficiency in operating each of the system's major types of vehicles in a safe, timely manner. Ability to provide a smooth, comfortable ride, in accordance with YTS published timetable, is considered a key factor in the success and future growth of the YTS.

Supervisory controls. New bus operators are expected to start at the extraboard or fill-in status. Work will be assigned either in response to anticipated operator shortages due to vacations and sick-leave, or unanticipated shortages due to sickness and miss-outs. In both situations, it is the operator's responsibility to be thoroughly familiar with the piece of work assigned, and to perform accordingly. While on call, the operator will be assigned various tasks by the dispatcher that include, but are not limited to, counting transfers, summarizing riding checks, replenishing map supplies, or whatever clerical tasks need to be done at that time. On-street work will be supervised by the road supervisor.

Guidelines. Bus operators will be responsible for operations in accordance with YTS standard operating procedures. In the absence of supervisory directives, good judgment is expected in unforeseen or emergency circumstances.

Complexity. Work involves operating a 40-foot bus (or whatever size is used by the system) in various traffic and environmental conditions, in a safe, timely manner. Most operations are routine; however, alertness must be maintained at all times so the operator can quickly recognize and effectively deal with unexpected situations. Key skills that must be mastered to ensure the desired level of YTS service include: on-street equipment troubleshooting, breaking up passenger disputes, and defensive driving.

Scope and effect. The purpose of a bus operator's work is to be the link between the YTS and the consumer of YTS's services. He or she is responsible for the delivery of a service, as stipulated in YTS's published timetable, which is considered by YTS to be a contractual agreement with the public. Satisfactory provision of this service ensures YTS's continued acceptance and growth within the community.

Personal contacts. Contacts are with other YTS employees and the general public.

Purpose of contacts. First and foremost is the provision of transit service to the consumer. This includes inquiries about the service, Yourtown, or other subjects. A favorable interaction is an important component of providing service to the consumer. Contacts with other YTS employees include: management, in communicating or clarifying operational information; and maintenance, in communicating equipment malfunctions.

Physical demands. Health and physical characteristics must be acceptable for operating a 40-foot bus in all extremes of climate. New operators must also cope effectively with the demands of work schedules that span YTS's service day and, in all likelihood, will change daily.

Work environment. Includes YTS bus routes in all types of weather during any hour that YTS service is operated. Commensurate precautions must be taken for weather, driving, and geographical neighborhoods.

Job Description for Mechanics

Knowledge required. Thorough working knowledge of the principles behind gasoline and diesel engines, hydraulic and air brake systems, electrical system troubleshooting, trends in fluid in-take and various fluid analyses is required. Knowledge and demonstrated proficiency in these areas will be used extensively in troubleshooting reported equipment defects in addition to establishing, monitoring, and adjusting preventive maintenance intervals. Knowledge of YTS's routes is a must, as is the ability to meet timetables so that immediate, on-street attention can be given when an in-service failure occurs.

Supervisory controls. Work is assigned by the shop foreman or the general manager on a priority basis designed to maximize fleet revenue-service availability. Work is limited to prescribed preventive maintenance procedures, troubleshooting and corrective actions necessary to make running repairs. Discrepancies discovered subsequent to the mechanic's previously agreed upon course of action will be brought to the immediate attention of the foreman. All work will be inspected by the foreman while recurring equipment failures will be monitored closely by the general manager.

Guidelines. All work is performed according to prescribed procedures or factory technical manuals; however, judgment must be used in remedying modified factory components. Particular care must be taken in monitoring the effectiveness of current preventive maintenance intervals.

Complexity. Other responsibilities include interpreting the results of oil analyses, maintaining accurate inventory records, and assuring adequate safety precautions while in the work environment. The mechanic makes recommendations to the foreman when unusual findings in oil samples are discovered, inventory stock-outs are apparent, or a potential safety hazard exists.

Scope and effect. Effective maintenance actions ensure the desired level of service to the consumer. Buses in good working condition, with a good appearance, are one of YTS's most effective marketing tools. The importance of the maintenance function cannot be underestimated.

Personal contacts. Contacts are predominantly with other YTS employees. Mechanics will occasionally come in contact with YTS consumers either during in-service delays or as emergency operators.

Purpose of contacts. Contact with other YTS employees includes other mechanics and bus operators. It is crucial that efficient communication take place in both circumstances. Occasionally, the mechanic will meet with salesmen in order to restock inventory.

Physical demands. Mechanics are occasionally required to lift and manipulate heavy components and supplies.

Work environment. Most work is performed in a heated garage; however, refueling and road calls will require work in varying weather extremes.

Source for Appendix 6B

[1] U.S. Office of Personnel Management, How to Write Position Descriptions Under the Factor Evaluation System, Washington, DC: Superintendent of Documents, U.S. Government Printing Office, 1979.

APPENDIX 6C

SAMPLE OF STRUCTURED INTERVIEW QUESTIONS FOR OPERATORS

The following questions show the type of questions used in structured interviews.

1. Your bus is 10 minutes late and you stop to pick up a passenger who is, subsequently, going to be late for work. Upon paying his fare the passenger remarks that, "Since this bus is late, I'm going to be late. Why aren't you on time?" He awaits your reply.

2. An intoxicated passenger gets on your bus, refuses to pay a fare, then sits down in the back of the bus. It is the rush hour and your bus is fairly crowded. What would you do?

3. A passenger, upon alighting from your bus, comments that the bus service is a value to the community and that your efforts are much appreciated. What would you do?

4. We are in the midst of an organizational transition, and some of the employees are unhappy about their jobs and are not willing to work with management during the transition. If you become the successful candidate for this position, how would you handle this situation?

5. While operating your bus, you observe an accident between two automobiles that might involve personal injury. You are operating on a tight schedule. What would you do?

APPENDIX 6D

ORIENTATION AND TRAINING: AN EXAMPLE

Orientation Program

The driver training program begins with the orientation period. During this stage, the following subjects must be thoroughly explained:

1. The history and operation of the company.
2. The chain of command within the company.
3. The union contract.
4. The probationary period.
5. The company benefit program.
6. The compensation program including wages, deductions and percentages, vacation procedure, and off days.
7. Extraboard drivers.
8. The goals of the formal training program.

A conference should be held with the trainee and management and union representatives to ensure that the trainee is thoroughly aware of his rights and responsibilities under the contract. The trainee should be told how much he will be paid during the orientation and training programs.

Training Program

After the driver has successfully completed the orientation program, formal training will be necessary regardless of previous training and experience. A driver training program should be designed to mold the happy combination of an expert salesman and a professional bus operator, as well as to instill proper attitudes. The driver training program will be divided into classroom instruction and behind-the-wheel training.

Training Instructor

For a small property, the instructor is often an experienced operator who fulfills a dual role of driver and safety supervisor. Generally, the instructor receives a differential rate of pay for training new operators. The driving instructor should have:

1. Experience, and should be well-known and respected by other drivers.

2. Excellent driving skills, with a good driving record (perfection is not necessary).

3. The attitude, appearance, and personality that the company is trying to impress on the trainees.

4. An interest in people and a desire to train new employees to be good drivers.

5. Extensive knowledge of all phases of driving and the routes, with an ability to communicate this knowledge to others.

6. An understanding of the trainee's situation.

Classroom Instruction

Oral instruction should prepare the employee for behind-the-wheel training. The instruction should include four areas.

1. Familiarization with equipment

    a. Dimensions of the bus
    b. Locations and functions of the controls
    c. Operation of doors and door-brake interlock mechanism
    d. Seat adjustment
    e. Mirrors
    f. Location and operation of emergency exit
    g. Running repairs
    h. Air conditioning

2. Safety

    a. A complete explanation of the crucial importance of safety
    b. Safety literature--audiovisual aids, handbooks, and leaflets
    c. Passenger safety
    d. Emergencies such as robberies, sudden illness of passengers and accidents
    e. General precautions, such as assisting the elderly and handicapped

3. Public relations

    a. Appearance
    b. Manners
    c. Importance of the driver
    d. Service (the product of the transit agency)
    e. Knowledge of routes, schedules, and fares
    f. Public speaking

4. Clerical procedures

    a. Pretrip inspections
    b. Defect reporting
    c. Periodic passenger counts
    d. Other miscellaneous reporting procedures

Classroom instruction, while intended to prepare the driver-trainee for behind-the-wheel training, does not end at the outset of road training. The material covered in such instruction must be emphasized continually throughout the entire training program.

Behind-the-wheel Instruction

The goals of behind-the-wheel training are:

1. To reemphasize the material presented orally.

2. To present the fundamental skills of driving to the trainee.

3. To mold a professional driver who is skillful, safe, familiar with the equipment, and aware of the importance of good public relations.

Yard driving. The initial phase of behind-the-wheel training should be conducted on the property or in a sparsely populated area. The emphasis should be on allowing the trainee to get the feel of driving. At the outset no attempt should be made to have the trainee perform skillful maneuvers or turns. Use of equipment, safety, and public relations should be reemphasized.

The next step in yard driving should be to mold a safe and skillful driver. Accordingly, skills and rules of the road are presented to the trainee after he or she develops the feel of driving. The topics to be covered include nine areas.

1. Downtown driving

2. Suburban driving

3. Highway driving

4. Boarding customers (trainees may act as passengers)

    a. Approaching the stop
    b. Pulling into a stop after negotiating a right or left turn
    c. Positioning the bus at a stop
    d. Leaving the stop

5. Fare receipts

    a. Operating the farebox
    b. Accepting fares
    c. Giving change
    d. Transfers
    e. Passes
    f. Special fares (if applicable), park 'n' ride, reduced fares for senior citizens, special promotions

6. Changing lanes

7. Turns

8. Interval between vehicles

9. Accidents

    a. Frequent causes
    b. Prevention
    c. Procedure in case of an accident
        (1) passengers
        (2) property

Driving in traffic. After the trainee has acquired the basic driving skills, the next phase of behind-the-wheel training is to operate the vehicle in downtown areas, suburbs, and on highways. The objectives of city driving are to allow the trainee to practice and demonstrate the skills acquired in yard driving.

This phase of the training program should be conducted in two stages:

1. Nonrevenue service, where city driving is merely an extended form of off-street training; this would include following routes and practicing operation along particularly difficult route segments

2. Revenue service with instructor and experienced operators

    a. Observing the experienced operator driving and dealing with the public
    b. Practicing with the instructor present

APPENDIX 6E

EXAMPLES OF

EVALUATION AND FINANCIAL INCENTIVE PLANS

BUS OPERATOR: FINANCIAL INCENTIVE PLAN

Introduction

The purpose of this plan is to reward bus operators monetarily for performance above and beyond what is routinely expected in the workplace. In the continuation of the spirit of "catching people doing something right," and the reality of the constraints on management's ability to "catch" all employees each time their efforts warrant recognition, this plan assumes exemplary performance unless there are indications to the contrary.

This financial incentive plan awards employees 100 points for basic performance, additional points for bonus performance, and applies a penalty against the bonus points for performance that falls below expectations. At the end of the year, employees receive a cash bonus based on their total cumulative points.

Guidelines

Performance Period

The performance period for the annual financial incentive program is January 1 through December 31. At the beginning of the performance period, all employees who are not on probation will start with the full 100 points.

Special Conditions

1. Bonuses for new employees who are not on probation will be calculated in the same manner as for existing employees because the key factor in determining the bonus amount is each employee's gross earnings.

2. Any employee who is terminated during the performance period is automatically ineligible for a bonus payment.

3. Any employee who resigns during the performance period is automatically ineligible for a bonus payment.

Monetary Constraints

Bonuses for individual employees are limited to 3% of their annual gross earnings during the performance period. The total amount to be distributed throughout the transit system is limited to $10,000.

Scoring System

Guidelines are suggested for the four basic performance categories, the bonuses, and the penalties applied against the individual's bonus when performance falls below what is expected. (See Figure 6E.1 for a scoring form for bus operators.)

Basic Performance

Basic performance consists of attendance, punctuality, adherence to procedures, and professionalism. A detailed breakdown of point allocations for the four basic performance categories follows.

Attendance (40 points)

No Sick Days	40
First Occurrence	40
Second Occurrence	-10
Third Occurrence	-20
Fourth Occurrence	-30

Note: this progression is cumulative and continues with no lower bound, as long as the employee has sick time to take.
Example: three occurrences = -30 points; net = 10
six occurrences = -150 points

Punctuality (9 points)

No Late Arrivals	9	
One Late Arrival	9	
Each Late Arrival Thereafter	-3	(No lower limit.)

Example: four late arrivals = -12 points

Adherence to Procedures (33 points)

Interaction with the Public

No valid complaints	8	
One valid complaint	-2	
Each valid complaint thereafter	-2	(No lower limit.)

Example: five valid complaints = -10 points, subject to discharge.

Operational Safety

No chargeable or preventable accidents	10	
No chargeable, one preventable accident	-5	
One chargeable accident	-10	
No chargeable, two preventable accidents	-10	

Rule Compliance

No violations	15	
One violation	15	
Each violation thereafter	-5	(No lower limit.)

Professionalism (18 points)

Satisfactory Observation Rides	12	Measured semi-annually. Scale: 0-6 points, depending on skill level.
Attitude and Spirit of Cooperation	4	Measured semi-annually. Scale: 0-2 points, based on management judgment.
Neatness and Appearance	2	Measured annually. Scale: 0-2 points, based on management judgment.

Bonus Performance

Safety Recommendations	1	Awarded for each implementable suggestion. (No limit.)
Acceptance of Extra Work	1	Awarded for each acceptance. (Limit: 10 points.)

Penalties

Two Miss-outs	No bonus for the year.	
Sick Leave Abuse	-50	Deducted for each occurrence.

FIGURE 6E.1

INDIVIDUAL POINT SCORES: BUS OPERATOR

	Possible Points	Actual Score
Basic Performance		
1. Attendance	40	________
2. Punctuality	9	________
3. Adherence to Procedures	33	________
4. Professionalism	18	________
5. Base Score (sum of lines 1-4)		________
Bonus Performance		
6. Implementable Safety Suggestions	no limit	________
7. Acceptance of Extra Work	10	________
8. Bonus Score (line 6 + line 7)		________
9. Total Incentive Points (line 5 + line 8)		________
Penalties		
10. Deductions or Loss of Bonus		________
11. Net Incentive Points (line 9 - line 10)		________
12. Bonus Percentage (line 11/100)		________
13. Base Bonus (3% of gross earnings)		________
14. Actual Bonus (line 12 x line 13)*		________

* Subject to the system's bonus pool limit of $10,000.

MAINTENANCE: FINANCIAL INCENTIVE PLAN

Introduction

The purpose of this plan is to reward employees in maintenance classifications for performance above and beyond what is routinely expected. In the continuation of the spirit of "catching people doing something right," this plan outlines the conditions for exemplary performance as well as sanctions when such performance is compromised.

This financial incentive plan awards employees points for basic performance, additional points for bonus performance, and applies a penalty against the bonus points for performance that falls below expectations. At the end of the year, employees receive a cash bonus based on their total cumulative points.

Guidelines

Performance Period

The performance period for this program is January 1 through December 31. At the beginning of the performance period, all employees who are not on probation will start with the full number of points for the period. Should performance comply with the following guidelines, the employee will automatically be eligible for the full bonus amount at the end of the period.

Special Conditions

1. Bonuses for new employees who are not on probation shall be calculated in the same manner as for existing employees because the key factor in determining the bonus amount is each employee's gross earnings.

2. Any employee who is terminated during the performance period is automatically ineligible for a bonus payment.

3. Any employee who resigns during the performance period is automatically ineligible for a bonus payment.

4. Sanctions applied to these guidelines do not limit the employee's liability with respect to the regular disciplinary process.

Monetary Constraints

Bonuses for individual employees are based on 3% of their annual gross earnings. The total amount to be distributed throughout the transit system is limited to $10,000.

All employees achieve their maximum potential bonus; the actual bonus amount will be prorated within the constraints of the total amount of money available for the period.

Scoring System

Guidelines are suggested for the four basic performance categories, the bonuses, and the penalties applied against an individual's bonus when performance fails below what is expected. (See Figure 6E.2 for a scoring form for maintenance employees.)

Basic Performance

Basic performance consists of attendance, punctuality, adherence to procedures, and professionalism. An explanation of the point allocations for the four basic performance categories follows.

Attendance (40 points). Exemplary performance in this category means that the employee reports to work for all scheduled shifts, including those voluntarily accepted as "extra work." The commitment to extra work is established the moment the employee is offered a shift, having signed up for availability for extra work.

Each employee can use one day of sick leave in each period and remain eligible for the maximum number of points.

Sick leave use beyond one occurrence in each period reduces the employee's score from its maximum as follows:

Second Occurrence	-10 points
Third Occurrence	-20
Fourth Occurrence	-30

Sick leave use during a period continues to work against the employees bonus with no lower bound, and is subject to the disciplinary process with respect to use and availability of time to use. Example: Three occurrences = -30 points
Six occurrences = -150 points

Punctuality (9 points). Exemplary performance in this category is similar to attendance in that the employee is expected to arrive at all regularly scheduled, or voluntarily accepted assignments, within the three-minute grace period as stated in the Personnel Manual.

Each employee may have one late arrival in each period and remain eligible for the maximum number of points.

Tardiness beyond the one occurrence in each period reduces the employee's score from the maximum as follows:

- Each late arrival in the period will "cost" the employee 3 points, with no lower limit. Example: four late arrivals = -12 points

Adherence to procedures (33 points). Exemplary performance in adhering to procedures means that the employee routinely follows existing procedures plus those developed and implemented by management over time. The maximum point score of 33 points includes:

- Consistency in following established procedures (23 points).

- Vehicle safety in the shop and on the street (10 points).

These guidelines allow for one procedural violation, provided the violation does not jeopardize the safety of either personnel or equipment.

Reductions in the 23-point maximum score for consistency in following maintenance procedures are as follows:

- The second, and each procedural violation thereafter will cost the employee 5 points. Example: six procedural violations = -25 points, subject to discharge.

Reductions in 10-point maximum score for shop and vehicle safety are as follows:

- No chargeable accidents; one preventable accident = 5 points.
- One chargeable accident = -10 points.
- No chargeable; two preventable accidents = -10 points.

Professionalism (18 points). Although there are varying degrees of responsibility throughout each of the classes, the underlying objective of maintenance efforts is the same: ensuring an adequate, reliable, safe, and comfortable fleet for daily operations. The key component of the professionalism category is the "fleet stability" index, which is based on a monthly availability-reliability composite calculated as follows:

$$A \times R = \text{Composite}$$

where: A = overall fleet availability

R = overall fleet reliability

A threshold value of .84 is established, which allows for one service failure and one unavailable vehicle each day. Maintenance employees are awarded 1 point each month the index is above the threshold value, and are penalized 1 point for each month that it falls below.

Employees are awarded 4 points in each period that they (in the opinion of management) demonstrate an attitude and spirit of cooperation that is consistent with the system's mission of providing safe, timely, courteous, and efficient public transportation service.

Employees are awarded 2 points in each period that they consistently present an appearance in accordance with the image that management has defined as appropriate.

Bonus Performance

Implementable Safety Suggestions	1	Awarded for each. (No limit.)
Acceptance of Extra Work	1	Awarded for each. (Limit: 10 points.)
Outstanding Situational Performance	5	(Limit: one documented, verifiable occurence.) Subject to Board approval.
Validated, Verifiable Commendations	1	Awarded for each. (Limit: 5 points.)

Penalties

Sick Leave Abuse	-50	Deducted for each occurrence.
Failure to Accept Extra Work (when signed into the extra work book)	-1	Deducted for each occurrence.
Two Miss-outs		No bonus for the year.

FIGURE 6E.2

INDIVIDUAL POINT SCORES: MAINTENANCE EMPLOYEES

		Possible Points	Actual Score
Basic Performance			
1.	Attendance	40	______
2.	Punctuality	9	______
3.	Adherence to Procedures	33	______
4.	Professionalism	18	______
5.	Base Score (sum of lines 1-4)		______
Bonus Performance			
6.	Implementable Safety Suggestions	no limit	______
7.	Acceptance of Extra Work	10	______
8.	Outstanding Situational Performance	5	______
9.	Bonus Score (line 6 + line 7 + line 8)		______
10.	Total Incentive Points (line 5 + line 9)		______
Penalties			
11.	Deductions or Loss of Bonus		______
12.	Net Incentive Points (line 10 - line 11)		______
13.	Bonus Percentage (line 12/100)		______
14.	Base Bonus (3% of gross earnings)		______
15.	Actual Bonus (line 13 x line 14)*		______

*Subject to the system's bonus pool limit $10,000.

SUPPORT STAFF: FINANCIAL INCENTIVE PLAN

Introduction

The purpose of this plan is to reward support staff for performance above and beyond what is routinely expected. Because each member of the support staff has a unique role, these criteria are more subjective than those used for operating and maintenance employees, yet they are designed to enable an evaluation of the individual staff member's participation in the achievement of overall system objectives.

The base score for support staff employees is 50 points, which assumes an "above expectations" rating in each of the 10 categories. In effect, ratings in the "excellent" category act as bonus points to the support staff.

The evaluation and financial incentive plan is designed to reward employees for efforts above and beyond what is expected. Consequently, the rating of "fully satisfactory" in each of the 10 categories would yield an overall score of 0, in which case the employee would receive no bonus.

Category Breakdowns

Attitude

Excellent	consistently maintains a positive attitude regardless of the nature of the assignment
Above expectation	maintains a positive attitude in most assignments
Fully satisfactory	maintains a satisfactory attitude in his approach to routine tasks
Needs improvement	demonstrates a satisfactory attitude, yet lacks consistency
Unsatisfactory	maintains consistently unacceptable attitude

Interaction with Management

Excellent	consistently excels in the accomplishment of management directives
Above expectation	demonstrates accomplishment of management directives in most assignments
Fully satisfactory	interaction is sufficient given the employee's capabilities
Needs improvement	demonstrates that satisfactory interaction is possible, yet lacks consistency
Unsatisfactory	demonstrates that satisfactory interaction is not possible

Interaction with Co-workers

Excellent	consistently excels in interactions with other employees
Above expectation	can interact with most employees in most situations
Fully satisfactory	interaction is sufficient on a regular basis
Needs improvement	demonstrates conflicting interactions in certain instances
Unsatisfactory	consistently demonstrates unsatisfactory interactions with co-workers

Initiative

Excellent	consistently excels in showing initiative productively
Above expectation	demonstrates initiative productively in certain circumstances

Fully satisfactory	demonstrates sufficient initiative for the job
Needs improvement	is capable of initiative under limited circumstances
Unsatisfactory	fails to demonstrate satisfactory initiative on a routine basis

Marketing Skills

Excellent	consistentlly demonstrates productivity improvements in the delivery of services
Above expectations	significantly contributes to the delivery of services
Fully satisfactory	shows consistent efforts in maintaining the delivery of system's services
Needs improvement	demonstrates deficiencies in the effort to maintain the delivery of services
Unsatisfactory	consistently demonstrates deficiencies in perpetuating the delivery of services

Job Knowledge

Excellent	is consistently productive in developing and performing on the job
Above expectation	is able to enhance the performance and productivity of the job in certain circumstances
Fully satisfactory	consistently demonstrates performance satisfactory to the job
Needs improvement	unable to perform the job satisfactorily due to certain knowledge limitations
Unsatisfactory	consistently unable to grasp the knowledge necessary in performing the job satisfactorily

Automation Skills

Excellent	consistently demonstrates proficiency, productivity, and maintenance of various forms of administrative automation
Above expectation	demonstrates satisfactory proficiency, productivity, and maintenance in limited forms of administrative automation
Fully Satisfactory	demonstrates proficiency in most forms of administrative automation
Unsatisfactory	demonstrates proficiency in a limited variety of office automation

Dependability

Excellent	consistently dependable in the performance of all tasks related to the job
Above expectation	consistently dependable in the performance of tasks that the employee is strong in
Fully satisfactory	dependable in the performance of most tasks related to the job
Needs improvement	shows inconsistency in the thoroughness of basic performance
Unsatisfactory	consistently demonstrates deficiencies in thoroughness of basic performance

Punctuality

Excellent	is consistently punctual regardless of the workload and nonjob-related circumstances

Above expectation	consistently punctual regardless of workload but sometimes varies due to nonjob-related circumstances
Fully satisfactory	demonstrates consistent punctuality dependant on workload and nonjob-related circumstances
Needs improvement	is consistently punctual in most instances, subject to nonjob-related circumstances
Unsatisfactory	inconsistent punctuality which often results in disruption to overall productivity

Neatness and Appearance

Excellent	maintains a pleasant appearance, consistent with a desirable public image
Above expectation	adapts appearance to the immediate objective
Fully satisfactory	consistently maintains a neat, well-kept appearance
Needs improvement	maintains a neat, well-kept appearance most of the time
Unsatisfactory	consistently maintains an appearance which is undesirable to our public image

	Scoring
Excellent	+10
Above expectation	+ 5
Fully satisfactory	0
Needs improvement	- 5
Unsatisfactory	-10

(See Figure 6E.3 for a scoring form for support staff.)

FIGURE 6E.3

PERFORMANCE EVALUATION CRITERIA: SUPPORT STAFF

Employee Name____________________ Job Title____________________

Category	Score	Comments
1. Attitude	_____	____________
2. Interaction with Mgmt.	_____	____________
3. Interaction with Co-workers	_____	____________
4. Initiative	_____	____________
5. Marketing Skills	_____	____________
6. Job Knowledge	_____	____________
7. Automation Skills	_____	____________
8. Dependability	_____	____________
9. Punctuality	_____	____________
10. Neatness & Appearance	_____	____________
11. Net Incentive Points	_____	
12. Bonus Percentage (line 11/50)	_____	
13. Base Bonus (3% of gross earnings)	_____	
14. Actual Bonus* (line 12 x 13)	_____	

* Subject to the systemwide bonus pool limit of $10,000.

(continued)

FIGURE 6E.3 Continued.

SUPPORT STAFF PERFORMANCE EVALUATION CRITERIA - COMMENTS

1. Significant accomplishments since the last evaluation:

2. Strengths:

3. Weaknesses:

4. Goals for the next 12 months:

5. What actions will be taken to help the employee achieve the goals listed above?

Reviewer's Comments:

Employee's Comments:

Reviewer's Signature ______________________ Date ______________

Employee's Signature ______________________ Date ______________

CHAPTER 7

THE MAINTENANCE PROGRAM

Introduction

For most transit properties, especially those of small and medium size, maintenance consists simply of upkeep of facilities and equipment. In the best properties, regardless of size, a more formalized maintenance program is used as a technique to reduce expenses. It has been found that the number of breakdowns can be reduced by scheduling certain types of routine maintenance. This type of maintenance is known generally as proactive or preventive maintenance. Maintenance performed upon failure is referred to as reactive or running maintenance. A preventive maintenance program is implemented because it costs the transit system less than running maintenance.

The goal of maintenance in the transit industry is to preserve a systematic pattern of transit operation that is as free from interruption as possible. This effort is critical in the transit business because schedules for personnel and equipment have been set to run on a strict timetable to meet the needs of the public. Breakdowns in equipment may result in a failure to live up to this timetable or else may depend on a considerable oversupply of equipment on hand to handle contingencies. The result is either a lack of dependability in serving the public or an investment in underused equipment. The chances of wasting driver time are also increased when equipment maintenance is of low standard and reliability.

A second major aspect of the maintenance program is maintaining the maintenance facility itself. The orderliness of work areas, the proper functioning of accessories and equipment, the accessibility of tools and supplies are all crucial to running a smooth, safe maintenance program. Clearly, the morale of maintenance employees is affected by the condition of their work area. Facility maintenance can easily be incorporated into the maintenance program through simple procedures, done on a routine basis. For the purposes of this handbook, vehicle maintenance will be highlighted.

The Need for Maintenance

A city transit bus operates in one of the harshest environments any vehicle could operate. Maintaining buses means constantly assessing the vehicle's components in conjunction with conditions, that over time, will eventually disable them. This includes: striving to get maximum brake life with constant stop-and-start applications; maximizing fuel economy under the same conditions; providing air conditioning, and heat, with doors opening and closing; monitoring structural integrity while operating over streets in various states of disrepair; and so on. A good maintenance program attempts to maximize the probability of a vehicle's successful completion of its assigned trip, while minimizing the chance of a service failure or any other discrepancy that would render the vehicle unavailable for service.

Developing and Managing a Maintenance Program

Goals and Objectives

The maintenance program for small-scale mass transit systems described here is based on findings from visits to a number of small- and medium-sized properties and from a close association with small transit properties over a number of years. In setting up a maintenance program, the first step is to establish goals and objectives of the program.

The ideal preventive maintenance program would prevent any breakdown whatsoever. However, the expenses involved in such a program would be prohibitive. If zero breakdowns is not a goal, then the optimal number of breakdowns cannot be specified. In a small transit agency, one breakdown per day would be too many; whereas, in a very large transit system a rate that low probably could not be achieved. Transit properties should aim for a range of breakdowns-per-time-period that does not lose ridership or force the system to invest in additional equipment and/or lead to excess operating expense. In most cases, ridership will be affected first. Although minimizing costs is one goal of preventive maintenance, these costs include opportunity costs of lost ridership. If management minimizes the costs of the maintenance program, while the opportunity costs associated with lost ridership increase, then costs have not been minimized at all.

Safety is a paramount goal of any maintenance program. At a minimum, the preventive maintenance program should ensure that all vehicles are able to pass a rigid safety inspection at any time, by any agency--management or regulatory. Indeed, this goal should be made part of the program with surprise inspections by management as a quality check.

From a marketing standpoint, the objectives should be set so that the passenger can at least expect to ride on a clean vehicle, with an interior that is not an eyesore. The seats should be in good repair. The windows should not be cracked. Riders should expect heat in the winter and air-conditioning in the summer; vehicles should not be dispatched or continue to operate beyond the end of any run if these components are not operating properly. Riders should also have a high expectation that service will not be delayed or interrupted because of equipment breakdowns.

Objectives could be put in terms of so many breakdowns or serious failures for every 10,000 miles of revenue service offered. Another method would be to use breakdowns per day, week, or month, without regard to the amount of service offered. For an operating transit property, there might be an existing breakdown level of perhaps three breakdowns or service failures per 10,000 miles. An objective of no more than one service failure per 10,000 miles of revenue-service might be established. The causes of breakdowns would then be analyzed to determine the major reasons for failure, and steps would be taken to prevent those failures in the future.

The definition of service failure is closely related to the system's overall service objectives. For example service failure might be defined as a breakdown of equipment such as engine failure, transmission failure, or a flat tire. Stricter definitions might include air-conditioning failure, broken windows, water leaks, or interior lighting failures. Some well-managed transit systems with high standards may pull a vehicle out of service for as small a problem as graffiti on an interior advertisement.

Personnel

The average annual number of vehicle miles and vehicle hours, per mechanic, for three different system sizes is shown below [2].

Fleet Size	Vehicle Miles	Vehicle Hours
under 25	123,476	11,564
25-49	168,819	14,022
50-99	150,105	11,106

A maintenance manpower planning methodology, which takes into account differences in fleet size, fleet composition, topography, climate, and fleet use, is documented in Source 4 at the end of the chapter. Another source for estimating different classifications of employees is actually a worksheet that assists in personnel and facility planning (refer to Source 8 at the end of the chapter).

Good maintenance candidates can be found in existing heavy equipment and fleet maintenance operations. Excellent sources for apprentices are local vocational and high schools offering automotive courses.

Maintenance Training

Maintenance training is crucial to the small city transit system due to the operating environment coupled with the variety in the types of equipment that the system is likely to have. Training becomes even more important when the system receives new equipment which almost always involves changes and "improvements" to subsystems and component applications. Furthermore, as recruitment of qualified, experienced labor becomes harder, the need for training increases [7].

Four options for training follow:

1. Developing in-house training (classroom environment, manuals).
2. Sending employees to outside institutions for instruction (local technical schools, other transit systems, or participating manufacturers).
3. On-the-job training through formal apprenticeship.
4. On-the-job training with essentially no formal structure.

These four options are listed in order of effectiveness and resource requirements. Although the fourth option is least desirable, it recognizes that some transit agencies, especially the smaller ones, lack the resources to invest in the overhead of training programs [7].

Facilities

A discussion of facilities and equipment at the small city transit system must be based on goals and objectives developed by the policy board. The amount of contracted-out maintenance work and work done inside, coupled with the level of managerial control over the process, become guidelines for internal facility and equipment needs.

Small city transit operators averaged one light maintenance facility in 1983 [10]. A rule of thumb for the size of the facility follows [1].

$$\text{Total Square Feet} = (1{,}400 \times M) + 564$$

Where M = annual vehicle miles in 100,000s

(Note: Total square feet excludes service and storage lanes.)

For example, a system that runs approximately 100 vehicles in maximum scheduled peak service will generate approximately 4,000,000 vehicle miles per year. Therefore, total square feet for the actual maintenance area = (1,400 x 40) + 564 or 56,564 square feet. Storage area is simply a direct function of the number and size of the vehicles to be stored.

Various tasks are performed at the maintenance facility including:

- Heavy repairs
- Engine overhauls
- Unit rebuilding
- Major body repairs
- Painting
- Upholstering
- Route sign preparation
- Bus stop sign manufacturing
- Brake relining
- Brake drum turning

What are the facility needs of a typical transit property? Specifically, how do these needs compare with the facilities feasible for the small-scale public transit system? The basic functional areas in an all-around maintenance facility are described below [3].

These facilities cover the typical maintenance functions for a public transit property. Managers may have some difficulty applying these functions to small-scale transit operations, particularly when they compare facility cost and need. Because all functions must be performed, some work might have to be contracted out if it cannot be done in-house.

Running repair area. Diagnostic work, major and minor repairs, excluding component rebuild and paint and body work, are performed in the running repair area. Stalls are usually the back-in type due to the location of bus power plants in the rear of coaches. Mechanics will need easy access to the materials handling area in order to obtain parts. Maintenance personnel working in running repair will usually have to walk the entire site; they frequently walk to the bus parking area to pick up a specific bus and from that area after returning a bus on which repairs have been completed. Hoists or pits are usually located in the running repair area.

Inspection and campaign lanes. Typically, inspectors drive buses from the scheduled repair section of the bus parking area into the inspection bay where they perform inspection, lubrication, minor repair and parts or component replacement from floor level and from pits beneath the bus. The inspection area is usually located between materials handling and service and cleaning. Inspectors make frequent trips to materials handling to obtain parts and make occasional trips to the battery room.

It is sometimes necessary to "campaign" the entire fleet to install new systems or accessories, to correct fleet defects, or to meet safety or regulatory requirements. This activity takes place in a dedicated campaign lane to avoid disrupting routine maintenance and inspection programs. Inspections and campaigns in this area are set up in an assembly line fashion.

Service and cleaning lanes. Two different shifts usually perform two distinct activities in the service and cleaning area. The day shift cleans the interiors of the buses which is called day clean. Buses are typically scheduled through the day clean cycle every two or three weeks. During the evening shift, service and cleaning personnel drive buses from the bus parking area into the service lanes where they check and correct tire inflation, engine oil, diesel fuel, and coolant levels. They also check the level of automatic transmission fluid and, if low, send it to the parking area for maintenance work. Evening shift service personnel clean the bus floor, drive the bus through the bus washer, and return the bus to the designated area for service-ready buses, to the scheduled maintenance area, or to day-cleaning areas.

Chassis wash area. Before making an undercarriage inspection or repair, the chassis is washed. The chassis wash area is usually located near the brake shop where brake drums and wheels are removed from the bus and brought to the chassis wash by forklift for cleaning.

Brake shop. At the brake shop, brake drums are turned on a lathe, rebuilt shoes are fitted, bearings are removed from hubs and are checked, packed with grease, and replaced, and new seals are installed. As mentioned earlier, brake drum and wheel assemblies are removed from buses, taken by forklift to the chassis wash for cleaning, and then returned to the brake shop for necessary work.

Materials handling department. Parts, materials, and supplies are warehoused in the materials handling department. Here, shipments are also checked in, and the appropriate receiving documents are generated. The parts storage area usually has a window on one side to serve mechanics, and another window on the other side to serve inspectors. The parts windows are directly opposite from and in sight of each other so that one clerk can serve both windows when demand is low. The parts manual library should also be located near the parts window.

All maintenance disciplines require parts or supplies from the materials handling area. Audit and control procedures for the inventory generally restrict access to the storeroom to a few authorized mechanics and other personnel. Moving engine cradles and other large items out of the storeroom may require assistance by mechanics; however, this need can be minimized by moving heavy inventory items by forklift.

The materials handling area generally has an upper level where lightweight bulk and slow-moving items are stored. The upper level is served by some form of a freight elevator designed to carry clerks, carts, dollies, and hand trucks laden with light, bulky inventory items.

Battery room. The battery room is usually located near the materials handling and inspection areas. Parts personnel and inspectors frequently remove batteries from buses or from stock and deliver them to the battery room for charging. Equipment should include a battery charger, eyewash and safety shower and hot and cold water bibs. In addition, the room must have an exhaust and acid neutralizing drains.

Machine shop. For the very small public transit property, a complete machine shop may not be practical. Instead, much of the work may be contracted out. However, properties with 10 buses or more clearly need a machine shop with a lathe, valve grinder, and other small repair tools.

Body shop and paint shop. All but the smallest properties, which contract out these functions, have paint and body shops. Usually, if a company has between 40 and 100 buses, one bus will be in the body shop and another in the paint shop each day. At one time, paint and body shops were often combined. But recent federal regulations required that painting facilities be separated from the rest of the maintenance facility and constructed using strict, comprehensive guidelines.

Lubricant pumping room. This room is also located near the materials handling area. Barrels of chassis grease and gear oil are stored here and are connected to the lubrication drum pump system as required.

Tire storage and repair area. This area is usually run by a private tire contractor; therefore, shipments should be received, and tire work performed, here. Tires are usually stored face down and stacked eight high.

Bus tires are removed from buses when the tread thickness falls below established minimums. Tires average about 25,000 miles between regroovings, and usually can be regrooved twice before being recapped. Recapping is done at the contractor's recap outlet. Assuming an average annual bus mileage of 30,000 to 40,000 miles, every bus will receive a different set of tires at least once a year.

During peak dispatch periods, buses often arrive at the tire bay needing a quick tire change because of damage received during previous service. Inspectors also record tire condition; when it falls below established standards, buses are scheduled for tire repair or replacement. The tire room should be equipped with a compressed air outlet for a 1" air-impact wrench.

Buildings and grounds maintenance area. This area is also usually located near the materials handling area because supplies are often delivered directly here, and their receipt must be coordinated with the clerks in the receiving areas. The buildings and grounds shop must be secured and off-limits to all but those directly responsible for it because the type of equipment used in facility maintenance is quite useful elsewhere. The mechanical, electrical, and air-compressor rooms are inspected daily by the buildings and grounds personnel. Because safety is a primary concern in these areas, admittance is restricted.

Revenue retrieval/security building and fuel island. These areas are usually located inside the entrance, allowing sufficient room for entering buses to queue before having fares removed and for support vehicles to queue before refueling. Persons removing fares from fareboxes usually remain within the revenue retrieval facility.

Administration and operators building. This building is often located at the end of the property opposite from the maintenance building. It has offices for the transportation superintendent, assistant superintendent, clerical personnel, road supervisors, and operators. Before, between, and after runs, operators can read, converse, watch television, or play pool in the operator's room. The dispatch clerk monitors the activities in the operator's room and should be able to see all areas.

Personnel areas. Lunchrooms, classrooms, lockers, and showers may be located on the second floor, above the parts and office areas. The first aid room and restrooms are located on the first floor.

Maintenance administration offices. Administrative offices are located on the first floor near the running repair and materials handling areas. It is best for the maintenance superintendent to be located away from the mainstream of the work flow. Conversely, foremen should have their work stations on the floor in the midst of activities so they can direct and assist maintenance personnel. Foremen should have additional access to a quiet place where they can counsel employees and do work requiring concentration.

Shop Equipment and Tools

As with facility needs, decisions about shop equipment must be based on the policy goals and objectives of the maintenance department. The combinations of vehicle types and the trade-off between work done inside and work contracted out result in shop equipment specifications too numerous to mention. Durability and proven reputation should be strong considerations in selecting all shop equipment. Recommendations from other public transit systems are very good guidelines.

Maintenance Repair Policies

As previously mentioned, the two most common maintenance policies are proactive and reactive, or preventive maintenance and running repair, respectively. Preventive maintenance involves correcting a potential failure in a part or component before it is expected to fail. Running repair corrects a failure in a part or component after it has already failed.

Preventive maintenance has been widely adopted in the transportation industry, particularly by the more progressive public transit properties. Naturally, systems respond differently to breakdowns. Therefore the high costs of equipment failures during service make adherence to preventive maintenance a necessity.

The general field of carriage-for-hire is particularly sensitive to breakdowns because of the quality control and reliability aspects of the service. In the transit industry, breakdowns have an immediate effect on expenses and, more importantly, on revenues. For example, one federal mass transportation demonstration project found that while the express service trips were operated on schedule over 99% of the time, those riders who were occasionally inconvenienced quickly found alternative travel means [9]. As in any enterprise, the cost of lost sales in transit is both incalculable and large.

Transit systems use preventive maintenance techniques as the least costly method of ensuring quality control and reliability--two factors that probably have a more immediate effect on demand in the transit industry than for industry in general. Because of its impact on the quality of service, preventive maintenance programs should be thought of as marketing variables controlled by the system. Four ways of dealing with the maintenance of parts or components are described in the sections that follow [5]. Guidelines for selecting among these policies are presented in Source 5, listed at the end of this chapter.

Condition-based. With condition-based maintenance, failures are predicted and dealt with when a monitorable condition exceeds a tolerable limit [5]. Examples include brake shoes wear and engine oil consumption. Condition-based maintenance (1) reduces the chance of an in-service failure, (2) allows maximal use of a component while avoiding the consequences of a failure, and (3) permits scheduling of preventive repairs at the convenience of the maintenance department.

Fixed-mileage. Fixed-mileage maintenance is best applied where there is a known relationship between the mileage traveled and the failure mechanism [5]. Examples include oil and oil filters.

Operate until failure. When a part or component is operated until it fails, clearly all maintenance will be corrective. Generally, this policy is the least preferable in terms of work flow management. However, there are two circumstances where it is the most cost-effective policy [5]. First, if the condition of the part or component cannot be monitored and/or the failure mechanism has no relationship to mileage, then this policy is cost-effective. Second, this policy may be preferable if the total cost of repairing a part or component after a failure is equal to the cost of repairing it before a failure. A light bulb is a good example.

Design-out. While the three previously mentioned policies seek to minimize maintenance problems, design-out maintenance seeks to eliminate it. Manufacturing flaws and infeasible design usually require the modification or elimination of a part or component, which results in a campaign to correct the problem in as many vehicles as it occurs.

Maintenance Procedures

To ensure the service quality set by the transit agency, the maintenance department can use a variety of procedures in its maintenance program.

Bus operator inspection and trouble reporting. The heart of any preventive maintenance program is the driver. The driver should report all defects in writing on the driver's defect report (see Appendix 7A). The importance of this report should be emphasized in driver training and retraining programs. Drivers should be encouraged in this endeavor by the management of the firm so that prompt attention can be given to defects as soon as they are reported. In addition, if for some reason defects cannot be repaired immediately, the driver should be notified and should be given an explanation for the delay. Too often maintenance people and drivers defeat this system with petty squabbling. The operators complain that the mechanics will not make the repairs, and the mechanics complain that the drivers are too picky. This situation indicates a lack of leadership on the part of management. When a maintenance problem occurs that may lead to squabbling, top management must evaluate the situation, determine what is at fault, find a solution, and, most importantly, communicate to all parties--drivers and mechanics--the problem and the solution. (Note the recommended distribution at the bottom of Figure 7A.1 in Appendix 7A.)

Daily fluids inspection. A second preventive maintenance tool is the daily fueling inspection. Buses must be fueled at least once a day; each fueling takes at least 5 to 10 minutes. During that time, a thorough vehicle inspection can be performed--tire pressures, oil levels, lights, windshield wipers, brakes, doors, windows, seats, and so forth, can be checked, and defects noted. During or after this process, quick internal, external, and undercarriage visual inspections should be made, looking for the slightest signs of hairline cracks, panel cracks and dislocated stanchions. These tend to be early warning signs of major structural flaws that must be given immediate attention. The process therefore entails two checks per day that cost very little; one by the drivers who operate the buses and the other by the people who fuel them. These two checks are the keys to achieving the goal of uninterrupted service.

Mileage inspections. These inspections are designed to monitor a list of components with similar expected life cycles. When deciding which mileage intervals should be used, four basic factors must be considered:

1. The type of coach.

2. The length of time it takes a component to reach the end of its expected life-cycle.

3. The manufacturer's suggested procedure.

4. Climate and operating conditions.

Appendix 7A shows two fixed mileage inspections.

Inventory control. Transit systems must control two types of inventory: (1) fuel, lube oil, and grease; and (2) parts, special tools, tires, and batteries.

