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## UMTA/TSC Project Evaluation Series



# Accessible Bus Service in St. Louis

**Final Report**
**February 1980**

## Service and Methods Demonstration Program

**U.S. DEPARTMENT OF TRANSPORTATION**
**Urban Mass Transportation Administration and**
**Research and Special Programs Administration**
**Transportation Systems Center**

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16. Abstract

The Bi-State Development Agency in St. Louis began operating buses equipped with hydraulic lifts for boarding persons in wheelchairs in August of 1977. This was the first large scale accessible bus project in transit history. One hundred fifty-seven lift equipped buses were put into revenue service over a three and one-half month period. Seventeen routes were selected for accessible bus service. In September of 1978, scheduled accessible service was cut back by two-thirds due to malfunctions of the lift equipment. Wheelchair user ridership decreased gradually during the first year of service but dropped off markedly during the last ten months of the evaluation period.

The evaluation covered the development planning, the implementation process, operations, service and equipment reliability, travel behavior, productivity, economics, and service impacts. The results of the St. Louis accessible service which have important implications for other operators are also discussed.

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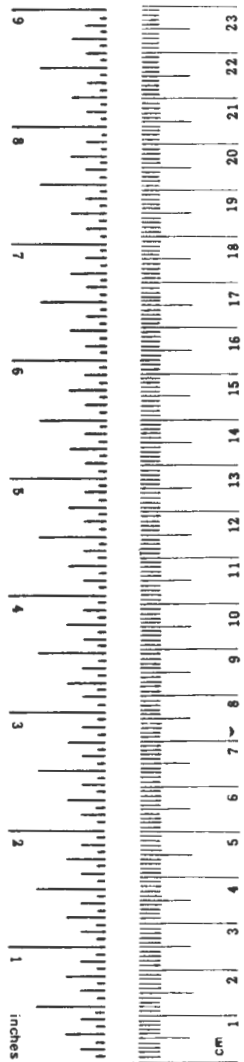
# METRIC CONVERSION FACTORS

## Approximate Conversions to Metric Measures

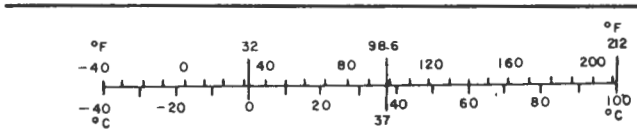
| Symbol | When You Know | Multiply by | To Find | Symbol |
|---|---|---|---|---|
| | **LENGTH** | | | |
| in | inches | *2.5 | centimeters | cm |
| ft | feet | 30 | centimeters | cm |
| yd | yards | 0.9 | meters | m |
| mi | miles | 1.6 | kilometers | km |
| | **AREA** | | | |
| $in^2$ | square inches | 6.5 | square centimeters | $cm^2$ |
| $ft^2$ | square feet | 0.09 | square meters | $m^2$ |
| $yd^2$ | square yards | 0.8 | square meters | $m^2$ |
| $mi^2$ | square miles | 2.6 | square kilometers | $km^2$ |
| | acres | 0.4 | hectares | ha |
| | **MASS (weight)** | | | |
| oz | ounces | 28 | grams | g |
| lb | pounds | 0.45 | kilograms | kg |
| | short tons (2000 lb) | 0.9 | tonnes | t |
| | **VOLUME** | | | |
| tsp | teaspoons | 5 | milliliters | ml |
| Tbsp | tablespoons | 15 | milliliters | ml |
| fl oz | fluid ounces | 30 | milliliters | ml |
| c | cups | 0.24 | liters | l |
| pt | pints | 0.47 | liters | l |
| qt | quarts | 0.95 | liters | l |
| gal | gallons | 3.8 | liters | l |
| $ft^3$ | cubic feet | 0.03 | cubic meters | $m^3$ |
| $yd^3$ | cubic yards | 0.76 | cubic meters | $m^3$ |
| | **TEMPERATURE (exact)** | | | |
| °F | Fahrenheit temperature | 5/9 (after subtracting 32) | Celsius temperature | °C |

*1 in = 2.54 (exactly). For other exact conversions and more detailed tables, see NBS Misc. Publ. 286, Units of Weights and Measures, Price $2.25, SD Catalog No. C13.10:286.