Quantity discounts generally make it mandatory for transit systems, large or small, to purchase fuel in transport or bulk quantities. The cost reduction per gallon usually far outweighs the increased inventory holding costs. Purchasing in transport quantities requires the installation of storage tanks with a minimum capacity of 8,000 gallons.

The system that uses a bulk lube oil system can purchase lube oil in 2,000-gallon lots delivered in tank trucks; with proper plumbing, the oil can be distributed from the supply tank to several locations. Metering nozzles are available to measure quantities delivered. Scale considerations determine whether a system will use this system. If systems do not purchase in bulk, the standard unit of delivery is the 55-gallon drum.

Actual inventory control procedures for fuel are simple. Pump readings taken at the beginning and end of each day are checked against the fuel tickets for discrepancies; a dip stick reading of the tanks is taken weekly. When fuel delivery is made, the tanks are checked before and after delivery to make sure that the gallonage in the tanks equals the gallonage on the delivery ticket. A similar procedure is followed for the bulk lube oil system. Grease is generally not controlled.

Parts inventories are harder to regulate because many different items with wide price variations are involved. Generally, systems set a lower cost limit for parts costs, and then control the inventory of parts that exceed this lower limit.

Parts costing less than the lower limit are usually not subject to rigorous controls.

Parts are kept in bins when possible. Bin compartments are labeled with the part number and/or the part identification, the part cost, the reorder point, the number of units to order, and the supplier. This information allows the parts clerk to monitor much of the parts inventory daily as he supplies parts to the mechanics. This situation is true especially for larger, frequently used parts. For the less frequently used parts, periodic, routine monitoring during slack periods will allow the parts clerk to make out requisitions for purchase.

Special tools, tires, and batteries can be monitored separately with procedures that fit individual circumstances. For example, special tools may be checked out to mechanics in a manner similar to the checking out of library books.

A great deal of money can be tied up in obsolete parts inventory. One of the most important inventory procedures to implement is the periodic, routine campaign to eliminate obsolete parts. Most suppliers will buy back obsolete parts if they can be used by their other customers. Naturally, the part or its package must present a reasonably good appearance, and the part generally cannot be too old. The periodic campaign to eliminate obsolete parts should be undertaken often, perhaps quarterly.

A rule of thumb on control is to separate the inventory into A, B, C items as follows:

A = the 15% of all items that account for 70% of the system's annual dollar usage. More management attention will be given to these items. Monitor well, closely track, and minimize the variability of these items.

B = the 30% of items that account for 20% of annual dollar usage. These items should be looked at periodically.

C = 55% of all items that account for 10% of annual dollar usage. These items require almost no management. A good way to monitor these items is by using, when feasible, a two-bin system. When one bin empties, reorder material for the first bin and begin using the second.

A policy might be to tolerate stockouts of A items once a year; of B items, twice a year; and of C items, three times a year.

Maintenance and New Equipment

A common misconception held by managers of small city transit systems is that new equipment will ease the stress of a running maintenance effort. It is true that nagging equipment failures due to the vehicle age will subside; however, two very distinct types of problems can be expected with new equipment.

The break-in period. New equipment must be monitored closely over its wear-in or break-in phase. This period is usually determined by the manufacturer of the bus or particular component. However, it is a good practice to monitor a new bus very closely throughout the duration of the warranty. It is also a good idea to structure some form of maintenance training into the procurement to familiarize the maintenance staff with problems likely to occur.

Specific items to monitor include:

- Performance of off-the-shelf components, (engine, transmission, air conditioning).
- Structural integrity (all mounts, compartment doors, undercarriage supporting members, interior stanchion joints).
- Fluid intake (all lubricating and cooling fluids).
- Brake and tire wear.

Reputable manufacturers have a strong interest in seeing their vehicles through the wear in and warranty periods. The small city system should seek manufacturers' advice and keep them involved throughout the warranty period.

The all-at-once crisis. Even normal use of equipment will eventually result in the or wearing out of a particular component or subsystem. When a group of vehicles is purchased at the same time, the expected life cycles of like components will be reached at the same time. Ironically, the more reliable the component, the bigger the problem. For example: it is not unusual for smaller systems to replace 25% to 50% of their peak-hour vehicle requirements in one procurement. Using random route and operator assignments with known (or high probability) engine and transmission life cycle estimates, a reasonable prediction of the point when all engines and all transmissions are likely to require replacement can be determined simply by monitoring daily mileage and extrapolating into the future.

If the number of vehicles expected to be down because of component replacement is greater than the system's spare ratio, then the change-out point must be altered in order to meet peak-hour vehicle requirements. Careful oil analyses and previous vehicle maintenance histories can be used to identify the poorest performers, which can then be overhauled before they reach the end of their life expectancy. Assigning a priority for the remaining vehicles in the series is done in the same way. This procedure, which changes a component that may not necessarily need repair and probably still has a useful life, has two advantages. First, it minimizes the disruptive effect of the all-at-once crisis on service. Second, it eliminates the chance of the all-at-once crisis in the future by staggering the expected life cycles of the replaced components. This also leads to more efficient scheduling of future preventive maintenance and periodic inspections.

Maintenance Costs

What does maintenance cost the transit industry? Financial statements contain a section under operating expenses titled maintenance costs. This category is supposed to give a complete picture of maintenance costs, but it probably does not. Parts and labor comprise the major portion of maintenance costs. However, the loss of revenue, the number of dissatisfied customers, and the disruption of service from coach breakdowns are also costs attributable to maintenance. Putting dollar figures on indirect maintenance costs is a tricky business at best, but the unhappy customer and the disruption in service surely do not help the company, and these costs are factors to be reckoned with constantly.

Within industry in general, a quality control or reliability function is usually determined by the production department. This activity, through a variety of techniques, seeks to ensure that the finished product has a certain minimum level of acceptable quality. If a piece of machinery is consistently turning out substandard products, the quality control activity takes that machine off the line until it is repaired or replaced. Firms act this way because engaging in quality control costs less than having unhappy customers. Firms seek to increase the reliability of their products or services because reliability attracts and keeps customers and clients. Preventive maintenance is not merely an expense, but an investment that can help keep present patrons and attract new ones.

Maintenance and Marketing

Vehicle maintenance plays an integral role in the promotion and delivery of the transit product. Moving consumers between any two points on the system depends on whether or not the bus can be successfully operated between those two points. A published timetable can be viewed as a contract entered into by the transit system and the public. The key clause in the contract is the commitment to provide transportation along a route, or within an area, at a predetermined time. The mechanical reliability of the vehicle is inherent to this commitment. Without it, the product delivery contract with the public will be breached.

The public will likely form an image of its local transit system based on the appearance of the system's buses. Whether or not consumers, or potential consumers, are impressed by what they see will no doubt influence their future use of the system. A well-maintained interior and exterior enhances the likelihood of a positive, or at least neutral, image of the service, given a successful mechanical operation.

A roadcall is necessary when a mechanical problem disrupts service and requires the corrective assistance of someone other than the operator. A system that uses an operate-until-failure maintenance policy maximizes the number of roadcalls. Therefore, this policy inherently conflicts with the system's service delivery contract with the public. Clearly, each disruption has an adverse impact on choice and occasional ridership. It often takes just one inconvenience before the choice rider will stop using the service, while to the occasional rider a bad experience will be construed as being representative of the service and, therefore, not to be relied upon in the future. Frequent service failures will result in a market of disgruntled captive riders which is unfortunate because this group is usually the first to offer support for transit services in times of budget cuts and other adverse political circumstances.

To put it another way, when a coach breaks down on a scheduled route, it is likely to cause the following problems:

- Delayed and missed appointments, which in turn cause customer frustration and, eventually, lead to lost patronage. The cost oflost riders is virtually impossible to estimate, but it is undoubtedly large.

- Extra maintenance costs because of damage to parts and equipment.

- Extra driver or personnel costs to switch equipment.

- Disruption of the routine maintenance program.

- Lost revenue and additional future revenue losses.

- Investment in extra equipment, which then may be underused.

- Increased insurance cost, if the breakdown causes an accident resulting in personal injury or property damage.

Maintenance and UMTA

Interest in capital investment. Capital assistance from the Urban Mass Transportation Administration (UMTA) has enabled small city transit operators to acquire new rolling stock. Because UMTA monies are used to subsidize most of the purchase price in most bus procurements, UMTA has a majority interest in most small city transit system fleets. As a result, UMTA has published guidelines on the expected life of various types of buses; therefore, it behooves the system to ensure that this life span is achieved [12]. The best way to accomplish this is through a sound maintenance program.

Spares ratio. UMTA has also established guidelines on the number of spares--vehicles in addition to the peak hour fleet requirement--that a small city system may have [12]. Spares are used as replacements for vehicles scheduled for preventive maintenance, vehicles disabled because of accidents, component failures, or general unreliability. A limitation on the number of spares in the fleet requires a commensurate availability ratio on the regular service fleet. Once the number of unavailable buses (ones out of service because of problems with reliability or maintainability) becomes greater than the number of spares, the system is unable to meet service requirements. This is a crucial issue for smaller systems, since a 15%--20% spare ratio at a 10-bus system translates into one and a half or two spares. Each time a bus is kept off the street for routine preventive maintenance, that leaves one spare. Extreme weather conditions, at any given time, could easily disable two or more of the in-service vehicles even if they are in top condition.

Section 15. For a review of Section 15 Of the Urban Mass Transportation Act of 1964, as amended, refer to Source 11, at the end of this chapter. A complete history and description of Section 15. However, management of the small city transit system must know (1) if the system is affected by Section 15, and (2) if so, what are the "required" information needs, and (3) which voluntary reporting level is desirable.

Although comprehensive information is desirable for a functional maintenance management information system, it makes sense for that design include information required by federal, state and local government agencies. Once outside requirements are satisfied, management can supplement the overall design with information needed to monitor the efficiency of the system. This type of design coincides with the one-time data entry which maximizes the usefulness of information to all who require it while minimizing the effort needed to capture it.

Other Maintenance Programs

Outside Maintenance Contracts

Option 1. An option to establishing an in-house repair facility is negotiating a contract with an outside party for vehicle maintenance and repair. This option might be most attractive for systems with fewer vehicles because it avoids the substantial fixed investment of equipping a repair facility. Setting up an outside contract involves negotiating a contract for performance of vehicle inspections and repairs with an automobile dealer, truck dealer, independent garage, or user of related equipment.

Disadvantages of outside maintenance contracts include:

1. Control over the quality of the inspections is lost.

2. Work scheduling is harder because of priority considerations.

3. The expenses incurred, although variable in nature, may be higher.

4. Because much bus work is specialized, more than one contract may have to be negotiated resulting in a loss of quality control and increased scheduling difficulties.

5. The outside contractor might be unwilling to stock the necessary parts, leading to lengthy periods whenthe vehicle is out of service.

6. Off-the-shelf components are often modified in transit applications and cannot be maintained as originally intended. Special maintenance procedures are often necessary, thus requiring close, precise communication among the manufacturer, the system, and the outside contractor.

Because of these disadvantages, outside contracts are not desirable for any but the smallest systems, and are probably useful only for those not operating standard transit vehicles.

Option 2. A more practical option would be to use outside contracting for specialized maintenance and repair work while the transit agency continues to perform the more routine tasks at its own facility. Many transit firms now follow this approach for tire replacement, but the concept might be extended to repair work on glass, bodies, seats, diesel engines, and so forth. In this case, the firm has the fixed investment of a facility, but it does not have a large fixed investment in specialized repair equipment and tools. Moreover, the wages of a highly skilled specialist are better absorbed by a larger organization that can utilize their skills more fully. The disadvantages previously discussed pertain to this situation, but they are not as severe because the system has some in-house capability.

Performing Maintenance on Other Vehicles

As a third option, the transit system could repair vehicles belonging to other organizations. This could be done on an open-shop basis or on a contractual basis. For planning and scheduling ease, the contractual basis is preferred.

Because parts for standard city transit buses are specialized and not widely distributed, it is generally considered infeasible for truck dealers or garages to perform preventive maintenance programs and repair work for buses. However, truck parts are widely distributed and easily obtained on short notice. It is therefore possible, indeed attractive, for transit maintenance departments to perform maintenance on trucks without a drastic increase in inventories or investment in additional equipment or extra employees. For small transit firms in outlying locations, this service would represent an attractive method of spreading the repair facility overhead, as well as generating revenue.

A natural customer for a publicly owned transit agency is local government. Maintenance may be provided for city trucks, fire engines, heavy equipment, and perhaps police cars. Work on heavy vehicles may be especially attractive because local government can avoid the costs of installing expensive special equipment similar to that already found at a transit property.

Out-of-house vehicle maintenance can be done selectively. For example, the transit firm could open its own facilities for diesel engine work. Perhaps it could contract solely for the purpose of conducting preventive maintenance inspections.

To establish charges for this work, the firm can easily determine competitive labor costs by investigating the rates charged by the local automobile dealers, independent garages, or truck dealers. A better method is to contract for in-kind services from other city departments. Parts can be priced at cost, plus 15%. These are starting points; the final prices will be determined through negotiation.

The variations on this theme are endless. The important aspect is the spreading of the overhead. One or two sound maintenance contracts may spell the difference between a small city being able to afford a good transit system, a poor one, or none at all.

Maintenance Management Information Systems

Managing the complex interaction of the activities in a vehicle maintenance program can only be done using some form of management information system (MIS). An appropriate form might include a manual card catalog or a complex, computerized vehicle-tracking system. With the variety of equipment on the market, improved components, and market pressures for increased service reliability, the trend has been toward more sophisticated maintenance management information systems. Other maintenance efforts requiring a sound information base include: planning labor needs, parts inventory quantities and maintenance budgeting; time standards for mechanics; work-load scheduling and planning; life cycle costing; and maintenance performance indicators [6]. Appendix 7B includes a simple, yet practical, maintenance MIS.

The discussion of maintenance management information systems and the data requirements of the various parties who have an interest in the small city transit system may seem somewhat mind boggling to the smaller systems that lack the administrative time for such a comprehensive task. However, there are two strong arguments in favor of the effort. First, some of this information is required by law. Second, accurate and brief information is a basic prerequisite to sound management practice.

A system that provides required information and is supplemented with other useful management information can easily be worked into the daily routine of the operation. A data flow design effort that adequately reorganizes the appropriate information identification, capture and storage will make both the compliance and management reporting functions simple exercises in output formatting. Microcomputer hardware and software capabilities can make this entire process both simple and economical. Specifications will vary slightly with the size of the small city transit system. However, provided that the data flow design process is sound and efficient, and the manual version works, the entire process should have the potential to be converted to a microcomputer using any of several off-the-shelf, database software packages. Successful implementation will depend on the quality of the data-flow design process and, most importantly, the accuracy of the actual data capture effort. Capturing fuel and fluids usage, inventory transactions, preventive and corrective maintenance information and labor usage as they occur makes them relatively simple housekeeping chores. Storing this information on a computer becomes a simple bookkeeping effort. With accurate information and efficient storage, compliance and management reports can be generated, literally, with the push of a button, at whatever frequency is desired.

Technical assistance in data-flow design and microcomputer hardware and software selection is readily available to the transit industry. A good effort in establishing the information system will maximize its success. Time spent on managing the small city transit system is much more valuable than time spent on manually deriving, or fabricating, compliance information.

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Notes for Chapter 7

1. The discussion of facilities, shop equipment, and tools is based on a report entitled, Design Criteria for a Satellite Bus Maintenance Facility, published by Fleet Maintenance Consultants, Inc. The examples cited in the document were based on a facility designed for approximately 250 buses; the document is intended to be used as background information for architectural and engineering firms involved in the design of transit maintenance facilities. This document is not intended as a verbatim facility design manual. Guidelines used in this version of the handbook have been supplemented by the authors for use at smaller systems.

2. The forms in Appendixes 7B and 7C were based on many different sources including the systems mentioned in the Acknowledgements of this chapter, the Second Revision of the handbook, the documents listed in the sources for this chapter, and UMTA Section 15 guidelines. It would be rather lengthy to list the exact references and their commensurate influence on each form, and in due respect to the equipment manufacturers we have intentionally left the sources of these forms anonymous. We do, however, wish to thank those people who were kind enough to help us. They are listed in the acknowledgements.

Sources for Chapter 7

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APPENDIX 7A

DESIGNING A PREVENTIVE MAINTENANCE PROGRAM

A comprehensive maintenance program must be custom fit to each individual system. It is crucial that the program take into account the system's level of service, climate, operating conditions, labor agreement, personnel procedures, and other factors that affect the operation of the system.

A good preventive maintenance program is founded on a safety inspection, which is performed after a fixed-mileage, or basic, interval. A vehicle's service manual, in conjunction with the manufacturer's service representatives, should be consulted. A safety inspection usually involves: lubrication, filter replacement, inspection for wear and damage, and fluid level checks. Subsequent inspections are performed at higher mileage intervals, depending on the equipment, its age, and component makeup. Each subsequent inspection is more thorough than the previous one, until the cycle repeats. All inspections include a safety inspection.

Once the mileage interval for the safety inspection is chosen, and with the help of the manufacturer, a successive preventive maintenance program can be developed. For example, a common program uses the "A-B-C-D-E" approach whereby the A, almost always the safety inspection, is performed upon the vehicle's accumulating mileage equal to the basic interval. Successive inspections are performed at even multiples of the safety inspection each becoming more thorough until the cycle repeats. The advantage of performing progressively more thorough fixed-mileage inspections in even multiples of the basic safety inspection is that only one miles-between-inspections figure needs to be monitored. For example: a clerk simply needs to watch the miles-between-inspections figure as it approaches the safety inspection limit. Knowing that some kind of inspection is due, the clerk just checks the vehicle's inspection record to determine the next inspection in the progression.

A better method is to structure successive inspections in even multiples of the previous inspection. For example, with a safety inspection interval of 2,500 miles as the A inspection,

- Choose a multiple of two for the B, or 5,000 miles inspection.

- Make the C an even multiple of the B, for example two, which becomes the 10,000 mile inspection.

- Make the D twice as much as the C for a 20,000 mile inspection, and make the E twice the D for a 40,000 mile inspection.

A system based on even successive multiples, with the most comprehensive inspection equated with the average annual mileage of the vehicle, is convenient in four ways:

1. The cycle of inspections will repeat itself immediately after the most comprehensive inspection, in this case, one year. In addition to being useful during budget development, a one-year cycle works quite nicely in scheduling seasonal campaigns, which include servicing heating and air conditioning systems.

2. Campaigns and major cleanings can be programmed to coincide with vehicles scheduled for preventive maintenance thereby minimizing their downtime.

3. Only one accumulative miles-between-inspections figure needs to be monitored.

4. The tasks for a particular inspection inherently include the tasks of each of the previous inspections in the progression. For example: a B inspection includes the tasks of the B and A inspections. The C inspection includes the tasks of the C, B and A inspections. The D inspection includes the D, C, B, and A and so on.

Figure 7A.1 shows the tasks in a preventive maintenance program based on even multiples of the basic interval, in this case, 6,000 miles.

Figure 7A.2 shows a list of tasks in a preventive maintenance program based on successive even multiples of the basic interval which, in this case, is 3,000 miles. (Please note: Bus Industries of America reserves the right to alter or amend any design equipment or procedure at any time and the contents herein do not imply or express any guarantees, warranties or contracts and liabilities.)

Figure 7A.3 shows an actual preventive maintenance checklist based on even multiples of the basic interval, or 3,000 miles.

Figures 7A.4 through 7A.6 show actual forms, used in a small-city system, based on successive, even multiples. Figures 7A.3 through 7A.6 are not related to the programs outlined in Figures 7A.1 and 7A.2.

FIGURE 7A.1 Tasks in a Preventive Maintenance Program (6,000 mile interval)

COACH MAINTENANCE SCHEDULE

ITEM	INSPECT OR SERVICE	MANUAL SECTION	INSPECT DAILY OR AS REQUIRED	6,000 MILES OR 400 HOURS	12,000 MILES OR 800 HOURS	18,000 MILES OR 1,200 HOURS	24,000 MILES OR 1,600 HOURS OR 6 MONTHS	30,000 MILES OR 2,000 HOURS	36,000 MILES OR 2,400 HOURS	42,000 MILES OR 2,800 HOURS OR YEARLY
COACH INTERIOR										
Interior	Inspect for damage.		X							
Floor Covering	Inspect for damage.		X							
Glass	Inspect for damage.		X							
Mirrors	Inspect for damage and adjust.		X							
Driver's Window	Check operation and inspect for damage.		X							
Sun Visor	Check operation.		X							
Entrance and Exit Door Step Treads	Inspect for damage.		X							
Windshield Washer Reservoir	Check fluid level.		X							
Passenger Seats	Inspect for damage and loose seat mountings.		X							
Route Sign	Inspect for damage and proper operation.		X							
Run Number Sign	Inspect for damage and proper operation.		X							
Roof Escape Hatch	Check operation, then close and latch the hatch. Check that the hatch is properly sealed.		X							
Roof Ventilator	Check operation, then close and latch the unit. Check that the unit is properly sealed.		X							
Driver's Seat Belt	Inspect for damage.		X							
Steering Column	Check that the tilt lock lever secures the column in each tilt position.		X							
COACH EXTERIOR										
Cooling System	Check coolant level.		X							
Reflectors	Inspect for damage.		X							
Skirt Panels	Inspect for damage.		X							
Closure Doors	Inspect for damage and proper latching.		X							

COACH MAINTENANCE SCHEDULE

ITEM	INSPECT OR SERVICE	MANUAL SECTION	INSPECT DAILY OR AS REQUIRED	6,000 MILES OR 400 HOURS	12,000 MILES OR 800 HOURS	18,000 MILES OR 1,200 HOURS	24,000 MILES OR 1,600 HOURS OR 6 MONTHS	30,000 MILES OR 2,000 HOURS	36,000 MILES OR 2,400 HOURS	42,000 MILES OR 2,800 HOURS OR YEARLY
COACH EXTERIOR (Cont'd)										
Wheels	Inspect rims, wheels and stud nuts for damage and cracked, broken or missing stud nuts.		X							
Tires	Check for proper operating air pressure, bulges, knots, cuts, punctures, abrasions and separation.		X							
	Inspect for damaged valve stems and loose or missing valve caps.		X							
ENGINE RUNNING										
Start the Engine	Look and listen for signs of trouble.		X							
Gages	Check that all gages are operating with the engine running.		X							
Parking Brake	Apply the parking brake and check operation by trying to move the coach with the knob pulled up.		X							
Tell-tale Lamp System	Check low air lamp and buzzer.		X							
	Check low oil lamp and buzzer.		X							
	Check hot engine lamp and buzzer.		X							
Tell-tale Lights	Rotate the run switch to the "RUN" position, then push the telltale test switch to see that all telltale lights turn on.		X							
OPERATING CONTROLS										
Headlights	Check high and low beam operation. Push on foot dimmer switch to check high beam operation.		X							
Clearance, Marker and I.D.	Check operation.		X							
Directional Lights	Check operation.		X							
Stepwell Lights	Check operation.		X							
Interior Lights	Check operation.		X							

COACH MAINTENANCE SCHEDULE

ITEM	INSPECT OR SERVICE	MANUAL SECTION	INSPECT DAILY OR AS REQUIRED	6,000 MILES OR 400 HOURS	12,000 MILES OR 800 HOURS	18,000 MILES OR 1,200 HOURS	24,000 MILES OR 1,600 HOURS OR 6 MONTHS	30,000 MILES OR 2,000 HOURS	36,000 MILES OR 2,400 HOURS	42,000 MILES OR 2,800 HOURS OR YEARLY
OPERATING CONTROLS (Cont'd)										
Kneeling Warning Horn	Check by listening for the horn while kneeling the coach.		X							
Back-Up Alarm Horn	Check by listening for the horn while backing the coach.		X							
Climate Control System	Check operation by placing the climate control switch in the "ON" position and observing operation.		X							
Fast Idle	Check operation by placing the "Fast Idle" switch in Fast Idle position and observing engine RPM.		X							
Wheelchair Lift	Operate the lift to see that it is working properly. Be sure the lift is in the parked position and the control panel cover is closed and locked. Check that the wheelchair master switch is "OFF" and the key is in the switch.		X							
Brakes	Move the coach slowly and bring it to a stop to check that the brakes stop the coach and keep it from moving. Check to see that all gages remain in the normal range.		X							
Steering	Move the coach a short distance at a slow speed and turn the steering wheel to check that the steering feels normal. Listen for unusual noises. Check that the coach is under control and handles properly.		X							
Fuel the Coach	Fuel the coach with engine off to provide enough fuel for normal coach operation.		X							
Engine Crankcase	Check fluid level on dipstick.	OB	X							
Transmission	Check fluid level on dipstick.	OB	X							
LUBRICATION										
Driver's Seat	Remove, clean and lubricate.	1	—	—	—	—	—	—	—	X
Destination Sign	Lubricate motor drive gears.	1	—	—	—	—	—	—	—	X

COACH MAINTENANCE SCHEDULE

ITEM	INSPECT OR SERVICE	MANUAL SECTION	INSPECT DAILY OR AS REQUIRED	6,000 MILES OR 400 HOURS	12,000 MILES OR 800 HOURS	18,000 MILES OR 1,200 HOURS	24,000 MILES OR 1,600 HOURS OR 6 MONTHS	30,000 MILES OR 2,000 HOURS	36,000 MILES OR 2,400 HOURS	42,000 MILES OR 2,800 HOURS OR YEARLY
LUBRICATION (Cont'd)										
Door Guide Arms	Lubricate rod and lever bearing surfaces.	1	A/R							
Exit Door Lower Pins	Lubricate.	1		X	X	X	X	X	X	X
Door Engine and Base Plate	Lube door rod and lever bearing surfaces.	1		—	—	X	—	—	X	—
Windshield Wiper Posts	Lubricate pivot points.	0	—	X	X	X	X	X	X	X
Throttle Control	Lubricate ball joints.		—	X	X	X	X	X	X	X
Front Wheel Bearings	Pack with grease and adjust.	0	A/R	—	—	—	X	—	—	X
Steering Column U-Joints	Lube 2-Joints (4-fittings).	0	—	—	—	X	—	—	X	—
Steering Miter Gear	Lube 3-fittings.	0	—	X	X	X	X	X	X	X
Steering Tie Rod Ends	Lube 2-fittings.	0	—	X	X	X	X	X	X	X
Steering Drag Link Ends	Lube 2-fittings.	0	—	X	X	X	X	X	X	X
Steering Knuckle Pins	Lube 4-fittings	0	—	X	X	X	X	X	X	X
Spindle and King Pins	Lube 4-fittings.	0	—	X	X	X	X	X	X	X
Propeller Shaft U-Joints	Lube 2-fittings.	0	—	X	X	X	X	X	X	X
Propeller Shaft Slip Joint	Lube 1-fitting.	0	—	X	X	X	X	X	X	X
Parking Brake Shoe Anchor Pins and Rollers	Lubricate.	0	A/R	—	—	—	—	—	—	—
Parking Brake Camshaft	Lube 1-fitting.	0	—	X	X	X	X	X	X	X
Parking Brake Linkage	Lubricate.	5A	—	X	X	X	X	X	X	X
Rear Axle Differential	Check fluid level.	0	—	X	X	X	X	X	X	X
	Drain and refill.	4	—	—	—	—	X	—	—	X
	Remove breather and clean.	4	—	—	—	—	—	—	—	X
Rear Wheel Bearings	Pack with grease and adjust.	5A	A/R	—	—	—	X	—	—	X
Emergency Engine Shut-Off at Blower	Lubricate.	—	A/R							
Engine Air Restriction Indicator	Replace air cleaner when red flag appears on indicator.	6A	A/R							

COACH MAINTENANCE SCHEDULE

ITEM	INSPECT OR SERVICE	MANUAL SECTION	INSPECT DAILY OR AS REQUIRED	6,000 MILES OR 400 HOURS	12,000 MILES OR 800 HOURS	18,000 MILES OR 1,200 HOURS	24,000 MILES OR 1,600 HOURS OR 6 MONTHS	30,000 MILES OR 2,000 HOURS	36,000 MILES OR 2,400 HOURS	42,000 MILES OR 2,800 HOURS OR YEARLY
LUBRICATION (Cont'd)										
Engine Air Cleaner	Remove and blow clean with air.	6A	A/R							
Power Steering Fluid Level	Check level at reservoir sight glass or dipstick.	0&9	—	—	X	—	X	—	X	—
Power Steering Reservoir Filter	Replace filter element.	9	—	—	—	—	X	—	—	X
Power Steering Fluid Line Filter	Remove and clean element and magnetic plug.	9	—	—	—	—	X	—	—	X
Engine Crankcase	Drain and refill. Based on Oil Analysis.	0	X	X	X	X	X	X	X	X
Engine Crankcase Breather	Clean element.	0	—	—	—	—	—	X	—	—
Engine Oil Filter	Replace filter.	0&6A	X	X	X	X	X	X	X	X
Engine Full Flow Oil Filter	Replace filter element.	0&6A	X	X	X	X	X	X	X	X
Engine By-Pass Oil Filter	Replace filter.	0&6A	X	X	X	X	X	X	X	X
Engine Water Filter	Replace element.	6A	—	—	X	—	X	—	X	—
Oil Cooled Generator	Drain oil from unit and refill.	6	A/R							
Primary Fuel Filter	Replace filter.	8A	—	X	X	X	X	X	X	X
Secondary Fuel Filter	Replace filter.	8A	A/R							
Transmission	Check for oil, water, air and fluid leaks.	0&7	—	X	X	X	X	X	X	X
	Drain and refill.	0	—	—	—	—	—	X	—	—
	Replace external filter.	7	—	—	—	—	—	X	—	—
	Clean governor screen.	7	—	—	—	—	—	X	—	—
	Replace Transmission Air Modulator.	7	—	—	—	—	—	X	—	—
	Clean or replace internal filter at overhaul.	7	A/R							
Radiator Shutters	Lubricate.	13	A/R							
Battery Terminals	Lubricate.	12B	A/R							
Battery Tray Slides	Lubricate.	12B	A/R							
Compartment Door Locks	Lubricate.	1A	A/R							
Wheelchair Lift Cam and Slide	Lubricate.	0A	—	X	—	X	—	X	—	

COACH MAINTENANCE SCHEDULE

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BODY										
Underbody	Flush with water.	1A	A/R							
	Check welds at bulkheads, support beams and component mounting brackets for cracks or damage.	1B	—	—	—	—	—	X	—	—
Door Emergency Release Valve	Check operation.	1C	—	—	—	—	X	—	—	X
Door Engine and Base Plate	Check mounting bolts and adjusting screw jam nuts for tightness.	1C	—	—	—	X	—	—	X	—
	Check air lines and connections for leakage and chafing.	1C	—	—	—	X	—	—	X	—
Door Panel Alignment	Check alignment.	1&15	—	X	X	X	X	X	X	X
Door Opening and Closing Speed	Check for proper speed adjustment.	1&15	A/R							
Door Seals	Inspect for damage.	1C	—	X	X	X	X	X	X	X
Exit Door Lower Pins	Inspect for damage.	1C	—	X	—	X	—	X	—	X
Roof Escape Hatch and Ventilator	Check for damaged seals or water leaks at each hatch.	1C	—	X	—	X	—	X	—	X
Compartment Access Doors	Check operation and adjustment.	1C	A/R							
	Inspect for worn or damaged rubber bumpers.	1C	A/R							
Sun Visor	Check operation and inspect for damage.	1A	A/R							
Mirrors	Inspect for loose or damaged support arms and brackets.	1B	A/R							
Interior Trim	Inspect for damage and missing screws.	1A	—	—	—	—	X	—	—	X
Modesty Panels	Inspect for damage and missing or loose mounting screws.	1A	—	—	—	—	X	—	—	X
Grab Rails and Stanchions	Inspect for damage and loose mounting bolts.	1A	—	—	—	—	X	—	—	X
Destination Sign	Check for damaged curtains.	1A	—	X	X	X	X	X	X	X
	Clean compartment and check for loose items.	1A	—	X	X	X	X	X	X	X
Driver's Seat	Check seat mounting bolt torque.	1A	—	—	—	—	—	—	—	X

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BODY (Cont'd)										
Passenger Seats	Check seat mounting bolt tightness.	1A	—	—	—	—	—	—	—	X
Bumper Mounting Bolts and Brackets	Check for damage and proper mounting bolt tightness.	1A	—	—	—	—	—	—	—	X
Fenders and Splash Aprons	Check for damage and loose bolts.	1A	—	—	—	—	X	—	—	X
Windshield Wipers and Washers	Check wiper arm adjustment.	1D	—	—	—	—	X	—	—	X
Wiper Control Valve	Remove, disassemble and clean.	1D	A/R							
Wiper Motor Air Strainer	Remove, disassemble and clean.	1D	—	—	—	—	—	—	—	X
Washer Control Valve	Check operation.	1D	—	—	—	—	X	—	—	X
Skirt Panels	Check mounting bolts and brackets for damage and tightness.	1A	—	X	—	X	—	X	—	X
Rub Rails	Inspect for damage.	1A	—	X	—	X	—	X	—	X
HEATING AND AIR CONDITIONING										
System Operation	Check for proper operation.	2A	A/R							
Defroster Switch	Check for high and low speed operation and air flow.	2A	—	X	X	X	X	X	X	X
Booster Fan Switch	Energize switch and check for proper blower operation.	2A	—	—	—	—	X	—	—	X
High Speed Blower Switch	Energize switch and check by observing air flow.	2A	—	—	—	—	X	—	—	X
Refrigerant Pressure Switches	Check operation.	2B	—	—	—	—	X	—	—	X
Water Circulation System	Check shut-off valve position.	2A	—	—	—	—	X	—	—	X
	Clean water supply tube filter.	2A	—	—	—	—	—	—	—	X
Water Circulation Pump and Motor	Check operation and motor brushes for wear.	2A	—	—	—	—	—	—	—	X
Air Circulation System	Clean air intake grilles and filters.	2A	—	X	X	X	X	X	X	X
Driver's Heater	Clean air filter and intake grille.	2A	—	—	—	—	X	—	—	X
	Check motor operation.	2A	A/R							

COACH MAINTENANCE SCHEDULE

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HEATING AND AIR CONDITIONING (Cont'd)										
Return Air Shutters	Check operation.	2A	—	—	—	—	—	—	—	X
Condenser	Clean condenser coil.	2B	A/R							
Condenser Fan Drive Motor	Inspect brushes for wear.	2B	—	—	—	—	—	—	—	X
	Inspect fan blade for damage and proper clearance to fan shroud.	2B	—	—	—	—	—	—	—	X
Evaporator Coil	Clean coil and straighten bent fins.	2B	A/R							
Heater Core	Clean and straighten bent fins.	2A	A/R							
Evaporator Blower Motors	Check fan wheel alignment and mounting bolts for tightness.	2B	A/R							
	Inspect brushes for wear.	2B	—	—	—	—	—	—	—	X
Refrigerant System	Check refirgerant level at receiver tank sight glass.	2B	—	X	X	X	X	X	X	X
Dehydrator Strainer	Replace dehydrator strainer.	2B	—	—	—	—	—	—	—	X
Refrigerant Valves	Inspect valve cap seals for damage and valve caps for proper tightness.	2B	A/R							
Air Conditioning Compressor	Check oil level at compressor sight glass.	2B	—	X	X	X	X	X	X	X
	Check compressor and platform mounting bolts for tightness.	2B	—	—	—	—	—	—	—	X
	Check compressor drive belt condition and tension.	2B	—	—	—	—	X	—	—	X
	Check Compressor oil pump pressure.	2B	—	—	—	—	X	—	—	X
	Check compressor cylinder unloader operation and adjustment.	2B	—	—	—	—	—	—	—	X

COACH MAINTENANCE SCHEDULE

ITEM	INSPECT OR SERVICE	MANUAL SECTION	INSPECT DAILY OR AS REQUIRED	6,000 MILES OR 400 HOURS	12,000 MILES OR 800 HOURS	18,000 MILES OR 1,200 HOURS	24,000 MILES OR 1,600 HOURS OR 6 MONTHS	30,000 MILES OR 2,000 HOURS	36,000 MILES OR 2,400 HOURS	42,000 MILES OR 2,800 HOURS OR YEARLY
FRONT AXLE AND SUSPENSION										
Front Suspension	Check front end alignment.	3A	A/R							
	Check toe-in.	3A	A/R							
	Check front wheel camber.	3A	A/R							
	Check for loose or damaged suspension mounting parts.	3A	—	X	X	X	X	X	X	X
	Check for proper ride height.	3A	—	—	—	—	X	—	—	X
Upper Control Arms	Check for loose, bent or damaged parts and worn bushings.	3A	—	X	X	X	X	X	X	X
Lower Control Arms	Check for loose, bent or damaged parts and worn bushings.	3A	—	X	X	X	X	X	X	X
Stabilizer Bar	Inspect for loose, bent or damaged parts and worn bushings.	3A	—	X	X	X	X	X	X	X
Air Springs	Inspect for cracks, abrasions and damage.	3A	—	—	—	—	X	—	—	X
Suspension Air System	Inspect air lines for chafing or damage.	3A	—	X	X	X	X	X	X	X
Suspension Air Tank	Drain moisture from tank.	3A	—	X	X	X	X	X	X	X
	Check mounting bolts for tightness.	3A	—	—	—	—	—	—	—	X
Air Strainer	Remove, disassemble and clean.	3A	—	—	—	—	—	—	—	X
Check Valves	Remove, disassemble and clean.	3A	—	—	—	—	—	—	—	X
Pressure Protection Valve	Check operating pressure.	3A	—	—	—	—	X	—	—	X
	Remove, disassemble, clean and inspect.	3A	—	—	—	—	—	—	—	X
Front Shock Absorbers	Check for leaks, damage or worn rubber bushings.	3A	—	—	—	—	X	—	—	X
Height Control Valve	Check operation.	3A	—	—	—	—	X	—	—	X
Kneeling System	Check operation.	3A	—	X	X	X	X	X	X	X
Kneeling Sense Switch	Check switch adjustment and mounting.	3A	A/R							

COACH MAINTENANCE SCHEDULE

ITEM	INSPECT OR SERVICE	MANUAL SECTION	INSPECT DAILY OR AS REQUIRED	6,000 MILES OR 400 HOURS	12,000 MILES OR 800 HOURS	18,000 MILES OR 1,200 HOURS	24,000 MILES OR 1,600 HOURS OR 6 MONTHS	30,000 MILES OR 2,000 HOURS	36,000 MILES OR 2,400 HOURS	42,000 MILES OR 2,800 HOURS OR YEARLY
REAR AXLE AND SUSPENSION										
Saddle and Frames	Inspect for cracks and damage.	4	—	X	X	X	X	X	X	X
Pinion Oil Seals	Check for leaks.	4	—	X	X	X	X	X	X	X
Axle Shaft Flange	Check gasket for leakage.	4	—	X	X	X	X	X	X	X
Carrier to Housing Gasket	Inspect gasket for leakage.	4	—	X	X	X	X	X	X	X
Axle Shaft and Pinion Cage Stud Nuts	Check for proper torque.	4	—	—	—	—	X	—	—	X
Axle and Suspension Mounting	Check for proper tightness.	4	—	—	—	—	X	—	—	X
Propeller Shaft	Inspect yoke flanges for broken lock wire, excessive movement and looseness.	4	—	—	—	—	—	—	—	X
	Inspect U-Joints for wear or damage.	4	—	—	—	—	—	—	—	X
Air Springs	Inspect for cracks, abrasions, damage and proper height.	4	—	X	X	X	X	X	X	X
Suspension Air System	Inspect air lines for chafing or damage and leakage.	4	—	X	X	X	X	X	X	X
Radius Rods	Check for proper torque and worn bushings.	4	—	X	X	X	X	X	X	X
Drive Line Bolts	Check for proper torque.	4	—	—	—	—	X	—	—	X
Rear Axle Flange Nuts	Check for proper torque.	4	—	—	—	—	X	—	—	X
Rear Shock Absorbers	Inspect for leaks, damage or worn rubber bushings.	4	A/R							
BRAKES										
Brake Chambers	Check diaphragm for leaks.	5A	—	X	X	X	X	X	X	X
	Remove, disassemble, clean and inspect.	5A	—	—	—	—	—	—	—	X
Brake Shoe Assemblies	Check lining thickness.	5A	—	X	X	X	X	X	X	X
Automatic Adjusters	Check operation.	5A	—	—	X	—	X	—	X	—
Wheel Bearings	Check adjustment.	5A	—	—	—	—	X	—	—	X

COACH MAINTENANCE SCHEDULE

ITEM	INSPECT OR SERVICE	MANUAL SECTION	INSPECT DAILY OR AS REQUIRED	6,000 MILES OR 400 HOURS	12,000 MILES OR 800 HOURS	18,000 MILES OR 1,200 HOURS	24,000 MILES OR 1,600 HOURS OR 6 MONTHS	30,000 MILES OR 2,000 HOURS	36,000 MILES OR 2,400 HOURS	42,000 MILES OR 2,800 HOURS OR YEARLY
BRAKES (Cont'd)										
Brake Application Valve	Check rubber plunger boot for cracks, holes or deterioration.	5B	—	X	X	X	X	X	X	X
	Clean, lubricate and check boot.	5B	—	—	—	—	X	—	—	X
	Remove, disassemble, clean and inspect.	5B	—	—	—	—	—	—	—	X
Parking Brake Control Valve	Remove, disassemble, clean and inspect.	5C	—	—	—	—	—	—	—	X
Air Brake Lines	Check for chafing, leaks and damaged connections.	5D	—	X	X	X	X	X	X	X
Air Reservoirs	Drain moisture from air tanks.	5E	—	X	X	X	X	X	X	X
	Inspect mounting bolts for tightness.	5E	—	X	X	X	X	X	X	X
Safety Valve	Remove, disassemble, clean and inspect.	5E	—	—	—	—	X	—	—	X
	Check operation.	5E	—	X	X	X	X	X	X	X
Check Valves	Remove, disassemble, clean and inspect.	5E	—	—	—	—	X	—	—	X
Air Dryer	Inspect for leaks.	5E	—	X	X	X	X	X	X	X
	Check operation.	5E	—	—	X	—	X	—	X	—
	Replace dessicant cartridge.	5E	—	—	—	—	—	—	—	X
	Check mounting bolts for tightness.	5E	—	—	—	—	—	—	—	X
Pressure Regulator Valve	Check operation and air pressure.	5E	—	—	—	—	X	—	—	X
Quick Release Valve	Remove, disassemble, clean and inspect.	5E	—	—	—	—	—	—	—	X
Synchro Valve (SV-1)	Remove, disassemble, clean and inspect.	5E	—	—	—	—	—	—	—	X
Inversion Valve (TR-3)	Remove, disassemble, clean and inspect.	5E	—	—	—	—	—	—	—	X
Relay Valve (R-8)	Remove, disassemble, clean and inspect.	5E	—	—	—	—	—	—	—	X
	Check operation and look for leaks.	5E	—	X	X	X	X	X	—	X
Moisture Ejector Valve	Check operation.	5E	—	—	—	—	X	—	—	X
	Remove, disassemble, clean and inspect.	5E	—	—	—	—	X	—	—	X

COACH MAINTENANCE SCHEDULE

ITEM	INSPECT OR SERVICE	MANUAL SECTION	INSPECT DAILY OR AS REQUIRED	6,000 MILES OR 400 HOURS	12,000 MILES OR 800 HOURS	18,000 MILES OR 1,200 HOURS	24,000 MILES OR 1,600 HOURS OR 6 MONTHS	30,000 MILES OR 2,000 HOURS	36,000 MILES OR 2,400 HOURS	42,000 MILES OR 2,800 HOURS OR YEARLY
ENGINE										
Starter Cables	Inspect cables and connections for chafing and looseness.	6A	—	—	—	—	—	—	—	X
Engine Cooling Fan	Check operation and inspect fan blades for cracks or looseness.	6A	—	—	—	—	—	—	—	X
Fan Drive Belt	Inspect for nicks, cuts and wear.	6A	—	—	—	—	—	—	—	X
Fan Drive Pulley	Clean rust or rough spots from pulley grooves.	6A	—	—	—	—	—	—	—	X
Air Induction System:										
Air Cleaner Body	Inspect for cracks, loose mounting bolts and damage.	6A	—	—	—	—	X	—	—	X
Air Filter	Replace filter element.	6A	A/R							
Restriction Indicator	Check for looseness or damage.	6A	A/R							
Vacuator Valve	Check that the valve is not loose, worn or turned inside out.	6A	—	—	—	—	X	—	—	X
Hoses and Clamps	Inspect for leaking hoses or loose or damaged clamps.	6A	—	X	X	X	X	X	X	X
Mounting Brackets	Check for damaged or loose mounting strap bolts.	6A	—	—	X	—	X	—	X	—
Front Engine Cradle to Bulkhead Support Brackets	Inspect for cracks, damage and proper bolt tightness.	6A	—	X	X	X	X	X	X	X
	Inspect mounting for oil soaking, wear or damage.	6A	—	X	X	X	X	X	X	X
Rear Engine Cradle to Bulkhead Support Hangers	Inspect for cracks, damage and proper bolt tightness.	6A	—	X	X	X	X	X	X	X
	Inspect mounts for oil soaking, wear or damage.	6A	—	X	X	X	X	X	X	X
Engine to Cradle Cushion Type Mounts	Inspect mounts for oil soaking, wear or damage.	6A	—	X	X	X	X	X	X	X
	Check mounting bolts and nuts for proper tightness.	6A	—	X	X	X	X	X	X	X
Transmission to Engine Bolts	Check bolts for porper torque.	6A	A/R							
Transmission to Cradle Cushion Type Mounts	Inspect mount for oil soaking, wear, damage and proper torque.	6A	—	—	—	—	X	—	—	X

COACH MAINTENANCE SCHEDULE

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ENGINE (Cont'd)										
Engine Stop Cylinder	Check operation and lubricate.	6A	—	—	—	—	X	—	—	X
Emergency Stop Cylinder	Check operation and lubricate.	6A	—	X	X	X	X	X	X	X
Engine Governed Speed	Check and adjust.	6A	—	—	—	—	X	—	—	X
Engine Idle Speed	Check and adjust.	6A	—	—	—	—	X	—	—	X
Engine Exhaust Manifold Bolts	Check tightness.	6A	—	—	—	—	X	—	—	X
Throttle Control Tubing and Fittings	Inspect for loose, broken, charred, or leaking lines and fittings.	6B	—	X	X	X	X	X	X	X
Treadle Valve	Check valve operation.	6B	—	X	X	X	X	X	X	X
	Clean and inspect valve plunger dust boot for wear or damage.	6B	—	—	—	—	X	—	—	X
Throttle Control Assembly	Clean to remove dirt and debris, check for loose mounting bolts and fasteners.	6B	—	X	X	X	X	X	X	X
	Check operation and inspect dust boot on rod end for wear or damage.	6B	—	—	—	—	X	—	—	X
Throttle Stop Air Cylinder	Check operation and lubricate.	6B	—	—	—	—	X	—	—	X
Air Compressor	Inspect air and oil lines for leaks.	6C	—	X	X	X	X	X	X	X
	Check and tighten mounting bolts.	6C	—	—	—	—	—	—	—	X
Air Compressor Governor	Check cut-in and cut-out settings.	6C	—	—	X	—	X	—	X	—
	Clean or replace filters.	6C	—	—	X	—	X	—	X	—
	Remove, disassemble, clean, inspect and reset.	6C	—	—	—	—	—	—	—	X
Oil Cooled Generator	Inspect for excessive noise or vibration with engine running.	6D	A/R							
Starting Motor	Inspect cables for chafing, wear or damage.	6D	—	—	—	—	—	—	—	X
	Inspect brushes for wear and lube oil wicks and reservoirs.	6D	A/R							

COACH MAINTENANCE SCHEDULE

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TRANSMISSION										
Exterior	Inspect for fluid leaks.	7	—	X	X	X	X	X	X	X
	Clean and check mounting bolts for proper tightness.	7	—	—	—	—	—	X	—	—
Shift Linkage	Clean and lubricate moving linkage.	7	—	X	X	X	X	X	X	X
	Inspect for loose threaded connections, loose bolts and excessive dirt or grease.	7	—	X	X	X	X	X	X	X
	Check operation: look for worn, bent or loose or damaged parts.	7	—	X	X	X	X	X	X	X
Lines and Fittings	Inspect for damaged lines, loose connections and leakage.	7	—	X	X	X	X	X	X	X
Transmission Breather	Remove and clean.	7	A/R							
Transmission Fluid Cooler	Inspect water and fluid lines for leakage.	7	—	X	X	X	X	X	X	X
	Remove, disassemble, clean and inspect.	7	A/R							
Power Take-Off	Inspect for fluid leakage at housing and lip type shaft seal.	7	—	X	X	X	X	X	X	X
FUEL SYSTEM										
Primary Fuel Filter	Drain small amount of fuel from filter and inspect for water.	8A	A/R							
Secondary Fuel Filter	Check pressure.	8A	A/R							
Fuel Lines	Inspect for damage or fuel leakage.	8A	—	X	X	X	X	X	X	X
Fuel Tank	Inspect for damage, leaking and loose mounting bolts.	8A	—	X	X	X	X	X	X	X
EXHAUST SYSTEM										
Exhaust	Inspect for restrictions and leaks.	8B	—	—	X	—	X	—	X	—
Muffler	Inspect for leaks and loose mounting straps and bolts.	8B	—	—	X	—	X	—	X	—
Tailpipe	Check for restrictions, kinks and damage.	8B	—	—	X	—	X	—	X	—

COACH MAINTENANCE SCHEDULE

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EXHAUST SYSTEM (Cont'd)										
Hangers	Inspect for damage and loose mounting bolts.	8B	—	—	X	—	X	—	X	—
Mounting Brackets	Inspect for cracks or damage.	8B	—	—	X	—	X	—	X	—
STEERING SYSTEM										
General	Inspect all fluid lines and connections for fluid leaks.	9	—	X	X	X	X	X	X	X
Power Steering Pump	Check operation and mounting bolt tightness.	9	—	—	—	—	X	—	—	X
Steering Column and Shaft	Inspect steering shaft universal joints for wear or damage.	9	—	—	X	—	X	—	X	—
Steering Column Mounting Bracket and Support Bracket.	Check mounting bolts for tightness.	9	—	—	X	—	X	—	X	—
Steering Gear	Check mounting bolt torque.	9	—	—	X	—	X	—	X	—
Steering Shaft Seal	Inspect for wear or damage.	9	—	—	—	—	—	—	—	X
Steering Gear	Inspect for fluid leakage at gear.	9	—	X	X	X	X	X	X	X
	Inspect for bent, twisted or worn parts.	9	—	X	X	X	X	X	X	X
Turning Angle	Check and adjust.	9	A/R							
Steering Drag Link	Inspect Pitman arm and bellcrank end for wear or damage.	9	—	X	X	X	X	X	X	X
Steering Miter Gear	Inspect for loose mounting bolts and cracked or damaged brackets.	9	—	X	X	X	X	X	X	X
Steering Tie Rods	Inspect ball studs for excessive up and down motion and end play at ball end of studs.	9	—	—	X	—	X	—	X	—
	Inspect for bent condition or damaged tube threads.	9	—	—	X	—	X	—	X	—
	Check mounting stud nuts and end socket bolt nuts for tightness.	9	—	—	X	—	X	—	X	—

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STEERING SYSTEM (Cont'd)										
Steering Arms	Inspect for bent or damaged condition and proper mounting nut tightness.	9	—	—	X	—	X	—	X	—
WHEELS AND TIRES										
Wheel Stud Nuts	Check for proper torque.	10	—	X	X	X	X	X	X	X
Wheel Mounting Studs	Check for damaged threads.	10	—	X	X	X	X	X	X	X
Tires	Rotate tires.	10	A/R							
CHASSIS ELECTRICAL										
Passenger Signal Chime	Check operation of tape switches and chime.	12A	—	X	X	X	X	X	X	X
Battery Disconnect Switches	Check operation.	12A	A/R							
Battery Cables	Check for frayed or damaged cables.	12B	—	—	—	—	—	—	—	X
	Inspect for loose or corroded terminal connections and clamps.	12B	—	—	—	—	—	—	—	X
Battery Mounting	Check that hold-down clamps are tight and in good condition.	12B	—	—	—	—	—	—	—	X
Battery	Clean and inspect for damage.	12B	—	—	—	—	—	—	—	X
"RUN" Switch	Check for proper operation in each switch position.	12A	A/R							
Headlights	Check and adjust headlight aim.	12C	—	—	—	—	—	—	—	X
Interior Lighting	Check operation, mounting and lenses.	12C	A/R							
Exterior Lights	Check operation, mounting and lenses.	12C	A/R							
Engine Compartment Lights	Check operation.	12C	A/R							
COOLING SYSTEM										
Coolant	Test coolant solution.	13	—	—	—	—	—	—	—	X
	Drain and flush the system.	13	—	—	—	—	—	—	—	X

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COOLING SYSTEM (Cont'd)										
Radiator	Inspect for leaks, dirt and debris.	13	X	X	X	X	X	X	X	X
	Clean radiator core, inspect and repair bent fins, and inspect mountings and insulators for condition and tightness.	13	—	—	—	—	—	—	—	X
Hoses and Pipes	Check condition of hoses, pipes and mounting clamps. Tighten loose clamps.	13	—	X	X	X	X	X	X	X
Air Recirculation Baffles and Seals	Check condition	13	—	X	X	X	X	X	X	X
Surge Tank	Check condition of tank and filler cap.	13	—	X	X	X	X	X	X	X
	Check pressure relief valve.	13	—	—	—	—	—	—	—	X
Loss of Coolant Indicator	Check operation.	13	—	—	—	—	X	—	—	X
OPTIONAL EQUIPMENT										
Sidewall Heating System	Check underseat blower operation.	2A	—	X	X	X	X	X	X	X
Automatic Engine Shut-Off	Check operation.	6A	—	—	X	—	X	—	X	—
Exit Doors	Check for proper opening and closing.	1C	X							
	Check door opening and closing adjustments.	1C	A/R							
Exit Door Touch Bars	Check operation.	1C	A/R							
Fuel Tank Anti-Spill Device	Remove whistle valve and clean.	8A	—	—	—	—	—	—	—	X
Front Interior Dome Light	Check operation and switch adjustment.	12A	A/R							
Wheelchair Lift	Check for proper system operation and check mechanical components for sticking and binding.	1E	—	X	X	X	X	X	X	X
	Inspect air lines and connections for leakage, looseness and damage.	1E	—	X	X	X	X	X	X	X
	Check limit switches for proper operation and adjustment.	1E	—	—	—	—	—	—	—	X

COACH MAINTENANCE SCHEDULE

ITEM	INSPECT OR SERVICE	MANUAL SECTION	INSPECT DAILY OR AS REQUIRED	6,000 MILES OR 400 HOURS	12,000 MILES OR 800 HOURS	18,000 MILES OR 1,200 HOURS	24,000 MILES OR 1,600 HOURS OR 6 MONTHS	30,000 MILES OR 2,000 HOURS	36,000 MILES OR 2,400 HOURS	42,000 MILES OR 2,800 HOURS OR YEARLY
OPTIONAL EQUIPMENT (Cont'd)										
Wheelchair Lift (Cont'd)	Inspect electrical harnesses and wires for chafing and terminals for corrosion and proper tightness.	1E	—	—	—	—	—	—	—	X
	Inspect hydraulic lines for leakage or damage.	1E	—	X	—	X	—	—	X	—
	Inspect V-groove rollers, roller track panels, platform hinges, restraint arms and deploy arms for misalignment, binding and wear.	1E	—	—	—	—	—	—	—	X
	Check support tower alignment and mounting bolts for proper tightness.	1E	—	—	—	—	X	—	—	X
	Check floor level adjustment.	1E	—	—	—	—	—	—	—	X
	Inspect condition of deploy cables and check adjustments.	1E	—	—	—	—	—	—	—	X
	Check step lock tab operation and adjustment.	1E	—	—	—	—	—	—	—	X
	Check park sense switch operation and adjustment.	1E	—	—	—	—	—	—	—	X
Radiator Shutters	Clean vane bearings and lubricate.	13	—	—	—	—	—	—	—	X
	Check shutter airfilter for leakage.	13	—	—	—	—	—	—	—	X
	Replace shutter air filter.	13	—	—	—	—	—	—	—	X
	Drain filter bowl and lubricate.	13	—	—	—	—	—	—	—	X
	Check shutterstat operation.	13	—	—	—	—	—	—	—	X
	Check shutter air cylinder operation.	13	—	—	—	—	—	—	—	X
Emergency Parking Brake	Remove, disassemble and clean check valve.	5C	—	—	—	—	—	—	—	X
	Remove release valve, disassemble, clean and inspect.	5C	—	—	—	—	—	—	—	X
(1) Transmission: Without Low Oil Sensor, Telltale Light and Alarm	Check fluid level weekly or as required.									
With Low Oil Sensor, Telltale Light and Alarm	Check fluid level monthly or as required.									

FIGURE 7A.2 Tasks in a Preventive Maintenance Program
(3,000 mile interval)

Section 00
Preventive Maintenance Schedule

For Transit and
Suburban Coach Models

Table of Contents

APRIL 1983
Revised January 1985

INTRODUCTION

The following Preventative Maintenance schedules have been designed to cover the operating features and special equipment of the ORION bus. These schedules will also comply with other transit equipment in your fleet, allowing for no interruption of the normal maintenance routine. There are four phases of inspections that are performed as the mileage and age of the vehicle increases. This manual only points out which components or areas are to be serviced or lubricated. For specific disassembly and servicing instructions, see the appropriate section of the ORION Service Manual.

INSPECTION "A"	Safety Service Check -every 3,000 miles (5,000 km)
INSPECTION "B"	Intermediate Inspection -every 12,000 miles (20,000 km).
INSPECTION "C"	Major Inspection - including the power train every 24,000 miles (40,000 km).
INSPECTION "D"	Clinical Inspection - every 48,000 miles (80,000 km). Each major system is thoroughly checked and serviced.
START UP INSPECTION	Although ORIONS are put through a stringent pre-delivery inspection at the factory; upon delivery many operators conduct their own inspection before the buses are placed into service. When this is done Inspection "A" can be used as a guideline.

MANUFACTURERS LUBRICATION, MAINTENANCE PROCEDURE AND REFERENCE BOOK LIST

TRANSIT BUS AND SUBURBAN COACHES

A diagram is included (Fig.1, pg.4) to provide approximate locations of key lubrication points on the ORION bus or coach. Individual figure numbers on diagram refer to paragraph numbers in the various inspection checks following. Where cleaning, removal or dissassembly are required for lubrication purposes, these procedures are covered in the applicable sections of the ORION Service Manual.

The lubrication intervals are based on normal operating conditions. Under adverse conditions, increased servicing is required.

Lubricants in the transmission and differential are supplied as factory fill; new vehicles should be drained and refilled at 1,000 miles (1,600 km), in no case over 3,000 miles of initial operation.

It is recommended that buses equipped with a Sundstrand hydraulic system have the fluid and filters replaced initially at 10,000 miles and every 48,000 miles thereafter.

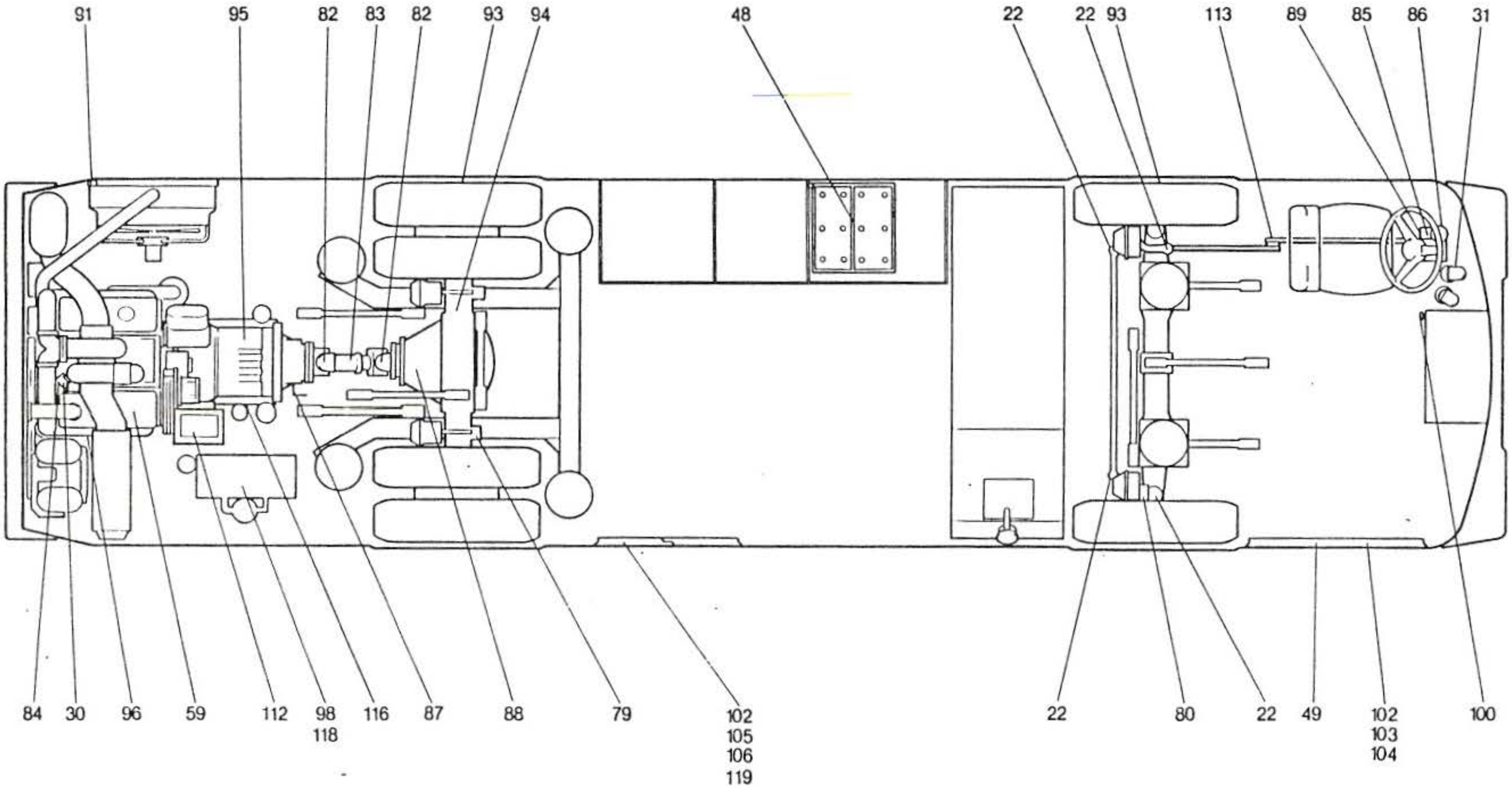
Since the ORION is assembled with many components of different manufacturers, it is recommended that we refer to individual manufacturers' manuals for their maintenance procedures and lubricants. The chart below indicates where the information can be found.

Front Axle	Rockwell Field Maintenance Manual No.1
Brakes	Rockwell Field Maintenance Manual No.4,4A
Rear Axle	Rockwell Field Maintenance Manual No. 1,No.5
Differential	Rockwell Failure Analysis Manual No. TP-8398 for Drive Axle Carriers
Transmission	Detroit Diesel Allison Transmission Service Manual
Engine	Detroit Diesel Allison Engine Manual. Refer to Detroit Diesel Allison Engine Service Manual for engine lubrication and filter change intervals. Only after an oil analysis is performed can time of lubrication intervals be increased.

DAILY CHECK LIST

DESCRIPTION	METHOD
Engine	Check engine oil level. Check coolant system level. Check air conditioning freon level - receiver tank. Check A/C Compressor oil level.
Transmission	Check transmission fluid level.
Hydraulic Fluid	Check hydraulic fluid level (see sight level).
Front & Rear Wheel Bearing Oil & Grease Level	Check Visually for leakage.
Wheel Chair Lift (Option)	Operate through all modes.
Interior & Exterior Lighting	Check operation of all lighting.
Windshield Wipers and Washer	Check operation of wipers and check washer fluid level in tank.
Pull Cord or Touch Tape Chime Operation	Check operation.
Entrance and Exit Doors	Check Operation.
Air System	Check air system operation. Check for satisfactory braking of bus.
Instrument Panel	Ensure all gauges and controls are operating correctly.

LUBRICATION DIAGRAM



MAINTENANCE

INSPECTION "A" - 3,000 MILES (5000 KM)

1. Driver's side switch panel and front instrument panel - operator's compartment

   a) Check all gauges for correct operation of systems.
   b) Check all warning and indicator lights.
   c) Check operation of warning buzzer.
   d) Check all switches.

2. Driver's Seat and Seat Belt

   a) Inspect seat coverings for wear.
   b) Check seat operation and adjustments.
   c) Check seat base for secure mounting.
   d) Check seat belt operation and adjustment.

3. Windshield Wipers and Washer - Check for:

   a) Proper operation.
   b) Worn blades and arms.
   c) Worn linkage.

4. Rear Door Interlock

   a) Check door interlock with rear door authorized... ..service brakes should be applied with a reduced pressure of 45 P.S.I.
   b) Check door interlock with control lever in the door closed position ....service brakes should be fully released.

5. Check air compressor governor cut in and cut out pressure. Cut in 90 P.S.I., cut out 120 P.S.I.

6. Check and adjust brakes(if not equipped with automatic slack adjusters). Check if air loss is at an acceptable level when brake application is made using dash-mounted air pressure gauges; no more than 5-8 P.S.I. loss per application is allowed.

7. Check operation of slack adjusters, cams and brake chambers.

8. Check for brake system air leaks.

9. Air Tanks

   a) Check air tanks for secure mounting.
   b) Check drain cocks for proper operation and air leaks.
   c) Drain air tanks and check for oil and water discharge.
   d) Check operation of AD-2 Dryer discharge.

10. Parking Brake-Air Operated

    a) Check for correct operation.

11. Hoses and Lines

    a) Check all hoses and lines for leakage, deterioration and tightness.

12. Advertisement Signs

    a) Check for secure mountings.

13. Windows and Mirrors

    a) Check all windows for cracks and broken glass.
    b) Check all mirrors for cracks, fogging and loose hardware.
    c) Check windshield for cracks, stone chips.
    d) Check all windows and latches for correct operation.
    e) Note any indication of water leaks.

14. Overhead Handrails and Stranchions

    a) Check all handrails and stanchions for security of mounting, sharp edges, cracks and peeling.

15. Seats

    a) Check all seats for wear, rips, slashes.
    b) Check seat frames for security of mounting, breaks, cracks or corrosion.

16. Fire Extinguisher

    a) Check indicator for pressure loss.

17. Check step wells and floor coverings for damage.

18. Check decals (Watch Your Step), etc. for any damage.

19. Driver's Curtain and Destination Sign

    a) Check operation.

20. Tires

    a) Check for correct inflation pressure and adjust if required. See tire manufacturer Specs. for correct inflation pressure.
    b) Tread depth - not less than 3/32" on all tires.
    c) Check for indications of abnormal tire wear.

21. Entrance, Exit Door and Access Door Operation

a) Check operation of doors (opening, closing, sensitive edge).
b) Check operating linkage for proper adjustment... ..tighten jam nuts and secure mountings.
c) Check front and rear door air system for leaks.
d) Check door wiring for tight connections and security of cables.
e) Check all compartment doors for security of latches and hinges.

22. Front and Rear Axle and Suspension

Front Axle

a) Check radius and lateral rod mounting bolts and tie rod end clamp bolts for correct torque.

	BOLT	WET TORQUE
Adjustable radius rod bolts	1"-14 x 5 Gr 5	660 ft. lbs.
Fixed radius rod bolts	" " " " " "	" " "
Lateral stay rod bolts	1"-14 x 5 Gr 5	660 ft. lbs.
Lateral Stay rod bolts	3/4"-10x1-3/4"Gr8	375 ft. lbs.
Tie rod end clamp nuts	5/8"-18x3 Gr 5	50-65 ft. lbs.
Adjustable radius rod clamp nuts	5/8"-18x2-1/2 Gr5	45 ft. lbs.

b) Lubricate the following:

King Pin Bushings - 2 zerk fittings.
Tie rod ends - 2 zerk fittings.
Drag link ends - 4 zerk fittings.

Rear Axle

a) Check radius and lateral rod mounting bolts for correct torque.

	BOLT	WET TORQUE
Fixed Radius Rod Bolt	1"-14x5 Gr5	660 ft. lbs.
Fixed radius Rod Bolt	3/4"-10x1-3/4 Gr 8	375 ft. lbs.
Lateral Stay Rod Bolt	1"-14x5 Gr 5	660 ft. lbs.

b) Check all torque rods for loose or worn bushings.
c) Check axle mounting bolts.

23. Shock Absorbers

    a) Check for indication of loose mountings.
    b) Check for fluid leaks.

24. Differential

    a) Remove filler plug and check level. If level is low, check and repair any leaks that are found before filling.
    b) Check for correct operation of vent.

25. Drive Shaft

    a) Check universal joints for wear of the yoke,flange, slip yoke, journal or needle bearings.
    b) Check needle bearing cover cap screws for tightness.
    c) Check shaft slip joint for excessive play and ensure that the dust cap is in place and tight.
    d) Clean or replace faulty or damaged Zerk fittings at lubrication points.

26. Engine and Accessories

    a) Check engine for oil leaks.

27. Check for exhaust system leaks.

28. Ensure engine air intake hoses are secure.

29. Check and adjust tension of V-belts.

30. Lubricate throttle control, cylinder linkage.

31. Lubricate accelerator and brake treadle controls.

32. Emergency Shutdown - 6V53 Series Engines and 6V71 NA Engines

    a) Check emergency engine shutdown operation.

33. Lower mounted Alternator - Check Filter.

34. Check water hoses and radiator for coolant leaks.

35. Transmission

    a) Check transmission connections and lines for fluid leaks.

36. Check neutral start switch for correct operation and adjustment.

37. Air Conditioning Condenser - cleaning

a) Spray condenser with warm soapy water or steam.
b) Remove all dirt, grease and lint.
c) Straighten any bent coil fins.

38. Air Conditioning Freon Level

a) Ensure liquid is seen in sight glass of receiver.

39. Air Conditioning Compressor

a) Check oil level, after running.

40. Air Conditioning Connections

a) Check for oil and dirt; clean if necessary.

41. Shut off Condenser fan when out of season.

42. Front and Rear Heater

a) Check blower operation.

43. Front Heater Core

a) Check for indications of leaks from heater core, hose connections, circulating pump, water shut off valves and connecting water lines.

44. Main Heater - Rear

a) Clean or change air return filter for heater and clean any accumulated debris from heater core.
b) Check core for water leaks.
c) Check heater air intake hose.

45. Circulating Pumps

a) Check pump motors for operation.

46. Oil Burner - Auxiliary Heater (Option)

a) Start up and check operation - occasional use of heater prevents heater electrodes from oxidizing.

47. Battery

    a) Clean battery terminals if required.
    b) Check battery for cracked case, broken cell tops, missing caps, cracked cell connectors and loose terminals.
    c) Check battery hold-down for security.
    d) Clean and check terminals and cables for broken insulation and corroded terminals.
    e) Coat terminals with corrosion resistant compound, Korode Kure or Permatex.
    f) Clean electrolite from battery.
    g) Clean compartment drain holes.
    h) Check and record specific gravity reading of battery cells. Fill to correct level (use automatic water jug if possible).

48. Check battery slide track for lack of lubrication.

    a) Swing out tray (transit).
    b) Slide out tray (coach).

49. Wheelchair Lift (Option)

    a) Lubricate all fittings.

50. Fare Box Light and Mechanism

    a) Check operation of coin drop.

51. Check all exterior lighting for defective bulbs, security of mounting, broken lenses and proper operation.

52. Interior Lighting

    a) Check operation and security of lens mounting.
    b) Replace all defective bulbs or fluorescent lights.

53. Crack open fuel tank drain cocks to allow condensation to drain from bottom of tank.

INSPECTION "B" - 12,000 MILES (20,000 km)

OR FOUR MONTHS.

54. Carry Out Steps 1 - 53

55. Air Compressor

    a) Check for security of mounting.
    b) Check for oil and water leaks.
    c) Check for correct build-up time.
    d) Check for excessive noise in drive coupling.

56. Air Throttle (air operated)

    a) Check accelerator pedal for wear.
    b) Check general throttle operation.

57. Engine Air Intake

    a) Check air intake for secure mounting to blower.
    b) Check air intake system for restriction.
    c) Check air intake restriction indicator for cracks and operation.
    d) Replace engine air filter when a restriction of 20" of Mercury is indicated on the NA Engines.
    e) Replace engine air filter when a restriction of 25" of Mercury is indicated on the TA Engines.

58. Check for fuel leaks and security of mounting of tank and lines.

59. Engine

    a) Check engine oil pressure with gauge on vehicle.
    b) Check all seals and gaskets for indications of oil leaks.
    c) Change engine fuel filters after 10,000 to 15,000 miles of operation.
    d) Change engine oil and filters. Oil change intervals may vary when oil analysis is performed - see Detroit Diesel Engine recommendations.

60. Transmission

    a) Check shift lever and controls for proper adjustment.

    b) Transmission - Bennett Shifter - check accumulator pressure.

61. Engine Mounts

    a) Check engine mounts for indication of movement or loose hardware.

62. Air Spring Assembly

    a) Check body height and adjust to proper specifications.
    b) Check air springs for air leaks and security of mountings.

63. Levelling Valve and Lines

    a) Check Levelling valve for proper operation and air leaks.
    b) Check for loose or broken anchor brackets.

64. Seals and Bearings

    a) Check front and rear grease seals for leakage.
    b) Check bearings for wear/looseness.

65. Tie Rods and Drag Link

    a) Move steering wheel and check drag link for wear.
    b) Check for broken or damaged dust seals.
    c) Check Pitman and idler arms for distortion or damage.

66. Steering Shaft, Box and Column

    a) Turn steering wheel and check for rough spots or excessive play.
    b) Check steering for security of mounting.
    c) Check steering for oil leaks.
    d) Check universal joints for wear or excessive play.
    e) Check steering wheel for cracks or rough edges.

67. Front Wheel Alignment

    a) Check for uneven tire wear.
    b) Check toe-in.

68. Evaporator Coil Air Conditioning

    a) Remove all dirt, grease and lint.

69. Pressure test Air Conditioning System.

70. Evaporator Blowers

    a) Ensure proper motor operation by checking for adequate air flow at both right and left outlets.

71. Alternator

    a) Check condition of Air Conditioning alternator.

72. Condenser Fan

    a) Ensure proper motor operation by standing near condenser compartment to verify that air flow through coil is adequate, and fan is operating properly.

73. Hose and Compressor Seal

    a) Visually check for oil and dirt accumulation on any surface imdicating a refrigerant and/or oil leak. Visible leaks, bubbling or oil accumulation indicates a worn out hose or seal.
    b) Replace defective parts.

74. Compressor Mounting

    a) Tighten loose mounts, replace cracked or broken mounts and brackets.

75. Engine Idle

    a) Set engine idle r.p.m. with air conditioner operating, if equipped; refer to manufacturer's specification.

76. Dehydrator Strainer

    a) Determine that no temperature difference exists across filter drier.

    b) If variance is found replace filter.

77. Check conditions and tension of all air conditioning belts.

78. Road Test Bus. Check operation of all systems and controls.

LUBRICATE THE FOLLOWING:

79. Brake slack adjusters
    1 fitting per adjuster

80. Brake cam shaft
    1 fitting per cam shaft

81. Brake anchor pins - newer models only
    Apply as required (do not overload with grease).

82. Drive shaft U-joints

83. Drive shaft slip joints

84. Governor housing

85. Steering column U-joints
    2 fittings
    NOTE: To gain access to lubricate U-joints and slip joint, slide up front cover of steering column pedestal.

86. Steering Column slip joint

87. Speedometer cable

88. Ensure oil level in differential is kept up to filler plug - check vent operations.

89. Steering box (mechanical) check oil level.

90. Starter Motor - add oil sparingly through cups with cover wicks on each side of starter.

91. Lubricate radiator shutters and linkage.

INSPECTION "C" - 24,000 MILES (40,000 km)

OR EIGHT MONTHS

92. Carry Out Steps 1 - 91

93. Front Axle
    Wheel bearings - drain, flush, refill,or repack, when brakes are relined or at least once a year.

94. Rear Axle
    Differential and wheel bearings - drain, flush, refill, or repack, when brakes are relined or at least once a year, 20,000 - 40,000 miles.

95. Transmission
    Drain transmission fluid, change filter, clean screen and fill with new Dextron 2 oil.
    Replace transmission modulator, Torque mounting bolts 15 to 20 ft. lbs.

96. Engine Mounts
    Torque all engine mounts and supports to proper specifications.

97. Steering
    Check front axle king pins and ball joints for excessive wear and play.

98. Hydraulic System - All Systems except Sundstrand
    a) Change hydraulic oil.
    b) Change filter (s).
    c) Check and clean system.

99. Air Dryer
    a) Check for moisture in air brake system.
    b) Determine whether desiccant is to be replaced in cartridge.
    c) Check all mounting bolts for tightness.
    d) Check all electrical and air connections for security.
    e) Check general operation of air dryer.

100. Front Heater
    Lubricate defroster linkage and all moving parts.

INSPECTION "D" - 48,000 MILES (80,000 km)

OR 12 MONTHS.

101. Carry out steps 1-100.

102. Front and Rear Door - 2 Leaf Plug-Bode
Inspect or Lubricate the following:

a) Inspect all ball joints on the radius rod and the door support arm. Ensure ball joints operate correctly.

b) Ensure all locknuts are secure on the swingarm.

c) Grease the spindle drive with 3 to 5 injections of high temperature grease.
*Note: Do not overgrease as this may cause damage to spindle drive unit.

d) Remove spindle drive motor cover and clean cover and motor. Move grease from bottom of cover up around inside of cover.

e) Check operation of solenoid and steptreadle.

103. Front Door - Slide Glide

a) Lubricate with oil the pin that connects the clevis attachment to the door turning lever.
b) Inspect hoses and fittings for leaks using soap and water solution.

104. Front Door - Single Leaf Sedan

a) Lubricate upper hinge assembly - 1 Zerk fitting.

b) Repack lower hinge with grease.

c) Inspect hoses and fittings for leaks using soap and water solution.

105. Rear Door - Swing Out

a) Inspect and lubricate upper door shaft bearings and lower door shaft bearings on adjusting brackets.

b) Inspect hoses and fittings for leaks using soap and water solution.

c) Check operation of solenoids, relays, micro switches, touchbars, or steptreadle.

106. Rear Door - 2 Leaf Plug

a) Inspect and Lubricate upper lever thrust bearings, lower shaft bearings and upper and lower spindle assembly bushings.

b) Inspect hoses and fittings for leaks using soap and water solution.
c) Check operation of solenoids, relays, micro switches, touchbars or steptreadle.

107. Brake and Air Operated Valves and Switches

a) Check valves - check for proper operation and leakage.
b) Treadle valve - check operation, mounting and leakage.
c) Relay valves - apply brakes and check that air pressure is quickly exhausted from exhaust ports.
d) Stop light switch - check electrical connections and leakage.
e) Low air pressure switch - check operation of low air warning buzzer and fittings for leakage.
f) Pressure regulating valves - check for leakage and correct regulated pressure. If not correct, set to manufacturer's recommendations.
g) Door control valve - check for smooth operation, micro-switch adjustment, electrical connections and leakage.
h) Entrance door mechanism - check closing and opening speeds.

108. Accelerator Interlock Solenoid

a) The accelerator interlock disconnects throttle from engine so the r.p.m. cannot exceed idle speed when doors are authorized or open. When cylinder is not functioning properly, replace with rebuilt or new unit.
Check operation of brake interlock and accelerator interlock solenoids; ensure that they function simultaneously.

109. Air Tanks

a) Inspect brackets of air tanks for security of mounting.
b) Leak test all fittings.

110. Battery

a) Remove batteries from the bus or coach, clean off all corrosion from tray and repair and paint if necessary. Wash batteries clean; visually inspect and reinstall. If no defect is found, the batteries are to be given a light load test to determine the condition of the battery cells.

111. Voltage Regulator

a) Carry out a voltage regulator check and adjust regulator to specifications, if required.

112. Lubricate alternator mounting saddle. (Leece Neville, Delco)

113. Steering Idler Arm - older models - repack with grease.
- newer models - grease fitting.

114. Transmission Shift Speeds - operate bus and observe that transmission shifts at correct speeds. Also check that shifts are not sluggish, hesitant or rough.

115. Engine

a) Inspect and torque all engine mounts.

High Idle

a) Fast idle, if equipped, should be set at recommended rpm.

116. Transmission - Engine Linkage

Check linkage, control levers, clevis pins and shaft bearing for wear. Replace, repair or lubricate as needed.

117. Differential

a) Check differential for noise.
b) Inspect differential for oil leaks.
c) Check breather.
d) Torque mounting bolts.

118. Sundstrand Hydraulic System

a) Drain hydraulic fluid from reservoir and flush thoroughly.
b) Clean magnets attached to suction line filter holders.
c) Replace all filters.
d) Replace reservoir gasket if swollen or damaged.

119. Rear Door
Swing Out and 2-Leaf Plug

Lubricate with oil spherical rod end bearing located on operator piston rod(s).

FIGURE 7A.3

PREVENTIVE MAINTENANCE INSPECTION

COACH NO. ________ MILES ________ TYPE: 3,000 - 6,000 - 9,000 - 12,000 - 24,000 FUEL MILEAGE ________ M.P.G.

DATE COMPLETED ________________ OIL MILEAGE ________ M.P.Q.

SYMBOL FOR CHECKING: XX - REPAIRS MADE; X - ADJUSTMENTS; ✓ - O.K.

Description	Repairs Made	Adj.	O.K.	Mech. Init.
Engine				
Steam clean:				
Change oil (6,000)				
Change oil filter (6,000)				
Change fuel filters				
Primary (6,000)				
Secondary (9,000)				
Pull dry filter (12,000)				
Oil bath (6,000)				
Transmission filter (12,000)				
Transmission oil (24,000)				
Perry water filter (12,000)				
"Check" all belts				
Pully wear				
Motor mounts				
Alternator mounting				
Brackets, etc.				
Radiator hose & clamps				
Clamps, leaks				
Radiator mounts				
Surge tank & cap				
Low oil warning				
Hot engine warning				
Oil Leaks				
Engine condition				
Fuel lines & leaks				
Exhaust system				
Air filter hose, clamps				
Brackets				
Engine tune-up (24,000)				
Check injector timing				
Rack adjustment				
Head bolts — proper torque				
Check emergency shutdown				

Description	Repairs Made	Adj.	O.K.	Mech. Init.
Valve adjustment				
Engine R.P.M.'s idling				
Top gov. R.P.M.'s				
Hot-oil pressure idling				
Oil pressure 1800 R.P.M.'s				
CHASIS INSPECTION:				
Lubricate all fittings				
Brake cams (6,000)				
CHECK:				
Steering linkage				
Drag line				
Tie rod ends				
Sector mounting				
Drop arm				
Hydraulic lines				
Leaks, mountings				
Transmission oil (24,000)				
Mounting bolt				
Drive shaft "U"				
Joints alignment				
Flange mounting				
Adjust brakes				
Slack adjustor bushings				
% of lining				
Cam bushings				
Check brake interlock				
Set leveling valves				
Radius rods				
Stabilizers bars				
Mounting bolts				
Front and rear				
Wheel brg's adjustment				
Wheel lugs — axle flange bolt				

Description	Repairs Made	Adj.	O.K.	Mech. Init.
Inflate tires and mate				
Check air tanks				
Automatic drain				
Apply brakes for leaks				
All lines and chambers				
CHANGE DIFFERENTIAL				
Oil (24,000)				
Pinion seal				
Check heater line & duct				
Air filters				
Shocks & Mountings, links				
Fuel tanks				
Road test — shifting				
Up and down shift				
ELECTRICAL:				
CHECK:				
All lights				
Alternator voltage (6,000)				
Operation of water				
Sensing probe				
Over rule switches				
Heaters — defrosters				
A.C. fan				
Dash fan				
Instrument panel				
Battery cables				
Terminals — clean				
Post install resister				
Felts				
All wires & terminals				
Passenger signal				
Battery water & caps				
CHECK:				

(OVER)

FIGURE 7A.3 Continued.

Description	Repairs Made	Adj.	O.K.	Mech. Init.	Description	Repairs Made	Adj.	O.K.	Mech. Init.	
BODY CONT'D.					AIR CONDITIONING					
Inspection sticker					CHECK:					
General appearance					Freon					
Condition of paint					Compressor operation					
Body and wheels					If low – check for leaks					
Body damage					Note sight glass in Freon flow					
Condition steps					Belts and adjustment					
Ft. rear					Evaporator filters					
Seats – floor					Blower for air volume					
Glazing, mirrors					Freon line for chafing					
Stanchions					Oil level in compressor					
Emergency roof latch					Pump mounting					
Fare box mounting & light					Belts, air cylinder adjustment					
Door valve					Caps on valves					
Doors – fr. rear					Re-charge/check head pressure					
Outside advertisement frames					Wire connection on all units					
Windshield wipers					Fan switch for H-speed operation					
WHEELCHAIR LIFT					Lines to condensor/brackets, etc.					
CHECK:					Clutch adjustment					
Control switches										
Complete operation										
Linkage										
Hydraulic lines										
Manual operation										
Binding or wear (correct)										
Modual controls										
Adjustments										

REPORT OF ADDITIONAL REPAIRS TO BE MADE

THIS IS TO CERTIFY THAT EACH ITEM HAS BEEN CHECKED ACCORDING TO INSTRUCTIONS

MECHANICS' SIGNATURES

FOREMAN ____________________

SIGNED AND FILED ____________________

SUPERINTENDENT OF MAINTENANCE

FIGURE 7A.4

2,500 MILE SERVICE INSPECTION

ALL COACHES

Property: ____________________

Coach No. ____________ Inspection Miles: ____________ Date ____________ 19____

Symbol Definition: / O.K.
X ADJUSTED
O REPAIRS NEEDED

NOTE: REFER TO MANUFACTURER'S MAINTENANCE MANUALS FOR DETAILS OF INSPECTION PROCEDURES

COACH INTERIOR INSPECTION

MECH. NO.	SYMBOL	CHECK The Following:
___	___	FREE-PLAY IN STEERING WHEEL
___	___	BRAKE & ACCELERATOR-PEDAL OPERATION
___	___	HORN FOR SOUND & BUTTON OPERATION
___	___	AIR, OIL & GENERATOR GAUGES FOR OPERATION
___	___	TEMPERATURE GAUGE FOR OPERATION
___	___	SHIFT-TOWER & LEVER OPERATION
___	___	HAND OR AIR BRAKE OPERATION
___	___	WINDSHIELD-WIPER SWITCH & OPERATION
___	___	WINDSHIELD WASHER
___	___	REAR-VIEW MIRRORS
___	___	HEAD-LIGHTS & DIMMER SWITCHES
___	___	DOME, DASH & STEPWELL LIGHTS
___	___	OPERATION OF TURN-SIGNAL LIGHTS
___	___	PASSENGER-BUZZER FOR SOUND & ACTION
___	___	CHECK DESTINATION-SIGN OPERATION & LIGHTS
___	___	FRONT AND REAR-DOOR OPERATION
___	___	INSTRUMENT-PANEL SWITCHES
___	___	START & STOP SWITCHES
___	___	HEATER & BLOWER OPERATION
___	___	DASH FANS
___	___	DRIVER'S - SEAT AND OPERATION
___	___	WINDOWS, LATCHES & OPERATION
___	___	STANCHION & GRAB-RAILS FOR DEDFECTS
___	___	SEATS, FRAMES & COVERING FOR DEFECTS
___	___	BUZZER-CORD
___	___	EMERGENCY DOOR-LEVER & OPERATION
___	___	FLOOR-COVERING FOR LOOSENESS & DEFECTS
___	___	STEPWELLS FOR LOOSE COVERING & DEFECTS
___	___	SAFETY-DOOR EDGES & TREADLES, ETC.
___	___	WHEELCHAIR LIFT
___	___	FAREBOX MOUNTING & LIGHT
___	___	A/C FILTERS

COACH EXTERIOR INSPECTION

MECH. NO.	SYMBOL	CHECK The Following:
___	___	GENERAL BODY & PAINT CONDITION
___	___	EXTERNAL LIGHTS
___	___	TIGHTEN WHEEL & AXLE-FLANGE NUTS

CHECK AND SERVICE BATTERIES

VOLTAGE	BATTERY NO.	HYDROMETER
___	___	___
___	___	___
___		___
___		___
___		___
___	___	___
___	___	___
___		___
___		___
___		___
___		___

COACH UNDER CHASSIS INSPECTION

MECH. NO.	SYMBOL	CHECK The Following:
___	___	TIE-ROD & DRAG-LINK FOR WEAR
___	___	CHECK AND ADJUST BRAKES
___	___	CHECK AND DRAIN AIR-TANKS
___	___	CHECK VISUALLY ALL UNDER-FLOOR EQUIPMENT
___	___	COMPLETE CHASSIS LUBRICATION AS PER MFG. SF
___	___	DIFFERENTIAL OIL-LEVEL
___	___	HEATER FILTER

COACH ENG. COMPARTMENT INSPECTION

MECH. NO.	SYMBOL	CHECK The Following:
___	___	CHECKS FOR LEAKS-WATER, OIL FUEL & AIR-LINE
___	___	CHECK TRANSMISSION-LEVEL
___	___	CHECK HYD. FLUID-LEVEL
___	___	SERVICE AIR-COMPRESSOR & AIR-CLEANER
___	___	CHECK & SERVICE ENGINE AIR-CLEANERS

COACH ENG. COMPARTMENT LUBRICATION

MECH. NO.	SYMBOL	CHECK The Following:
___	___	GREASE BELLCRANKS, ETC.
___	___	OIL CLEVISES AND LINKAGE
___	___	STARTER
___	___	GENERATOR
___	___	CHECK & AIR-TIRES
___	___	BELTS

NOTE: Any repairs needed which cannot be made at the time of the Inspection should be listed under Remarks on reverse side.