## Approximate Conversions from Metric Measures

| Symbol | When You Know | Multiply by | To Find | Symbol |
|---|---|---|---|---|
| | **LENGTH** | | | |
| mm | millimeters | 0.04 | inches | in |
| cm | centimeters | 0.4 | inches | in |
| m | meters | 3.3 | feet | ft |
| m | meters | 1.1 | yards | yd |
| km | kilometers | 0.6 | miles | mi |
| | **AREA** | | | |
| $cm^2$ | square centimeters | 0.16 | square inches | $in^2$ |
| $m^2$ | square meters | 1.2 | square yards | $yd^2$ |
| $km^2$ | square kilometers | 0.4 | square miles | $mi^2$ |
| ha | hectares (10,000 $m^2$) | 2.5 | acres | |
| | **MASS (weight)** | | | |
| g | grams | 0.035 | ounces | oz |
| kg | kilograms | 2.2 | pounds | lb |
| t | tonnes (1000 kg) | 1.1 | short tons | |
| | **VOLUME** | | | |
| ml | milliliters | 0.03 | fluid ounces | fl oz |
| l | liters | 2.1 | pints | pt |
| l | liters | 1.06 | quarts | qt |
| l | liters | 0.26 | gallons | gal |
| $m^3$ | cubic meters | 35 | cubic feet | $ft^3$ |
| $m^3$ | cubic meters | 1.3 | cubic yards | $yd^3$ |
| | **TEMPERATURE (exact)** | | | |
| °C | Celsius temperature | 9/5 (then add 32) | Fahrenheit temperature | °F |



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APPLIED RESOURCE INTEGRATION, LTD.

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**East West Gateway Coordination Council

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# CHAPTER 1

## EXECUTIVE SUMMARY

The Bi-State Development Agency (BSDA) is the public transit operator for metropolitan St. Louis, Missouri. Beginning in August of 1977, BSDA began to operate buses equipped with hydraulic lifts for the handicapped. BSDA owned a total of 157 such accessible buses and utilized them in regular revenue service. Anyone in a wheelchair was permitted to board the bus by using the lift. This was the first large scale accessible bus project in transit history.

Handicapped access to public transit facilities and vehicles has been a controversial issue in recent years. In April 1976, the U.S. Department of Transportation (DOT) passed regulations which allowed local areas to modify their fixed route transit to accomodate the handicapped or to provide other "special efforts", usually a form of paratransit for the handicapped. Subsequent policy decisions at HEW and DOT, made in response to Section 504 of the Rehabilitation Act of 1973, changed this local option policy to one of mandated fixed-route accessibility. In May 1979, DOT changed its regulations to require that all new buses solicited after July 2, 1979 must be accessible to persons in wheelchairs.

For evaluation purposes, the accessible bus project was divided into three phases. In Phase I, which began on August 15,1977 and covered 3 1/2 months, BSDA owned 60 accessible buses and operated them on 10 routes. After receiving an additional order of 97 accessible buses, BSDA was able to expand the service greatly. In Phase II, which started on November 27, 1977 and lasted for 9 months, there were 17 accessible routes which, taken together, carried almost half of BSDA's total ridership and provided relatively wide-scale geographic coverage. About 71% of all bus trips operated on the 17 accessible routes were scheduled with an

accessible bus; headways between acccessible buses were generally from 12 - 30 minutes, depending on the route and time of day. The schedule called for operation of 102 accessible vehicles in the base period and 126 accessible vehicles in peak periods. Phase III began on September 5, 1978 in response to severe equipment difficulties. Accessible service was reduced to 12 routes and only 40 scheduled accessible buses. Although Phase III service is continuing, the evaluation effort for that phase was limited in scope compared to Phases I and II and only covered the first 10 months through June 1979. Overall, the evaluation period covered the first 22.5 months of accessible bus operations.

Because the lifts could not be kept in proper working order, the service has been marred throughout its life with serious reliability problems. During much of Phase II, no more than 50% of the lift buses were available for accessible service. Lifts either malfunctioned on the road or tended to "drift" and had to be blocked up with bolts to insure that the buses could be operated at all. In addition, the new buses had non lift related problems which caused them to be out of service. Thus, people in wheelchairs who attempted to ride the lift buses often encountered problems and delays. This definitely had an inhibiting effect on the level of ridership.

As a result of these problems, the findings of this evaluation report are not necessarily transferable to other sites attempting to use lift buses. BSDA incurred unusually high costs because of the problems with the lifts, and the wheelchair riders suffered abnormal inconveniences. Unless other transit systems experience similar equipment problems, their overall experiences may not be the same as BSDA's. The extent to which lift design and reliability can be improved, however, is beyond the scope of this evaluation.