FIGURE 7A.5

5,000 MILE SERVICE INSPECTION

ALL COACHES

Property: ____________________

Coach No. ____________ Inspection Miles: ____________ Date ____________ 19____

Symbol Definition: /O.K.   X ADJUSTED   O REPAIRS NEEDED

NOTE: REFER TO MANUFACTURER'S MAINTENANCE MANUALS FOR DETAILS OF INSPECTION PROCEDURES

COACH INTERIOR INSPECTION

MECH NO.	SYMBOL	CHECK The Following:
___	___	FREE-PLAY IN STEERING WHEEL
___	___	BRAKE & ACCELERATIOR-PEDAL OPERATION
___	___	HORN FOR SOUND & BUTTON OPERATION
___	___	AIR, OIL & GENERATOR GUAGES FOR OPERATION
___	___	TEMPERATURE-GUAGE FOR OPERATION
___	___	SHIFT-TOWER & LEVER OPERATION
___	___	HAND OR AIR BRAKE OPERATION
___	___	WINDSHIELD-WIPER, SWITCH & OPERATION
___	___	REAR-VIEW MIRRORS
___	___	HEAD-LIGHTS & DIMMER SWITCHES
___	___	DOME, DASH & STEPWELL LIGHTS
___	___	OPERATION OF TURN-SIGNAL LIGHTS
___	___	PASSENGER-BUZZER FOR SOUND AND ACTION
___	___	CHECK DESTINATION SIGN-OPERATION & LIGHTS
___	___	FRONT AND REAR DOOR OPERATION
___	___	INSTRUMENT-PANEL SWITCHES
___	___	START & STOP SWITCHES
___	___	HEATER & BLOWER OPERATION
___	___	DRIVER'S-SEAT AND OPERATION
___	___	WINDOWS, LATCHES & OPERATION
___	___	STANCHION & GRAB-RAILS FOR DEFECTS
___	___	SEATS, FRAMES & COVERING FOR DEFECTS
___	___	BUZZER - CORD
___	___	EMERGENCY EXITS
___	___	GENERAL INTERIOR CONDITION: PAINT, PANELS, ETC
___	___	FIRE EXTINGUISHER
___	___	DOOR-ENGINES FOR AIR LEAKS, ETC.
___	___	FLOOR COVERING FOR LOOSENESS & DEFECTS
___	___	STEPWELLS FOR LOOSE COVERING & DEFECTS
___	___	SAFETY-DOOR EDGES & TREADLES, ETC.
___	___	WHEELCHAIR LIFT
___	___	DASH FANS
___	___	A/C FILTERS
___	___	CHECK FAREBOX MOUNTING & LIGHT

COACH EXTERIOR INSPECTION

MECH NO.	SYMBOL	
___	___	CHECK MARKER & CLEARANCE, STOP & TAIL LIGHTS
___	___	DOOR & FRNDER-RUBBERS
___	___	GENERAL BODY & PAINT CONDITION
___	___	TIGHTEN WHEEL & AXLE-FLANGE
___	___	CHECK VISUALLY TIRES FOR UNEVEN WEAR, CUTS, ET

CHECK AND SERVICE BATTERIES

FILL IN THE FOLLOWING:

VOLTAGE	BATTERY NO.	HYDROMETER
___	___	___
___		___
___		___
___		___
___		___
___		___
___		___
___	BATTERY NO.	___
___	___	___
___		___

COACH UNDER CHASSIS-PIT INSPECTION

MECH NO.	SYMBOL	CHECK The Following:
___	___	DRAG-LINK & TIE-ROD FOR WEAR
___	___	PEDAL SHIFTER, ACCELERATOR & HAND BRAKE RODS FOR WEAR
___	___	FRONT AIR RIDES & MOUNTINGS
___	___	CHECK & DRAIN AIR-TANKS-MOUNTINGS
___	___	CHECK FUEL TANKS FOR LEAKS, ETC.
___	___	REAR-AIR RIDES & MOUNTINGS
___	___	HAND-BRAKE LINKAGE & ADJUSTMENT OF SHOE
___	___	DRIVE-SHAFT & "U"-JOINTS FOR LOOSENESS
___	___	DIFFERENTIAL-PINION-SEALS & HOUSING FOR LEAKS
___	___	BRAKE DIAPHRAMS FOR LEAKS (BRAKES APPLIED)
___	___	CAM-TRAVEL & POSITION (BRAKES APPLIED)
___	___	BRAKE-RELEASE OPERATION & ADJUST BRAKES
___	___	CHECK HEATER FILTER & CORES
___	___	CHECK RADIUS ROD BUSHINGS
___	___	CHECK SHOCK ABSORBERS
___	___	BRAKE SHOE RETURN SPRING OPERATION
___	___	WHEEL-SEALS FOR OIL OR GREASE LEAKS
___	___	ENTIRE UNDER-CHASSIS OF COACH FOR DEFECTS
___	___	CHECK DIFFERENTIAL OIL-LEVEL
___	___	COMPLETE CHASSIS-LUBRICATION PER MFG'S SPEC.

COACH ENG. COMPARTMENT INSPECTION

MECH NO.	SYMBOL	CHECK The Following:
___	___	BLOW-OUT RADIATOR FINS FROM INSIDE
___	___	RADIATOR FILLER CAP & GASKET
___	___	CHECK RAIATOR SHUTTER OPERATION
___	___	TAIL-PIPE AND MOUNTINGS
___	___	BULKHEAD BELLCRANKS, RODS & CLEVISES
___	___	AIR-COMPRESSOR INLET TUBE
___	___	CHECK MUFFLER & EXHAUST PIPE
___	___	CHECK WATER-MANIFOLD FOR LEAKS
___	___	CHECK AND AIR TIRES

COACH ENG. COMPARTMENT LUBRICATION

MECH NO.	SYMBOL	
___	___	SHUTTER AIR CYLINDER
___	___	THROTTLE AIR CYLINDER
___	___	STARTER
___	___	GENERATOR
___	___	CLEAN ENGINE AIR-CLEANERS & CHECK INTAKE
___	___	CLEAN ENGINE OIL STRAINER (IF EQUIPPED)
___	___	CHANGE ENGINE OIL FILTER ELEMENT
___	___	CHANGE ENGINE LUBE OIL
___	___	CHECK TRANSMISSION OIL LEVEL
___	___	CHANGE FUEL FILTERS (10,000)

FIGURE 7A.6

20,000 MILE SERVICE INSPECTION

ALL COACHES

Property:______________________________

COACH NO.____________
INSPECTION MILES____________
DATE____________________

SYMBOL DEFINITION: / O.K.
X ADJUSTED
O REPAIRS NEEDED

NOTE: REFER TO MANUFACTURER'S MAINTENANCE MANUALS FOR DETAILS OF INSPECTION PROCEDURES

COACH INTERIOR INSPECTION

MECH NO.	SYMBOL	CHECK The Following:
____	____	FREE-PLAY IN STEERING WHEEL
____	____	BRAKES, ACCELERATOR-PEDAL OPERATION
____	____	HORN FOR SOUND & BUTTON OPERATION
____	____	AIR, OIL & GENERATOR, GUAGES FOR READING & OPERATION
		TEMPERATURE-GUAGE OPERATION
____	____	SHIFT-TOWER & LEVER OPERATION
____	____	HAND OR AIR BRAKE OPERATION
____	____	WINDSHIELD-WIPER, SWITCHES & OPERATION
____	____	REAR-VIEW MIRRORS
____	____	HEAD-LIGHTS & DIMMER SWITCHES
____	____	DOME, DASH & STEPWELL LIGHTS
____	____	TURN-SIGNAL OPERATION & LIGHTS
____	____	PASSENGER-BUZZER FOR SOUND & OPERATION
____	____	DESTINATION -SIGN FOR OPERATION & LIGHTS
____	____	FRONT & REAR-DOOR OPERATION
____	____	INSTRUMENT-PANEL SWITCHES
____	____	STOP & START-SWITCHES
____	____	HEATER & BLOWER OPERATIONS
____	____	DRIVER'S-SEAT & OPERATION
____	____	WINDOWS, LATCHES, OPERATION & GLASS
____	____	STANCHION & GRAB-RAILS FOR DEFECTS
____	____	SEAT-FRAMES & COVERING FOR DEFECTS
____	____	BUZZER-CORD
____	____	EMERGENCY EXITS
____	____	GENERAL INTERIOR CONDITION, PAINT, PANELS, ETC.
____	____	DOOR-ENGINES FOR AIR-LEAKS, ETC.
____	____	FIRE EXTINGUISHERS
____	____	FLOOR-COVERING FOR LOOSENESS & DEFECTS
____	____	SAFETY-DOOR EDGES, TREADLES, ETC.
____	____	CHECK FAREBOX (MOUNTING & LIGHT)
____	____	WHEELCHAIR LIFT
____	____	DASH FANS
____	____	A/C FILTERS

COACH EXTERIOR INSPECTION

____	____	MARKER, CLEARANCE, STOP & TAIL-LIGHTS
____	____	DOOR & FINDER-RUBBERS
____	____	GENERAL BODY & PAINT CONDITION
____	____	CHECK WHEEL & AXLE-FLANGE NUTS
____	____	VISUALLY, TIRES FOR UNEVEN WEAR, CUTS, ETC.
____	____	ADJUSTMENT ON WHEELS-BEARINGS (RAISED WHEELS)
____	____	KING-PIN WEAR (RAISED WHEELS)
____	____	CHECK AND SERVICE BATTERIES

FILL IN The Following:

VOLTAGE	BATTERY NO.	HYDROMETER
____	____	____
____	____	____
____		____
____		____
	BATTERY NO.	
____	____	____
____		____
____		____

CHECK VOLTAGE REGULATOR (IF NECESSARY)

ENGINE COMPARTMENT LUBRICATION

____	____	SHUTTER AIR CYLINDER
____	____	THROTTLE AIR CYLINDER
____	____	CLEAN ENGINE AIR CLEANERS & CHECK INTAKE
____	____	CLEAN ENGINE OIL STRAINER
____	____	CHANGE ENGINE OIL FILTER ELEMENT
____	____	CHANGE ENGINE LUBE OIL
____	____	CHANGE FUEL OIL FILTER ELEMENT
____	____	CHANGE TRANS. FULID & CLEAN STRAINER

COACH UNDER CHASSIS-PIT INSPECTION

MECH NO.	SYMBOL	
____	____	DRAG-LINK & TIE-ROD FOR WEAR
____	____	PEDAL, SHIFTER, ACCELERATOR & HAND BRAKE-ROD FOR WEAR
____	____	FRONT AIR RIDES & MOUNTINGS
____	____	SHOCK-ABSORBERS FOR FLUID & LINKAGE ADJ.
____	____	AIR-TANKS, MOUNTING, "DRAIN TANKS"
____	____	FUEL TANKS FOR LEAKS, ETC.
____	____	REAR AIR RIDES AND MOUNTINGS
____	____	HAND-BRAKE LINKAGE & ADJ. OF SHOES
____	____	DRIVE-SHAFT & "U" JOINTS FOR LOOSENESS
____	____	DIFFERENTIAL-PINION-BEARING FOR EXC. LASH
____	____	BRAKE-DIAPHRAMS FOR LEAKS (BRAKES APPLIED)
____	____	BRAKE-CAM TRAVEL & POSITION (BRAKES APPLIED)
____	____	RELEASE-ACTION & ADJUST BRAKES
____	____	BRAKE-SHOE-SPRING OPERATION
____	____	WHEEL-SEALS FOR OIL OR GREASE LEAKS
____	____	ENTIRE UNDER-CHASSIS OF COACH FOR DEFECTS
____	____	MUD-SPLASH FLAPS
____	____	COMPLETE CHASSIS LUBRICATION PER MFG'S SPEC
____	____	DIFFERENTIAL CHANGE OIL
____	____	CHECK HEATER FILTERS & CORES
____	____	CHECK RADIUS ROD BUSHINGS
____	____	TRANSMISSION-FILTER & FLUID

COACH ENGINE COMPARTMENT INSPECTION

____	____	CHECK STARTER OPERATION
____	____	BLOWER-BOX-DRAINS FOR OBSTRUCTIONS
____	____	ENGINE GOVERNOR LINKAGE, ETC.
____	____	FRONT ENGINE SUPPORT
____	____	FAN AND FAN-HUB
____	____	FAN-SHROUD FOR LOOSENESS, CRACKS, ETC.
____	____	RADIATOR & SURGE-TANKS FOR LEAKS
____	____	MOUNTINGS FOR LOOSENESS
____	____	BLOWOUT RADIATOR-FINS FROM INNER SIDE
____	____	RADIATOR FILLER-CAP & GASKET
____	____	RADIATOR SHUTTER OPERATION
____	____	TAIL-PIPE, MOUNTINGS
____	____	BULKHEAD BELLCRANKS, RODS, & CLEVISES
____	____	AIR COMPRESSOR INLET TUBE
____	____	MUFFLER & EXHAUST-PIPE
____	____	WATER-MANIFOLD FOR LEAKS
____	____	CHECK & AIR TIRES
____	____	ALL WIRING FOR BROKEN INSULATION, ETC.
____	____	ENGINE COMPARTMENT SWITCHES
____	____	ENGINE STOP, REAR STARTER, ETC.
____	____	ENGINE ALARMSTAT
____	____	ALL OIL, FUEL, AIR, WATER LINES FOR LEAKS, ETC.
____	____	ALL WATER HOSE & CLAMPS
____	____	TRANS. OUTPUT-BEARING FOR EXCESSIVE LASH
____	____	TRANS. OUTPUT-SEAL FOR LEAKAGE
____	____	NEUTRAL STOP ADJUSTMENT AND OPERATION
____	____	GENERATOR
____	____	ENGINE INSULATORS
____	____	AIR COMPRESSOR-CUT IN-CUT OUT
____	____	FLUID PUMP FOR LEAKAGE

ROAD TEST

____	____	ENGINE OPERATION
____	____	TRANSMISSION OPERATION
____	____	BRAKES: STOPPING POWER
____	____	STEERING
____	____	SUSPENSION NOISE

REMARKS:______________________________
____

Note for Appendix 7A

1. The forms in this appendix were based on many different sources including the transit systems listed in the Acknowledgements to Chapter 7, the documents listed in the Sources for Chapter 7, UMTA Section 15 guidelines, and the Second Revision of this handbook.

APPENDIX 7B

A MAINTENANCE MANAGEMENT INFORMATION SYSTEM

This appendix briefly describes the developmental stages, data flows, and the source and summary forms that make up a simple, practical maintenance management information system (MIS). This MIS, which is based on an outline from Conceptualizing and Planning of Maintenance Management Information Systems and Considerations for System Design, is supplemented with summary and report forms derived from forms being used by small city systems.

Developmental Stages

The five developmental stages of maintenance MIS follow [1]:

1. Conceptualizing--the determination of the objectives of the MIS. Initially, this is accomplished by management-level brainstorming sessions.

2. Planning--the determination of information needs and evaluation methods. Planning should result in a system performance specification.

3. Design--the determination of what hardware and software are required to meet performance specifications. How will the system be organized? How will transit agency procedures be changed? What about staff training?

4. Implementation--the installation of the new information system. Transit agency staff become proficient in its use and the "bugs" are worked out of the system.

5. Maintenance--this stage covers the life of the system.

Data Flows in the MIS

Information Format

The forms that comprise the maintenance MIS are presented at the end of this appendix in Figures 7B.1 through 7B.16. Although the forms are based on reports used by actual transit systems, we have redesigned them in a consistent format that is "generic" enough to be used by most small city transit systems. To the extend practical, the forms have been designed to ease the meeting of Section 15 reporting requirements. Table 7B.1 shows which figures in this handbook meet various Section 15 reporting requirements.

TABLE 7B.1 Partial Section 15 Conversion

Form	Line	Description	Handbook Figures
101	03	Materials and Supplies Inventory	7B.17
202	25	Sales of Maintenance Services	7B.5
301	02	Other Salaries and Wages	7B.5, 7B.12
	04	Services	7B.5, 7B.12
	05	Fuel & Lubricants	7B.2, 7B.5, 7B.12
	06	Tires & Tubes	7B.5, 7B17, 7B.12
	07	Other Materials and Supplies	7B.5, 7B.17, 7B.12
402	01	Roadcalls for Mechanical failure	7B.4
	02	Roadcalls for Other Reasons	7B.4
	04	Total Labor Hours for Inspection and Maintenance	7B.5, 7B.12
	10	Gallons of Diesel Fuel	7B.2, 7B.5
	11	Gallons of Gasoline	7B.2, 7B.5
	12	Gallons of LPG or LNG	7B.2, 7B.5
408	N/A	Revenue Vehicle Inventory Schedule	7B.13

Information Description

Operator inspection report. A proactive maintenance system takes advantage of all opportunities to report problems and exceptions. A typical day at a small city transit system starts with the bus operator pulling out of the storage facility. Most systems pay operators an allowance for pull-out time, during which they prepare for their day's service by inspecting their vehicle, stocking it with maps and schedules, and so on. The operators' observations of the appearance of the vehicle and their assessments of the functioning of its major components are valuable. These observations are noted using a standard format, with Figure 7B.1. This form should be serialized so that it can be tied to a work order later on.

Daily fueling-servicing inspections. If the day has gone according to plan and there were no mechanical or electrical discrepancies, the next opportunity to inspect the vehicle comes during refueling and consumable servicing. The servicer makes a quick visual inspection noting body, mechanical, electrical, and interior appearance. Fuel and consumable replacements, and routine service tasks are noted in the standard format shown in Figure 7B.2. If any kind of discrepancy is found, it is noted on a serialized form, as shown in Figure 7B.3.

Bus servicer trouble report. This report simply provides another means of documenting a defect, discovered by an additional observer--the bus servicer. This form shuld be serialized so that it can be tied to a work order later on. An example is shown in Figure 7B.3.

Roadcall report. The purpose of a proactive maintenance system is to avoid in-service failures, or roadcalls. However, in the unlikely event of such an occurrence, it is crucial that the precise nature of the roadcall, and the circumstances surrounding it, get recorded properly. This system takes a completely different approach to a roadcall in that is considered a marketing problem as much as a maintenance problem. The theory is that the need to accommodate passengers with destinations is a much greater priority than simply getting a bus rolling again. Figure 7B.4 shows that there is as much information regarding the market as there is about the discrepancy itself. As with other trouble reports, it is essential that this report be coded with a unique serial number so that it may be tied to a specific work order and a summary report later on.

Work orders. The work order is the heart of the maintenance management information system. Any information pertaining to maintenance, inspections, materials used, labor-hours and vehicle hours contracted out is captured here. An important point about work orders is that they do not occur without some kind of other action, otherwise known as a triggering event. Events that trigger the need for a work order include: the bus operator inspection report, a servicer trouble report, a road call report or notice of inspection due. A work order is also assigned a unique serial number so that it can be tied back with various types of triggering incidents and summarized in periodic reports. One key objective of a maintenance MIS is to track the maintenance cost by vehicle. The work order provides the basis to meet this objective. Figure 7B.5 shows the work order format.

Daily vehicle status and mileage report. This report has several purposes. First, it provides a way of tracking vehicle mileage so that fixed-mileage maintenance can be scheduled. Second, it provides an easy way for the maintenance department to communicate to the dispatcher the availability of each vehicle for service at the start of each operating day. This report is shown in Figure 7B.6.

Notice of inspection due. The proactive maintenance system is based around a series of progressively more thorough inspections, performed at fixed-mileage intervals. The accumulation of mileage each day brings the vehicle closer to its next inspection. At a particular level of accumulated mileage, a notice is generated which tells the maintenance foreman that an inspection is due within some predetermined mileage interval. This interval allows the foreman flexibility in scheduling the work based on whatever other priorities exist. Figure 7B.7 shows the format of the notice of inspection due.

Notice of inspection completed. Upon completing an inspection, the foreman notifies the bookkeeper to update the inspection record through the use of a notice of inspection completed. Figure 7B.8 shows the format for the notice of inspection completed.

Inspection record log. Each vehicle has its own inspection record log that lists the date, mileage and type of inspection performed. Again, the inspection is tied to a specific, unique work order number for periodic summary reporting. Figure 7B.9 shows the format of the inspection record log.

Daily and monthly miles, inspections, and fuel log. This is a summary report that tracks daily miles, cumulative monthly mileage, total cumulative mileage, mileage of the most recent inspection, types of inspections that month, and fuel and fluid consumption by day. This report provides a convenient way to look up key vehicle operating information. Figure 7B.10 shows the format of the daily and monthly miles, inspections, and fuel log.

Annual bus maintenance history ledger. This is another report used to summarize major maintenance actions, both monthly and cumulative: miles, fuel and oil consumption, and fuel and oil economy. This report contains key vehicle maintenance information. Figure 7B.11 shows the format of the annual bus maintenance history ledger.

Annual vehicle maintenance cost ledger. A key objective of a maintenance MIS is to track the maintenance cost per vehicle. This ledger provides a single maintenance cost summary for each vehicle per year. It tracks labor, parts, fuel, and fluids, tires and tubes, and services contracted out. The format of the annual vehicle maintenance cost ledger is shown in Figure 7B.12.

Daily work sheet. The daily work sheet is used by the maintenance foreman in assigning a status and priority code to each vehicle that is not available for service. The daily work sheet is used as input for the dispatcher's daily vehicle status and mileage report. The format for this report is shown in Figure 7B.13.

Bus location report. Although extremely simple in concept, the bus location report provides a very useful means of communication between the fuelers, servicers, maintenance foremen, dispatchers and bus operators. After each day's cleaning and servicing, each bus is parked in the storage facility, or lot, awaiting the next day's service. Buses used on specific runs can be "lined-up" in a particular order as specified by the dispatcher. The maintenance foreman can specify a particular location to place vehicles awaiting service or repair. This simple graphic representation eliminates any reason to send someone looking for a particular vehicle while it also eliminates the need to jockey buses around in order to get at a vehicle. The format of this report is shown in Figure 7B.14.

Purchase requisition and price quotation. This form is used to communicate the need for a part not in stock to someone who has the authority to make the actual purchase. Although this format accommodates UMTA small purchase procedures that call for several quotes, it may not be applicable to more restrictive state or local procedures. This sample format, shown in Figure 7B.15, is intended to illustrate a concept and not an actual procedure.

Part tag. Part tags are useful in controlling "A" priority inventory items, or any item that is monitored on a unit basis. Components such as alternators, generators, water pumps, and door control units are "tagged" as they are stocked in inventory. Upon using the part, the mechanic or parts clerk removes the tag and sends it to the person responsible for posting inventory usage. The format for the parts tag is shown in Figure 7B.16.

Inventory control record. A perpetual, or ongoing, inventory control system is based on an individual record for each item or part number. This record shows those items that are on order, those that have been received, disbursement and quantities on-board. Also listed are the parts minimum and maximum quantities on hand, location, vendors, and account number. The total value of inventory on hand is determined from this form. An example is shown in Figure 7B.17.

No: ______________

Operator Inspection Report

Bus Number: ____________ Date: ________________

Pre-trip Inspection
(Operator to (x) each item as inspected)

Operators are to remark on unsatisfactory items.

[] tires/lug nuts	[] horn	Beg. mileage: ____________
[] lights/reflectors	[] wipers	
[] glass	[] air pressure	
[] other	[] emergency pressure	End mileage: ____________
	[] cleanliness	

Operator's Remarks: ____

Trip Report

[] Bus OK

Operators to (x) each item not satisfactory and provide brief explanation.

Brakes	Lights	Noise Location	Miscellaneous
[] soft	[] head lamps	[] left-front	[] buzzer or light
[] noisy	[] turn indicators	[] right-front	[] radio or PA
[] grab	[] interior	[] left-rear	[] emergency equipment
[] air pressure	[] dash	[] right-rear	[] body damage
	[] step well	[] engine	[] other (explain)
		[] transmission	

Engine	Steering	Body	
[] no power	[] hard	[] doors	[] defroster
[] stalls	[] shimmy	[] heating	[] wipers
[] vibration	[] free play	[] A/C	[] seats
[] temperature		[] glass	

Operator's Remarks: ____

Operator's Name: ______________ Supervisor's Initials: ________________

Distribution: white-maintenance; pink-transportation; yellow-operator

Work Order #: ____________

FIGURE 7B.1 Operator Inspection Report

DAILY FUELING - SERVICING INSPECTION

DATE:______________

SERVICER:______________

PAGE:_____of_____

	CHECK AND REPLENISH AS NECESSARY																
	NOTE QUANTITIES																
VEHICLE	FUEL	OIL	TRANS FLUID	ANTI-FREEZE	WIND-SHIELD WASHER FLUID	WATER	TIRE AIR	BATTERY WATER	VAULT REMOVED BY	AIR TANKS DRAINED	FLOORS SWEPT	FLOORS MOPPED	INTERIOR WASHED	INTERIOR WINDOWS CLEANED	FRONT & SIDE DASHES CLEANED	EXTERIOR WASHED	WHEELS SCRUBBED	SERVICER TROUBLE REPORT

FIGURE 7B.2 Daily Fueling - Servicing Inspection

NO. XXXXX

VEHICLE#: ____________

DATE: ____________

SERVICER: ____________

BUS SERVICER TROUBLE REPORT

OPERATORS AREA	PASSENGER AREA	EXTERIOR
[] SEAT	[] SIDE DESTINATION SIGN	[] LOOSE BODY PANELS
[] STEERING WHEEL	[] CEILING	[] SKIRT LATCHES
[] HORN	[] HATCHES	[] BUMPERS
[] TURN SIGNALS	[] HANDRAIL	[] DENTS & SCRATCHES
[] DASH LIGHTS	[] REAR AIR VENTS	[] HEADLIGHTS: ___LOW ___HIGH
[] OPERATOR LIGHT	[] BACK DOOR OPERATION	[] FRONT MARKER LIGHTS
[] OPERATOR FAN	[] REAR STEP WELL LIGHTS	[] ROAD SIDE MARKERS
[] AIR VENT	[] FLOORING	[] CURB SIDE MARKERS
[] DESTINATION SIGN	[] SEAT CUSHIONS AND FRAMES	[] REAR MARKER LIGHTS
[] LOOSE BOLTS IN DASH	[] WHEELCHAIR SEATS AND LOCKS	[] WIPERS AND WASHERS
[] DOOR HANDLE CONTROL	[] WINDOWS	[] REAR RUNNING LIGHTS
[] FRONT DOOR OPERATION	[] WINDOW LATCHES	[] BRAKE LIGHTS
[] INTERIOR MIRRORS	[] PASSENGER BUZZER STRIPS	[] TURN SIGNALS
[] WHEEL CHAIR LIFT	[] DOME LIGHTS & LENS'	[] BACKUP LIGHTS
[] STEP TREAD	[] ____________	[] LICENSE PLATE LIGHT
[] STEP WELL LIGHT	[] ____________	[] LIGHTS ABOVE FRONT & REAR DOORS
		[] WINDOW SLIPPAGE
		[] TIRE NUMBERS:
		________RF ________LF
		________RRI________RRO
		________LRI________LRO

ENGINE COMPARTMENT

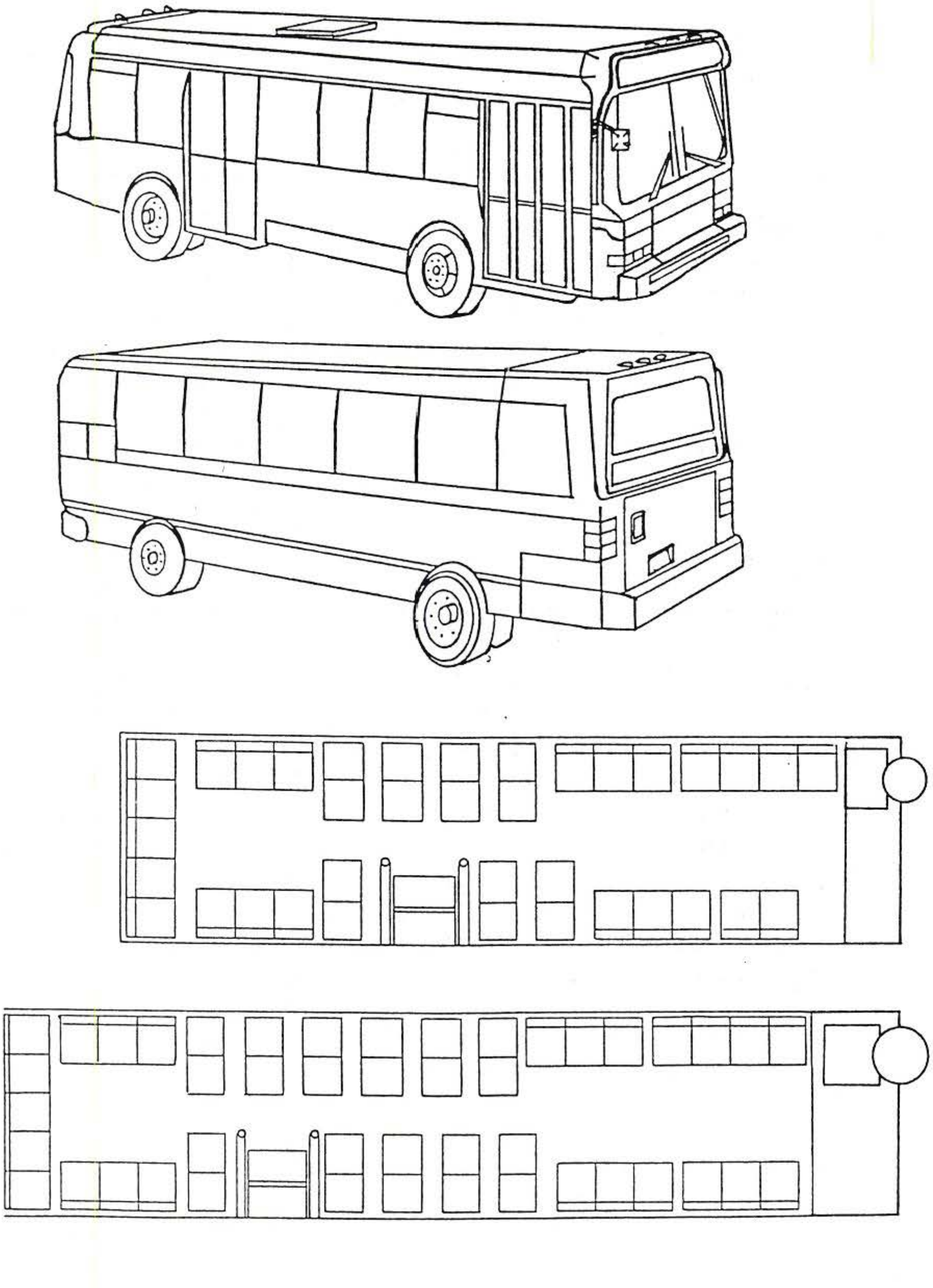
[] ENGINE COVER, LATCH, HINGE AND CYLINDERS	[] LOOSE OR RUBBING LINES
[] EMERGENCY TAIL LIGHTS	[] MISSING BOLTS
[] OIL LEVEL	[] REAR START AND SHUT-OFF SWITCHES
[] WATER LEVEL	[] ENGINE COMPARTMENT LIGHTS
[] ATF LEVEL	[] EMERGENCY ENGINE SHUT-OFF SWITCH
[] POWER STEERING FLUID LEVEL	[] MAIN BATTERY SHUT-OFF SWITCH
[] FLUID LEAKS	[] CABLES GOING INTO ELECTRICAL BOX
	[] BATTERIES AND CABLES

ILLUSTRATE ALL BODY AND SEAT DAMAGE ON DIAGRAMS ON REVERSE SIDE

(OVER)

FIGURE 7B.3 Bus Servicer Trouble Report

FIGURE 7B.3 Continued.



No. XXXXX

ROADCALL REPORT

MECHANIC'S REPORT		DISPATCHER'S REPORT
VEHICLE TAKEN ON CALL: ____________		DAY: ____________
TIME ARRIVED AT VEHICLE: ____________		DATE: ____________
ACTION TAKEN: ____________		TIME: ____________
____________		OPERATOR: ____________
____________		REPORTED BY: ____________
TIME VEHICLE RELEASED: ____________		RECEIVED BY: ____________
MILEAGE: ____________		ROUTE: ____________
		LOCATION: ____________
ROADCALL CLASSIFICATION (check one only)		VEHICLE #: ____________
		PASSENGERS ON-BOARD: ____________
MECHANICAL FAILURE [ ]	OTHER REASONS [ ]	SERVICE DISRUPTION: ________(MINS)
____ AIR EQUIPMENT	____ TIRE FAILURE	
____ BRAKES	____ FAREBOX FAILURE	RESTORATION EFFORTS:
____ BODY PARTS	____ AIR CONDITIONING SYSTEM	____VEHICLE CHANGE-UP - VEH#____
____ DOORS	____ OUT OF: FUEL-COOLANT-LUBRICANT	____HOLD CONNECTION
____ COOLING SYSTEM		____TRANSPORT VIA OTHER MEANS:
____ HEATING SYSTEM	____ OTHER: ____________	____________
____ ELECTRICAL UNITS	____________	____OTHER: ____________
____ FUEL SYSTEM	____________	____________
____ ENGINE	____________	
____ STEERING AND FRONT AXLE		
____ REAR AXLE AND SUSPENSION		
____ TORQUE CONVERTER		
TOW-IN ORDER #: ________		
TOW-IN MILEAGE: ________		
WORK ORDER #: ________		
MECHANIC: ________		DISPATCHER: ____________

FIGURE 7B.4 Roadcall Report

WORK ORDER

CUSTOMER:__________

[ ] VEHICLE

[ ] NON-VEHICLE

MATERIAL USED				
QTY	PART NUMBER	DESCRIPTION	PRICE	EXTENSION
			Total	

WORK DONE				
TASK	DESCRIPTION	MECH	TIME	COST
			TOTAL	

CONTRACTED OUT			
VENDOR	INVOICE	WORK DONE	COST
		Total	

FUEL - LUBRICANTS						
______	GAL	______	@	______	=	______
______	GAL	______	@	______	=	______
______	QTS	______	@	______	=	______
______	QTS	______	@	______	=	______
______	LBS	______	@	______	=	______
______	LBS	______	@	______	=	______
				TOTAL		

SUMMARY	
TOTAL LABOR	______
TOTAL MATERIAL	______
FUEL - LUBRICANTS	______
TIRES & TUBES	______
CONTRACTED OUT	______
GRAND TOTAL	

VEHICLE:__________

DATE IN:__________

MILEAGE IN:__________

DATE OUT:__________

MILEAGE OUT:__________

OP - TROUBLE RPT #:__________

SERV - TROUBLE RPT #:__________

ROADCALL #:__________

INSPECTION #:__________

FIGURE 7B.5 Work Order

DAILY VEHICLE STATUS & MILEAGE REPORT - DAY:_________ DATE:_________

VEHICLE	MILEAGE		TOTAL	VEHICLE STATUS	POS	COMMENTS
	IN	OUT				

STATUS CODES

A - AVAILABLE FOR REGULAR SERVICE

T - AVAILABLE FOR TRIPPER SERVICE

E - AVAILABLE FOR EMERGENCY SERVICE ONLY

H - HOLD IN

POSITION CODES

B - P

(B = BAY, P = POSITION FROM FRONT)

FIGURE 7B.6 Daily Vehicle Status & Mileage Report

NOTICE OF INSPECTION DUE — DAY :

NOTE: X = AVERAGE DAILY MILES — DATE:

VEHICLE	(A) TODAY'S BEGINNING MILEAGE	(B) INSPECTION DUE AT:	(C) (B - A) DIFFERENCE	TYPE	(C / X) OP-DAYS BEFORE INSP	COMMENTS

FIGURE 7B.7 Notice of Inspection Due

NOTICE OF INSPECTION COMPLETED

VEHICLE	COMPLETION MILEAGE	INSP TYPE ('X')					DATE STARTED	DATE COMPLETED	WORK ORDER #	COMMENTS
		A	B	C	D	E				

FIGURE 7B.8 Notice of Inspection Completed

VEHICLE:____________

INSPECTION RECORD LOG

DATE STARTED	DATE COMPLETED	COMPLETION MILEAGE	INSP TYPE ('X')					WORK ORDER #	COMMENTS
			A	B	C	D	E		

FIGURE 7B.9 Inspection Record Log

VEHICLE:______________

MONTH:______ YEAR:_____

DAILY AND MONTHLY MILES, INSPECTIONS AND FUEL LOG

						INSP TYPE ('X')					FLUIDS			
DATE	DAILY MILES	MILES THIS MONTH	CUMULATIVE MILEAGE	MILEAGE LAST INSPEC	MILES SINCE LAST INSPEC	A	B	C	D	E	FUEL	OIL	ATF	ANTI-FREEZE
1														
2														
3														
4														
5														
6														
7														
8														
9														
10														
11														
12														
13														
14														
15														
16														
17														
18														
19														
20														
21														
22														
23														
24														
25														
26														
27														
28														
29														
30														
31														
			Monthly Totals											

Comments:____

FIGURE 7B.10 Daily and Monthly Miles, Inspections and Fuel Log

BUS MAINTENANCE HISTORY LEDGER: ____________ (YEAR)

COACH NO__________

MAKE____________________ MOTOR ORIGINAL NO______________ NEW USED GEAR RATIO___________ HP_____ MODEL_____ YEAR___

CHASSIS NO______________ REPLACED_____________ NO________ WHEELS-TYPE, SIZE_____________ NO_____ SEAT CAPACITY_____

DATE RECEIVED___________ REPLACED_____________ NO________ TIRES________________________ FRONT STANDING CAP._____

FROM____________________ FUEL TYPE______________________ TIRES________________________ REAR WEIGHT MTY________

TASK	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
CUR MILES												
TOT MILES												
CUR FUEL												
TOT FUEL												
CUR OIL												
TOT OIL												
MPG: FUEL												
MPG: FUEL												
MPG: OIL												
MPG: OIL												
COMPLETE MOTOR OVERHAUL												
BLOCK AND PISTONS												
OVERHAUL TRANS-MISSION												
OVERHAUL DIFFER-ENTIAL												
OVERHAUL GENERATOR												
BLOWER												
RECOND. CYLINDER HEAD												
INJECTORS												
COOLING SYSTEM												

(over)

FIGURE 7B.11 Annual Bus Maintenance History Ledger

FIGURE 7B.11 Continued.

TASK	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
STARTER AND BATTERY												
REPLACE GEAR TRAIN & CAM SHFT												
CLUTCH												
STEERING GEAR												
AIR COMPRESSOR												
FRONT AXLE												
BRAKES AND DRUMS												
DRIVE LINE AND UNIVERSAL												
WHEEL BEARINGS												
LIGHTS AND WIRING												
SPRINGS												
FUEL PUMP AND TANK												
VOLTAGE REGULATOR												
BODY PAINT												
OTHER												

COMMENTS: ______________________________

VEHICLE:__________

YEAR:__________

ANNUAL VEHICLE COST LEDGER

	DIRECT OPERATING COSTS					
MONTH	LABOR	PARTS	FUEL & FLUIDS	TIRES & TUBES	CONTRACT SERVICES	COMMENTS
JANUARY						
FEBRUARY						
MARCH						
APRIL						
MAY						
JUNE						
JULY						
AUGUST						
SEPTEMBER						
OCTOBER						
NOVEMBER						
DECEMBER						
TOTALS						

FIGURE 7B.12 Annual Vehicle Maintenance Cost Ledger

DAY: ________

DATE: ________

DAILY WORK SHEET

VEHICLE	STATUS	PRIORITY	COMMENTS

FIGURE 7B.13 Daily Work Sheet

BUS LOCATION REPORT

DAY:____________

FRONT DATE:____________

FIGURE 7B.14 Bus Location Report

PURCHASE REQUISITION AND PRICE QUOTATION

ON HAND	QTY REQ	PART NUMBER	DESCRIPTION	1 UNIT PRICE	2 UNIT PRICE	3 UNIT PRICE	4 UNIT PRICE	AWARD	TOTAL AMOUNT	COMMENTS

VENDORS

1. ______________________ 3. ______________________

2. ______________________ 4. ______________________

FIGURE 7B.15 Purchase Requisition and Price Quotation

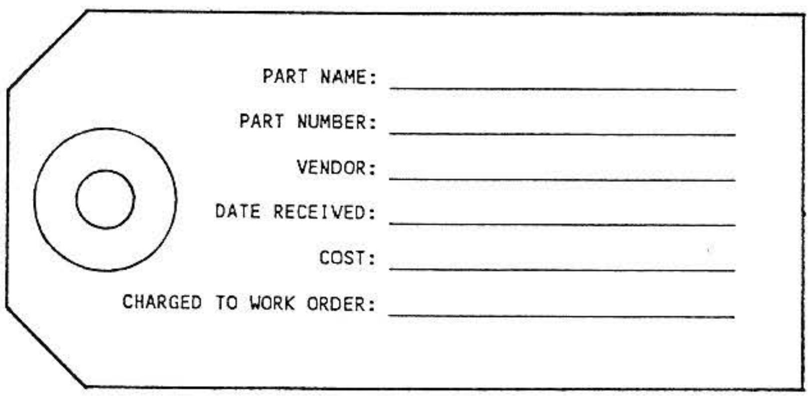


FIGURE 7B.16 Part Tag

INVENTORY CONTROL RECORD

ON ORDER				RECEIVED				DISBURSED AND ON-HAND						
										ISSUED				
DATE	P.O. NUMBER	VENDOR	QTY	DATE	QTY	UNIT COST	TOTAL COST	VEH	DATE	QTY	W.O. #	BALANCE ON HAND	UNIT COST	TOTAL VALUE

VENDORS

1 __________ 4 __________

2 __________ 5 __________

3 __________ 6 __________

SHEET________ MIN________ PART NAME: ________

LOCATION________ MAX________ PART #: ________ ACCOUNT #:________

FIGURE 7B.17 Inventory Control Record

Notes for Appendix 7B

1. The MIS presented in this appendix could be converted to a microcomputer relational database application. With few changes, one could design the tables of the file around input forms in Figures 7B.1 through 7B.9 and design output reports using the formats for forms in Figures 7B.10 through 7B.15.

2. The forms in this appendix were based on many different sources including the transit systems listed in the Acknowledgements to Chapter 7, the documents listed in the Sources for Chapter 7, UMTA Section 15 guidelines, and the Second Revision of this handbook.

Source for Appendix 7B

[1] Maze, T.H. et al, Conceptualizing and Planning of Maintenance Management Information Systems and Consideration for System Design, University of Oklahoma, U.S. DOT, UMTA, Washington, DC, OK-11-0004, p. 4.

APPENDIX 7C

MISCELLANEOUS MAINTENANCE FORMS

Other useful maintenance forms are provided in this section. Though not necessarily vital to the development of a sound maintenance management information system, they supplement the flow of useful data.

Work Quality Appraisal (Figure 7C.1)

Nothing sharpens and tightens a preventive maintenance program as much as random inspections by a member of the management team. This system gives concrete evidence that management is serious about the quality of the maintenance work and is paying attention to it.

Management should use this inspection to reward the outstanding performers in the maintenance and repair area. Inspections can also be used to upgrade low-quality performance when they are on an instructional basis rather than censuring individuals. Mechanics, like all other people, have their own pecking order. Their desire to be the best mechanic can be used as an instrument to raise the quality of the whole system. A system of quarterly dinner meetings, where individuals are specifically cited and rewarded (wallets, pins, and so forth) before their peers, is a prime means of eliciting high-quality job performance from these people. Outstanding examples of high-quality foreman's investigation should be made part of the employee's permanent record file.

Weekly Preventive Maintenance Schedule (Figure 7C.2)

This form provides a simple graphic representation of the vehicles due for some type of preventive maintenance inspection during the week.

Tire History (Figure 7C.3)

Just as in any other component or subsystem, tires require regular monitoring and maintenance. This form is especially useful for monitoring the status of leased tires, and for tracking Section 15 tires and tube costs.

Battery History (Figure 7C.4)

This form traces the history of each battery from the date of purchase to the date of final disposition.

WORK QUALITY APPRAISAL

TYPE OF APPRAISAL	TYPE OF INSPECTION	
[ ] TECHNICAL	[ ] DAILY FUELING - SERVICING	WORK PERFORMED BY:________
[ ] AESTHETIC	[ ] A - 3,000 MILE	WORK APPRAISED BY:________
[ ] COMPLETION	[ ] B - 6,000 MILE	DATE:________
[ ] OTHER:________	[ ] C -12,000 MILE	VEHICLE:________
________	[ ] D -24,000 MILE	WORK ORDER#:________
	[ ] E - OTHER:________	

NOTE OUTSTANDING PERFORMANCE:________________________________

____

____

OVERALL, THE QUALITY OF THE WORK WAS:

- [ ] OUTSTANDING DUE TO________________________
- [ ] THOROUGH, AS PLANNED
- [ ] SATISFACTORY
- [ ] INCOMPLETE BECAUSE________________________
- [ ] POOR BECAUSE________________________

THE TIME REQUIRED TO COMPLETE THE JOB WAS:

- [ ] AS PLANNED
- [ ] AS PLANNED, EXCEPT FOR________________________
- [ ] SATISFACTORY
- [ ] SATISFACTORY CONSIDERING________________________
- [ ] UNSATISFACTORY BECAUSE________________________
- [ ] UNACCEPTABLE DUE TO________________________

GOALS FOR FUTURE WORK________________________________

____

____

____

____

WAS THE EMPLOYEE PRESENT DURING THE APPRAISAL ? [ ] YES [ ] NO ________ (SUPERVISOR)

IF NOT, HAVE THEY BEEN INFORMED ? [ ] YES [ ] NO ________ (EMPLOYEE)

HOW MUCH TIME WAS SPENT ON THE APPRAISAL ? ________ ________ (EMPLOYEE)

________ (EMPLOYEE)

FIGURE 7C.1 Work Quality Appraisal

WEEKLY PREVENTIVE MAINTENANCE SCHEDULE

WEEK OF: __________

PREPARED BY: __________

DATE: __________

DAY	DATE	VEHICLE	INSPECTION TYPE	VEHICLE	INSPECTION TYPE	VEHICLE	INSPECTION TYPE	VEHICLE	INSPECTION TYPE	VEHICLE	INSPECTION TYPE
MONDAY											
TUESDAY											
WEDNESDAY											
THURSDAY											
FRIDAY											
SATURDAY											
SUNDAY											

FIGURE 7C.2 Weekly Preventive Maintenance Schedule

TIRE HISTORY

1ST RECAP AT __________ CASING-MILES

RECAPPED BY: ____________________

P.O. #: ____________________

INVOICE #: ____________________

2ND RECAP AT __________ CASING-MILES

RECAPPED BY: ____________________

P.O. #: ____________________

INVOICE #: ____________________

TIRE #: ____________________

P.O. #: ____________________

VENDOR: ____________________

INVOICE #: ____________________

MAKE: ____________________

SIZE: ____________________

DATE RECEIVED: ____________________

VEHICLE	DATE ON	POS	VEHICLE MILEAGE	DATE OFF	VEHICLE MILEAGE	REASON FOR REMOVING (NOTE WORK ORDER NO)	DISPOSITION	CASING MILEAGE	TREAD MILEAGE

POSITION CODES

LF - LEFT FRONT
LRI- LEFT REAR INSIDE
LRO- LEFT REAR OUTSIDE

RF - RIGHT FRONT
RRI- RIGHT REAR INSIDE
RRO- RIGHT REAR OUTSIDE

FIGURE 7C.3 Tire History

BATTERY HISTORY

BATTERY NO. ____________________

P.O. NO. ____________________

VENDOR ____________________

INVOICE NO. ____________________

MAKE ____________________

DATE RECEIVED ____________________

VEHICLE	DATE INSTALLED	VEHICLE MILEAGE	DATE REMOVED	VEHICLE MILEAGE	REASON FOR REMOVING	DISPOSITION	MILEAGE BATTERY OPERATED

COMMENTS ____________________

FIGURE 7C.4 Battery History

Note for Appendix 7C

1. The forms in this appendix were based on many different sources including the transit systems listed in the Acknowledgements to Chapter 7, the documents listed in the Sources for Chapter 7, UMTA Section 15 guidelines, and the Second Revision of this handbook.

APPENDIX 7D

SHOP EQUIPMENT AND TOOLS

Shop equipment and tools vary considerably from system to system, and depend on factors such as types of rolling stock, age of the facility, size of the fleet, percentage of maintenance done in-house, and so on. Equipment types, quantities and procurement methods must be carefully reviewed and tailored to each specific application. The sections that follow are based on the development of a facility for 250 buses, but will be useful to any size system. The types of equipment listed below, which are found within the common functional areas of a maintenance facility, come from Design Criteria for a Satellite Bus Maintenance Facility [1].

Running Repair Area

- work bench with vise
- buffer with grinder
- parts cleaning tank
- 75T hydraulic press
- portable ladder
- 17 in. drill press
- drum dolly
- drum pump
- chain hoist
- oil drain pan
- stand-up shop desk
- stool

Inspection and Campaign Lanes

- work bench with vice
- parts cleaning tank
- buffer/grinder
- portable hoist
- stand-up shop desk
- stool

Service and Cleaning Lanes

- exterior bus washer
- water reclamation system
- diesel fuel dispensers
- tank level gauge
- semiautomated fluid management system
- vacuum cleaner
- hand drum pump
- bus interior cleaning system
- high pressure hot water washer
- trash compactor
- mop cleaning equipment
- stand-up shop desk
- stool

Chassis Wash Area

- H type bus hoists
- high pressure, hot water cleaner

Brake Shop

- hydraulic brake lathe
- 75T hydraulic press
- buffer/grinder
- work bench with vise
- parts cleaning tank
- glass head cleaner
- bearing packer
- machine cabinet
- storage cabinet

Materials Handling Department

- shelving unit
- reinforced shelving unit
- pallet rack
- flammable mat'l cabinet
- gasket cabinet
- hose bin
- glass rack
- body panel
- small parts bin
- parts transfer cart
- overhaul cart
- inspection cart
- warehouse cart
- safety stairs
- hand pallet truck
- two wheel hand truck
- platform truck
- barrel truck
- reel rack
- pipe rack (face arm)
- storage rack (gas cylinder)

Battery Room

- battery charger, fixed
- battery bench
- breakdown tester
- lift cart (battery)
- hand truck (battery)

Tire Storage and Repair Area

- floor jack
- tire storage rack
- portable air compressor
- wheel balancer

Buildings and Grounds Maintenance Areas

- shop desk (stand up)
- stool
- electric floor buffer
- vacuum cleaner
- work bench with vise
- flammable mat'l cabinet
- general tool set
- sewer router
- step ladder (6 ft.)
- step ladder (8 ft.)
- step ladder (10 ft.)
- ladder extension (28 ft.)
- stud driver kit
- table saw, tilt arbor
- band saw (wood)
- welder, portable
- buffer/grinder & dust collector
- janitorial cart

Tool Crib

- ram (10T, 10 in. stroke)
- shop vacuum
- scaffold set
- safety ladder
- safety ladder (6 ft.)
- 1 in. impact wrench
- 1/2 in. impact wrench
- air disc sander
- air grinder
- air tool accessory set
- electric drill motor
- electric drill motor (1/2")
- drill bit set with index
- metal saw set
- puller set
- wrench set (open end)
- wrench set (box end)
- 3/4 in. socket set
- tap & die set (NF, N3, NC)
- torque wrench (100 ft./lb.)
- torque wrench (250 ft./lb.)
- torque wrench (600 ft./lb.)
- torque wrench (200 in./lb.)
- torque multiplier (1:10)
- torque meter (1,000 ft./lb.)
- bearing & seal driver set
- precision measuring set
- soldering gun
- safety ladder (10 ft.)
- porta power (3T)
- inert gas welder
- elect. test equipment
- air hammer
- air drill
- 90° air drill
- jumper cable set
- battery charger/booster
- diesel diagnostic kit
- headlight alignment tester
- power steering tester
- 121 system tester
- gas leak detector
- AC charge test unit
- AC leak detector
- battery/antifreeze tester
- portable crane (4,000 lb.)
- portable crane (300 lb.)
- fuel tank dolly
- portable fuel tank drain
- compressor dolly
- wheel dolly
- transmission jack
- jack set (5, 8, 10, 12, 15, 20T)

Source for Appendix 7D

[1] Design Criteria for a Satellite Bus Maintenance Facility, Houston, Texas: Fleet Maintenance Consultants, Inc., p. 16.

CHAPTER 8

SELECTION OF EQUIPMENT AND FIXED FACILITIES FOR PASSENGERS

Introduction

Passenger-carrying equipment is not a standardized element of a transit service that can just be "plugged into" service without careful consideration. The kind of equipment, the uses for which it is intended, and the quality of service it offers are important factors in the product portion of the marketing mix. Because of the interrelated and interdependent nature of elements in a transit operation, the buses must fit into the whole service package. The role played by equipment, therefore, is creative, not passive.

The Creative Role of Equipment in the Marketing Mix

Creating an Image

The quality of service--a complex bundle of factors that includes service frequency, scope of service, ease of accessibility to the service, and hours of operation--is probably the most critical factor in winning transit riders. Closely allied are factors that might be termed amenities, in that they affect all nonservice factors associated with a transit ride. Such factors may not be the initial reason why a passenger takes a trip (the bus coming along at the right time and going to the right place within the right time span was probably responsible for that), but they may be the reason why a consumer continues to use transit or supports the service.

In the area of transit amenities, the fact that the bus is air conditioned--and that the air conditioning works--is apt to help keep a passenger during the warm days of the year. Attractive decor inside the vehicle is not likely to get a passenger to ride in the first place, but cheerful and clean interiors promote continued ridership. Again, shelters may not cause a rider to take the bus, but when the weather is poor they may help retain the rider as a steady, fare-paying customer. The appearance and comfort of the equipment is an intangible comfort factor, but it is nevertheless critical to the success of a transit operation.

The rolling stock of a transit agency is the largest outward image of the firm; whether or not a member of the public uses the bus service, he most certainly notices the buses. Regardless of the efforts of advertising, promotion, and public relations, the equipment will form at least the initial image of the transit agency in the minds of the public. Great care must be taken in acquiring equipment that will maintain the desired image, not only when it is new, but over the years of its useful economic life. Careful maintenance and cleaning of equipment is, of course, essential to building and retaining a favorable public impression.

Clearly, a bus is not everything--routes, schedules, and fares also are a vital part of the transit package. But it is too easy for management to regard equipment as a given fact, even when great pains are taken and great creativity is used in all the other elements of the marketing mix.

Meeting the Service Requirement

In providing a mix of services to various segments of the market, equipment must be geared to meet the particular needs that arise from the differentiation of service.

Regular route service. Equipment should provide an interior layout that makes boarding and leaving the bus fast and easy. It should also provide reasonable seat comfort and sufficient room for passengers to stand without being crowded. In smaller cities most patrons on regular routes ride for short distances, so it may not be necessary to provide extraordinary levels of comfort either in the seating or suspension of the vehicle. However, if streets are rough or poorly cared for, it may be wise to opt for equipment that will provide the smoothest possible ride.

Under federal rules and regulations, transit services supported with federal funds must provide service that is accessible to elderly and handicapped riders. Indeed, federal rules now require that all new buses be equipped with wheelchair lifts or that there be some reasonable alternative--usually lift-equipped vans operating in the dial-a-ride mode--to assure that all citizens have access to public transit service. There still is some debate on whether it is best to make all transit vehicles accessible through the installation of ramps or lifts for wheelchairs or to provide specialized services with a separate fleet of equipment for the elderly and handicapped. The Urban Mass Transportation Administration (UMTA) regulations on service for the handicapped change from time to time. Contact with the UMTA regional office will provide the latest information.

Specialized service. The particular needs of the service will determine key features of the buses to be used. For example, in gearing service to make travel easy for the handicapped, special equipment may be necessary on buses. To meet the needs of those who have difficulty in moving up or down steps, a minimum number of steps of low height are needed, along with additional handrails. Persons traveling in wheelchairs may have great difficulty in passing down bus aisles; space should be set aside near the lift to provide room for wheelchairs and a means of anchoring them safely and securely. Because many potential customers may be elderly, consideration must be given when choosing vehicles in order to meet the needs of this group as well as the rest of the public. In addition, the buses used in conjunction with demand-activated special services (dial-a-ride) should be highly maneuverable to enable them to reach any place quickly and easily.

Where subscription bus service is offered, the ideal equipment used should not be so large or costly that filling it to profitable levels sacrifices the potential time advantages of the service. Maneuverability of the vehicle is another factor to be considered with any arrangement that attempts to offer door-to-door service.

Charter service. Whether or not publicly owned transit properties should offer charter service is a debatable issue, but privately owned transit services using vehicles acquired with private funds can certainly provide such service. In the case of charter service, patrons must often travel long distances to reach their destinations. In such instances, equipment should be carefully selected and designed to provide maximum comfort. Restrooms, air suspension, high-back seats, a public address system, tables, ice water, snack bar, and perhaps taped music are all part of the mix of quality that may be included in such a vehicle.

In recent years, federal laws and regulations have cut back the charter work that a publicly owned transit system may operate in the face of competition from privately owned bus companies. Before purchasing equipment for charter use, management must make sure that it can be used as intended.

Using Equipment as Promotion

The revenues that may be earned from using transit vehicles as an advertising medium can be attractive. However, management must consider the implications of advertising on transit's image. A maximum degree of managerial control should be exercised in cases where equipment is used to carry advertising messages on its exterior. Interior ads are less obtrusive, but the question of the desired overall image must be weighed against the possible revenue in order to determine whether ads should be carried. A transit firm trying to build a champagne image with its equipment will be hard-pressed to do so if its vehicles are plastered with ads for beer and cold cuts.

As a symbol of transit, the bus itself can be used as a promotional device. Delivery of a vehicle--particularly if there is something new and interesting about it--offers an opportunity for good advertising and community relations work. Transit is news, and because local newspapers are usually hungry for local news features that lend themselves to photographs, the delivery of new equipment can be the source of free newspaper and television publicity.

Symbolism is very important in promotional work, a fact illustrated by the pains large business firms take to develop a distinctive trademark or logo that is instantly recognizable. When the symbol is attached in the public's mind to a quality product, the symbol becomes a complete advertising message each time it is seen.

Some distinctive feature connected with the buses can be used as a symbol, not only for the transit system but perhaps for the city itself. London is as much symbolized by its famed red, double-decker buses as it is by Big Ben. The cablecars are as much a symbol of San Francisco as the Golden Gate Bridge. Great care should be taken in selecting decor and other features of the vehicles because they may have a direct bearing on the ability of the promotion and public relations people to symbolize the transit service easily and effectively. The use of a distinctive type of horn, or perhaps a chime similar to that used on some British police and emergency vehicles, might provide an interesting audible logo for the transit service.

The name used to identify transit service is usually displayed prominently on the equipment, which in effect makes the bus a large, moving billboard. Again, the service can be promoted through use of its name. For example, the word "Metro" has replaced the familiar American term "subway" on the underground railways in Montreal and Washington, DC. The word, subway has dank, dark, unpleasant connotations that Metro does not stir up. In many places "transit" may also be a term to be avoided. Some other name, such as "Extra Car"--used in Los Angeles' promotional and advertising work--"Metrobus," "Transporter," "Transpo," "Metro Coach," or "Metropolitan Transport" may be desirable. In other cases, plain facts have carried the day, and the transit system is dubbed simply, "The Bus Company."

Transit should, if possible, take advantage of the symbolism a city has or is trying to create for itself. There is a potential for tie-ins and the opportunity for city promotion to help advertise transit in an indirect fashion. For example, the purchase of special buses built to resemble old-time trolley cars may be used for shuttle or downtown distributor service in a downtown under restoration.

Important Specifications for Equipment Selection

In deciding which equipment to buy, management should start with broad, largely nontechnical specifications based on the service functions the equipment is to perform. These considerations will form the basis of the transit agency's guidelines for technical specifications. These technical specifications will be used to make valid mechanical and operational comparisons between different makes and types of equipment.

Features important to many operators would be items such as the type of engine and/or transmission necessary to meet power requirements; the rate of acceleration, where tight schedules must be maintained; and the turning radius, which is a fair indication of the maneuverability of the vehicle. Where comfort is to be a major part of the product element of the marketing mix, the type of suspension and air conditioning are also important.

The outer dimensions of the buses and the weight on the axles are important factors if the equipment is to be used both in city service and on state and county roads. For example, a 102-inch wide city transit bus provides a service quality advantage, giving standees six inches more aisle room or seated passengers wider seat room than the standard 96-inch wide bus can provide. However, wide buses cannot be operated on many state highways. Similarly, an air conditioned, 53-passenger transit bus offers the advantages of both air-cooled comfort and high passenger capacity. In some cases, the 40-foot frame of the bus and the additional weight of the air-conditioning unit, along with a diesel engine large enough to propel the bus and the air conditioner, will place considerable weight on the rear axle, more than is allowed by many state axle-loading limits. A smaller or lighter bus may have to be found to run on state roads in outlying areas or on intercity charters. Because of conflicting needs, management should carefully consider whether to buy one or more buses exclusively for charter work, if such services can be legally operated.

Several firms provide transit equipment, and it is not the province of this handbook to name specific makes or models that are "ideal" in one way or another. However, guidelines for selection are offered to help managers develop specifications that meet their particular needs. Manufacturers can then indicate what their wares have to offer.

The transit properties to whom this handbook is directed will be interested in vehicles ranging from small vans, for small city operations and special types of service, up to the largest capacity standard transit buses. In all cases, public officials involved in new transit undertakings should consult with others in the industry to learn about their experiences with various types of equipment and perhaps for aid in writing specifications. Agencies seeking buses that carry fewer than 30 passengers will have the most difficult job in finding good, substantial, long-lasting, reliable equipment. Many manufacturers have sought a place in this segment of the bus market, but few have lasted very long, and the quality of their products has often been poor. Operators of small buses may have to reconcile themselves to purchasing the best equipment available and replacing it frequently. The standard transit bus has an economic lifespan of 12 to 15 years; small buses, particularly those with gasoline engines, may have an economic life of no more than three to five years. UMTA has a very specific schedule based on size and usage. Transit operators should check with the UMTA regional office for the latest information.

Selection Guidelines

These guidelines are set forth to ensure that management considers all possibilities related to equipment, keeping in mind the interrelated nature of transit service. These guidelines form the background issues and ideas from which a listing of both broad and precise specifications for equipment may be developed. From this listing will come the decisions that will influence the final choice. (Note: when a commercial brand or model number is used, it must be followed by the term "or approved equal".)

1. Body structure

    a. Body on chassis or integral
    b. Riveted or welded
    c. Length
    d. Width
    e. Standard number of seats (and available seat configurations
    f. Height, from ground to first step
    g. Number of steps
    h. Height, from ground to floor (at front axle)
    i. Flat floor (transit only)
    j. Headroom
    k. Approximate unloaded weight
    l. Weight on front axle
    m. Weight on rear axle

2. Suspension

    a. Wheelbase
    b. Track--front
    c. Track--rear
    d. Turning radius over outside
    e. Turning radius of body (at front corner)
    f. Type of suspension (air, spring, and so forth)
    g. Steering manufacturer and model "or approved equal"
    h. Rear axle manufacturer and model "or approved equal"

3. Engine (recommended for given specifications)

    a. Location
    b. Inline or transverse
    c. Manufacturer "or approved equal"
    d. Gas or diesel "or approved equal"
    e. Configuration (6, V-6, V-8, and so forth)
    f. Displacement

g. Peak hp-Rpm
h. Peak torque-Rpm
i. Estimated engine life before major overhaul

4. Brakes

a. Type
b. Total area
c. Estimated life

5. Transmission

a. Manufacturer "or approved equal"
b. Model "or approved equal"
c. Type (torque, converter, 3-speed, etc.)

6. Performance

a. Acceleration speed
0-20 mph
0-30 mph
0-40 mph
b. Maximum grade
c. Braking

7. Ventilation and lighting

a. Heat type (recirculating or fresh air)
b. Air-conditioning capacity
c. Air-conditioning type (integral with heat or other)
d. Candle-power at reading plane

8. Other specifications

a. Seat spacing
b. Aisle width
c. Fuel tank capacity
d. Standard tire size
e. Front axle capacity
f. Rear axle capacity
g. Estimated fuel mileage

9. Price (typical price for the coach, rounded to the nearest $1,000)

10. Other items usually considered optional equipment

Demand Characteristics

In selecting a vehicle or type of vehicle, the characteristics of the demand for service must be considered carefully. This task requires far more than mere calculation of the total passenger volume a vehicle may have to carry; qualitative aspects of the demand are also involved. For example, on a smaller transit property where excess equipment is an expensive luxury, a vehicle must be versatile enough in capacity and design to be used in a variety of services. A bus that meets the standards--high standards, it is hoped--of regular route service may be unsuitable for use in special service or in charters.

A vehicle offering the widest variety of services should be flexible enough in design and construction to meet not only changes in the magnitude of demand but also changes in its nature. Ideally, it should have a seating arrangement that can be changed easily. Indeed, for those transit operators considering small buses or vans, it may be possible to have the seats of the bus palletized for easy removal and replacement. Without seats, the vehicle may be used for the movement of freight, mail, or parcels during off-peak hours.

Equipment that meets the general demand charactistics must fit the expected volume of traffic at any one time. As a rule of thumb, if numerous trips per day with a large volume of customers are likely, it makes sense to have relatively large vehicles so that customers can be handled quickly, comfortably, and conveniently. However, if regular route service calls for the handling of relatively large numbers on only one or two trips a day, it would be unwise to acquire a bus with a large seating capacity only to haul around empty seats most of the time. For instance, if the peak hour load is 50 patrons twice a day, and if passenger loading never exceeds 30 patrons at any other time, it is foolish to pay a high price for the extra seats--which may mean buying a bus that costs up to twice as much--merely to meet demand 10 times per week. Careful scheduling and the use of smaller buses could alleviate the standee problem. However, the use of high-capacity vehicles for some other services, such as lucrative evening and weekend charters, may make large vehicles a wise choice. This is obviously an issue that requires much thought and careful judgment.

Inevitably, members of the community will suggest having two fleets of buses: a fleet of large buses for peak hours and small buses or vans for the rest of the day. Public board members and public officials need to be informed that the major cost of operations is personnel and that drivers are paid the same whether they drive large or small buses. Therefore, the cost of maintaining two different fleets is an unwise expenditure of money.

Operating Conditions

In setting specifications and in selecting equipment careful attention must be paid to the operating conditions under which it will be used. The width and clearance of roads and streets over which service may be operated should be among the first factors to be considered along with the sharpness of curves and corners.

Local topography, particularly hills and valleys, is another important factor. Sufficient engine power must be provided to meet schedules. A combination of steep hills, narrow streets, and tight corners calls for a bus with a high degree of maneuverability and power. Hills also require extra braking power. The combination of power and maneuverability necessary to meet operating characteristics is probably the key factor under such conditions.

Another important decision arises in areas where high temperatures demand air conditioning. The bus power plant must be strong enough to propel the vehicle at scheduled speeds, up and down hills, while operating an air conditioning unit. Vehicles operating under such conditions probably need to be equipped with diesel engines, although gasoline-powered engines may be suitable where few hills are encountered and stops are spaced far apart. When a new transit property is getting underway, inquiries should be made of transit properties that have been operating in the same region for a period of time in order to learn what type of equipment has served them well.

Regardless of the terrain, vehicle maneuverability imposes limitations on the quality of service that may be provided. It may be impossible to take very large vehicles, such as standard 35- to 40-foot transit buses, into certain areas with restricted clearances that are common in residential areas. Yet, offering a fine-grained service that penetrates the entire city may be very critical to a transit operation. (Fine-grained operations are those in which routes are placed close together. They typically penetrate residential areas more deeply than routes confined to principal thoroughfares.) If streets are relatively narrow and if curves are sharp, a highly maneuverable vehicle with a relatively short wheelbase is probably needed.

Noise is a sensitive factor, especially in fine-grained operations serving residential areas. The hustle and bustle of traffic on busy streets tends to muffle the operating noise of buses. In quieter residential neighborhoods, however, excessive bus noise will stand out annoyingly, as will the pounding and vibration caused by heavy vehicles. Transit must be a good neighbor when extending its reach into residential areas. It may be difficult to make very large and heavy vehicles "friends" to those who live along the routes.

Comfort and Quality Needs

The comfort and quality characteristics of a vehicle are critical decision factors in vehicle specification and selection. As an example, the suspension of the vehicle--whether it be metal springs, torsion bars, or some sort of air bag system--is important in assuring overall vehicle riding comfort. Beyond that, air conditioning, heating, and ventilating systems must be given serious thought. As a rule of thumb, in any part of the country where restaurants, motion picture theaters, supermarkets, beauty parlors, and other businesses are typically air conditioned, transit vehicles should also be air conditioned. In very cold climates, heavy-duty heating systems should be installed and the buses should have extra insulation.

Another important factor is the feeling of spaciousness in the vehicle. Because buses use public highways, their width is necessarily limited. This fact makes the treatment of the interior space in terms of window size and location, decor, and the colors used on seating and floors all the more important. It is important to avoid a cramped interior appearance.

Bus seating leaves much to be desired in many cases, not so much because the seats themselves are uncomfortable, but because they are placed so close together that taller passengers have difficulty fitting their legs into the small space available. Maximizing the number of seats and at the same time maximizing discomfort for many potential patrons appears to be poor economy. Some thought should be given to having the buses fitted with fewer than the maximum number of seats usually installed. The use of diagonal seats or single row seating down one or both sides of a bus should be seriously considered. This choice can be difficult if there are large peak loads, because patrons do not like to stand.

Buses with large windows and bright interior colors usually appear to be larger inside. Careful thought should be given before purchasing buses with darkly tinted windows; while such glazing may reduce heat gain in the summer and reduce the air-conditioning burden, the large dark surfaces may make the bus very gloomy inside, especially when it is dark outside. It is also difficult to see outside at night and passengers may miss their stop because they cannot see landmarks. Caution must also be used in specifying nonglass windows. Some of the plastic windows are virtually indestructable but get badly scratched by automatic bus washers. Eventually, it may be difficult to see through them, and passengers may feel they are riding in a perpetual fog.

Interior lighting is another part of the transit sales package. One of the advantages of public transit is the opportunity afforded passengers to read a book or magazine, work a puzzle, or do some office or school work, rather than worry about driving. The lighting should be adequate to ensure ease of reading during darker times of the day. At the same time, care must be taken so that there is no undue glare on the inside of the windshield during night driving hours. Angled windshields are helpful and there should be a curtain or solid panel immediately behind the driver's position to prevent glare.

The modern appearance and cleanliness of buses are very important items in creating passenger appeal. Exterior and interior designs should be selected carefully so that a fresh, cheerful, and modern appearance can be easily maintained. Exterior paint should be durable and easy to maintain. Colors or paints that fade easily should be avoided. Striping and other designs may be provided by means of self-adhering plastic; this is a highly durable and comparatively inexpensive covering that can withstand years of use.

Vehicles may be selected with the thought in mind that interior or exterior redecoration could be easily accomplished by means of quick-change panels or paint. A relatively complete change in decor could be accomplished at least three times during the 12- to 15-year vehicle life of a standard transit bus, provided the change could be made easily and inexpensively.

The head signs (sometimes called destination curtains or blinds) that indicate route number, name, and destination are an aid to patrons using the transit service. Within space limits, the main head sign on the front of the bus should give as much information about the route as possible, such as destination, the major streets used, and principal points served. Other clearly visible signs should indicate the fare, where to enter, and so forth. In addition to the large head sign, a smaller curtain should be mounted on the right side of the bus so that passengers approaching from the sidewalk can easily see the route number and destination. Ideally, signs should also be placed at the rear and left side of the bus to show at least the route number and preferably the route name. Another possibility is to have each route identified by a colored metal flag or similar device that could be mounted on the roof just above the front door so that it is visible from all directions. Regardless of the direction from which a patron approaches, it should be possible to know what route the bus serves. This can help patrons avoid missing the bus or running about unnecessarily as they look for the right bus.

In recent years, electronic destination signs have become available. These may be programmed for a wider variety of destinations than the conventional roller curtain. Electronic signs may provide much more information than standard head signs. For instance, a regular head sign might simply read, "College Mall." An electronic sign could flash (1)"College Mall," (2) "Via Atwater Avenue," (3) "Third Street and Eastland," (4) "Have a pleasant day!" Such installations can be fitted to the front and rear of the bus and activated from the dashboard of the bus without the need for the driver to turn four roller handles.

<u>Drivers' Needs</u>

Vehicle specifications and selection must take the drivers' needs into consideration. Bus drivers must be able to work under conditions that minimize fatigue. Otherwise, they are likely to grow careless, which may lead to an accident, or they may become grumpy, which is bound to result in surly treatment of patrons. Both situations must be avoided.

The vehicle must be easy to drive and, except perhaps for vehicles used in over-the-road charter service, should include an automatic transmission. The instruments and control devices in all buses should be located so that they are within convenient sight and reach of the driver. The driver's seat should be comfortable and designed to help reduce fatigue.

The quality of the buses themselves can be a factor that helps to maintain a high level of driver morale. Equipment that looks good and is well-maintained and comfortable can help to instill a strong sense of pride in all employees. This will help provide better service for the public.

Maintenance Needs

Without question, the vehicle must be easy to maintain. Ease of maintenance involves not only the upkeep of mechanical devices, but cleaning as well.

As many of the mechanical components of a bus as possible should be provided in a modular form, so that the entire air conditioner, engine, generator, or whatever the part may be pulled out or replaced quickly and easily without putting the vehicle out of service for long periods of time. The modular approach should apply to any components likely to cause trouble. If extra initial cost is involved in purchasing buses with modular components, it must be weighed against the cost of a breakdown in service, as well as the cost of owning extra buses to serve mainly as stand-by equipment.

For housekeeping maintenance purposes, the interior of the bus should be designed and constructed to avoid as many dirt-trapping surfaces or obstacles as possible. Seats cantilevered from the bus wall, without the pedestals that can trap papers and other debris, may be a wise choice where automatic vacuums (often called cyclone cleaners) are used to clean bus interiors. The exterior of the bus should be as free as possible from protrusions so that it may be washed easily and quickly. The ever rising cost of labor will make it increasingly expensive to maintain high standards of tidiness if cleaning is done by hand. Mechanical means of cleaning should be adopted for all but very small bus fleets. Side mirrors can be spring mounted and radio antennas of small, streamlined design can be specified to pass through automatic washes without damage. The mechanical devices that are on the market at the current time should be carefully evaluated.

Graffiti has become a major problem in some cities; felt tip pens and spray paint cans are the usual means of carrying out this type of vandalism. Special castings and materials are graffiti-resistant or at least make it relatively easy to remove. Manufacturers of vehicles and components may give useful advice about graffiti control; advice may also be sought from the large city transit properties plagued by the graffiti problem.

Vandalism of seats by cutting may be prevented by use of fiberglass seats or another, similar material. Such seats are not terribly comfortable although some improvement may be possible by the use of padded inserts on the seat and the seat back. If the inserts are vandalized they may be replaced with relative ease.

Probably the best advise on controlling graffiti and vandalism is to remove its signs immediately so the idea will not be passed on to other creatively disadvantaged persons.

Other Considerations

Standardization. One of the most obvious features in many U.S. transit systems, particularly in the past, is the high degree of equipment standardization. Many transit properties operated buses of the same type made by the same manufacturer; this made inventory management of parts easy and assured familiarity with the equipment by the mechanical staff. Usually it is believed that the savings accrued through standardization make it an advantageous policy and, indeed, it may be. But it is probably unwise to standardize strictly for the sake of standardization, particularly if a variety of vehicle makes and styles could better perform the different types of service needed by various market segments. Furthermore, strict standardization by manufacturer is usually not possible under a competitive, sealed-bid method of procurement.

With multiple service needs and a minimal likelihood that any one type of vehicle can satisfy all those needs, acquisition of several types of equipment may be the wisest course of action. This approach does not mean acquiring the largest variety possible of different sizes, shapes, and makes of buses. It does mean making sure that the equipment fits properly into the marketing mix and is consistent with the firm's objectives and policies about cost and revenue.

Small buses. Small buses often suggested for use in smaller cities may be a smart buy. However, some transit managers are reluctant to buy smaller vehicles, pointing out that the major operating cost is drivers' pay, which does not vary according to the size of the vehicle operated. The important thing to consider, however, is not the hourly wages of a driver or operating costs divided by the number of seats in the bus, but whether the vehicle itself is part of a package of services that the public needs and is willing to buy. If the small bus--or, indeed, a horsecar or rickshaw--fits the market or an important market segment, then it is the proper vehicle.

Cost. In addition to the sheer capacity of the vehicle, the cost of ownership should be calculated in light of the flexibility with which the bus, as a unit of passenger capacity, may be used. It may be better to own two smaller buses than one large one. The larger number of vehicles of smaller size adds to the variety, number, and flexibility of services that may be offered. Unless the total demand per trip is high, it appears unwise to have unused seating capacity tied up in a given vehicle and thereby locked to a given route at a given time.

Many smaller transit firms may consider the use of school-type buses for their service. As a general rule, school buses are much less expensive to buy than are buses built primarily for transit service. The reason is simple: a school bus body is usually placed on a mass-produced truck chassis equipped with a mass-produced engine. Although the economies initially seem attractive, the use of such vehicles in transit service might not make much marketing sense. Patrons in most market segments probably would not be very happy about riding in something that looks like a school bus. The image is simply not that of a progressive transit operation, especially if the vehicle has the engine obviously located in the front. A squared-off, more bus-like appearance might overcome this potential objection. Some truck producers manufacture rear-engined school bus chassis, and the bodies fitted to them appear much like a standard bus. Even so, school bus type vehicles may present maintenance difficulties, especially with the brakes; the chassis and fittings of most are not designed for the difficult stop-and-go environment of transit. If such vehicles offer sufficient advantages to outweigh the possible disadvantages, then they should be seriously considered. In any case, if school buses are used, transit management must recognize that such vehicles will have to be replaced every three to five years.

School bus body manufacturers can be important in another way. Where specialized needs in small city transit operations cannot be met by regular transit-type vehicles, it may be practical to arrange with a school bus body manufacturer to build bodies to meet custom specifications. Special equipment for the elderly and handicapped is a case in point.

Leasing buses. Transit managers should carefully weigh the question of leasing buses or of buying used buses for economic reasons. Not only should the cost in dollars and cents be measured, but also whether the equipment fits into the marketing mix. With capital improvement money available from UMTA for new equipment, leasing is primarily a short-term option so that service can be provided while waiting for new equipment to be delivered under a federal grant.

New or used buses. One important consideration, especially for a transit firm starting from scratch, is how to pace the replacement of equipment through purchase of a mixture of new and used equipment. If, at the start, similar equipment is acquired all at the same time, it will tend to wear out at about the same time. Unless a transit enterprise foresees a steady enlargement of service over its first four or five years of operation, so that several new buses will be added each year, both new and used equipment should probably be included in the initial fleet. Older buses should be kept for a year or two and should then be replaced by new equipment.

New buses. Ideally, the transit firm should add some new vehicles each year. This practice will help keep the average age of the fleet low. It will also rule out the need for very large periodic capital expenditures. The constant influx of new equipment helps maintain a good image for the service and creates public relations opportunities.

The Need For Other Equipment

Other Vehicles

In addition to the rolling stock for carrying passengers, a transit operation needs other vehicles. A tow truck large enough to handle any job is one piece of equipment that may be well worth having. The question is whether it is worth tying up the capital in a tow truck or whether it is better to rent the service when needed. In a firm with very few buses, it may be best to enter into an agreement with a local operator of trucks or a truck service agency to use its towing equipment.

A service wagon might be a useful investment. This would be a relatively small truck or van used to make light, running maintenance on the buses to help cut down on the need to take the bus off its route for very simple repairs. The service wagon might also include a fuel tank and pump so that buses could be fueled at terminal points, rather than having to return to the garage. (The fuel tanks on small buses and vans may not be large enough to cover a whole day's operation.) Depending on cost and availability, it may be wise to purchase a general purpose truck large enough to perform towing chores as well as needed service jobs.

Street supervisors, who usually make their rounds in ordinary automobiles, might be better equipped with small bus-type vans. Vans have the maneuverability of a car, but may be useful for transporting drivers to and from relief points. In a pinch they may be used to carry passengers if a regular bus breaks down. The car/van decision will depend on the route configuration and company policy, as well as cost considerations. If the property has a major goal of on-time performance and no missed trips, supervisors should be equipped with 15-passenger vans that can pick up passengers if a bus is delayed in traffic or breaks down.

Snowplows may be required in some cities and towns to clear the area around the maintenance facility. Depending on the size of the job, the snowplow may be no more than a four-wheel drive vehicle or a tow truck equipped with a plow blade. Unless snowfall is regular and heavy, a vehicle equipped solely for snow service is not needed. Another option would be to contract for plowing service with a local construction company, the city street department, or a local snow removal company.

Passenger Facilities

High-quality rolling stock can do much to make public transportation an attractive means of travel. Passenger facilities that complement the equipment complete the package of high-quality service. No matter how attractive equipment may be or how pleasant it is to use, passengers who have to stand on a cold or wet street corner waiting for a bus are bound to be displeased with the total package of service provided for them.

Shelters. Shelters should be provided at all principal stops and at as many lesser stops as is economically feasible. The shelters may range from simple fiberglass or metal canopies erected on steel pipes to small, enclosed structures. The transit firm may wish to construct its own structures or purchase the prefabricated shelters now on the market. Because these facilities are likely to be costly, agreements may be made with firms that will supply shelters or benches at no cost in return for advertising privileges on the structures. The decision to advertise on or in the shelter depends upon the image that the transit firm is seeking. Contracting with a private firm for shelters or benches sets a good example of public/private cooperation.

The location of shelters can be determined by means of passenger boarding counts or by interviews with drivers. The places where most passengers board are the first priority locations for shelters. Often it is harder to get permission to erect a shelter than it is to determine where it should be located. City ordinances may restrict the construction of passenger shelters because they may partially block the sidewalk. It may be necessary to have the ordinances changed. Furthermore, adjacent property owners or businesses may object the placement of shelters. If a shelter is placed on private property then permission must, of course, be obtained. Purchase of a small parcel of land may be necessary.

Terminals. Wherever a number of routes share a common terminal station, facilities should be more elaborate, depending upon the expected passenger traffic. The facility should be comfortable and attractive and should probably be air conditioned and/or heated if extremes in temperature are common.

If the system has a major downtown focus, a terminal facility of ample size should be provided. In addition to waiting space and shelter for passengers, it should contain restroom accommodations for both the public and for drivers and other staff personnel. The central controller or supervisor and telephone information personnel should also have offices here. Facilities should be equipped with air conditioning and heating units.

Architecturally, the transfer house, which may be a separate structure or built into an existing structure, should be as attractive as possible. It has the advertising and promotional potential to help create and maintain the positive image that the transit firm must establish. The outer part of the structure should include the logo of the system, and perhaps a time and temperature sign. The latter feature is to ensure that the transfer house attracts the attention of even those persons who do not intend to use the service. It never hurts to be in the public eye under favorable circumstances. The facility may be jointly developed with the private sector or a public agency. If the terminal is large enough it may provide good rental space to private firms, thereby adding to the income of the transit property.

Parking. Parking lots for park-and-ride services are an increasingly common feature of transit service. The location of parking lots should be along major corridors leading to central core areas or major destinations where parking is difficult. The precise location may depend upon the available land. UMTA funds can be used for the purchase and construction costs of transit parking facilities. It is not necessary to buy and clear land in all cases; there may be parking lots already in existence that can be used for the transit service. Shopping centers are often willing to let part of their parking lot be used for park-and-ride bus service in the expectation that some of the passengers may become customers later on. Church parking lots and drive-in theaters are another source of space that is used to capacity only at times when the park-and-ride service would not be used.

Whenever possible, the buses should enter the parking lot so that park-and-ride patrons need not have to walk an inconvenient distance. Passenger shelters should be made a part of the lot, along with proper signs and information.

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CHAPTER 9

PROCUREMENT

Introduction

Methods and procedures used in the procurement of goods and services consumed by the small city transit system reflect the relative efficiency of the way the system is managed. Aside from simply making good business sense, these procedures must conform to specific federal, state, and local standards. With the help of the appropriate experts and with sound legal advice, the procurement process can be translated into a simple set of internal staff procedures.

This chapter cannot possibly present a usable prototype due to the variety of influences at each different organization. In addition to federal, state, and local guidelines, it is likely that each individual system is governed by some form of a policy board or city council and an executive director, general manager, or some other top manager. Each of these positions will influence the internal procurement process.

This chapter will identify those governing bodies and individuals who set procurement policy. It will present basic procurement principles and suggest a structured, modular framework that a small city system might use in developing its own internal procedures. Common procurement problems are also described. Appendix 9A outlines several issues involved with capital improvement planning.

Groups That Influence Procurement

Governing Bodies

The balance of this chapter rests on the assumption that every system receives some combination of federal, state, and/or local funding. With funding comes procedural influence, and nowhere is this more obvious than with procurement within the small city transit system.

Federal government. Federal procurement guidelines are primarily developed by the Office of Management and Budget, interpreted by the Department of Transportation, and then customized for use by the Urban Mass Transportation Administration (UMTA). The result is UMTA Circular 4220.1A entitled, "Third Party Contracting Guidelines." This circular clearly yields to individual state procurement procedures, yet establishes minimum guidelines that must be adhered to in the process.

State government. State procurement procedures may, or may not, address the same issues as the federal government, and are usually more restrictive.

Local government. Again, procedures at the local level may, or may not, address those at the federal and state levels, and tend to be even more restrictive. The local city council, county council, or board of public works may all have influence on the procurement procedures.

Policy board. The local board of directors or other policy board may impose another layer of influence on the procurement process to accomplish an objective that is more specific, and inherently more restrictive. Policy board influence usually revolves around approving individual purchases above the threshold amount authorized for the management staff.

Senior Management

Superimposed on these procedures is the influence of executive directors or general managers. They will be concerned with determining the exact internal procedures to be followed by staff in initiating any procurement action.

Conflict Between Governing Bodies

Conflict arises where the procedures of one governing body differ from the others on the same issue. These differences include dollar amount thresholds in defining purchase categories, degrees of specificity in a particular procedure, silence from one body on a particular issue while the other has prescribed guidelines. The prevailing direction is usually shaped by the most restrictive guidelines.

For example, UMTA's threshold on small purchases is $10,000, whereas some states use a $5,000 limit. The most restrictive limit is that of the states; therefore, the system adopts the $5,000 threshold. Furthermore, although UMTA Circular 4220.1A specifically yields to the state's small purchasing procedures, for threshold values under $10,000, UMTA still has prescribed guidelines on how these purchases are to be made.

An example of varying degrees of specificity on a procedure is UMTA's formal advertising requirement that "the invitation shall be publicly advertised," whereas a particular state code specifies that "such expenditure shall be made only after a notice calling for bids has been published once a week for two consecutive weeks in at least one newspaper of general circulation within the territorial boundaries of the regional transit authority." In this case, the system must conform with the state's more restrictive code, which inherently satisfies UMTA's guidelines.

A third example is the federal requirement of including a specific, comprehensive list of provisions in a final contract document, whereas a particular state's code is silent on specific provisions. Again, the system is obligated to comply with the more restrictive federal requirement.

The three examples above merely illustrate the complexity of the purchasing process and are neither all-inclusive in terms of the mutual exclusivity of one set of guidelines over another, nor are they necessarily sound in legal opinion. They merely reinforce the fact that when spending public funds one cannot simply pick up the phone, or go to the supply house and place an order. As in all other sound business dealings, it is essential that specific legal advice is sought regarding each purchasing action.

Components of the Procurement Process

Components of procurement process include types of procurement, methods of procurement, procurement procedures, and associated tasks. General explanations of each are presented in the following sections.

Types of Procurement

Some systems refer to specific types of procurement in order to simplify buying needs over a particular period of time. Examples include annual bulk purchases of fuel, materials, supplies, replacement parts, and various services. Buying in bulk simplifies the procurement process and minimizes the efforts of the staff over the course of the budget year.

Methods of Procurement

Methods of procurement are usually specified by federal, state, and local codes. As previously discussed, the prevailing code is usually that which is the most restrictive. For the purposes of this handbook, UMTA guidelines on the four methods of procurement will be used: (1) small purchases, (2) competitive sealed bids, (3) competitive negotiation, and (4) noncompetitive negotiation. Each method is discussed in the paragraphs that follow. Grantees may use additional innovative procurement methods with the approval of UMTA.

Small purchases. Small purchases include simple, informal purchases costing in aggregate not more than $10,000. Price or rate quotations must be obtained from an adequate number of qualified sources.

Competitive sealed bids. Such bids will be used in the following three circumstances:

1. Complete and realistic specification or purchase description is available.

2. Two or more responsible suppliers are willing and able to compete effectively for the grantee's business.

3. The procurement lends itself to a firm fixed-price contract whereby selection of the successful bidder can appropriately be made principally on the basis of price.

Competitive negotiation. If conditions are not appropriate for the use of formal advertising, then competitive negotiation may be used. Proposals are requested from a number of sources and the call for proposals is publicized.