The bulk of this evaluation was conducted during the 12.5 month period of Phases I and II. This report also contains an addendum chapter which describes the results of Phase III through the end of June 1979. Most of the conclusions in the evaluation refer only to Phases I and II. However, specific references are made to conclusions drawn from Phase III where they are warranted.

A summary of major results are as follows:

o Use of the lifts on the accessible buses was quite low compared to the general public ridership. During the initial 12 1/2 months of operation (Phases I and II) an estimated 2,052 unlinked one-way trips were made by handicapped persons in wheelchairs for an average of 164 trips/month. In the following 10 month period (Phase III), an estimated 578 trips were made for an average of only 58 trips/month. The resulting average over the first 22 1/2 months of operations was 117 trips/month.

o Wheelchair ridership decreased over time. Decreases were only moderate in Phase II but became precipitous in Phase III, in response to service cut-backs and continued unreliability of the lifts. Wheelchair trips per scheduled accessible bus per month decreased from 3.0 in September 1977 to 1.1 in June of 1979, showing that lift use with respect to the service provided had gone down substantially.

o Wheelchair ridership was substantially affected by winter weather. In the winter of 1977-78, which was unusually severe in St. Louis, ridership decreased by 51% during a 10 week period of constant snow cover. A decrease in ridership also occured in the 78-79 winter.

o Forty (40) different people rode the lift buses at least once during Phases I and II. These users were approximately 2% of the estimated 1,863 wheelchair-using persons residing within 1/4 mile of the 17 accessible routes. Thus, about 98% of the wheelchair-using persons in the 1/4 mile catchment area never tried the accessible buses.

o Most of the 40 different users did not ride often. During Phases I and II, only 9 persons used the lifts more often than once per week. In fact, the three users who rode most often accounted for almost 50% of all reported wheelchair transit trips.

o People in wheelchairs encountered substantial difficulties, and delays in using the service, primarily because of mechanical problems with the lifts. Potential riders were often denied entry to the bus when the lift did not work, was blocked up, or when the scheduled lift bus had been replaced with an inaccessible bus. A total of 116 trip denials were reported to BSDA during Phases I and II. Some kind of en-route trouble occurred in 78% of a sample of 40 trips recorded in user's travel diaries.

o The major problems perceived by those in wheelchairs who did ride the buses were the unreliability of the lifts and the lack of curb-cuts. The major improvements desired by these users were that all BSDA routes be accessible and that the reliability of the lifts be improved. A followup survey in Phase III indicated that 90% of the non-institutional users did not think the lifts were reliable and only 40% of these persons trusted the drivers to work the lifts properly.

o Among people in wheelchairs who had never tried the lift buses, the major reasons for not doing so were difficulties in going out of the house, in traveling on sidewalks, in negotiating curbs without curb-cuts, presence of bad weather, and the availability of private (automobile) transportation. The unreliabilty of the lifts was not cited as a major reason for never trying the service.

o Major improvements suggested by persons in wheelchairs who had never ridden the buses were an improved sidewalk environment (curb-cuts and adequate snow removal) and the provision of dial-a-ride in addition to the lift buses. Institutionalized persons in wheelchairs, who have limited use of their arms, desired a more convenient lift.

o BSDA could not keep enough accessible vehicles working to meet its published accessible schedules, and the number of accessible vehicles available for service decreased with time. By the end of Phase II (August 1978), less than 80 of the 157 accessible vehicles were completely functioning. This was about 65% of the number of accessible vehicles needed in the peak period.

o BSDA had to operate many of the scheduled accessible runs with inaccessible buses or with buses in which the lift was out of order. These were called missed runs. By the end of Phase II, at least 16% of all scheduled accessible runs were missed.

o Operation of lift-equipped buses did not have a significant effect on running times. Although the average wheelchair boarding plus alighting time was estimated at 4.38 minutes, the wheelchair ridership was so low that little overall delay was added to the schedules. About 509 vehicle-hours of delay for both wheelchair boardings/alightings and on-road lift-related trouble occurrences were incurred over Phases I and II. This was less than .1% of accessible bus vehicle-hours.

o The marginal* operating costs of the accessible buses for Phases I and II were estimated at $622,170 or about $.10/vehicle mile. These costs included extra service hours added to the schedule, lift repair, preventive maintenance, administrative

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* Additional operating costs attributed to accessibility.

staff time, and accident liability costs. These costs represent a full allocation of the value of all time and materials contributed to the project. They include out-of-pocket* as well as non-out-of-pocket costs, repair costs covered under the manufacturer's warranty, and a great deal of unneeded schedule adjustments. The marginal operating costs can be reduced to $322,483 when only out-of-pocket costs are considered. When the cost of the unneeded schedule adjustments (extra platform hours) are excluded, the operating costs can be further reduced to $109,301.