Noncompetitive negotiation. If the award of a contract is infeasible under small purchase, competitive bidding, or competitive negotiation procedures then noncompetitive negotiation may be used. Circumstances include the following:

- The item is available from a single source.
- Public exigency or emergency. The item is urgently needed, and there is no time for competitive solicitation.
- UMTA authorizes noncompetitive negotiation.
- After solicitation of a number of sources, competition is determined inadequate.

Procedures for Procurement

Procedures simply refer to the steps that need to be taken to use a particular method of procurement. Procedures are derived from various sources including legal guidelines, policy decisions, executive directives, and good business sense. Examples of procurement procedures follow:

- Developing technical specifications
- Preparing a solicitation package
- Maintaining project records
- Formal advertising for bids
- Soliciting quotes
- Awarding a contract (selection procedures)

- Requesting proposals
- Processing invoices
- Securing purchase authorizations
- Making inventory purchases
- Using blanket purchase orders

Various players shape the precise procurement policies of any transit system; therefore, each system is likely to have unique procurement procedures. Even similarly sized systems in the same state will differ due to the influences of the individual system's policy board and general manager. It is important that these procedures be clearly documented, continually updated, and thoroughly understood by those authorized to enter into agreements with vendors.

Tasks of Procurement

Each procedure consists of a group of specific tasks designed to satisfy a particular requirement. A task is the most basic level of effort in a procurement. The definition and application of tasks are usually completely within the control of internal policymakers, directors, and managers. A task is simply an incremental step toward the achievement of a procedural objective. Two examples of procurement tasks are preparing purchase requisitions and purchase orders, and acknowledging receipt of goods and services.

Procurement Principles

The principles of good procurement are simple. The objective is to acquire high-quality goods and services in an efficient, timely, cost-effective manner, in adherence with all the appropriate legal and procedural guidelines. More specifically, persons in charge of procurement should:

1. Ensure that materials and services are obtained efficiently and economically and in compliance with the provisions of applicable federal law and executive orders (UMTA C4220.1A, S4);

2. Have the responsibility, in accordance with good administrative practice and sound business judgment, for settling all contractual and administrative issues that arise from procurements entered into in support of a grant (UMTA C4220.1A, S5A);

3. Use procurement procedures that reflect applicable state and local laws and regulations, provided that procurements for federal assistance programs conform to the standards set forth in (UMTA C4220.1A) and applicable federal law (UMTA C4220.1A, S5b., p. 2);

4. Maintain a written code or standards of conduct that govern the performance of the system's officers, employees, or agents engaged in the award and administration of contracts supported by federal funds. To the extent permitted by state and local law or regulations, such standards of conduct should provide for penalties, sanctions, or other disciplinary actions for violations of such standards by the grantee's officers, employees, or agents, or by contractors of their agents (UMTA C4220.1A, S10, p. 4).

Sample Goal Statement

A sample goal statement follows, which outlines key areas that might be addressed in a procurement procedure goal statement.

Our goal is to develop and use internal procurement procedures designed to speed the development of goods, materials, and services in a cost effective and timely manner. Our actions to achieve this goal should reflect applicable state and local requirements, provided that procurement for federal assistance programs conforms to the standards set forth in UMTA C4220.1A and applicable federal law. These procedures will:

1. Provide that the proposed procurement actions shall be reviewed by designated officials to avoid the purchase of unnecessary or duplicate items.

2. Assist in awarding a fair share of contract to small, minority, and women's business enterprises.

3. Include a written code of conduct which shall govern the performance of officers, employees, or agents in the award and administration of contracts. To the extent permitted by state or local law, this code shall provide for penalties, sanctions and disciplinary actions for violations by officers, employees, agents, contractors, or their agents.

4. Include written selection procedures which shall provide, at a minimum, the procedural requirements of solicitations of offers and awards to responsible bidders.

5. Outline the step-by-step procedures of four methods of procurement that will encompass any purchasing transaction.

6. Provide for a record keeping system designed to detail the significant history of a procurement which includes, yet is not limited to: the rationale behind the method of procurement, selection of the type of contract, contractor selection or rejection, and the basis for the cost or price.

7. Recommend precise techniques to aid users of goods and services in estimating their needs well in advance of actual usage.

A Structured, Modular Approach

Figures 9.1 through 9.4 show each of the four methods of procurement and suggested procedural topics. These topics are by no means considered to be exhaustive; they do however illustrate the modular approach. Notice that each figure also serves as a worksheet to help in planning the procurement, in addition to documenting the significant history of the procurement. Three estimates of time to complete each procedure are presented: shortest time (best), longest (worst), and most likely.

Other advantages of the modular approach are that responsibility for each task can be assigned, and the best, worst, and likely time estimates can be placed on each task. This lends any proposed procurement to a PERT, or CPM-type, analysis. The person (or persons) responsible for each task can also be noted on the worksheet. Another nice feature is that each single-page modular procedure becomes part of the documentation package, which is necessary for detailing the significant history of a procurement, as required by UMTA. This documentation might also be useful when evaluating the performance of the procurement professional, planning for procurements, and determining needed staffing levels.

Figures 9.5, 9.6, and 9.7 show three procedures and their associated tasks. Again, our purpose is not to present an exhaustive listing of tasks for a given procedure. However, these procedures and their associated tasks further illustrate the modular approach. Each figure also serves as a worksheet in fine-tuning the procurement and provides more detailed documentation of the significant history of the procurement.

SMALL PURCHASE PROCEDURES

Purchase Description: ____________________________________

Estimated Purchase Cost: ________________________________

	Estimated Work Hours			
	Best	Worst	Likely	Person(s) Resp.
1. Filling out purchase requisitions	____	_____	______	______
2. Identifying responsible vendors	____	_____	______	_____
3. Obtaining price or rate quotation	____	_____	______	_____
4. Selecting a vendor	____	_____	______	_____
5. Securing authorizing signatures	____	_____	______	_____
6. Cutting a purchase order	____	_____	______	_____
7. Encumbering funds	____	_____	______	_____
8. Communicating notice to proceed	____	_____	______	_____
9. Acknowledging receipt of goods or services	____	_____	______	_____
10. Processing the invoice and paying the vendor	____	_____	______	_____
11. Administering the contract	____	_____	______	_____

FIGURE 9.1 Small Purchase Procedures

COMPETITIVE SEALED BID PROCEDURE

Purchase Description: ______________________________

Estimated Purchase Cost: ____________________________

	Estimated Work Hours			
	Best	Worst	Likely	Person(s) Resp.
1. Filling out purchase requisitions	____	____	____	____
2. Developing complete, adequate, and realistic specifications	____	____	____	____
3. Identifying responsible vendors	____	____	____	____
4. Developing firm fixed-price contracts	____	____	____	____
5. Establishing bid evaluation criteria	____	____	____	____
6. Formally advertising a bid	____	____	____	____
7. Selecting a vendor and awarding the contract	____	____	____	____
8. Encumbering funds	____	____	____	____
9. Communicating notice to proceed	____	____	____	____
10. Acknowledging receipt of goods or services	____	____	____	____
11. Processing the invoice and paying the vendor	____	____	____	____
12. Administering the contract	____	____	____	____

FIGURE 9.2 Competitive Sealed Bid Procedure

COMPETITIVE NEGOTIATION PROCEDURES

Purchase Description: ____________________________________

Estimated Purchase Cost: _________________________________

		Estimated Work Hours			
		Best	Worst	Likely	Person(s) Resp.
1.	Filling out purchase requisitions	____	____	____	____
2.	Developing a statement of work	____	____	____	____
3.	Identifying responsible vendors	____	____	____	____
4.	Determining the appropriate contract type	____	____	____	____
5.	Establishing proposal evaluation criteria	____	____	____	____
6.	Issuing a request for proposals	____	____	____	____
7.	Choosing when to negotiate, whom to negotiate with, and what to negotiate	____	____	____	____
8.	Selecting the best and final offers	____	____	____	____
9.	Selecting a vendor and awarding the contract	____	____	____	____
10.	Encumbering funds	____	____	____	____
11.	Communicating notice to proceed	____	____	____	____
12.	Acknowledging receipt of goods or services	____	____	____	____
13.	Processing the invoice and paying the vendor	____	____	____	____
14.	Administering the contract	____	____	____	____

FIGURE 9.3 Competitive Negotiation Procedures

NONCOMPETITIVE NEGOTIATION PROCEDURES

Purchase Description: ________________________________

Estimated Purchase Cost: ______________________________

	Estimated Work Hours			
	Best	Worst	Likely	Person(s) Resp.
1. Filling out purchase requisitions	____	____	____	____
2. Developing a statement of work	____	____	____	____
3. Identifying responsible vendors	____	____	____	____
4. Determining the appropriate contract type	____	____	____	____
5. Choosing when to negotiate, whom to negotiate with, and what to negotiate	____	____	____	____
6. Selecting the vendor and awarding the contract	____	____	____	____
7. Encumbering funds	____	____	____	____
8. Communicating notice to proceed	____	____	____	____
9. Acknowledging receipt of goods or services	____	____	____	____
10. Processing the invoice and paying the vendor	____	____	____	____
11. Administering the contract	____	____	____	____

FIGURE 9.4 Noncompetitive Negotiation Procedures

PURCHASE REQUISITION PROCEDURE

Procedure: Initiating the procurement with a purchase requisition.

Method: Small purchase

Types: Inventory, grant capital, nongrant capital, special order

References: 1. Executive director to director's memo, 1-2-87; RE: purchase authorization amounts

Goal: Anyone may have a legitimate need for goods, materials, or services, at any given time. Responsible procurement starts with a purchase requisition that includes a description, the quantity, cost, account number, user, and appropriate authorizing signatures.

Tasks:	Estimated Work Hours			
	Best	Worst	Likely	Person(s) Resp.
1. Complete all items on the requisition	____	____	____	____
2. Secure the appropriate signatures for the amount of the expense	____	____	____	____
3. Send to finance department	____	____	____	____

FIGURE 9.5 Purchase Requisition Procedure

ACKNOWLEDGING RECIEPT OF GOODS AND SERVICES

Procedure: Acknowledging receipt of goods and services

Methods: Small purchase

Types: Special order

References: 1. Finance director, manager's memo, 2-1-87; RE: Invoice Processing

Goal: Maintaining a good working relationship with vendors entails paying for their goods and services when payment is due. Timely payment may also result in a considerable price discount. It is imperative that all ultimate users of goods and services notify _____________ promptly upon receipt.

Tasks:	Estimated Work Hours			
	Best	Worst	Likely	Person(s) Resp.
1. Be sure that all invoices are sent directly to accounts payable	____	_____	______	_____
2. For direct delivery to users, initial all packing slips and bills of lading, then send to A/P	____	_____	______	_____
3. (Fill in based upon your own specified tasks.)	____	_____	______	_____
4. " " "	____	_____	______	_____

FIGURE 9.6 Acknowledging Receipt of Goods and Services

IDENTIFYING RESPONSIBLE VENDORS

Procedure: Identifying responsible vendors

Methods: All

Types: All

References: 1. UMTA, C4220.1A, S16.b (2), S12.a.1-5

2.

3.

Goal: We maintain a list of responsible vendors in the _____ and ________ departments which includes certified minority and women's enterprises. Vendors are to be chosen from this list provided that the user's criteria are met. This information is maintained in order to facilitate a timely procurement.

Tasks: Estimated Work Hours

	Best	Worst	Likely	Person(s) Resp.
1. Obtain list of qualified vendors from ______________.	____	_____	______	_____
or				
2. If not available internally, obtain from other sources. You must justify and document your efforts.	____	_____	______	_____

FIGURE 9.7 Identifying Responsible Vendors

Common Procurement Problems

Common problems in third-party contracting include:

- Specifications or statements of work that are unduly restrictive or limit competition.
- Specifications that are written in a vague and ambiguous manner.
- Unrealistic technical or delivery requirements.
- Specifications or statements of work that contain insufficient information for contractors to formulate a realistic or accurate bid.
- Systems that avoid writing performance specifications by relying on manufacturer's specifications or other project specifications and that do not go through the process of assessing their own requirements.
- Standard specifications that are used without a review of their appropriateness.
- Use of brand name specifications without the "or equal" statement.

Summary

This chapter is intended as a guideline to the overall procurement process. Since the precise procurement process of any given system is shaped by various sources, some shared and some unique, it has been intentionally general.

The modular approach becomes an aid in analyzing the individual steps of a procurement, in terms of how well they were executed and who executed them. Problems with the process will manifest themselves in a particular step and thereby hold that step suspect, not the whole process. A discrepancy during a particular step can easily be identified as a problem of procedure or execution. Once identified, it can be corrected quickly, with less disruption to the procurement process.

A modular process also helps to document the significant history of a procurement, as required by UMTA. Worksheets used to determine the appropriate method, procedures, and tasks should become part of the procurement's file. Another benefit is in the simplification of documentation maintenance. As changes in the policies that affect the procurement process occur, only those procedures that need updating are changed, instead of the entire process.

In no way have we attempted to present an off-the-shelf, complete procedure to be used in the procurement of goods and services. A good procurement process must be developed with sound legal advice and tailored to each specific system. However, we have attempted to present a modular framework to which the precise procedural requirements of individual systems may be added.

Notes for Chapter 9

1. Up-to-date UMTA circulars can be obtained from the Office of Public Affairs, U.S. DOT, UMTA, Washington, DC, 20591, (202) 426-4865.

2. The Federal Register publishes notices of proposed rules relating to ongoing procedural modifications.

3. For help in developing a list of prospective vendors, see Disadvantaged Business Enterprise (DBE) Program Resource Manual, prepared by the Latin American Manufacturers' Association for the Office of Grants Management, Washington, DC: U.S. DOT, UMTA, October 1984, DOT-I-85-11.

4. For a complete presentation of DBE/WBE requirements, see UMTA Circular 4716.1, Urban Mass Transportation Administration Disadvantaged Business Enterprise/Women Business Enterprise Requirements for Recipients and Transit Vehicle Manufacturers, Washington, DC: U.S. DOT, UMTA, January 1985.

Source for Chapter 9

[1] "Orientation to Third-Party Contracting: A Seminar for UMTA Grantees," UMTA, developed for the Office of Administration by TCI, Inc., Washington, DC, January 1985.

APPENDIX 9A

CAPITAL IMPROVEMENT PLANNING

Introduction

Capital improvement planning is the process of developing a long-term plan for the capital expenditures of a transit system. Capital expenditures are expenditures for buildings, land, major equipment, and other commodities that are of significant value and have a useful life of several years. The capital improvement plan (CIP) is a plan for the capital expenditures to be made each year, over a fixed period of years. It sets forth each capital project, identifies the expected beginning and ending dates for each project, the amount to be expended in each year, and the method of financing the expenditures.

The capital budget is enacted annually. It includes appropriations for the first year of the CIP and targets the necessary funding to finance improvements in future years. The CIP must be updated after the enactment of the capital budget to: (1) make any adjustments in the timing of funding of future projects that arise from changes in the current situation, and (2) add a year of programming to replace the year funded.

Benefits of the Capital Improvement Plan

Capital improvement planning is an important capital and fiscal planning tool. It provides transit systems with several benefits, including those described in the sections that follow.

Meeting Replacement and Repair Needs

A CIP enables a transit system to provide for the orderly replacement and repair of capital facilities and equipment. With the CIP, management and staff can begin to undertake the task of refurbishing both equipment and physical plant in an efficient, orderly manner. This helps to assure that projects will be on time and in coordination with other expenditures.

Meeting New Needs

In addition to repair and replacement needs, the system will eventually require new facilities and equipment to accommodate growth. A CIP will help management and staff gain an overall perspective on new development in the community and will help to coordinate capital improvement for transit with plans for general community growth and improvement. A CIP can help a transit system foresee the need for an entire range of new capital projects and help plan to meet those needs.

Fiscal Planning

The CIP forecasts future demands on local revenue, borrowing power, and any federal or state aid available for capital purposes in a transit system. With a CIP and a forecast of financial resources available for capital purposes, a transit system can see what its capital needs will be and assess its ability to meet them. A transit system can avoid overextending itself financially through the CIP forecast period.

Project Planning and Design

Because the CIP identifies capital needs several years before funding and implementation occurs, it allows adequate time to plan these projects carefully. Without a CIP, a transit system may not foresee the need for many capital projects, especially the smaller ones. Consequently, planning and design must often be done hastily.

Securing Federal Grants

A CIP helps management acquire capital grants by identifying future projects and outlays before actual need. Working with the Metropolitan Planning Organization (MPO) and satisfying requirements for the Transportation Development Plan (TDP) become a much simpler process when program needs and specifications are known well in advance.

Implementing the CIP

The following steps are presented as a guideline to be used in formulating a capital improvement plan.

Preparing an Inventory

Each system should already have some form of inventory of its facilities and equipment. A typical format for this inventory is a fixed-asset ledger which includes as a minimum, a brief description of the assets, their date of acquisition, cost, and anticipated life in years.

Lines six and seven of Section 15, form 101, entitled "Balance Sheet Summary Schedule," require entries for tangible transit operating property and accumulated depreciation, respectively. Maintaining a fixed-asset ledger is actually the first step in planning for the eventual replacement of the asset. This type of information is necessary in grant programming and budget development, and is crucial to good procurement planning.

Establishing a CIP Calendar

Once an inventory of existing assets is completed, and a clear direction for levels of service for the immediate future is established, a CIP calendar should be developed. A CIP calendar is a useful coordinating device that identifies the responsible individuals and necessary activities, and sets a timetable for the entire CIP process. The CIP calendar also establishes priorities for what needs to be replaced and when it needs to be replaced.

Evaluating Proposed Capital Projects

In evaluating a proposed capital project, management should consider its effect on existing plans, policies, and work programs, in addition to its cost and relative need. UMTA circular 4220.1A states that "Where appropriate, an analysis should be made of lease versus purchase alternatives, and any other appropriate analysis to determine which approach would be the most economical."

Performing Financial Analysis and Programming

Financial analysis involves determining the system's financial capacity for capital expenditures. By examining past, present, and future revenues, plus expenditures and debt, management should determine what capital expenditures it can safely afford over the next five years.

Financial programming concerns selecting and scheduling funding sources for capital expenditures. Major objectives of financial programming are determining debt capacity and debt service levels, maintaining a preferred balance between debt service and current expenditures, and maximizing state and federal aid.

Adopting the CIP

The CIP and capital budget must then be worked into the system's budget cycle, which usually requires a public hearing and a board review prior to adoption. The adoption process provides the public and the board with information on the future need and financial requirements reflected by the proposed capital projects. The CIP reflects the system's view of the future direction of its services.

Programming Proposed Capital Projects

For each capital improvement proposed over a period of five years, management should develop a detailed description that includes enough information to give the board of directors and the public a full understanding of the project. The detailed description should include the following items:

- Project title and number.

- Narrative description of the purpose and need for the project.

- Expenditure summary that shows actual expenditures from previous years and proposed expenditures for each year of the CIP.

- Funding summary that shows the source of funds for the proposed expenditures for each year of the CIP.

- Statement of the anticipated impact the project will have on the annual operating budget.

Management should then develop a CIP summary project list providing a financial summary for all projects. It should include the following information:

- List of each project title and number.

- Prior, current, and proposed yearly expenditures for each project in the CIP.

- Total proposed expenditures.

- Total funding summary showing all the funding sources for all projects on the list.

Finally, management should develop a narrative statement that describes important issues relating to the CIP. The issues discussed might include the following:

- Rationale for projects.

- Summary of past activity and progress with an indication of problem areas.

- Summary of adjustments to be made in the CIP for current year.

- Analysis of the effect economic conditions might have on the CIP.

- Major funding uncertainties, especially with respect to the status of applicable grants.

Monitoring Capital Projects

Staff should review the progress of each project in the capital budget on a monthly basis. This review should summarize cumulative progress on each task in the project and identify any problems and anticipated changes in the capital project.

These reports should be prepared using the same format as required in UMTA Circular 5010.1 (entitled "UMTA Project Management Guidelines for Grantees," outlined in section I.4a., pages 1-2) and supplemented by any additional information required by the board or management staff. Submission of the quarterly reports to UMTA then becomes a simple compilation of the monthly reports. Development of monthly reports also minimizes "surprises" that may have an adverse impact on a project.

Updating the Budget Process

Monthly reports from the previous budget year should be summarized into a full year's worth of input into the budget development process for the following year. This summary serves three purposes. First, it specifies which projects are now being conducted, how much additional money will be required to continue them, and the amount of money left over from projects completed or discontinued. In this way, the summary notes the progress of approved projects and monitors the CIP and capital budget. Second, this summary helps to update the CIP and to prepare the new capital budget. Finally, the summary informs the board of directors and the public about the progress of projects approved in prior years.

CHAPTER 10

ROUTING AND SCHEDULING

Introduction

One of transit management's principal objectives is to minimize the consumer's costs in time, energy, and money, making transit an attractive means for making a particular trip. Two of the transit manager's prime tools in this area are routing and scheduling. Through careful route layout and proper scheduling technique, the transit manager can minimize the consumer's time, energy, and money expenditures, and reduce the transit system's opportunity costs in terms of foregone passenger revenue and lost sales penalty costs.

Although the opportunity and lost sales costs do not appear on the income statement, they are real costs, and their effects last over extended periods of time. Consumers and sales revenues are very sensitive to routing and scheduling variables on the downside, but much less sensitive to routing and scheduling on the upside. In other words, poor routing and scheduling will decrease ridership rapidly, but excellent routing and scheduling probably will only increase ridership slowly. Great care and patience are therefore necessary in this area.

On the production side, the transit system's ability to manipulate routing and scheduling variables is extremely limited because of scale considerations. The addition of a new route and/or more frequent service through cuts in the length of headways may require additional capital investments in equipment. For example, a property regularly operating seven buses on seven routes at 30-minute headways will need 14 buses to maintain 15-minute headways on the same route structure.

It is in the routing and scheduling function that the services and costs of transit are built and controlled. Constant sensitivity to viewpoints of the consumer and potential consumer of mass transportation services must be maintained. Five attributes of service that are important to consumers are listed on the next page.

Service Attributes	Variables
1. Travel time	- walking to and from stops - waiting - riding - transferring
2. Convenience	- frequency of service - hours of service - number of transfers - fare collection system
3. Comfort	- crowding or standing - vehicle characteristics - shelter at stops
4. Reliability	- schedule adherence - delays on route
5. Cost	- fares

Many of the service variables listed above are closely related to routing and scheduling processes. For example, placing routes close together will cut down on the average walk of patrons to and from transit stops. Through-routes connecting major origin and destination points will reduce the need of passengers to transfer between routes and vehicles. Likewise, schedules written realistically to reflect the traffic conditions and patronage level will make it easier to offer reliable service.

Forecasting Demand for Transit Service

The starting point for all routing calculations is the forecast of demand. A new transit firm must estimate demand from scratch. The transit firm that is already in operation can begin with the current ridership. If the service is poor, however, with badly planned routes, poor frequency, hard-to-obtain information, unreliable service, and/or poor equipment, potential demand will be seriously understated. Because one or more of these negative elements often exists in most small-scale operations, it is probably advisable to forecast demand as if the route did not exist previously.

The forecast starts with a street map of the total area to be served. All major traffic generators should be identified on the map including: (1) residential areas, (2) shopping areas, (3) industrial areas, (4) commercial areas, (5) hospitals, (6) schools, and (7) recreation areas. The route layout should serve these traffic-generating points so that origins and destinations are joined together, and every effort should be made to link these points directly. Forcing passengers to transfer only wastes their time and energy and places transit at a relative disadvantage to the private automobile.

Employers, schools, merchants, hospitals, and the riders themselves must be questioned in order to make a preliminary forecast of how many people will be traveling to and from major points. Answers to these questions will provide a good estimate of which areas should be linked and what the potential ridership would be on these links. (See Chapter 12 for more detailed information on researching the market for transit.)

By identifying traffic generators, a transit firm can determine where the largest number of people arrive and depart each day. The firm does not know what their behavior will be with respect to purchasing transit service, and this is precisely the information that the transit firm desires for the forecast. To make a responsible demand estimate, the total figure must be reduced to the number that can be reasonably expected to use the service. Salesmen, employees who live out of town, and people who dislike buses are examples of groups that cannot be expected to use transit.

For the remainder of this chapter it will be assumed that a reasonable and proper forecast has been made. It is very important that data be collected regularly on the composition of the ridership and its origin and destination points, as a part of the research for routing and scheduling work.

Routing

There are two general patterns of routing--radial and grid.

Radial Routing

The most commonly used form of routing is radial routing, in which the routes fan out from one or more central points--usually the central business district (CBD)--like the spokes of a wheel. The precise pattern will depend upon the street layout of a given city, but the major thrust is to a central focus (see Figure 10.1). Even in the radial-route pattern there may be some crosstown routes that connect several of the basic radial routes or key activity centers, but these will not be serious deviations from the overall pattern.

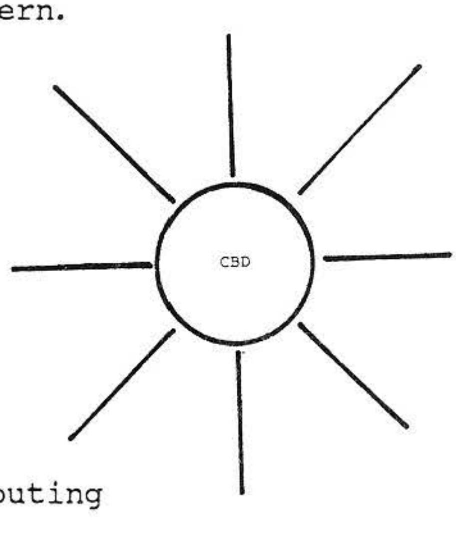


FIGURE 10.1 Radial Routing

Grid Routing

The grid pattern applies generally to large cities (see Figure 10.2). Here, a network of routes blanket most of the urban area; many of them do not touch the CBD. The successful grid system means that with no more than one transfer, any point in the urban area may be reached.

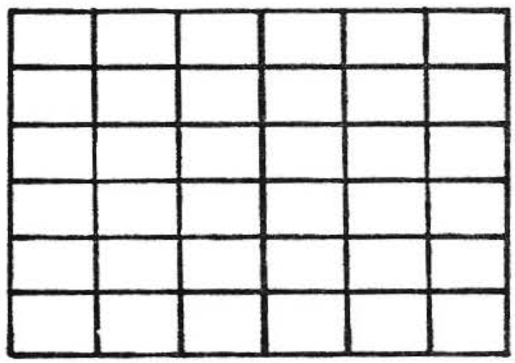


FIGURE 10.2 Grid Routing

The success of the grid depends upon frequent service on all lines. Ensuring close interface with each route when vehicles operate on infrequent schedules is practically impossible. Creating a schedule in which all transit vehicles reach route intersections at the same time is virtually impossible as well. Large cities, such as Chicago (a classic example), Philadelphia, New York, and Toronto, are generally the only places where the grid is workable. In such places the large population and relatively high population density can justify closely spaced routes and frequent schedules. Even if the grid is used as the general pattern, there may be some radial routes, particularly if the street pattern permits it. In the case of Chicago, the basic system pattern is that of the grid, but there are major radial bus routes too. The rapid transit lines also act as radial members of the route structure.

Other Routing Patterns

Beyond the major routing patterns, routing is of two types: through routing and cycle routing. Both are most applicable to radial route patterns.

Through routing. Through routing means routing the vehicles from one side of town to the other--generally through the CBD (see Figure 10.3). The route name and number may or may not be changed as the bus passes through the downtown area.

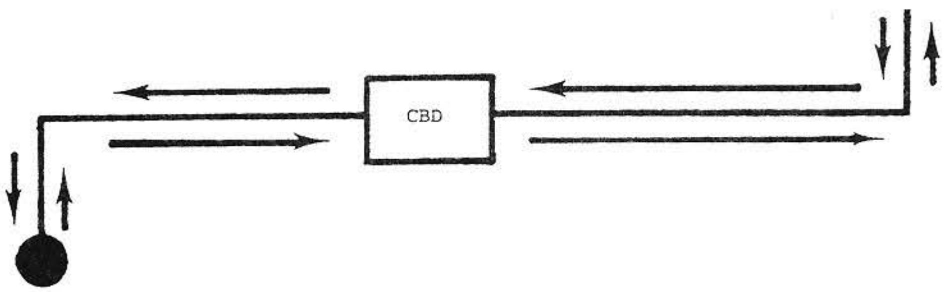


FIGURE 10.3 Through Routing

Through routing will minimize the number of passengers who must transfer at the CBD to complete their trips. If service is interrupted, however, two lines will be affected rather than one.

Cycle routing. Cycle routing is the practice of running the buses into the CBD and routing them back out over the same line, usually at a fixed interval (see Figure 10.4). It works particularly well with radial routing patterns. Both through routing and cycle routing allow arrivals at the CBD to be scheduled for convenient transfers to other lines.

Cycle routing simplifies scheduling somewhat, but it forces more pasengers to transfer from one line to another. If through-passenger traffic is heavy, through routing is preferable, because it minimizes time and effort for the passengers.

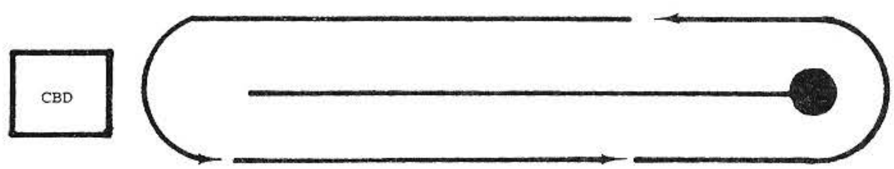


FIGURE 10.4 Cycle Routing

Reverse routing. In some areas, a type of routing called reverse routing or loop routing is used (see Figure 10.5). This technique involves shifting an outbound run to an adjacent line for the inbound run. The ordinary routing plan is to provide both outbound and inbound service over the same streets. The reverse routing plan has the advantage of reducing bus miles operated, because one bus seems to do the work of two. Reverse routing is not designed to increase ridership. A passenger on the outbound portion of the route who wishes to go to the CBD is forced to board the outbound bus, ride it to the end of the outbound line, ride the loop, and then ride in to the center of town. This "detour" increases the passenger's time on the bus and adds to his general inconvenience.

Reverse routing should be used sparingly because of the inconvenience and extra riding distance that it imposes on the public. Moreover, loops should never have layovers at the end of the outbound runs, and they should have short running times over the loop portion of the trip. The cost savings of reverse routing may be offset by revenue loss as riders find alternate means of making trips.

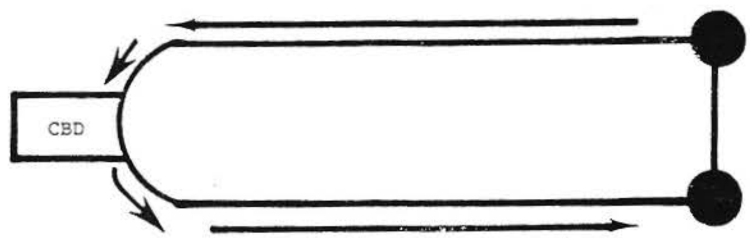


FIGURE 10.5 Reverse Routing

Balloon routing. Balloon routing is a useful tool for outlying areas. This type of routing is used at the outlying end as a line to serve residential areas. Figure 10.6 shows how more than one residential area can be served by this routing technique. In the route shown in Figure 10.6, each bus goes outbound from the CBD, detours from the main line of the route to serve subdivision A and subdivision B, and then returns to the CBD. The use of balloon routing results in "fine-grained" service in the area served. That is, routes lie close enough to each other that riders walk only a short distance to the nearest bus stop. If the residential areas are reasonably small subdivisions, the balloon routing technique can be regarded almost as door-to-door service. Balloon routing is a very consumer-oriented technique and should be used wherever it can provide a superior service. Note that the balloon loops are relatively small, covering a limited area, as opposed to reverse routing, which covers a large area.

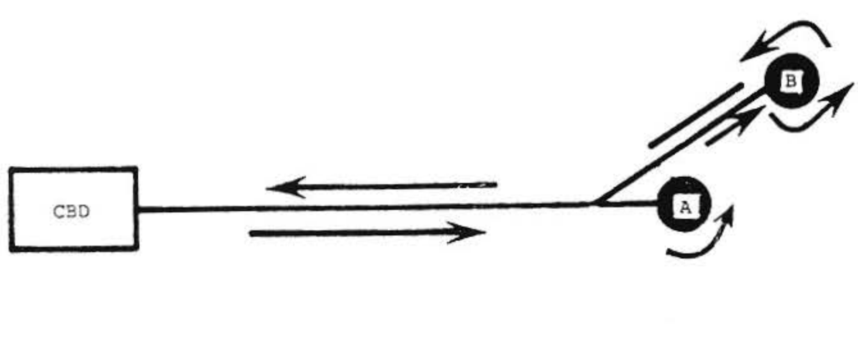


FIGURE 10.6 Balloon Routing

Access to Transit Service

Routing is concerned essentially with access, a service characteristic that may take different forms. The best plan for a particular route is the one that minimizes the cost of access to the consumer in time, effort, and money.

Fine-grained service. Fine-grained service keeps the consumer in mind. It tailors routes to the consumer's need for convenience--savings in time and effort. For one group of riders, it may involve door-to-door service. At the other end of the spectrum, it might involve parking facilities for riders so they may provide their own pick-up and delivery service. These, and the range of services between these two extremes, fall within the fine-grained service concept. The essential feature of fine-grained service is that it explicitly makes the consumer part of the transit system.

Loose-grained service. Another possibility is loose-grained routing, in which the transit routes are located relatively far apart (about one-half mile or more). This pattern is usually adopted as a money-saving effort; it is not a practice that is attractive to the consumer because it increases the average walking distance to the routes. Several independent demonstration projects have shown that ridership falls off sharply beyond the first block, because of the personal effort required. Loose-grained routing should be avoided if possible. Routes should be close together to provide the most convenient access to the traveling public.

Commuter-contractual service. Many transit systems use a consumer-oriented approach to providing service called commuter-contractual or subscription service. This is a door-to-door, home-to-work, work-to-home service, with a contract period of a short period of time, frequently only one month. In effect, transit riders subscribe for transit service. The routing and scheduling for this service is extremely flexible. A new customer can start the service immediately if he is on an established route. If serving a customer requires a route change, he is required to wait for service until the Monday following his application. Thus, a complete reevaluation of each route is made every week, and changes are implemented every Monday. (The service could also be operated on a monthly basis, with the changes occurring each month.) Scheduling problems are solved by building slack time into each route from the start, with the arrival and departure times governed by the starting and quitting times at the destination (work place). In some cases, scheduling considerations lead to the initiation of new fixed routes. Obviously, the subscription bus concept is highly consumer-oriented.

Transit Speed

Because minimizing passengers' time and energy plays a major role in influencing transit ridership, improvement of transit speed should be a high-priority goal in the design of the system's route network. Transit speed can be stepped up by selecting routes that have proper physical characteristics and by implementing traffic control.

Common sense dictates that narrow streets with long, steep grades and unrestricted parking should not be selected for routes if they can be avoided. Most cities have special streets (that often are not main streets) for peak-hour travel. The traffic lights on these streets are coordinated so that traffic maintaining the proper speed can make the entire trip without having to stop for traffic lights. Parking is forbidden on these streets, making it easier for buses to pull into bus stops and decreasing the time required for passengers to get on and off. Because parking is forbidden on these streets, the bus operator should never find a car parked in the bus-stop zone. Such streets are prime candidates for bus routes. The number of stops on these routes should be limited to major traffic generators and/or major transfer points to provide a semi-express service. A general rule is that private automobile drivers usually select routes that minimize travel time, and these routes should be considered for bus routes.

Steps taken to improve the movement of transit vehicles fall under the Transportation System Management (TSM) policy and UMTA regulations. TSM regulations require that urbanized areas develop plans and programs for low capital cost projects that can help use existing facilities to improve the flow of traffic (see Chapter 3). UMTA or the Federal Highway Administration (FHWA) funds can then be used to carry out the plans to improve the transit and other vehicular flow. Routes with bottlenecks can be improved and upgraded as part of TSM.

Marketing Effects of Routing

Implicit in the previous discussion has been the marketing effect of routing. The selection of the route network pattern and type determines the geographical markets the transit firm can serve. To provide quality service, the geographical area covered by a single route should be considered separately. By focusing on one geographical area, a planner is forced to examine the access to the route, and to regard passengers as part of the transit system. Routing, considered carefully and purposefully, is one of the major factors in attracting riders.

The route network chosen by the transit firm should never be considered permanent. Because it is a marketing variable under the control of management, the route layout should be audited at regular intervals, (annually at least, more often if conditions require it). Perhaps the best plan is to divide this audit into monthly or quarterly reviews, making the audit an ongoing activity of the transit agency, rather than a disruptive, unpopular, year-end activity. The audit would be a marketing audit--not a determination of whether the route is profitable. What is desired is an idea of marketing effectiveness, not cost effectiveness. In some cases, the approval of a regulatory agency is required for route shifting.

Summary of Routing Guidelines

The following guidelines for routing should be observed:

- Use direct routing where possible.
- Choose through routing over cycle routing.
- Use reverse routing very sparingly.
- Use balloon routing where possible.
- Make the access character of routing (fine-grained service in route spacing, parking facilities, door-to-door service, and so forth) part of routing analysis. Consumers and their interests regarding route planning should be considered.
- Exploit the physical characteristics of the possible routes (factors that affect trip speed, such as traffic flow, and so forth). These should be used to the transit agency's advantage in providing quick and efficient service to consumers.
- Avoid duplication of routes; it is better to run three routes on three separate streets than to run three routes onone street, assuming that the street layout permits such route spacing. Naturally the routes will tend to converge at the CBD.
- Begin and end the routes at traffic generators whenever possible (see Figure 10.7).

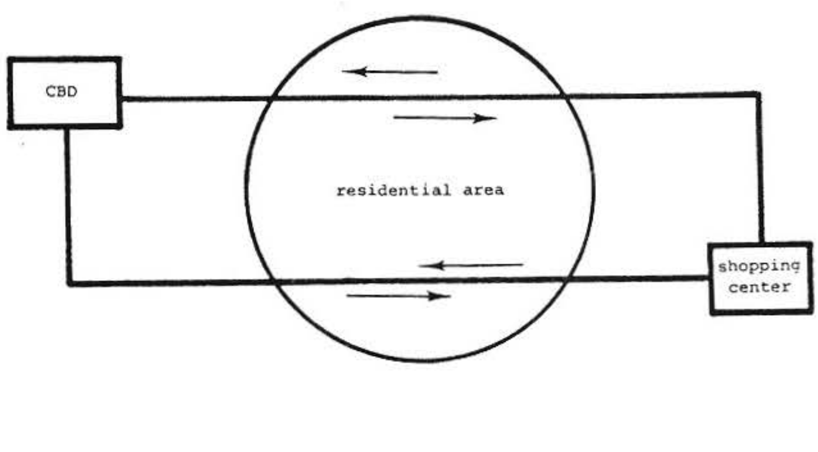


FIGURE 10.7 Routes Between Major Traffic Generators

- Routes should attempt to touch as many traffic generators as possible without becoming too circuitous. If a route becomes too circuitous--as measured by distance or running time--then another route may be needed to cover the territory (see Figure 10.8).

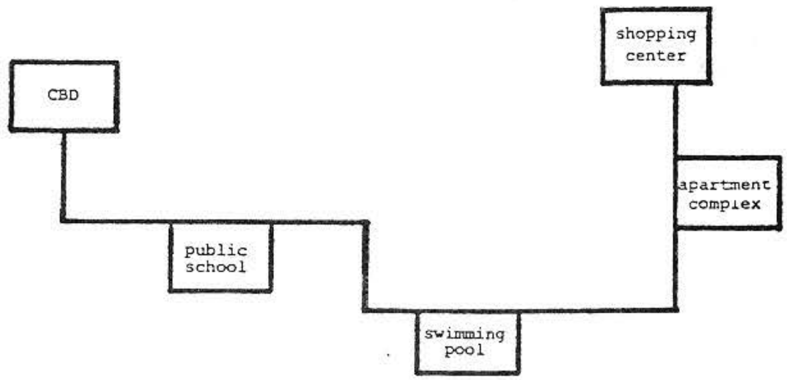


FIGURE 10.8 Inclusion of Traffic Generators in Route Design

- At a major downtown or shopping center terminus, the buses should pull up next to one another to make transfers more convenient. Passengers should never have to dash across a street to transfer. A transfer shelter should be almost mandatory at downtown sites, even if it means working with public officials for some change in street patterns (see Figure 10.9).

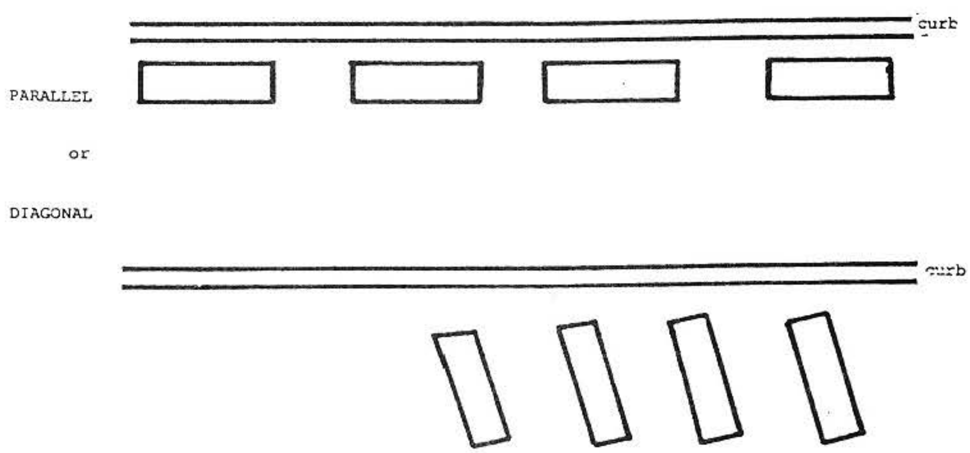


FIGURE 10.9 Parking To Permit Transfers Between Buses

- Where several routes focus on a subcenter (such as a shopping mall), service beyond this subcenter may require a separate routing analysis with the subcenter considered as the hub (see Figure 10.10).

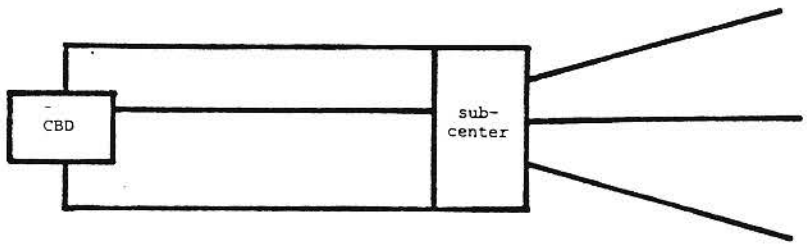


FIGURE 10.10 The Subcenter in Route Design

- Buses should, if possible, enter a shopping center, apartment complex, recreation area, factory complex, or other traffic generator (see Figure 10.11).

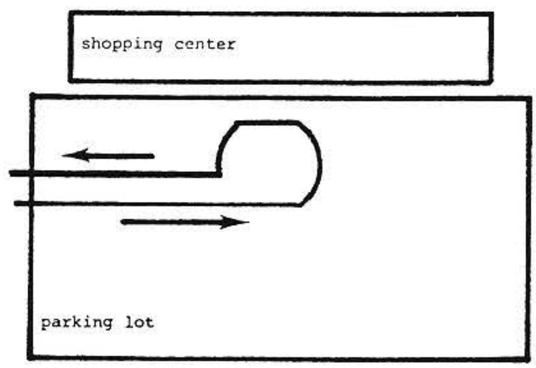


FIGURE 10.11 Loading within Major Traffic Generators

Evaluating Existing Routes

The first step in the evaluation of existing transit routes is to gather useful information. Route evaluation must be carried out regularly and changes must be made when necessary. A good manager will not hesitate to use bus operators as a source of information for evaluating routes because drivers are more familiar with the service than anyone else.

On-line riding checks. This involves riding each route, checking the number of passengers, and noting where they board and alight. (This information may also be gathered for scheduling purposes; the process will be detailed in the discussion of scheduling.) The essential information to obtain is the number of passengers per platform hour (a scheduled hour of revenue service) and the number of passengers per trip. Ideally, route and trip data should be collected as a routine matter.

Trail checking. In this method, buses are trailed by automobile, and boarding and alighting passengers are counted. Again, the major information sought is the number of passengers per platform hour and the number of passengers per trip.

Transfer analysis. By checking transfers, it is possible to determine the transfer patterns of riders. This is done by using transfers that show the name or number of the route of origin. Transfers are collected and kept by the driver on the bus in which the trip is completed. An analysis of transfer patterns will indicate the links that passengers make on their trips. On the basis of this information, linkages between routes can be made. For example, if large numbers of passengers are transferring from Route 8 to Route 9, it would make sense to join the two routes into one through route, thus eliminating the need to transfer. The through route will be more convenient for the passengers.