o The capital costs of the project (primarily the lifts) were $917,805, or an average of $5,846 per bus. The estimated project start-up costs for marketing, training, and staff time were $95,546. The capital costs are out of date and are not indicative of the current marginal cost of a lift on a bus.

o The total Phase I and II project costs were $718,429, including fully allocated operating costs, and depreciated capital and start-up costs. The total marginal costs, when only out-of-pocket expenses were included, were $418,742. Excluding the cost attributed to uneeded schedule adjustments, reduces the total to $205,560.

o Table 1-1 presents a summary of costs for the 22 1/2 month evaluation period from the inception of service in August 1977 through June 1979. Over this period, the total marginal out-of-pocket costs (including depreciated capital and start-up costs) averaged $296 per trip by persons in wheelchairs. Even when the cost of extra service hours are excluded, costs averaged $160 per trip. Over the last 10 months of the evaluation period (Phase III), these costs increased to an average of $623 and $372 per trip, respectively. Excluding capital and start-up costs, the marginal out-of-pocket operating costs averaged $230 per trip over the evaluation period. Without the cost of extra service hours,

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*Refer to page 9-20 for description of out-of-pocket costs.

| | Fully Allocated Costs | Marginal (Out-of-Pocket) Costs | Marginal (Out-of-Pocket) Costs Excluding Service Hour Costs |
|---|---|---|---|
| 1. Phase I & II Operating Totals | $ 622,170 | $322,483 | $ 109,301 |
| 2. Phase III Operating Total | 385,605 | 283,168 | 137,974 |
| 3. Depreciated Capital | 143,407 | 143,407 | 143,407 |
| 4. Depreciated Start-up | 29,858 | 29,858 | 29,858 |
| TOTAL | $1,181,040 | $778,916 | $ 420,540 |
| 5. Cost/Trip[1] | | $ 296 | $ 160 |

1. Based on an estimated total of 2,630 trips

TABLE 1-1 TOTAL PROGRAM COSTS (ALL PHASES - 22.5 MONTHS)

these costs averaged $94 per trip. These ratios are substantially higher than the BSDA systemwide annual operating cost of $0.81 per trip in FY 1978; however, the marginal costs only represented less than 1% of the annual BSDA operating budget.

o The project had only limited impacts on the handicapped. There was at least one person who rode often and whose life was significantly improved by the buses. In a follow-up survey conducted near the end of Phase III, users claimed to have received benefits from the project despite very infrequent use of the buses. It is possible that handicapped people receive psychological benefits from accessible buses.

o Surveys indicated that the project did not seem to have a major impact on BSDA operators, supervisors, or the general ridership. Despite the lift problems, the number of trouble occurrences and time involved were small compared with other types of operational problems. Thus, neither drivers nor supervisors felt that the lifts had placed an unmanageable burden on them. In general, the public transit ridership was in favor of the project and did not feel unduly delayed by the lifts; however, it is important to note that the respondents probably lacked knowledge of the costs involved.

# CHAPTER 2

# INTRODUCTION

## 2.1 OVERVIEW

In a pioneering effort beginning in 1977, the Bi-State Development Agency (BSDA), the transit operator for metropolitan St. Louis, Missouri, became the first public transit system in the country to provide substantial regularly scheduled, fixed route bus service with wheelchair-lift equipped buses. The service was initiated as a pilot or demonstration project.

To start the new service, BSDA purchased buses equipped with wheelchair lifts and a kneeler feature. Due to delivery schedules, the service was initiated in two phases: Phase I began August 15, 1977 with a fleet of 60 accessible buses; Phase II began on November 27, 1977, when the fleet was expanded to a total of 157 accessible buses. After its experience in these phases, particularly with regard to actual ridership and lift reliability, BSDA started a phase III in September, 1978, in which service levels were reduced below those of Phase II.

This evaluation report is primarily concerned with the 12 1/2 months of Phases I and II, lasting from August 15, 1977 to August 31, 1978. During this time period a complete analysis was made of the operations, results and costs of the experiment. The results of Phases I and II are described in chapters 3 through 11. After the major part of the evaluation was completed, an addendum was prepared for Phase III ,covering the period September 1978 through June 1979. The addendum, presented in chapter 12, contains summary data only, analyzed in less depth than the Phase I and II data. It is intended to give a longer range perspective on ridership trends, behavioral reactions of wheelchair users and the reliability of the lift equipment.

The St. Louis accessible bus project was not sponsored by the UMTA Service and Methods Demonstration (SMD) program (UMTA Section 6 funding). Because of the national importance of the project, however, and because the project clearly met one of the SMD objectives--improved mobility for transit dependents--SMD sponsored an evaluation of the project. The evaluation was directed by the U.S. Department of Transportation, Transportation System Center (TSC), with Applied Resource Integration, Ltd. (ARI) as their evaluation contractor.

BSDA also assisted in the evaluation, using UMTA Section 9 funds to provide the considerable local assistance which was needed by TSC. BSDA was responsible for collecting all necessary evaluation data. In addition, BSDA personnel critiqued and reviewed the evaluation as it progressed.

## 2.2 NATIONAL ACTIVITIES*

The national movement toward accessible transportation is considered by some observers to be a further development of the movement for minorities' civil rights, which manifested itself in the 1960's. Federal, and in some instances state, legislation and regulations recognized the need to address these concerns. Responses by government agencies have included both accessible fixed-route transit services and various forms of paratransit. The following sections provide a national perspective for the St. Louis project.

### 2.2.1 Federal Legislation and Regulations

Congress' concern for accessible transportation became evident in the 1964 Urban Mass Transportation Act and subsequent amendments. In 1970, Section 16 was added to the Act (Public Law 91-453):

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*Adopted from Multisystems, Inc., Cambridge, Massachusetts, Evaluation Plan for the Palm Beach County Fully Accessible Bus Fleet Demonstration Project, prepared for TSC, September, 1978 and Applied Resource Integration, Ltd., Boston, Massachusetts, Evaluation Plan for Bi-State Development Agency (St. Louis) Accessible Bus Project, prepared for TSC, January, 1977.

> Section 16(a). It is hereby declared to be the national policy that elderly and handicapped persons have the same right as other persons to utilize mass transportation facilities and services; that special efforts shall be made in the planning and design of mass transportation facilities and services so that the availability to elderly and handicapped persons of mass transportation which they can effectively utilize will be assured; and that all federal programs offering assistance in the field of mass transportation (including the program under this Act) should contain provisions implementing this policy.

The net result was to provide a general legislative mandate for planning and providing transportation for the elderly and handicapped. The implementation and administration of this mandate, however, has proved to be controversial. The most public part of this controversy has been a debate between proponents of "accessibility," meaning physical access to all transportation modes, and "mobility," meaning adequate transportation, regardless of its mode. Typically, accessible fixed route transit exemplifies "accessibility," and special demand-responsive systems for the elderly and handicapped exemplify "mobility."

The Federal-Aid Highway Act of 1973 (Public Law 93-87) for the first time included provision for the expenditure of federal-aid highway funds on public mass transportation projects. The 1973 Highway Act required that public transportation projects funded under this statute be designed so facilities could be effectively utilized by the elderly and handicapped. It also amended the UMT Act by adding the following new subsections to Section 16:

> Section 16(b). In addition to the grants and loans otherwise provided for under this Act, the Secretary is authorized to make grants and loans--
>
> (1) to states and local public bodies and agencies thereof for the specific purpose of assisting them in providing mass transportation services which are planned, designed, and carried out so as to meet the special needs of elderly and handicapped persons, with such grants and loans being subject to all of the terms, conditions, requirements, and provisions applicable to

> grants and loans made under section 3(a) and being considered for the purposes of all other laws to have been made under such section; and
>
> (2) to private non-profit corporations and associations for the specific purpose of assisting them in providing transportation services meeting the special needs of elderly and handicapped persons for whom mass transportation services planned, designed, and carried out...(by public transit bodies)...are unavailable, insufficient or inappropriate...

Although proponents of accessibility argued that total accessibility was the intent of the law, UMTA originally did not interpret Section 16 that way. If anything, UMTA believed, the new language in Section 16 endorsed the concept of special services to meet the needs of the elderly and handicapped. A major effort in the wake of the 1973 amendments was, therefore, directed toward implementing the new Section 16(b)(2) program--a program not designed to address the issue of accessible public transportation for the elderly and handicapped, but rather to assist private non-profit corporations in purchasing vehicles for the transportation of elderly and handicapped clients.