"Tell us where to go" campaign. Riders and potential riders can be encouraged to tell the transit agency literally what it should do and which services it should operate. Forms may be printed and run as ads in newspapers, or there may be handouts on the buses to be dropped into a box on the bus or mailed in. This is a relatively inexpensive way to find out what the public wants.

Land use changes. Land use in the city should be reviewed on a regular basis. Transit planners should be particularly aware of new land use patterns for apartment developments, industry, shopping centers, or other places of activity that promise to be traffic generators for transit. This can and should be done on a formal basis, by developing contacts with planning agencies so that the transit agency is informed regularly of changes in land use. Land use information can also be obtained through "windshield surveys"--simply by driving around town and observing what changes are happening.

In conducting this survey, answers should be sought for the following questions:

1. Does the existing route provide effective and efficient service? (Effective service means doing the right things; efficient service means doing things right.)

2. Are there additional places that should be served?

3. Should service be withdrawn from certain areas?

4. Does transfer analysis point to linking routes for through routing?

Performance reports. Performance indicators (ratios of measures of input and output, such as passengers/revenue hour) can be used in regular reports to evaluate the performance of individual routes. The two major types of performance reports are:

1. Peer group analysis--compares one route with the average of all routes or with industry standards.

2. Time trend analysis--compares one route's performance with its own performance over time.

See Appendix 10B for an example of a monthly route performance report.

Scheduling

Scheduling is the inventory or assortment of finished goods offered to the consumer by the retailing transit firm. The finished goods inventory of transit service is a very perishable commodity. It is offered as the bus approaches a stop and it disappears when the bus leaves that stop. Even though it disappears, the costs of its production are incurred. Thus, the scheduling variable is extremely important to the transit agency.

There are two categories of scheduling: (1) demand based and (2) policy based. Demand-based scheduling is the more complicated because it attempts to match the amount of service with the demand for transit. Such scheduling is practiced mainly in large cities where peak demand is substantial; indeed, in very large cities there is a significant difference between the amount of transit service provided at peak times and during off-peak periods.

Demand-based Scheduling

Demand-based scheduling is geared to the actual passenger demand imposed upon a system. Good data are necessary to do such scheduling. In the following material, we assume that service already exists. Where no service exists, estimates may be used to construct a schedule until a service is operated for a sufficient length of time to permit careful data collection based upon real conditions. Schedules can then be developed more accurately.

Passenger data. The number of passengers using the service must be determined. This is carried out by means of on/off riding checks. This is done most accurately by checkers who ride each trip and gather the needed data. The following information must be accumulated:

1. Route name or number, trip identification (either by time or by an assigned trip number), the number of the vehicle, and the direction of travel.

2. A list of stops in the order of their sequence.

3. A record of passengers getting on and off at each stop and the number of passengers on board--the passenger load--when departing each stop.

4. The actual time at check points.

5. Weather conditions.

Figure 10.12 shows a form that can be used to record the needed data. It is best to have such a form prepared in advance for each route, with all the stops listed. An alternative is to prepare a printed blank form with room for the checker to write in ahead of time all the stops on the route from a master list of stops for each route. The section at the top marked "unit number" is for identifying a given run. In larger, more complex transit systems, a number of vehicles will be needed to operate each route during the course of a day; each of these is identified by a unit number (some transit systems use the term "block number" or "division number" to refer to the same thing).

The on/off checks provide information on the patterns of use of the transit service and give a complete picture of the passenger loads and the maintenance of schedules under varying passenger loads. The continuing passenger count obtained by counting each boarding passenger on each trip can provide a much more complete picture of transit use over a long period of time. The information can be used in scheduling and in equipment assignment; it will also provide a means of determining the pattern of demand change over a period of time or in response to some innovation in service.

Conducting a comprehensive riding analysis in a short time period requires many checkers if the transit system is a large one. A less accurate way of gathering the data is to station a checker at one point--usually the assumed maximum load point--who boards each bus to make a quick count. Information is then entered on a form similar to the one shown in Figure 10.13.

The whole process of data collection can be aided greatly if, as a matter of daily routine, drivers count passengers on each trip. An inexpensive counter can be mounted on the dashboard of each bus. The driver then counts each passenger by merely pressing a button on the counter. At the end of each trip the total number of passengers is entered on a suitable form; the counter is cleared to 0, and the process is repeated on the next trip.

RIDE CHECK FIELD SHEET

BLOCK NUMBER 3 ROUTE NUMBER 1

DAY WED DATE 11-3-89 WEATHER FAIR - COLD

DIRECTION OF TRIP INBOUND OBSERVER M LEE

SCHEDULED START TIME 0700

Location	Passengers On	Passengers Off	Passengers Load	Time Check	Remarks
14th & MAIN	6	–	6	0700	
12th & MAIN	7	–	13		
11th & MAIN	1	–	14		
10th & MAIN	10	2	22		
8th & MAIN	6	3	25	0716	
6th & WALNUT	8	–	33		
4th & WALNUT	7	–	40		
3rd & WALNUT	2	3	39		
TERMINAL	–	39	–	0730	

FIGURE 10.12 Ride Check Field Sheet

Service determination. In determining the level of service to provide, the first consideration must be given to the load standard--the number of passengers--compared to the seating capacity of the vehicle. The load standard is usually not more than 150% of the seating capacity of the vehicle. That is, a bus with 40 seats would be at capacity with 40 seated passengers and 20 standees. If the ratio of standees to seated passengers is relatively high, more vehicles need to be operated on more frequent headways. (A headway is the amount of time between scheduled buses on the route. It may vary with the time of day.) Adjusting the load standard can have a major effect on headways. The comfort of the passenger (always an important factor) must be weighed against the cost and feasibility of providing more service.

Maximum load. The maximum load is calculated from passenger data. The maximum load is critical because it provides the basis for determining the number of trips for each route for each period of the day. A maximum load summary is shown in Figure 10.14. In the example shown, the day is divided into 15-minute periods during peak hours, and 60-minute periods for off-peak hours. The number of passengers using the route in each time segment is shown. Figure 10.14 shows the gradual build up to and subsequent decline of the morning peak.

POINT CHECK FIELD SHEET

ROUTE (S) 1 BUS STOP NUMBER 210801 3rd & WAL

DAY WED DATE 11-3-84 WEATHER FAIR-COLD

☒ ARRIVING LOAD
☐ DEPARTING LOAD

OBSERVER C. BROWN

Route Number	Direction	Block Number	Vehicle Capacity	Arriving Time: Scheduled	Arriving Time: Actual	Passengers
1	Inbound	3	53	0700	0701	35
		4	53	0730	0730	39
		5	31	0745	0740	28
		6	31	0800	0805	40
		1	53	0815	0816	45
		2	53	0830	0833	37
		3	53	0845	0825	28
		4	53	0900	0859	20
		5	31	0930	0930	10

FIGURE 10.13 Single Point Maximum Load Check Form

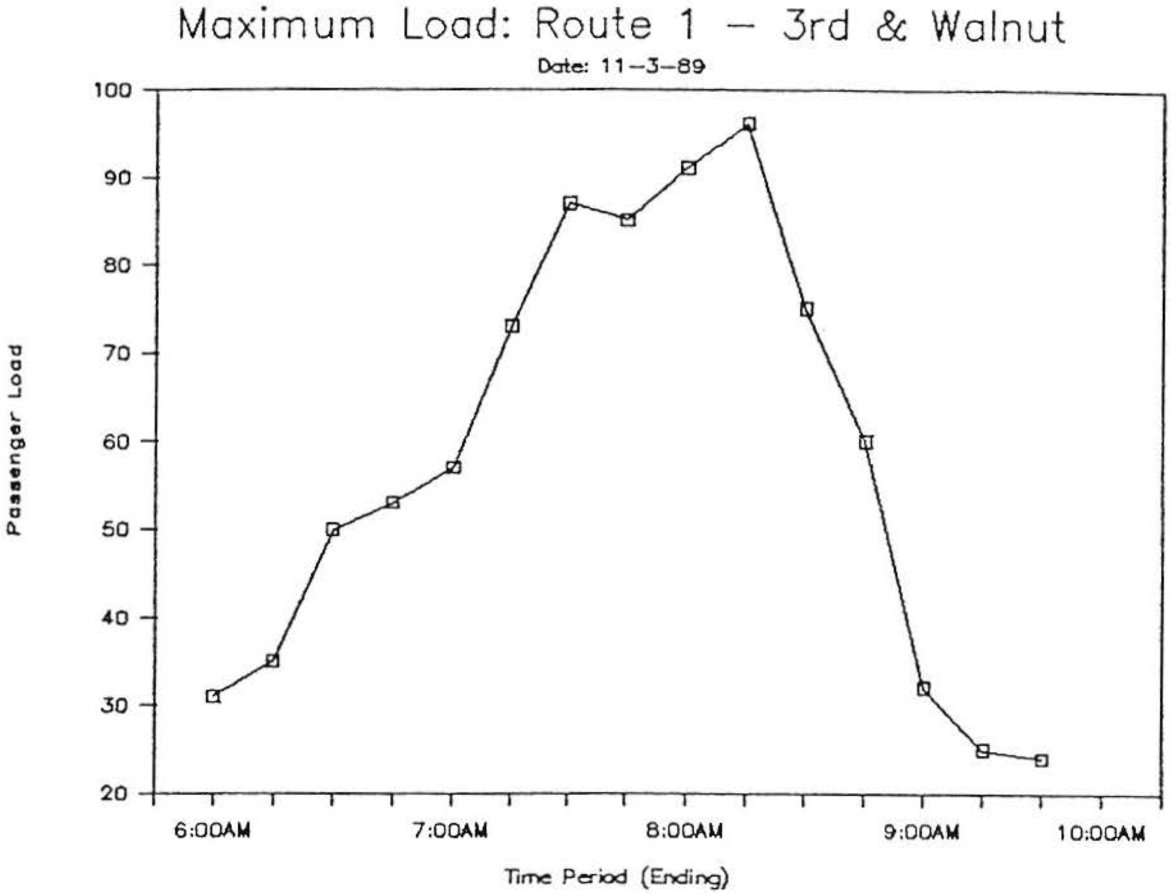


FIGURE 10.14 Summary of Maximum Loads by Time Period (15 Minutes)

Other important factors for scheduling should be considered. The following list shows examples of the more common ones:

1. Service shall begin at 6:00 a.m.
2. Peak-load standard will be 100% (one passenger for each vehicle seat).
3. Headways between 6:00 a.m. and 9:00 p.m. shall not exceed 30 minutes.
4. Service shall end at 12:00 midnight.
5. Vehicles with at least 50 passenger seats shall be used.

Policy-based Scheduling

In small transit operations there may be no need to schedule service to meet widely shifting demand. In the smallest urban places, service may simply be based on a combination of policy and what the transit agency believes it can afford, mixed in with some marketing considerations. Generally this means that regardless of the time of day, the service will be offered on a standard, policy headway, such as every 30 minutes.

The entire system may use the same headway, or there may be different headways for different routes. Those routes which have a higher level of demand may operate every 30 minutes; other routes may operate only every 60 minutes. Even in transit systems that use demand-based scheduling for peak-hour service, the off-peak base period of moderate to light demand is generally handled on the basis of policy headways.

There are two basic types of policy scheduling: (1) cycle schedules, and (2) noncycle schedules.

Cycle schedules. Under a cycle schedule, all buses leave the CBD at the same time. They travel their routes and return to the CBD at the same time--usually within 30-minute round-trips. This means the buses depart from the CBD (or other terminus) at the same time and return at the same time each hour. Thus the headway repeats itself each hour. For example, at a given point on a route a bus will pass by at 22 minutes after the hour and at 52 minutes after the hour. Schedules are easy for the public to remember. Cycle scheduling implies that each line or route is approximately the same length (in terms of round-trip time). Where routes are longer, more than one bus may be assigned to the route. The essential point is that a bus will pass a given point on a regular basis and that all buses will gather in the CBD central transfer point at the same time.

Once the routes have been selected and their round-trip time made uniform, only the departure times from the CBD need to be established to determine the rest of the schedules. The advantages of this system are obvious, as are its disadvantages. The chief disadvantage is inflexibility. Lengthening or shortening one route means putting all the other routes out of phase. The temptation to maintain the status quo is almost irresistible under these circumstances.

Noncycle scheduling. Under a noncycle schedule, each route is scheduled individually. Noncycle scheduling is more complex than cycle scheduling because good noncycle scheduling demands coordination between routes, or at least between certain routes where transfers are common. Noncycle scheduling, with its attendant flexibility, offers more opportunity for scheduling to be used as a marketing tool.

Schedule Time Periods

Both policy-based and demand-based scheduling will need to adjust to different schedule time periods. In each, there may be significant differences in the amount of service that should be scheduled. Systems that adhere to demand-based scheduling will be particularly interested in these periods:

Time Period	Type of Scheduling
Pre-morning peak	Policy
Morning peak	Demand
Base	Policy
Evening peak	Demand
Night base	Policy
Owl service	Policy
Saturday	Policy
Sunday/holiday	Policy

Even a small transit system that does not use demand-based scheduling may need to modify its service during peak periods if there is serious overcrowding on vehicles. If the bus fleet contains any larger vehicles, one of them should be operated during particularly busy runs to avoid serious overcrowding. Another possibility is an extra bus, operated a few minutes before or after the regularly scheduled bus, on the standard headway; this would help serve excess demand at busy periods and ensure greater passenger comfort.

Transit agencies that rely strictly upon policy-based schedules--and that would include most services for smaller cities--should reconsider their headways regularly. The maximum headway that should be operated under the name of transit service is 60 minutes. Even small cities should aim to have service offered at least every 30 minutes. If patronage develops well along certain routes, headways might be reduced to every 20 or 15 minutes, should passenger loadings justify the expense. There is no need to adhere to a uniform headway on each route if patronage suggests otherwise, as long as the headways mesh at a central transfer point for the convenience of transferring passengers.

Establishing the schedule. The first step in the process of establishing a schedule is to determine the time each trip will leave one of the terminals on a route. The number of trips is then fitted to meet the passenger load and the standards developed for the ratio of seated to standing passengers. Based on the running time needed, the schedule time at the other terminus of the route is determined. Time points are then established between the termini for the aid of both passengers and drivers.

Determining the headway. Three facts must be known to construct the actual headways to the nearest minute: (1) the coach capacity based on the adopted standards, (2) the time period under consideration (in this case, the peak hour) in minutes, and (3) the total number of passengers expected. To arrive at the headway the following formula is used.

$$\text{Headway} = \frac{\text{coach capacity x time (minutes)}}{\text{total passengers}}$$

Assuming that the coach capacity is 50 passengers, that the time period is 60 minutes, and that the total number of passengers is 200, the headways would be 15 minutes.

$$15 = \frac{50 \times 60}{200}$$

To determine the number of vehicles that will be required to operate the service, both the headway and the round-trip running time, including built-in recovery time (which may be a part of the union contract), must be known.

$$\text{Coaches required} = \frac{\text{round-trip running time}}{\text{headway}}$$

If the round-trip running time is 60 minutes and the headway is 15 minutes, then 4 vehicles will be needed to operate the service.

$$4 = \frac{60}{15}$$

Figure 10.15 shows a headway table. Please note that units 1 and 2 maintain the basic 30-minute headway of the route throughout the day. Additional units are added to the schedule as demand begins to build. Unit 3 covers the 6:18, 7:18, and 8:18 a.m. runs from the outer terminus; unit 4 covers the 6:48 and 7:48 a.m. runs; unit 5 covers only the 6:55 and 7:55 a.m. runs. Units 6, 7, and 8 each handle only one morning peak run.

Figure 10.16 shows the entire unit schedule for a weekday. Each unit number is listed on a separate line with the time of arrival at each terminus. At the bottom of the figure is a vehicle/hour summary. The eight units scheduled for this service operate a total of 49 hours and 36 minutes per day. Units 1 and 2 operate for the greatest number of hours in the day. The other assigned units operate for fewer hours.

Unit Number	Leave Outer Terminal	Time at Inner Terminal	Arrive Outer Terminal
1	5:33 a.m.	6:00 a.m.	6:27 a.m.
2	6:03	6:30	6:57
3	6:18	6:45	7:12
1	6:33	7:00	7:27
4	6:48	7:15	7:42
5	6:55	7:22	7:49
2	7:03	7:30	7:57
6	7:10	7:37	8:04
3	7:18	7:45	8:12
7	7:25	7:52	8:19
1	7:33	8:00	8:27
8	7:40	8:07	8:34
4	7:48	8:15	8:42
5	7:55	8:22	8:49
2	8:03	8:30	8:57
3	8:18	8:45	9:12
1	8:33	9:00	9:27
2	9:03	9:30	9:57
1	9:33	10:00	10:27
2	10:03	10:30	10:57
1	10:33	11:00	11:27
2	11:03	11:30	11:57
1	11:33	12:00 noon	12:27 p.m.
2	12:03 p.m.	12:30 p.m.	12:57
1	12:33	1:00	1:27
2	1:03	1:30	1:57
1	1:33	2:00	2:27
2	2:03	2:30	2:57
1	2:33	3:00	3:27

Note: Inner terminal is a central location to the entire route system (e.g., CBD, downtown transfer terminal). Outer terminal is the farthest bus stop away from the inner terminal.

FIGURE 10.15 Headway Table

Schedule Department Timetable	Division: Central	Route: 1- Main Street
	Schedule: 21	Effective: 11-2-88 / Supercedes: 20 / Sheet 1 of 1

Unit Number	Outer Terminal	Inner Terminal	Outer Terminal	Inner Terminal	Outer Terminal	Inner Terminal	Outer Terminal	Inner Terminal	Outer Terminal	Inner Terminal	Outer Terminal	Inner Terminal	Outer Terminal	Inner Terminal	Outer Terminal	Inner Terminal	Outer Terminal	Inner Terminal	Outer Terminal	Inner Terminal	Outer Terminal	Inner Terminal	Outer Terminal	Inner Terminal	Outer Terminal	Inner Terminal	Outer Terminal	Inner Terminal	
			9				5										9												
2			603	630	703	730	803	830	903	930	1003	1030	1103	1130	1203	1230	103	130	203	230	303	330	403	430	503	530	557		
					5																		5						
6					710	737	804																410	437	510	537	604		
			6																		7								
3			618	645	718	745	818	845	912												318	345	418	445	518	545	612		
					3																		3						
7					725	752	819																425	452	519				
	2																3		1										
1	533	600	633	700	733	800	833	900	933	1000	1033	1100	1133	1200	1233	100	133	200	233	300	333	400	433	500	533	600	633	700	cont
					4																4								
8					740	807	834														340	407	440	507	534				
			7																		6								
4			648	715	748	815	842														348	415	448	515	542				
			8																		8								
5			655	722	755	822	849														355	422	455	522	549				
1	cont	700	733	800	833	900	933	1000	1027																				

Vehicle Hour Summary

Unit No	AM Peak	PM Peak	Total
1	–	–	16:54
2	–	–	11:54
3	2:54	2:54	5:48
4	1:54	1:54	3:48
5	1:54	1:54	3:48
6	:54	1:54	2:48
7	:54	:54	1:48
8	:54	1:54	2:48
Total			49:36

FIGURE 10.16 Unit Operating Schedule

It is a general practice in the transit industry to assign the newest or lowest operating-cost vehicles to the more lengthy runs throughout the day. Vehicles that are older or more expensive to maintain and operate are assigned to the shorter running periods. The unit operating schedule is also useful to the maintenance department in planning its maintenance activities.

Cutting the runs. From the unit schedule shown in Figure 10.16, the driver assignments, or run cut, is determined. The process must be completed within the provisions of the labor contract between the transit agency and the union representing its employees. The following parameters are usually contained in a labor agreement:

1. The number of working hours before overtime.
2. The minimum daily guarantee. This is usually 8 hours of pay for the employee reporting for regularly scheduled duty.
3. The maximum hours of continuous duty without a break.
4. The maximum hours of spread. Because of the peaked nature of the demand for transit service, many drivers work a split shift. This provision limits the total number of hours worked from the time the driver starts working until the end of the final run. Working time beyond the maximum spread is paid on an overtime basis.
5. Absolute prohibition of work in excess of the total spread.
6. No more than one unpaid break.

Based on these limitations, the work of driving is divided into runs. The straight runs, those approximately 8 hours long, are cut first, then the other runs are fitted in. This is illustrated in Figure 10.16. The run numbers are written in, over the time of departure from a terminus in Figure 10.16. Note that run 1 starts at 2:33 p.m. and ends at 10:27 p.m., for a total of 7 hours and 54 minutes. Run 2 starts at 5:33 a.m. and ends at 1:33 p.m., for a total of 8 hours. The other runs are shorter.

All the runs are summarized in Figure 10.17. The other runs are all less than the platform hours worked on run 1 or 2. In some cases--runs 6, 7, 8, and 9--although the hours worked may be far less than on other runs, premium pay has been given because the amount of allowable maximum spread time has been exceeded.

Clearly, the objective is to get total pay hours as close to platform hours as possible. In the example shown in Figure 10.17, 49 hours and 36 minutes is the actual number of platform hours. The number of total pay hours, however, is 75 hours and 35 minutes, because of spread premium and minimum pay provisions.

Run No.	Time On	Time Off	Platform Hours	Spread Premium	Total Pay Hours
1	2:33 p.m.	10:27 p.m.	7:54	-	8:00
2	5:33 a.m.	1:33 p.m.	8:00	-	8:00
3	7:24 a.m.	8:19 a.m.			
	1:33 p.m.	2:33 p.m.			
	4:25 p.m.	5:19 p.m.	2:48	-	8:00
4	7:40 a.m.	8:34 a.m.			
	3:40 p.m.	5:34 p.m.	2:48	-	8:00
5	7:10 a.m.	8:04 a.m.			
	9:03 a.m.	1:03 p.m.			
	4:10 p.m.	6:04 p.m.	6:48	:27	8:27
6	6:18 a.m.	9:12 a.m.			
	3:48 p.m.	5:42 p.m.	4:48	:51	8:51
7	6:48 a.m.	8:42 a.m.			
	3:18 p.m.	6:12 p.m.	4:48	:51	8:51
8	6:55 a.m.	8:49 a.m.			
	3:55 p.m.	5:49 p.m.	3:48	:27	8:27
9	6:03 a.m.	9:03 a.m.			
	1:03 p.m.	5:57 p.m.	7:54	:57	8:57
		Total	49:36	3:33	75:33

FIGURE 10.17 Summary of Runs

Service Standards

Regardless of whether policy-based or demand-based headways are used, serious consideration must be given to the standards of service that will apply. The major factors to consider are: (1) headways, (2) vehicle occupancy, (3) area coverage, and (4) reliability.

Headways. The standard may be set loosely; that is, the maximum headway should be no more than 60 or 30 minutes, or whatever is determined reasonable. The headways should be timed so that the service always passes the same point on the same route at the same number of minutes past the hour.

Vehicle occupancy. Vehicles should not be loaded beyond a certain point. That point may be limited to the seating capacity of the vehicle used, or it may be some percentage greater than that. For example, if the vehicle occupancy standard is set at 150%, a bus with 45 seats should not carry more than a seated load plus 23 standees on a regular basis. Probably an ideal vehicle occupancy rate is no more than 125%.

Area coverage. This service standard may be set to provide coverage for all areas within the civic city limits in such a way that no point is more than three blocks (or some other number of blocks) from a transit route. The standard may also be set on the basis of population density: service will be provided in any area with a population density greater than some number of persons per square mile. Whatever is chosen as a basis will guide the routing and the scheduling of service. The population density standard can also be used to address service frequencies. For example, service shall be provided every 30 minutes to portions of the city with a population density of 3,000 per square mile; places of lesser population density would receive service every 60 minutes.

Reliability. This is a critical service standard because patronage will suffer greatly if service is not reliable. Typically, reliability is cast into the form of a statement such as: 95% of the service shall operate no more than 2 minutes behind schedule; no buses shall run ahead of schedule. If schedules cannot be maintained on a reasonable basis, for whatever reason, schedules should either be rewritten or other steps should be taken to maintain the reliability of the schedules.

Scheduling Questions

Whether the scheduling practice used is policy-oriented or demand-oriented, there are some basic questions which must be answered:

1. How long is the route?
2. How far is the garage from the route?
3. How long does it take to complete one round trip?
4. How long are headways?
5. What is the maximum peak-hour ridership?
6. What is the capacity of the coach to be used?
7. What are the time points?
8. What is the gas mileage of buses?
9. How many buses are required?
10. How many drivers are necessary?

Marketing Effects of Scheduling

From the standpoint of marketing considerations, the firm should use the scheduling variable as a means to attract and hold customers. Consumers must be enticed to ride the bus before the firm can appeal to them through its comfort, convenience of scheduling, and reliability. In all cases, schedules should be easy for the rider to understand, and should repeat throughout the day when possible. In other words, "Buses stop at Atwater and Magnolia at 5 minutes past the hour throughout the day." Buses whose schedules are designed to serve a specific traffic generator should not have arrival and/or departure times that are inconvenient to the patrons they are attempting to serve. Some transferring is bound to be necessary, but proper routing should minimize the passengers' needs to transfer. Scheduling should be coordinated to make all transfers as convenient as possible.

Schedules should be reviewed frequently. Flexibility is a keystone of good scheduling, but scheduling is a marketing variable, and any change has an effect upon the consumers as well as cost implications to the transit agency. Capricious, frequent schedule changes tend to confuse patrons and reduce ridership. While schedules should be reviewed continually, actual changes should be evaluated carefully. Changes that have favorable consumer implications (service increases, for instance) can be made immediately. Changes adversely affecting riders (service cutbacks, for instance) should be made only at fixed, stated intervals. Naturally, all schedules and schedule changes should be thoroughly publicized.

Guidelines for Scheduling

Nine adjectives should be applicable in practice to any transit schedule.

Marketable. Scheduling is a significant marketing variable. In the firm's marketing strategy, it is designed, in conjunction with other marketing tools, to hold customers who have been enticed to use the service.

Simple. Schedules should be simple and easy to remember. Ppassengers are not scheduling experts. Simplicity helps operating employees, drivers, and dispatchers alike. For a small transit property, scheduling should not require either highly skilled persons or a computer, in keeping with the restrictions on available funds.

Adequate. For cities of fewer than 100,000 in population, maximum headways of 30 minutes should meet the needs, although headways should be evaluated carefully for each and every route.

Prompt. From a financial standpoint, it probably is impossible to have very frequent headways (i.e., in the 5-minute range). Careful drawing and scrupulous maintenance of schedules therefore becomes extremely important.

Convenient. Schedules should be coordinated so that transferring is made as convenient as possible. Waiting time at transfer points should be minimized.

Practical. Schedules attempting to appeal to certain riders should be made in such a way that these riders are actually served. Buses that make work-related trips cannot be scheduled to arrive at the work place 5 minutes after the starting time.

Reliable. Schedules should be checked often to assure that they are being kept.

Available. Schedules and schedule changes should be well publicized.

Up to date. Schedules should be reviewed continually as an ongoing activity. All changes should be evaluated in terms of their marketing implications.

Computerized Scheduling

Increased levels of sophistication in the writing of software and the continual improvement of hardware technology has resulted in a number of driver and bus scheduling packages, ranging from inexpensive microcomputer applications to more powerful minicomputer applications. The simpler systems allow small fixed-route operations to develop initial schedules for each vehicle by merely supplying the specified headways, running time between stops, and layover times. Special work rules or unusual schedule complications must be written into the overall schedule by hand, but the automated system is still beneficial because it can quickly handle long blocks of repetitive trips that are consistent for long periods of time. Automated systems are useful for editing the "consistent" parts of the schedule so that the schedule writer can experiment with alternative schedules.

More sophisticated software packages are now available that can build timetables, print driver's paddles, construct passenger schedules, do runcutting, print day cards, and compile operating statistics. These advanced systems may also be capable of automatically switching and shifting schedules to identify the most efficient combinations. Although it may still be necessary to do some fine-tuning by hand for unusual events, these packages eliminate the time-consuming number-crunching and reduce the inefficient repetition of testing alternatives--a job traditionally done by hand.

Before acquiring any software package, thoroughly examine the program to be certain that it produces the needed results. Analyze your needs, select the software that meets those needs, and then select hardware that is appropriate for that software package. If you already have a substantial investment in hardware, then you may be forced to select a software package that is compatible with the existing hardware. However, compatibility is becoming less of a problem because most hardware and software providers are now striving to be compatible with the standard created by IBM. Always ask for references of other transit operations that use the software. Because all software packages have "bugs" it is wise to talk with others who have already used the software.

Resource Allocation

Transit firms are the same as any other economic endeavor. They are attempting to produce revenues through investment in and allocation of scarce resources.

Routing and scheduling have a direct effect on the allocation of a transit agency's limited resources. Routing determines the number of markets the firm will serve, and scheduling allocates the buses among the various markets or routes. Because the selection of a route implies the scheduling or allocation of at least one bus, the transit property, especially one just starting up, must avoid the pitfall of selecting too many routes to serve. That mistake could produce undesirable results. First of all, the transit agency, because of its limited resources, might be forced to schedule infrequently on some or all of its routes. This infrequent service could fall below the reasonable level of service needed to attract the best possible patronage. Second, money needed for promotional efforts might be used up in the purchase of equipment. Either of these conditions would produce disappointing results.

The resource allocation aspect of the routing and scheduling activities points out their extreme importance in the planning of the organization. Routing and scheduling are matters of concern to the entire enterprise. No planning, budgeting, or new investment should be undertaken until these two activities receive explicit attention in the analysis.

APPENDIX 10A

ROUTING AND SCHEDULING EXAMPLE

Introduction

This appendix presents a hypothetical routing and scheduling example that illustrates several concepts discussed in Chapter 10. The scenario is based on a small city transit operation in an urbanized area with a population of 55,000. Current service is within city boundaries; however, an adjacent, fast growing residential neighborhood has recently been annexed to the city. Everyone agrees that the neighborhood will need service but the question is: where and how much?

Management and the policy board pride themselves in having a well-run system that is based on a solid set of goals and objectives combined with rigorous service standards. Goals, objectives, and standards are reviewed by the policy board at budget time each year. Management staff plays an integral advisory role in the process.

The annual review includes an assessment of how well the system has met the goals established during the previous year. This assessment is based partly on performance indicators derived from the most recent Section 15 report. Management staff has an additional set of guidelines for monitoring the performance of each route on a monthly basis. A decision on the remedial action to be taken on routes that consistently perform poorly is made during the annual review. A summary of the annual review is used as a key input to the budget process.

Description of the Existing System

Service Characteristics

Routing and scheduling. Current service is based on a radial route structure operated on a pulse, or timed transfer, policy schedule originating from the central business district. The first major pulse, connecting almost all routes, occurs at 7:10 a.m., while the latest major pulse is at 6:10 p.m. Minor pulses that connect only several routes begin at 6:40 a.m. and end at 5:40 p.m. A diagram of the system is shown in Figure 10A.1.

System speed. The average systemwide speed is 13 mph, with very little variation by route and time of day.

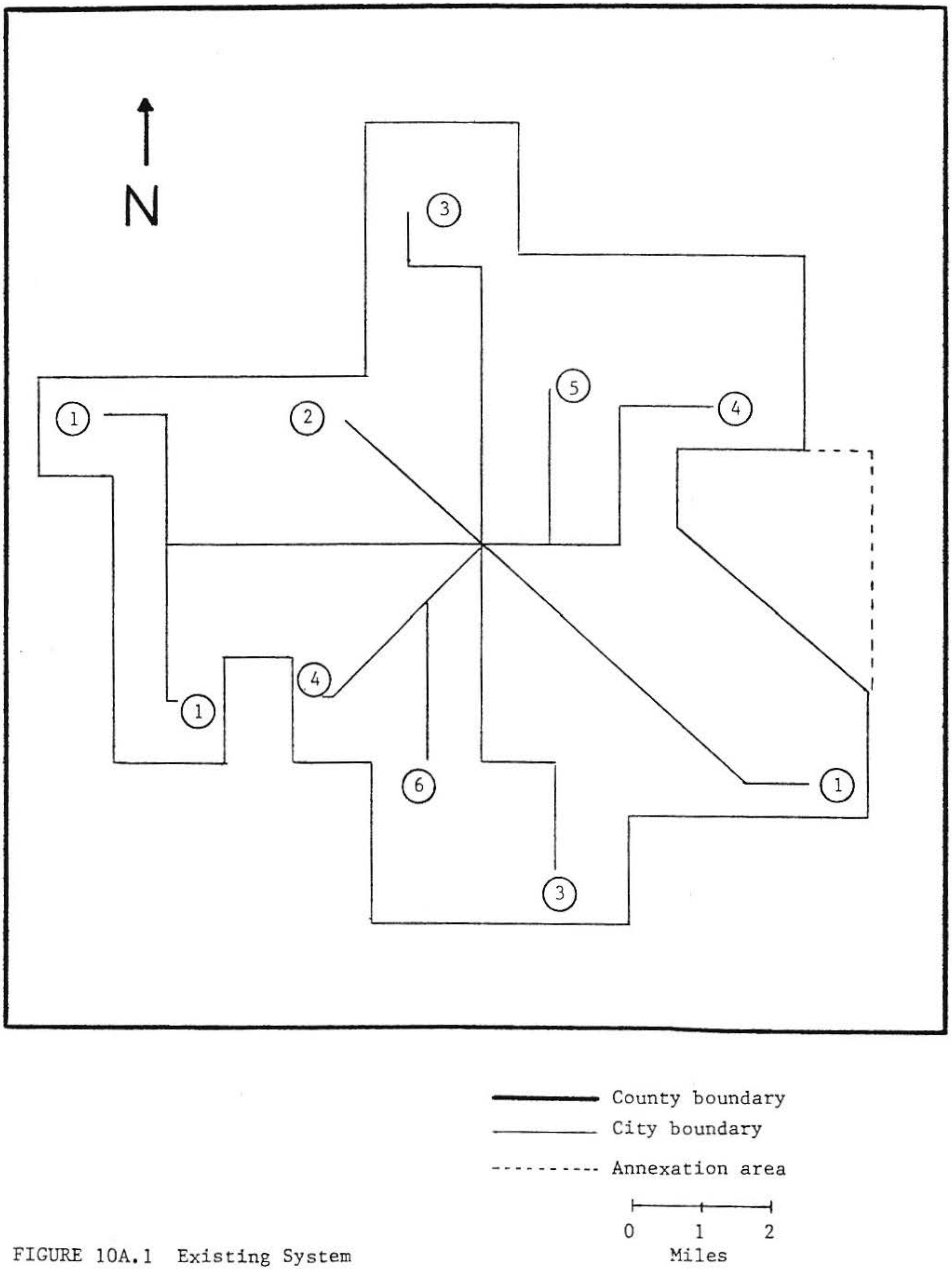


FIGURE 10A.1 Existing System

Average daily ridership. Table 10A.1 shows the average unlinked trips and transfers by route, for weekdays and Saturdays.

TABLE 10A.1 Average Unlinked Trips and Transfers

	Route	Unlinked Trips	Transfers	Transfer Rate
Weekday				
	1	578	139	24%
	2	226	29	13
	3	226	16	7
	4	101	14	14
	5	38	2	5
	6	88	12	14
	System	1,257	212	17%
Saturday				
	1	438	105	24%
	2	172	22	13
	3	172	12	7
	4	76	11	14
	5	29	2	7
	6	68	10	15
	System	955	162	17%

Fleet makeup. The fleet is in excellent condition, with an average age of 5.9 years. Two different bus sizes are used. The system also has an emergency fleet of four buses.

Service Evaluation Efforts

Fully allocated cost model. A cost model, which is used to evaluate both existing and proposed services, is developed during the budget process each year. The current model is shown in Equation 10A.1, below:

$$\text{Total cost} = \$18.63\ (RVH) + \$0.64\ (RVM) + \$9{,}000\ (PV)$$

where: RVH = revenue vehicle hours
RVM = revenue vehicle miles
PV = peak vehicles

Section 15 sample counts. Two randomly selected trips are sampled each day. Management feels that the daily sampling routine will help make the effort "second nature" to all those involved. Operators call in the odometer reading of the bus at the start of their trips. They then call in the odometer reading, location, and the number of passengers boarding and deboarding at subsequent stops until the trip is completed.

Boarding counts. Each bus is equipped with a simple one-button passenger counter used to record passenger boardings for all trips.

Transfer analysis. Operators collect transfers from boarding passengers, then turn in the transfers with their count sheet and vehicle defect report. Route-coded transfers are analyzed once a month, by time period.

Annual on-board survey. Once a year, during one week, passengers are surveyed on each trip. These surveys yield information on trip patterns and basic socioeconomic data.

Annual service policy objective assessments. Information from Section 15 counts, boarding counts, and annual on-board surveys are summarized in May of each year for use in the budget process. Each route is analyzed according to the board's previously adopted service standards.

Supervisory observations. The two supervisors are each required to make three daily observations. These observations include schedule adherence, curbing at stops, traffic signal adherence, and general driving skills.

Land use changes. The city's zoning department routinely contacts the general manager of the transit system on all approved zoning requests. The engineering department does the same for all multi-unit residential and retail development.

Service Standards

The board of directors has adopted a formal set of service standards based on route design, service quality, and economic and productivity criteria.

Route design criteria. These include route length, route coverage, route deviation, route structure, and bus stop spacing.

Economic and productivity criteria. These include the route's operating ratio, the number of passengers per revenue vehicle hour, the percentage of captive riders, and the percentage of households without automobiles that are served.

Service quality criteria. These include schedule adherence, passenger safety, passenger shelter location, transfer rates, hours of service, and complaints. These criteria are summarized in Table 10A.2.

TABLE 10A.2 Service Standards

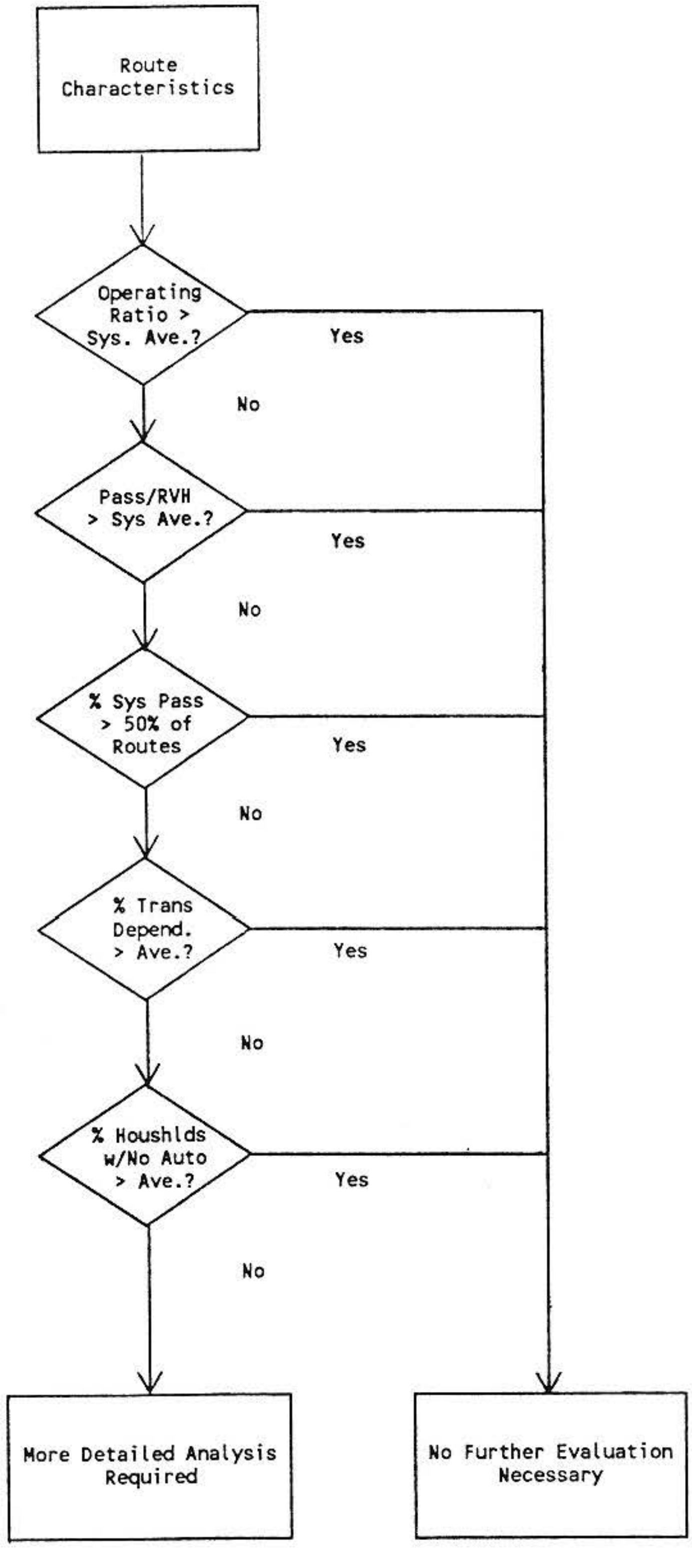
Indicator	Standard	Data Used to Measure
Route Design Criteria		
-route length	internally constrained by the headway of the timed-transfer system	
-route coverage	85% of all households should be within .5 miles of the route	city zoning map with decennial census tract overlay most recent Title VI submission
-route deviation	route not to exceed 1.5 times the distance of the most direct auto route between its two terminals	coefficient of directness: bus-miles/auto-miles
-route structure	routing should minimize transfers and maximize through trips	transfer analyses
-bus stop spacing	interval of at least 600 feet between bus stops	bus stop inventory Section 15 boarding/deboarding counts
Economic and Productivity Criteria		
-operating ratio	should be no worse than the system average	revenues/fully-allocated route operating costs
-passengers/ revenue vehicle-hour	should be no worse than the system average	boarding counts headway sheets
-% of system passengers	should fall within the upper 50th percentile	boarding counts
-captive riders	should be no worse than the system average	annual passenger survey
-community welfare	should be no worse than the system average	most recent Title VI submission auto availability, (decennial census)
Service Quality Criteria		
-headways	policy headways; inherently constrained by timed-transfer system	Section 15 boarding/deboarding counts; max. load point data
-schedule adherence	95% of arrivals at timepoints between 0-5 minutes late	supervisory observations
-passenger safety	there should be at least 50,000 vehicle-miles of service between preventible accidents	accident reports
-passenger shelter location	locations averaging 30 or more boardings per day will be considered for passenger shelter location	Section 15 boarding/deboarding counts

Economic and Productivity Assessment by Route

Management assesses the economic and productivity criteria of each route on a quarterly basis. The criteria are ranked in decreasing order of significance beginning with the route's operating ratio and ending with a measure of its overall value to the community. The other three criteria, in decreasing order, are: passengers per revenue vehicle mile, percentage of system passengers, and percentage of captive riders.

The average of each of these indicators for all routes within the system is used as a threshold value which is then successively compared with the individual values for each route. If a route's operating ratio is above average, the assessment for that route stops and it is deemed satisfactory. If it is below average, the analysis moves on to the next lowest priority measure. The analysis proceeds in a similar fashion through the percentage of passengers per revenue vehicle mile, the percentage of system passengers, and the percentage of captive riders (those with no automobile). The final assessment is based on the route's value to the community, measured by the percentage of households with no automobile. If the route fails the final assessment, it is put through a more rigorous analysis that includes assessment by trip. (Through routes are treated as two separate routes.)

The goal is to assess continually the application of the system resources based on measures generated from within the system's unique environment. Both management and the board agree that this is the best method because the parameters of the indicators can be tightened to include a particular percentile rank should the need for a major economy program arise. In this way, policymakers will always know which are the system's best and worst services. (Figure 10A.2 shows this process. Table 10A.3 shows the most recent economic and productivity data; Table 10A.4 shows the most recent route analysis.)



Notes: > = greater than
RVH = revenue veheicle hours

FIGURE 10A.2 Route Evaluation Algorithm

TABLE 10A.3 Current Economic and Productivity Data

Route	Operating Ratio	Pass./ RVH	% System Pass.	% Pass. w/ no Auto	% Households w/ no Auto
1	.13	13.8	46%	75%	14%
2	.22	23.9	18	90	12
3	.09	9.5	18	85	10
4	.08	8.2	8	92	13
5	.05	5.7	3	91	9
6	.09	9.5	7	87	11
System Average	.12	12.2	18%	88%	13%

Operating ratio = $\frac{\text{Operating revenue}}{\text{Operating expense}}$

RVH = revenue vehicle hours.

Alternatives for Service Annexation

Demand

The Metropolitan Planning Organization (MPO) estimates that the annexed area has the potential of generating between 29,000 and 37,000 average annual trips. These estimates are based on the residential makeup of the area and trip rates of contiguous, similar neighborhoods. It is estimated that 13% of the households in the neighborhood have no automobile.