The Federal-Aid Highway legislation passed in 1974 (Public Law 93-643) included a restatement of the Section 16(a) national policy language and amended Section 165(b) of the 1973 Highway Act to provide:

> ...the Secretary of Transportation shall require that projects receiving Federal financial assistance under (1) Subsection (a) or (c) of Section 142 of Title 23, United States code, (2) paragraph (4) of subsection (e) of Section 103, Title 23, Federal-Aid Highway Act of 1973 shall be planned, designed, constructed, and operated to allow effective utilization by elderly or handicapped persons who, by reason of illness, injury, age, congenital malfunction, or other permanent or temporary incapacity or disability including those who are non-ambulatory wheelchair-bound and those with semi-ambulatory capabilities, are unable without special facilities, or special planning or design to utilize such facilities and services effectively. The Secretary shall not approve any program or project to which this section applies which does not comply with the provisions of this subsection requiring access to public mass transportation facilities, equipment, and services for elderly or handicapped persons...

The National Mass Transportation Assistance Act of 1974 amended Section 5 of the UMT Act to include a new formula grant program for operating and capital assistance. In this section, Congress mandated a specific benefit to elderly and handicapped persons for the first time. Section 5(m) requires:

> ...the rates charged elderly and handicapped persons during nonpeak hours for transportation utilizing or involving the facilities and equipment of the project financed with assistance under this section will not exceed one-half of the rates generally applicable to other persons at peak hours...

To carry out the policies outlined in the various amendments to the UMT Act, UMTA published a set of regulations in April, 1976 on transportation for elderly and handicapped persons. These regulations required that the urban transportation planning process include special efforts to plan public mass transportation facilities and services that can be used effectively by elderly and handicapped persons. UMTA defined elderly and handicapped in the transportation context as...

> those individuals who by reason of illness, injury, age, congenital malfunction, or other permanent or temporary incapacity or disability, including those who are non-ambulatory wheelchair-bound and those with semi-ambulatory capabilities, are unable without special facilities or special planning or design to utilize mass transportation facilities and services as effectively as persons who are not so affected.*

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*Federal Register, Vol.41, No.85, Section 609.3, p. 18239; Friday, April 30, 1976.

The April 1976 regulations did not specify what special efforts were required but did provide examples of satisfactory levels of effort. In addition, UMTA outlined specific requirements for the approval of funds for construction, design, or alteration of fixed facilities and for purchases of new buses (over 22 feet long) and new light rail and rapid rail vehicles.

In 1971, UMTA had initiated a major research project to develop an improved transit bus that would attract mass ridership, be accessible to elderly and handicapped persons, and encourage continued competition among bus manufacturers. While the "Transbus" specifications initially did not require a ramp or lift device, the final DOT regulations of May, 1977 mandated a low-floor ramped bus, later modified to allow a lift option. The specifications required a stationary floor height of not more than 22 inches; an effective floor height (including a kneeling feature) of not more than 18 inches; and a ramp for boarding and exiting. In September 1977, UMTA's regulations on Transportation for the Edlerly and Handicapped Persons were amended to reflect the Tranbus mandate. The mandate was to take effect on September 30, 1979.

The most powerful overall legislative influence on transportation for the elderly and handicapped has probably been Section 504 of the Rehabilitation Act of 1973 (Public Law 93-112) which states:

> ...No otherwise qualified handicapped individual in the United States, as defined in Section 706(6) of this title, shall solely by reason of his handicap, be excluded from the participation in, be denied the benefits of, or be subjected to discrimination under any program or activity receiving Federal assistance...

The Department of Health, Education and Welfare (HEW) has overall responsibility for administering the Rehabilitation Act, including supervising the development of compliance programs by other federal agencies.

HEW published final guidelines in January, 1978, fulfilling its role as coordinator for implementation of Section 504. Some important aspects of the HEW guidelines include the following:*

> ....The Department...does not construe the section...to preclude in all circumstances the provision of specialized services as a substitute for, or supplement to, totally accessible services, nor...require door-to-door transportation service. Neither does...it require buses to move their regular route stops to the doors of handicapped riders.
>
> A recipient (of federal aid)...may not...provide different or separate aid, benefits, or services to handicapped persons or to any class of handicapped person than is provided to others unless such action is necessary to provide qualified handicapped persons with aid, benefits, or services that are as effective as those provided to others.
>
> A recipient shall operate each program or activity so that the program or activity, when viewed in its entirety, is readily accessible to and usable by handicapped persons. This paragraph does not necessarily require a recipient to make each part of its existing facility accessible...

On May 31, 1979, the Department of Transportation issued its final regulations in regard to Section 504.** These regulations supercede the earlier April 1976 regulations; they establish the overall principle that full accessibility to all mass transit facilities must be implemented in stages over time. Specific modal requirements embodied in these regulations are:

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* Federal Register, Vol. 43, No. 9, Part V, pp. 2132-2139; Friday, January 13, 1978.

**See Federal Register, Vol. 44, No. 106, Part II, pp. 31442-31483; May 31, 1979

- All new buses for which solicitations are issued after July 2, 1979 must be accessible to persons in wheelchairs. This applies to buses of any size as long as they are to be used in fixed route service.

- Within ten years, i.e., by July 2, 1989, half the buses used in peak service must be wheelchair accessible, and these buses must be used before inaccessible buses during off-peak hours. This is termed program accessibility.

- No buses solicited before February 15, 1977 need be modified with lifts.

- All new rapid rail facilities must be accessible .

- Existing rapid rail facilities must be made accessible over time, subject to a limited waiver provision. Key rapid rail stations must be made accessible within 30 years if extraordinary costs are involved.

- Existing commuter rail and light rail systems must also be made accessible, subject to a limited waiver provision. Key stations must be made accessible within 30 and 20 years respectively. New commuter and light rail vehicles purchased after January 1, 1983 must be accessible.

- Any system not achieving program accessibility by July 2, 1982 must provide interim accessible transportation between that date and the time when program accessibility is reached. Interim accessible transportation must be available in the normal service area. The DOT recipient must spend at least 2% of its total Section 5 apportionment on interim service, unless the elderly and handicapped advisory group agrees to a lower level. However, a recipient is not required to spend any more than 2% of its Section 5 funds.

- Until July 2, 1982, recipients must show reasonable progress in implementing previously programmed projects for the handicapped.

On August 3, 1979, DOT announced that it would delay implementation of the TRANSBUS mandate indefinitely. This action was in response to the failure of any U.S. or foreign manufacturers to bid on the first official solicitation of 500 TRANSBUS's held in the spring of 1979.

The final DOT regulations requiring full accessibility have stimulated great debate in the transit community. Conflict over the benefits of this course of action, and concern over the costs, have led to a lawsuit by the American Public Transit Association (APTA) and 12 U.S. transit systems against the U.S. DOT. This lawsuit is currently awaiting further court hearings. Because the BSDA project is our first national experience with a sizeable accessible bus system, the data provided by that experience is of considerable national interest.

### 2.2.2 Demonstration and Service Implementation

The UMTA Service and Methods Demonstration (SMD) Program has addressed the problem of transportation for the elderly and handicapped through a number of projects. Alternative service concepts have been identified and many have been demonstrated, including the following.*

- Service to elderly and handicapped by a door-to-door transit system serving the entire community. (Rochester, New York; Westport, CT)
- Special door-to-door service for an eligible transit dependent market, where the general public may have other transit modes available. (Syracuse, New York; Baton Rouge, Louisiana; Cleveland, Ohio; Portland, Oregon)
- Special door-to-door service for an eligible transit dependent market, with sufficient surplus capacity to serve a limited segment of the general public. (Naugatuck Valley, Connecticut)
- Fixed route transit service with special equipment on the vehicles to accommodate the transit handicapped. (Palm Beach, Florida; Champaign-Urbana, Illinois)
- Door-to-door feeder and distribution service for transit handicapped which is integrated with fixed route and fixed-schedule buses equipped to serve the disabled. (no active demonstrations)

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*Donald Kendall, et. al., Service and Methods Demonstration Program Annual Report, U.S. Department of Transportation, Transportation System Center, April, 1977, p.93.

In addition to these basic service alternatives, discounted fares and user-side subsidies* have been suggested and implemented. Finally, several demonstrations have included greater roles for taxis and other private operators in the provision of transportation services for handicapped and other transit dependent persons.

Beginning in 1978, other transit system began to take delivery of new accessible buses. By July of 1979, at least 16 U.S. transit systems besides BSDA owned at least 761 accessible buses. Areas which own accessible buses include Los Angeles, Milwaukee, Providence, Washington, D.C., Hartford and Westchester County. Most of these systems received their vehicles in 1979 and were cautious in implementing service. Thus, there is as yet no sizable body of data available from other sites. Two reports have been published on limited accessible operations in San Diego** and in Atlanta.*** TSC will be evaluating programmed accessible bus demonstrations, sponsored by SMD, in Champaign-Urbana, Illinois and in Palm Beach, Florida.