TABLE 10A.4 Route Analysis

Route	Operating Ratio	Pass./ RVH	% System Pass.	% Pass. w/ no Auto	% Households w/ no Auto
1	.13				
2	.22				
3	$\boxed{.09}$	$\boxed{9.5}$	18		
4	$\boxed{.08}$	$\boxed{8.2}$	$\boxed{8}$	92	
5	$\boxed{.05}$	$\boxed{5.7}$	$\boxed{3}$	91	
6	$\boxed{.09}$	$\boxed{9.5}$	$\boxed{7}$	$\boxed{87}$	$\boxed{11}$
System Average	.12	12.2	18%*	88%	13%

RVH = revenue vehicle hours.

$\boxed{}$ = A route that failed this particular test (refer to Figure 10A.2).

* In this case, the threshold is established such that the lower half (ranked in descending order) of the routes automatically fails.

Levels of Service

There are three basic service alternatives that will work with the existing policy based timed-transfer system. For all three alternatives, Saturday service will be on standard 60-minute headways. The first trip is usually scheduled at the timed-transfer point at 9:10 a.m.

Alternative 1. The first alternative is the most attractive to the consumer because it calls for 30-minute service throughout the day. Buses will connect with all routes that meet downtown both at 10 minutes after and 20 minutes before each hour.

Alternative 2. The second alternative calls for 30-minute service during peak periods, and 60-minute service in the base. During the base period, buses will connect with buses scheduled to leave downtown at 10 minutes after each hour.

Alternative 3. The third alternative is the most conservative in that it calls for 60-minute service throughout the day. All buses will connect with the majority of other routes, leaving downtown at 10 minutes after each hour.

Budget Constraints

With federal and state operating assistance frozen, the cost of new service will have to be funded entirely from fares and from the increase in the tax levy that the system will realize. The annual estimate of this figure is $140,000.

Route Design

At this point in our example, we begin to develop the actual service, including the length of the route, the number of vehicles needed for each service alternative, and the exact routing of the service. This is usually an iterative process that begins with a logical, or obvious, hypothesis that is modified until the final product conforms with accepted standards.

Route length. Since the service must work into the timed transfer system, the length of the route is inherently constrained to even multiples of the pulse headways. A bus traveling from the transfer site to the outer terminus and back has a range equal to the average speed multiplied by the time it has to return to its starting point. The terminus of the route will be an apartment complex located in the southeastern corner of the area, approximately 6 miles from the transfer point. To test the feasibility of this site, use the widest headway in the timed transfer system, which is 60 minutes, and multiply by the average system speed of 13 mph.

$$1 \text{ hour} \times 13 \frac{\text{miles}}{\text{hour}} = 13 \text{ miles}$$

This means that the maximum round trip route length at the widest headway is limited to 13 miles. A terminal located 6 miles from the transfer point is therefore within the range of a bus operating on a 60-minute headway.

Route coverage. The system standard for route coverage implies that 85% of all households should be within 1/2 mile of the route. Figure 10A.3 shows an enlarged map of the new area, with possible routings. Alternative 1 provides for 100% coverage within the 1/2 mile standard and goes from downtown-A-B-D-B-C-E-T and back for a round trip length of 16.6 miles. Alternative 2 provides for 86% coverage and proceeds from downtown to A-B-C-E-T and back for a round trip length of 11.6 miles. Alternative 3 is the most direct route, yet only provides for 75% coverage. Alternative 3 goes downtown-A-C-E-T.

Alternative 1 is infeasible because the range of the one vehicle at the widest headway is 13 miles, while the round-trip mileage would be 16.6 miles. Alternative 2 is operationally feasible and meets the coverage standard of 85%. Alternative 3 is also operationally feasible yet it fails to meet the 85% standard. Therefore, Alternative 2 is the desired routing.

Route deviation. The system standard for route deviation limits the meandering of the route to no more than 50% more than the most direct auto route between the two termini. In this case, the most direct route is 5.3 miles (one-way), implying a maximum route length of 5.3 x 1.5, or 7.9 one-way miles. Alternative 1 would also have failed this standard since its one-way mileage was 8.3 miles. Alternative 2 with 5.8 one-way miles meets the standard.

Route structure. Since this is a new link in an already established timed-transfer system, it would be unproductive to consider through routings until travel patterns become apparent. While one of the advantages of a timed-transfer system is that it maximizes coverage, an inherent disadvantage is that it usually implies a higher transfer rate.

Bus stop spacing. Placing bus stops involves a field review, assessing the feasibility of applying the standard 600 foot interval.

Evaluation of Alternatives

Once route design criteria are established, an evaluation of service alternatives can begin. This is a relatively simple process that involves costing out the three service alternatives over the newly determined route. Variables needed for the fully allocated cost model are: revenue vehicle hours, revenue vehicle miles, and the number of peak vehicles. The process begins with the preparation of a headway sheet and a determination of the number of buses needed for each alternative. The total cost of each alternative is then compared with available capital and operating resources.

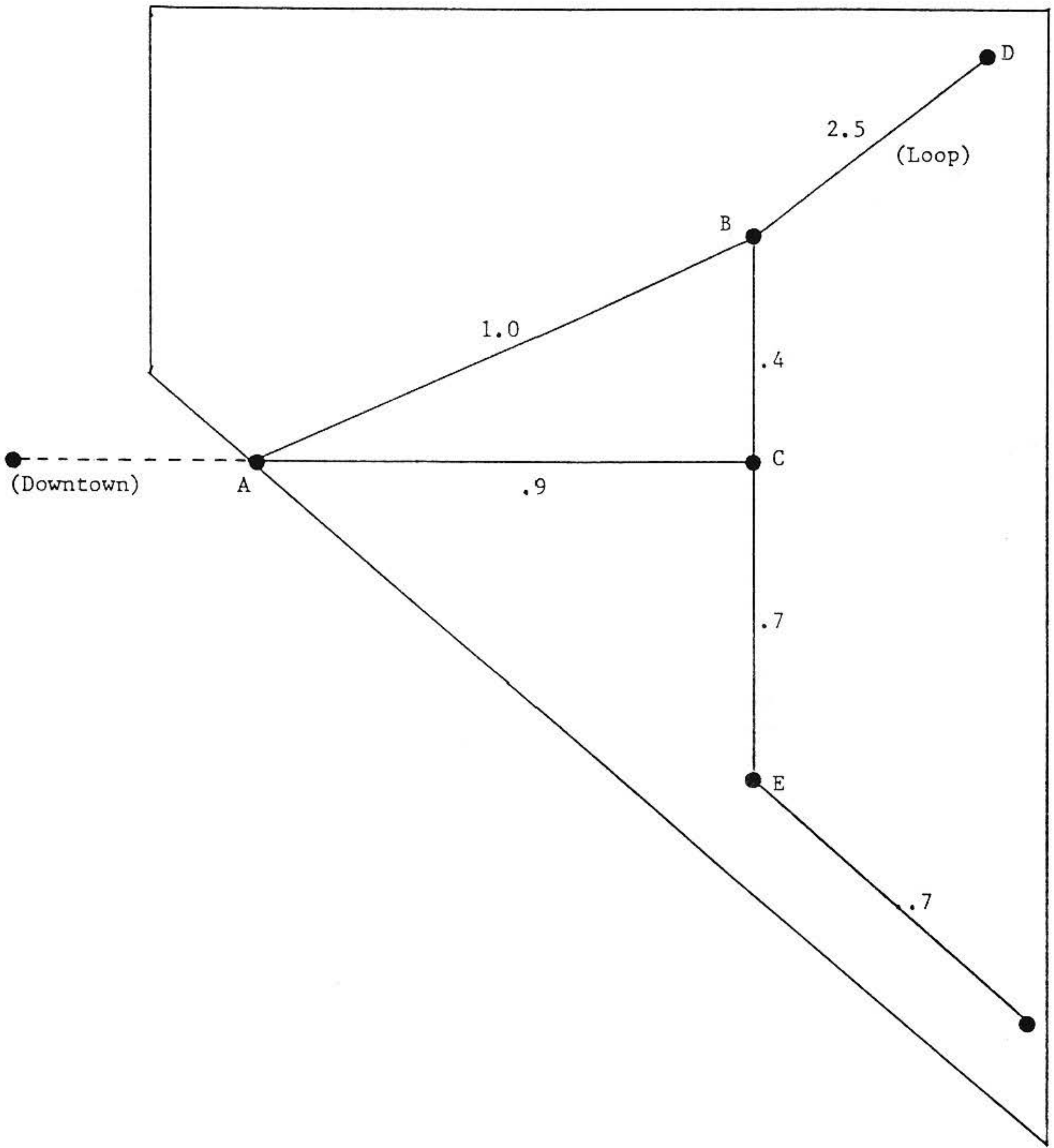


FIGURE 10A.3 Annexation Planning Map

For all three alternatives, the schedule times for the first and last trips for each day will be the same. To determine what time to leave from the outer terminus for the first morning trip, take the time of the first major timed transfer, 7:10 a.m., and "back-in" to the terminus using the following procedure:

$$7{:}10 \text{ a.m.} - Tr = Tt \qquad \text{[Eq. 10A.2]}$$

where: Tr = running time in minutes

$$= \frac{\text{distance}}{\text{route speed}}$$

Tt = terminal time

$$= \frac{5.8 \text{ miles}}{13 \text{ mph}}$$

$$= .45 \text{ hours}$$

$$= 27 \text{ minutes}$$

Substituting into Equation 10A.2:

$$7{:}10 \text{ a.m.} - Tr = Tt$$

$$7{:}10 \text{ a.m.} - 27 \text{ minutes} = 6{:}43 \text{ a.m.}$$

The first trip will therefore leave the apartment complex at 6:43 a.m. for all service alternatives.

To determine the time of the last arrival at the apartment complex, simply reverse the process: Take the last major timed transfer, 6:10 p.m., and add the running time to the terminal. Since the distance and speed are the same in the opposite direction, the equation becomes:

$$6{:}10 \text{ p.m.} + 27 \text{ minutes} = 6{:}37 \text{ p.m.}$$

With a starting time of 6:43 a.m. and an ending time of 6:37 p.m., the next steps in the exercise are to construct a complete headway sheet for each alternative, determine the number of buses needed, assign vehicles to each trip on the headway sheet, and determine revenue vehicle hours and miles. The last step is to apply the fully allocated cost model in Equation 10A.1, shown on page 429.

Alternative 1

Table 10A.5 is a headway sheet for Alternative 1. Calculations for the number of buses needed, revenue vehicle hours, and revenue vehicle miles follow:

$$\text{Buses} = \frac{F \times L}{R} \qquad \text{[Eq. 10A.4]}$$

where: F = frequency in buses per hour
L = round trip route length (miles)
R = speed (mph)

Substituting: $\text{buses} = \dfrac{2 \times 11.6 \text{ miles}}{13 \text{ mph}}$

$= 1.78$ or 2 buses

$$\text{Revenue vehicle hours} = Te - Ts \qquad \text{[Eq. 10A.5]}$$

where: Te = bus end time
Ts = bus start time

Substituting: bus 1 = 6:37 p.m. - 6:43 a.m. = 11.9 hours

bus 2 = 6:07 p.m. - 7:13 a.m. = 10.9 hours

22.8 total

$$\text{Revenue vehicle miles} = L \times N \qquad \text{[Eq. 10A.6]}$$

where: L = round trip route length (miles)
N = number of daily round trips

Substituting: 11.6×21

$= 243.6$ or 244 miles

TABLE 10A.5 Headway Sheet - Alternative 1

Vehicle	Leave Outer Terminal	Time Downtown	Arrive Outer Terminal
1 PO	6.43 a.m.	7:10 a.m.	7:37 a.m.
2 PO	7:13	7:40	8:07
1	7:43	8:10	8:37
2	8:13	8:40	9:07
1	8:43	9:10	9:37
2	9:13	9:40	10:07
1	9:43	10:10	10:37
2	10:13	10:40	11:07
1	10:43	11:10	11:37
2	11:13	11:40	12:07 p.m.
1	11:43	12:10 p.m.	12:37
2	12:13 p.m.	12:40	1:07
1	12:43	1:10	1:37
2	1:13	1:40	2:07
1	1:43	2:10	2:37
2	2:13	2:40	3:07
1	2:43	3:10	3:37
2	3:13	3:40	4:07
1	3:43	4:10	4:37
2	4:13	4:40	5:07
1	4:43	5:10	5:37
2	5:13	5:40	6:07 PI
1	5:43	6:10	6:37 PI

Note: PO = pull-out
PI = pull-in

Alternative 2

Table 10A.6 is a headway sheet for Alternative 2. Calculations for the number of buses needed, revenue vehicle hours, and revenue vehicle miles follow:

$$\underline{\text{Buses}} = \frac{F \times L}{R} \qquad \text{[Eq. 10A.4]}$$

where: F = frequency in buses per hour
L = round trip route length (miles)
R = speed (mph)

Substituting: $\text{peak buses} = \frac{2 \times 11.6 \text{ miles}}{13 \text{ mph}}$

$= 1.78$ or 2 buses

$\text{off-peak buses} = \frac{1 \times 11.6}{13}$

$= .89$ or 1 bus

$$\underline{\text{Revenue vehicle hours}} = Te - Ts \qquad \text{[Eq. 10A.5]}$$

where: Te = bus end time
Ts = bus start time

Substituting: bus 1 = 6:37 p.m. - 6:43 a.m. = 11.9 hours

bus 2 = 10:07 a.m. - 7:13 a.m. = 2.9 hours

6:07 p.m. - 3:13 p.m. = 2.9 hours

17.7 total

$$\underline{\text{Revenue vehicle miles}} = L \times N \qquad \text{[Eq. 10A.6]}$$

where: L = round trip route length (miles)
N = number of daily round trips

Substituting: $= 11.6 \times 18$

$= 208.8$ or 209 miles

TABLE 10A.6 Headway Sheet - Alternative 2

Vehicle	Leave Outer Terminal	Time Downtown	Arrive Outer Terminal
1 PO	6:43 a.m.	7:10	7:37
2 PO	7:13	7:40	8:07
1	7:43	8:10	8:37
2	8:13	8:40	9:07
1	8:43	9:10	9:37
2	9:13	9:40	10:07 PI
1	9:43	10:10	10:37
1	10:43	11:10	11:37
1	11:43	12:10 p.m.	12:37
1	12:43 p.m.	1:10	1:37
1	1:43	2:10	2:37
1	2:43	3:10	3:37
2 PO	3:13	3:40	4:07
1	3:43	4:10	4:37
2	4:13	4:40	5:07
1	4:43	5:10	5:37
2	5:13	5:40	6:07 PI
1	5:43	6:10	6:37 PI

Note: PO = pull-out
PI = pull-in

Alternative 3

Table 10A.7 is a headway sheet for Alternative 3. Calculations for the number of buses needed, revenue vehicle miles, and revenue vehicle hours follow:

$$\text{Buses} = \frac{F \times L}{R} \qquad \text{[Eq. 10A.4]}$$

where: F = frequency in buses per hour
L = round-trip route length (miles)
R = speed (mph)

Substituting: $$\text{peak buses} = \frac{1 \times 11.6 \text{ miles}}{13 \text{ mph}}$$

$$= .89 \text{ or } 1 \text{ bus}$$

Revenue vehicle hours = Te - Ts [Eq. 10A.5]

where: Te = bus end time
Ts = bus start time

Substituting: bus 1 = 6:37 p.m. - 6:43 a.m. = 11.9 hours

Revenue vehicle miles = L x N [Eq. 10A.6]

where: L = round trip route length (miles)
N = number of daily round trips

Substituting: 11.6 x 12

= 139.2 or 140 miles

TABLE 10A.7 Headway Sheet - Alternative 3

Vehicle	Leave Outer Terminal	Time Downtown	Arrive Outer Terminal
1 PO	6:43 a.m.	7:10	7:37
1	7:43	8:10	8:37
1	8:43	9:10	9:37
1	9:43	10:10	10:37
1	10:43	11:10	11:37
1	11:43	12:10 p.m.	12:37
1	12:43 p.m.	1:10	1:37
1	1:43	2:10	2:37
1	2:43	3:10	3:37
1	3:43	4:10	4:37
1	4:43	5:10	5:37
1	5:43	6:10	6:37 PI

Note: PO = pull-out
PI = pull-in

Saturday Service

The headway sheet for Saturday service is the same as for Alternative 3 with one exception: the first trip starts at 8:43 a.m. Calculations for the number of buses needed, revenue vehicle hours, and revenue vehicle miles follow:

$$\underline{\text{Buses}} = \frac{F \times L}{R} \qquad \text{[Eq. 10A.4]}$$

where: F = frequency in buses per hour
L = round trip route length (miles)
R = speed (mph)

Substituting: $\text{peak buses} = \frac{1 \times 11.6 \text{ miles}}{13 \text{ mph}}$

$= .89$ or 1 bus

Revenue vehicle hours = Te - Ts [Eq. 10A.5]

where: Te = bus end time
Ts = bus start time

Substituting: 6:37 p.m. - 8:43 a.m. = 9.9 hours

Revenue vehicle miles = L x N [Eq. 10A.6]

where: L = round trip route length (miles)
N = number of daily round trips

Substituting: 11.6 x 10 = 116 miles

Selection of the Best Alternative

The best alternative can be chosen after comparing the annualized operating cost and capital requirements of each alternative, using a standard year consisting of 255 weekdays (261 - 6 holidays) and 52 Saturdays. The fully allocated cost model previously presented in Equation 10A.1, the annualized operating costs minus best case and worst case revenue estimates, and the capital requirements of each alternative are summarized in Table 10A.8.

TABLE 10A.8 Net Cost and Capital Requirements for Alternatives

Alt.	Annual Operating Cost	Revenue Best	Revenue Worst	Net Best	Net Worst	Capital Req. (Buses)
1	$161,591	$12,950	$10,150	$148,641	$151,441	2
2	149,660	12,950	10,150	136,710	139,510	2
3	110,845	12,950	10,150	97,895	100,695	1

Alternative 3 is the best choice because the anticipated increase in the system's property tax levy of $140,000 more than adequately covers the best and worst net cost estimates of $97,895 and $100,695, respectively. Although Route 3 did not meet the route coverage criteria, it is important to note that it is the only alternative the system can afford. At this point a policy decision must be made as to whether or not an exception will be made in order to serve the annexed area.

Pro Forma Performance Indicators

Applying the ridership estimates to the service characteristics of Alternative 3 yields best and worst case pro forma actual operation estimates of the route's key performance indicators. This type of analysis is useful in establishing priorities for the system's market development goals and objectives. If the new route seems capable of developing on its own, then market development objectives can be concentrated on other services with the greatest need. If it appears that the new route may not successively exceed the system's threshold performance criteria, then a policy decision needs to be made about its viability. A potential decision might be to run the route on an experimental basis for one year--to cut potential losses. The best and worst case pro forma performance indicator analyses for Alternative 3 are shown in Tables 10A.9 and 10A.10, respectively.

Note that in the best case scenario, the new route, Route 7, holds its own by performing at about the systemwide averages in each category. This scenario would permit implementation of the new route with a normal marketing effort. Greater effort should be devoted to analyzing the poor performance of Route 6.

TABLE 10A.9 Best Case Scenario: Pro Forma Productivity Indicators

Route	Operating Ratio	Pass./ RVH	% System Pass.	% Pass. w/no Auto	% Households w/no Auto
1	.13	13.8	41	75	14
2	.22	23.9	16	90	12
3	.09	9.5	16	85	10
4	.08	8.2	7	92	13
5	.05	5.7	3	91	9
6	.09	9.5	6	87	11
New 7	.12	12.2	10	88**	13
System Threshold	.12	12.2	7*	88	13

RVH = Revenue vehicle hours.

= A route that failed the test (refer to Figure 10A.2).

* Arbitrarily set so that three routes automatically fail.

** Set exactly equal to the previous average.

TABLE 10A.10 Worst Case Scenario: Pro Forma Productivity Indicators

Route	Operating Ratio	Pass./ RVH	% System Pass.	% Pass. w/no Auto	% Households w/no Auto
1	.13	13.8	42	75	14
2	.22	23.9	16	90	12
3	.09	9.5	16	85	10
4	$\boxed{.08}$	$\boxed{8.2}$	$\boxed{7}$	92	13
5	$\boxed{.05}$	$\boxed{5.7}$	$\boxed{3}$	91	9
6	.09	9.5	6	87	11
New 7	$\boxed{.09}$	$\boxed{9.6}$	8	88**	13
System Threshold	.12	11.9	7*	88	13

RVH = Revenue vehicle hours.

$\boxed{}$ = A route that failed the test (refer to Figure 10A.2).

* Arbitrarily set so that three routes automatically fail.

** Set exactly equal to the previous average.

The worst case scenario presents a misleading picture because it causes Route 6 to improve. This occurs because the performance of the new route is so poor that it significantly lowers systemwide thresholds, thus making the previously poor performances look better. In this case, the average of the key indicators serves as a poor surrogate for a systemwide threshold value. A better approach would be to upgrade the threshold to, for example, the upper quartile or the median.

In review, note that the system's route design criteria were applied, then best and worst case productivity scenarios were developed well in advance of the services being implemented. Service quality criteria are the final inputs to a complete and effective assessment of the service once it has begun. It is not uncommon for a new route, or service, to be run for at least a full year before realizing its potential.

Notes for Appendix 10A

1. Service standards and classification categories are based on the findings of a 1981 study which resulted in a report entitled "Bus Service Evaluation Methods - A Review," prepared by the Metropolitan Transit Authority of Harris County, Houston, Texas, for the Office of Planning Assistance, UMTA. (DOT-I-84-49)

2. The algorithm for successively analyzing economic and productivity criteria was introduced in an article entitled "Toward the Development of an Accommodation Service Policy," by George T. Mauro and Lewis Polin, and appeared in Transportation Research Record #662, published by the Transportation Research Board in 1978.

3. For a discussion of cost allocation models see "Bus Route Costing Procedures: A Review," prepared by the Simpson and Curtin Division of Booz, Allen and Hamilton, Inc., for the U.S. DOT, UMTA, Office of Planning Assistance, May 1981.

4. Several demand estimation techniques are presented in the Transportation Research Board's Research Record #638, 1977. Estimates for this particular example are derived from the technique presented by Colangelo and Grange entitled, "Cross-Classification: An Approach to Passenger Estimation in Short-Range Transit Planning," p. 12.

5. A clear, easy-to-understand process for evaluating alternatives is presented in the Transportation Research Board's Research Record #638 entitled, "Simplified Procedures for Preliminary Evaluation of Public Transportation Alternatives," by Heathington and Brogan.

6. For a more complete listing of analysis techniques see the "Handbook of Manual Analysis Techniques for Transit Strategies," by Keith Gilbert, Alan M. Voorhees and Associates for the North Central Texas Council of Governments, U.S. DOT, UMTA, 1981, TX-09-0045.

7. For a complete presentation on the intricacies of a timed-transfer system see "Timed Transfer System Planning, Design and Operation," Vukan Vuchic, et al, University of Pennsylvania, prepared by the University Research and Training Program, U.S. DOT, UMTA, DOT-I-83-28, October, 1981.

APPENDIX 10B

ROUTE EVALUATION EXAMPLE

One of the best tools to evaluate the performance of a route is a peer group analysis using performance indicators (ratios of input and output). The best peer group to use when evaluating a route is all the routes within your own transit system. The physical, political, and financial constraints that affect one route within your system will affect all other routes. No better peer group is possible. The choice of best performance indicator depends on what you want to measure. If you are concerned with the overall efficiency of a route, then passengers/revenue hour or passengers/revenue mile are excellent measures.

The following example of route evaluation uses passengers/ revenue hour for each route within the system and compares each route to the system average. The passengers/revenue hour ratio for each route is divided by the systemwide passenger/revenue hour ratio to create a value for each route, which is called the "percentage of average productivity." A value of 100% means that the route's ratio of passengers/revenue hour is exactly equal to the systemwide average. A value of 90% means that the route's ratio is only 90% of the systemwide average. For example, if the systemwide average is 30 and the route's ratio is 27, then the route's percentage of average productivity is 90% (or 27/30).

This technique was borrowed from the Ann Arbor Transportation Authority (AATA), whose board of directors established standards for an internal review of system performance. The service standard for route productivity calls for a special analysis of any route with a productivity of between 50% and 80% of the fixed-route average, with consideration of special marketing efforts and route modifications for any route with productivity below 50%. The service standard also calls for a special analysis of any route with a 10% or greater drop in productivity from the previous month.

TABLE 10B.1 Regular Route Analysis: January 1984

Individual Fixed Route Service Productivity: Each fixed route shall be considered to achieve acceptable productivity if ridership is at least 80% of the overall fixed route system.

Route No.	Route Name	Passengers / Service Hour	% of Average Productivity	% Change in Pass./Serv. Hr. From Same Qtr. Last Year
Group I: Productivity Greater than 80% of System Average.				
4	Washtenaw	55	184	10%
11	Ypsilanti-South	41	137	8%
9	Jackson	38	127	9%
1	Pontiac	35	117	(10%)
6	State-Ellsworth	35	117	10%
10	Ypsilanti-North	33	110	9%
5	Packard	32	107	3%
5	Liberty-Pauline	27	90	(16%)
3	Huron-River	27	90	28%
12	Stadium-Miller	25	84	14%
2	Plymouth	25	84	(4%)
Group II: Productivity Between 50% and 80% of System Average.				
7	S. Main-Huron Pkwy.	21	67	---
13	Newport	17	52	6%
Group III: Productivity Below 50% of System Average.				
15	Maple	14	37	40%
9	Geddes	10	30	11%

Parentheses ( ) indicate a decline.

NOTE: The AATA service standard calls for special analysis of routes with productivity between 50% and 80% of the fixed route average and consideration of special marketing efforts and route modifications for routes with productivity below 50% of average. All routes with a 10% or greater drop in productivity are to be analyzed to determine the cause of the decline. Service levels on lower productivity routes will be considered in conjunction with Fall 1984 service changes.

CHAPTER 11

SUPERVISION, COMMUNICATIONS AND CONTROL OF OPERATIONS

Introduction

Supervision of transportation is inherently a challenge due to the dynamic nature of the transit product. Supervision is critical because the quality of the product is based on its delivery at previously published times along points on the route. Service must be reliable and this depends on the performance of the transit employees. Unless the agency pays meticulous attention to maintaining the published schedules, the public will soon become disenchanted with the transit service.

Advances in the technology of radio communications have resulted in a valuable supervisory aid in that real-time information does not have to be directly observed by a supervisor. Problems with the provision of service such as traffic tie-ups and equipment malfunctions can be communicated over the radio and can often be handled by a supervisor in a remote location.

Good supervisors working with a good communication system form a most effective control system for the delivery of the dynamic transit product. With bus operator labor and fringe benefit costs accounting for almost half of the average bus system's total operating costs, it is clear that effective control of the transit product will have a significant impact on the productivity of the system.

Supervision

There are two main categories of tasks with which a bus service supervisor must deal. The first is administering work and the second is managing people.

Administering Work

The five main tasks involved in administering work are monitoring performance, solving problems, ensuring safety, collecting data, and providing feedback.

Monitoring performance. Supervision helps to monitor the overall, on-time performance of the transit service.

Solving problems. When problems arise, such as flat tires or mechanical breakdowns, supervisors engage in minor troubleshooting procedures, and then act to restore service with either the same, or a replacement vehicle.

Ensuring safety. Supervisors observe the driving habits of bus operators and, where unsafe conditions exist, take steps to remedy problems. Supervisors also make continual observations of the operating environment to see where unsafe conditions exist, and they take appropriate steps to improve the safety of service. Some typical situations include: malfunctioning traffic signals, potholes, obstructions to traffic, and fire or police emergencies.

Collecting data. Most of the tasks that a supervisor gets involved with involve some form of written report. Additionally supervisors might collect information on ridership, vehicle running times, and other operating characteristics.

Providing feedback. Supervisors can observe the general functioning of the system and provide feedback to management for its planning. Observations gathered by the supervisors can also be used to make decisions about routing and scheduling.

Managing People

The three major tasks involved in managing people are taking on a leadership role, facilitating communication, and evaluating employees.

Taking on a leadership role. Being a transit supervisor entails promoting an atmosphere of enthusiasm and responsibility among employees as well as motivating each employee to perform to the maximum extent of his or her ability. Coaching and team-building skills are important to the supervisor's leadership effectiveness.

Facilitating communications. Supervisors facilitate the translation of management policy at the operating level. It is not always possible for management to develop policies that are acceptable and self-explanatory to the operators and mechanics. Therefore, the supervisor's role is to bridge the communication gap with explanations, reasoning, and encouragement. It is also quite possible for management to develop policies that simply do not work at the operating level. In these cases, it is crucial that the supervisor be able to listen to and understand views at the operating level, and then communicate them to management in a clear, concise manner.

Evaluating employees. Employees need regular constructive feedback, along with advice on how to develop better work habits, if they are to reach their fullest potential and maximize their effectiveness in the organization.

Recruiting, Selecting, and Developing Good Supervisors

Recruitment. Since thorough knowledge of the activity being supervised is required, it is not unusual for first-level supervisors to be former drivers or mechanics who have been promoted to the management level. To make the opportunities attractive to the best candidates, management should make very clear (1) the need to fill such a position at some point in the future, (2) the qualifications and requirements of the job, and (3) the advantages to anyone who takes the job.

Selection. Coming up through the ranks implies new responsibilities. The skills required of a supervisor differ significantly from the skills of a driver or a mechanic; job knowledge and experience, though still prerequisites, are not the sole factors in the selection process. A key factor in selecting supervisory candidates should be the candidate's potential for mastering new skills.

Development. Sample training and development topics for bus service supervisors follow:

- Situational leadership
- Leadership styles
- Interviewing and counseling
- Problem solving
- Motivational theory
- Labor relations
- Effective communication (listening, writing, speaking)
- Administrative procedures
- Customer relations
- Basic cost control theory
- Delegating responsibility
- Handling employee complaints
- Progressive discipline

Using Supervisory Personnel

If supervisors are used, they may be located at any of a number of places. Supervisors may use an automobile with or without a two-way radio. If the vehicle is not equipped with a radio, the supervisor must regularly call transit headquarters to find out if there is trouble. Based on their experience, supervisors can also use the vehicle to travel to places where they know difficulties are likely to arise.

Supervisors may also be stationed at places on the street where they can observe the operation of the transit system and take necessary corrective action. Supervisors on foot may or may not be equipped with radios. However, supervisors without two-way radios must call headquarters or rely on messages from bus drivers to keep aware of the situation. Hand carried two-way radios are available and can be used to extend the supervisory range of supervisors on foot.

Another option is for supervisors to remain at some central location--such as a downtown terminal and transfer point or at the main offices of the transit agency--with or without a two-way radio. A supervisor at a major downtown terminal can monitor on-time performance and may take actions when a bus does not arrive on schedule or shortly thereafter. A supervisor with a radio at a central location can be in contact with the buses and the maintenance garage and can act quickly to remedy problems.

Sometimes supervisors are located only at key transit traffic points. In general, they are on the street or in a car at these points to help put buses in the proper order for arrival at the terminal, turn back buses that are running off schedule, or to take other actions to ensure reliable operation.

The supervisor's ability to cover the field and to act quickly when problems arise is extremely limited without two-way radios. A supervisor located on the street without a radio is probably of value only when there is a great deal of transit traffic, for example, at rush hour. A supervisor at a downtown terminal may be extremely useful. In the long run, all supervisors should be equipped with two-way radios, whether in the car, at a fixed location, or on foot.

Dispatching

The dispatcher has a variety of duties, depending on the size of the system and the type of service offered. Systems operating demand-responsive services, separate from their fixed-route services, will rely on a dispatcher to take requests for service, schedule trips, and then ensure that clients are picked up and delivered on time. The dispatcher also handles disruptions to service by rescheduling pick-ups and drop-offs while staying in touch with the client by telephone and the bus operator by radio.

In fixed-route, timed-transfer systems, the dispatcher accommodates transferring passengers by holding connecting buses when a feeding bus is running behind schedule. In systems where bus operators can communicate with each other directly, the dispatcher serves a support role that includes telephoning police and fire services, tracking articles left on buses by passengers, and making special passenger accommodations. Dispatchers also serve in a clerical capacity; they record and report selected bus operator communications, Section 15 boarding and deboarding counts, roadcalls and defects, service disruptions, vehicle assignments, employee attendance, and other information.

A dispatcher may or may not have supervisory authority.

Communication Systems

Communication is as much a part of the marketing mix as the system's routes, schedules, and equipment. In the small-city transit system, two-way radio equipped buses have become a necessity. They enable management to meet its objectives of flexible and dependable transit service for various segments of the transit market.

The use of communication systems, particularly those with two-way radios, can provide significant supervisory assistance and play an important role in ensuring on-time service and overall dependability of transit operations. With an effective communication system, an active transit operations control system is possible. The location of vehicles can be found and service can be monitored. Problems associated with breakdowns can be corrected quickly. Often, information on traffic and safety can be relayed and action taken before a serious problem with the quality or reliability of service develops. Finally, communication systems enable bus drivers to communicate with one another to coordinate transfers of passengers between routes. Communication is also critical if the transit system offers all or some of its services in the form of a demand-responsive system.

Every effort should be made to use the communication system--whatever its mode--in an active role as a complete and continuing control device. This approach is the most sensible way to help maximize the quality of service in conjunction with organizational goals and to make efficient and effective use of personnel.

Methods of Communication

Supervision and control can be carried out in a number of ways. All of these methods involve communications of one sort or another. A transit system may choose to do without any supervisory personnel or communication system of its own, relying instead on customer complaints to detect undependable service. Such a system will be costly in terms of company image and community relations. Although it affords low costs in communication equipment, such a method only leads to falling ridership. This method has no place in a service-oriented, market-sensitive transit undertaking.

Two-way radios. Two-way radios, especially the greatly improved mobile types that have come on the market in recent years, offer considerable flexibility. They also provide a high degree of control without excessive expense. Many properties have already equipped all or part of their fleets with radios. With two-way radios, information can be transmitted instantly between vehicles and the base station. Communication delays can be virtually eliminated.

For the small-city transit system, probably the best bet in communication devices is the two-way radio. Several manufacturers produce a relatively wide selection of communication equipment. With regard to selection, installation, and operation, prime needs are ruggedness, durability, and sufficient range that all vehicles can maintain contact with the supervisor at the radio base station, or with each other.

Collecting certain types of data is possible with two-way radios. Section 15 ridership counts are an example. The drivers on given routes or runs can report the number of passengers boarding and alighting at each stop. This information can be recorded at the base station, either by hand or by a tape recorder. Spot checks on passenger traffic can thus be gathered easily and quickly.

Simple demand-responsive systems, which may be necessary to serve certain segments of the market, can use two-way radios. Potential riders merely call a controlling supervisor and request that a bus operating in a certain sector pick them up. This information then would be delivered by radio to the driver.

Telephone handsets. Two-way radios are fairly common in taxicab operations. However, the radio communication systems used in taxi service can be a great annoyance to both passengers and drivers because of the constant chatter. The ideal type of radio system for transit is one in which a centrally located supervisor may call all the buses at once or any one of them individually. The drivers may call in at any time. Some of the hardware used in large city transit even enables drivers to call other buses or road supervisors. The receiving and sending equipment on the vehicles is usually similar in design to a telephone handset.

For convenience, the drivers could be equipped with lightweight headsets that combine an earphone and a small microphone. The headset would leave the driver's hands free at all times. A foot control would enable the driver to initiate a call or to respond quickly and easily to a call from the central controller.

Telephone check-ins. As a kind of halfway point between personal supervision and some form of radio or instrumented control on each vehicle, drivers may check in at route ends and at certain places along the route, by means of telephone boxes. While this method is better than no communication at all or communication through supervisors alone, its effectiveness is limited by the location of the telephone boxes. Moreover, it may involve considerable inconvenience for the driver and passengers; there is also the possibility of delay.

Electronic vehicle monitoring systems. Another possibility for control is an electronic vehicle monitoring system used with two-way radios. Several of these systems are currently being developed and tested. In some systems, the vehicle emits a radio signal that is picked up by lineside detecting devices and transmitted to a central control station. By means of computerized map displays, it is possible to locate any bus on the portion of the transit system that is covered by the monitoring equipment. The bus or the entire fleet can be traced as it moves along routes.

More complicated versions of electronic vehicle monitoring systems will show only buses that are running either late or ahead of schedule. Others will flash an emergency signal automatically in the event of robbery or some other problem. With some systems it is possible to count the number of passengers boarding and alighting from the buses. Some monitoring systems under development report on the mechanical condition of the bus while it is operating its route. For example, engine temperature may be rising too high, the transmission may be showing symptoms of failure, or the air compressor may not be working properly. This type of data can be relayed automatically by radio or other means of transmission and stored in a computer; a signal is flashed if any defect becomes serious. Computer printout tells the nature of the problem.

Currently, the only drawback of such electronic systems is their cost, which may make them uneconomical for small-scale transit use. However, expected improvements and cost reductions may make it possible for even the smallest transit firm to use simple, inexpensive electronic vehicle monitoring systems in the future.

Closed-circuit television. In recent years, the development of small, rugged, and relatively inexpensive closed-circuit television cameras has made visual contact at key locations possible. Monitoring entire routes visually would probably be too costly, but television is an excellent means of monitoring multiple route subterminals or congested intersections. Combined with two-way radios, closed-circuit television would enable the communication system to have mechanical eyes and ears. For the small firm, cost is the major drawback--particularly the cost of linking remote locations to the supervisory control center by cable, if channels in the video spectrum are unavailable locally.

Central Control Concept

Because dependability is the critical factor in marketing a successful transportation package, a two-way radio communication system should be regarded as much more than a mere device for reporting emergencies or making casual checks on drivers. At the very least, the communication system can be used for the integration of services; for example, to dovetail the transfers between lines. Nothing is more frustrating to a passenger who must transfer from one route to another than to discover he has just missed a connection. This annoyance may be unavoidable if a bus is running late and the driver has no way to signal to another driver that he has a transfer passenger. A communication system would alleviate this problem by tying the vehicles together through a central control point.

A controller at a central point in the transit system can be even more useful as a monitoring and controlling agent for the entire operation. His or her main function would be to ensure the dependable, scheduled operation of the transit service, through regular contact with each route. In this case, the exact location of each bus at a given time could be easily ascertained. The advantages of electronic vehicle-monitoring systems could be enjoyed without the need for the installation of costly computers and automatic detection devices.

The central controller's tracking operation should also be used as a dramatic promotional device. For maximum impact on the public and as a visual dramatization of the importance given to dependability and flexibility of operations, the central controller should be located at some highly visible spot, probably the major downtown transit terminal. Using simple, electrically controlled map displays or the movement of markers on a map of the system, the central controller can plot the location of each vehicle in the system. Such overt concern for dependable operation of regular service can be a real contribution to the image-building process.

Summary

Guidelines for the selection of communication equipment follow:

1. The system should allow constant and immediate contact with all buses in regular route and special service operation to meet supervisory and dispatching needs, data-collection needs, and information and emergency needs.

2. The quality of the system should provide high range and coverage, clarity and precision in transmission and reception, and reliability in operation. It should not interfere with driver or customer comfort, nor with community radio, television, and telephone systems.

3. The equipment in the bus should be sufficiently compact so as not to impede the operator or inconvenience the passengers.

Appendix 11.A presents a more detailed specification framework.

APPENDIX 11A

RADIO COMMUNICATION SYSTEMS

Radio communication systems for transit operations have advanced considerably in recent years. Changes in technology have brought about a variety of features that have increased the effectiveness of communication between the dispatcher, supervisors, and in-service revenue vehicles.

System Acquisition

Suitability and Price

The initial step in obtaining a mobile radio system is to contact sales representatives or distributors dealing in mobile communication who can give information about range. The price range varies widely with the type of equipment obtained. General Electric and Motorola are among the leading manufacturers of equipment, but other sources, both domestic and foreign, are available. The company representative will first attempt to find out what the user wants the radio system to do. Thus, users should have a fairly definite idea of what range they desire, how much the communication system will be used, what equipment would fit needs best, and other relevant information. The representative will investigate the physical characteristics of the area, the related radio systems operating in the vicinity, and so on. Putting all of these data together, he or she will recommend a system for the transit agency that he believes will best suit its needs. Because systems designed by different representatives will vary, the transit system must pick the one that looks most suitable for the estimated price.

Upon identifying the system's needs, specifications should be written so that bids can be let (usually required for public operations). After the "lowest and best" bid is accepted, plans can be made for getting the equipment, installing it, and training the employees in its correct use.

FCC Compliance

All radio operations in the United States are under the supervision of the Federal Communications Commission (FCC). To build and operate a radio system, a construction permit and operating license must be secured from the FCC in Washington, D.C. The representative of the equipment supplier usually will be willing to help the buyer deal with the FCC. While regulations and procedures sometimes change, it is usually necessary to apply at least two months before the proposed starting date. The manufacturer needs much of this time to produce the order after the sale.

Usually, licenses must be renewed every five years. The license covers a specific base station and a specific number of mobile units. The original application can be written to include more mobile units than needed for current operation, in order to provide for expansion. However, the license must be modified if the system wants to move the base station, increase the number of mobile units, or change power output. The manufacturer will also help the applicant choose a broadcasting frequency, which is not arbitrarily assigned by the FCC. Several frequencies in each band have been allocated to Motor Carrier Radio Service. These will be the most likely frequencies for transit use. In choosing a frequency, the applicant will try to obtain one not already authorized for other use to allow a less congested operation.

In addition to the rules governing the establishment of a system, the FCC has rules for operation. The license, for example, must be displayed prominently. When using the communications system, proper user identification must be made during the transmission. Facilities must be open for inspection by the FCC at any time during regular operating hours. These and many other rules can be found in the FCC Rules and Regulations Manual or can be explained by the manufacturer.

Radio Equipment

Voice radio systems are currently allowed by the FCC for commercial use in three bands--low VHF (25-50 MHz), high VHF (150-173 MHz), UHF (450-470 and 800 MHz). In general, as the megahertz level increases, the range diminishes while voice quality improves (because of less interference). Since only limited numbers of frequencies are available, frequency selection is a problem. In large cities it may be necessary to use UHF (800 MHz) equipment (prices may be slightly higher than with the other two VHF bands) to get a clearer channel and minimize the chance of sharing a frequency with someone else. In smaller cities it may be possible to secure a low or high VHF band frequency that few others are using. This type of equipment usually has a range with a 15- to 25- mile radius from the antenna.

The latest technology available to two-way radio users is in the 800 MHz frequency band. This can be either a simple "conventional 800 MHz" radio system or, for more complex systems, an 800 MHz "trunked" system in which frequencies are "shared" much like the public telephone system, but with total isolation of units and bus-systems. Base station repeaters are driven by microprocessors that prevent individual units from hearing each other during routine operation but allow groups of vehicles to communicate when directed by the dispatcher. It also allows a private conversation between two vehicles when required, and has the potential for many other sophisticated features and benefits. In a large city operation, for instance, this system would allow the transportation department and the police department (and/or fire department and street department) to have direct conversation between vehicles in an emergency.

Mobile component. The mobile component will be the largest portion of the initial purchase expense. This unit is installed in the vehicle, usually mounted under or in back of the driver's seat with the microphone within reach of the driver. Various modifications such as a telephone handset or footswitch are available to fit the needs of the operator. Varying ranges of power output and solid state options are available.

Tower antenna. The antenna (and the tower on which it is mounted) is important to the performance of the system. The height of the antenna is significant and will be determined by the range desired, the power of the units used, and the topography of the area. Naturally, the location most central to the bus routes needs the shortest tower. The antenna can often be located on an existing installation. In some cases, the most central location may be in a valley; therefore, a nearby hill might be best. If the antenna is not at the dispatch site, it will be necessary to locate the base station at the antenna site and operate it by remote control at the dispatch office, via a leased phone line. Antennas are relatively inexpensive, but towers for mounting them can become very expensive if great height is necessary.

Base station. The base station is the control point for the system. Small models may be of desk-top size, while larger and more sophisticated ones may take up space similar to a filing cabinet and desk panel combined. A desk or boom microphone may be used by the dispatcher. As noted before, the station may be located at the antenna site, with only a control panel at the operating location.

The mobile component, the antenna, and the base station are essential to all systems. Tone-coded squelch should also be included in every system. Various other means of selectivity, whereby the dispatcher can call a particular bus or group of buses, should also be considered. Equipment which automatically identifies a bus making a transmission (even without the driver saying anything) is also available. This device also lets the dispatcher poll each vehicle in the system automatically to make sure the radio is working, without the driver's knowledge or participation.

Most radio operations currently in use are covered by a maintenance contract with the manufacturer's authorized service agent. This is usually the cheapest and most effective mode of operation. The contract will usually be set up to provide continuous coverage of the base station at the user's premises and allows pick-up service on mobile units. The service agent will visit the garage, pick up broken units that have been pulled from buses, fix them in his own shop, and drop them off again. With proper maintenance, good line equipment can be expected to last 10 years or more.

Other Systems

Other communication systems are also possible. These systems have evolved into two basic types: a route monitoring system, in which the bus is registered automatically as it travels its route, and a triangulation system, in which the bus is located by the direction of its signal from different receiving points. This pinpoint degree of control is probably unnecessary in small operations.

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