## 2.3 PROJECT OBJECTIVES AND INNOVATIONS

The primary objective of the St. Louis accessible bus project was to provide regularly scheduled, fixed route, accessible bus service over much of metropolitan St. Louis on a relatively frequent (low-headway) basis. This was the first time that such service was attempted on such a large scale, which is the principle innovation of the project.

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*User-side subsidy is a term applied to programs which provide direct subsidies to transportation users rather than the providers of transportation service(s).

**Robert F. Casey, San Diego Wheelchair Accessible Bus Study, TSC, September, 1977.

***Grant Paul and Robert Casey, Atlanta Wheelchair Accessible Bus Study, published by TSC, August 1978.

It is important to note at this point that the lift system is not well designed for a standing person. There is very limited headroom. Persons standing on the lift while it is in operation must stand at the inside part of the lift to avoid hitting their head. BSDA therefore ruled that only persons in wheelchairs could use the lift, excluding not only semi-ambulatory handicapped but also wheelchair attendants from standing on the lift. The target group of this evaluation is consequently limited to persons in wheelchairs.

A second objective of the accessible bus project was to provide somewhat easier entry for all persons not using the lift. The new buses have a "kneeling" feature which facilitates access to the semi-ambulatory by reducing the height of the first step. This feature, while apparently helpful to a number of people for whom the high first step on conventional buses presents a serious impediment, was not studied as part of the present evaluation project.

## 2.4 EVALUATION OBJECTIVES AND ISSUES

The primary objectives of the evaluation were to document and assess:

- The amount and quality of accessible service which was available. This included the number of routes and their geographic coverage, the headways and the percent of bus trips operated with accessible equipment. (This is described in Chapter 4.)
- The planning process which BSDA used to implement the service (described in Chapter 5), including questions like,
    a. How was the service concept developed?
    b. What alternatives were considered?
    c. Who had inputs and influences on the decision-making process?

d. How were routes and service frequencies selected?

e. What difficulties were anticipated with accessible service?

f. What training and orientation programs were used?

g. What marketing techniques were used?

- The performance of the accessible equipment, including the lift reliability, reasons for breakdowns, need for preventive maintenance and the downtime trend. (See Chapter 6.)

- The reliability of the service, as perceived by users, including trouble occurrences, missed runs, and delay in service caused by the lifts. (See Chapter 7).

- Ridership by wheelchair users, including questions like:

  a. How many trips were made by users?

  b. How often and why were trips denied?

  c. What was the effect of inclement weather on ridership?

  d. What was the long-term trend in ridership?

- Characteristics of the transit trips made by wheelchair users;

  a. How did users access the service?

  b. How far did a user travel to or from a bus stop?

  c. How long did it take to use the lift?

  d. How were user trips made prior to the start of the service?

  e. What was the trip purpose distribution?

- What were the characteristics of the wheelchair users and what were their attitudes towards the service? What specific problems did they see with the service and what were their suggested improvements?

- How many different individuals used the accessible service?

(See Chapter 8 for all ridership and user data)

- What kinds of wheelchair persons did not use the lift buses, why not, and what were their suggested improvements in the service. (See Chapter 8)

- The productivity and economics of the service, including (see Chapter 9):

  a. What was the capital cost of the lifts?

  b. What were the marketing and advertising costs?

  c. What were the costs of maintenance and repairs?

  d. What were the marginal operating costs?

  e. What were the cost per trip and other cost-related factors?

- What were the impacts of the service on (See Chapter 10):

  - Wheelchair users

  - The transit-riding public

  - BSDA operators and supervisors

## 2.5 EVALUATION APPROACH

All data collection activities for this evaluation report were carried out by BSDA and/or the East-West Gateway Coordinating Council. A number of data gathering instruments were used, and each is briefly described in this section.

### 2.5.1 Daily Wheelchair Trip and Denial Records

These two records were the primary data source on wheelchair ridership. Each wheelchair trip was supposed to be reported by the driver to the dispatcher over the two-way radio. The report included the time of boarding, the location of boarding and alighting, and the number from the users' handicapped half-fare card, if they had one. Time, location, and reason for denials were also to be reported. The dispatcher then entered this data on the regular dispatcher's log, which contains all other events, such as road calls, emergencies, breakdowns, and delays. Denials were also entered on the same log.

This reporting system did not work well because of heavy radio traffic between the dispatcher and other fleet vehicles. BSDA investigated other methods for tracking ridership, but could find none that were more feasible. One possibility, cycle counters mounted on the lifts, would not be accurate because of all the cycling done in the garage or during preventive maintenance checks. Written reports by the drivers were impractical because of the large number of drivers who operated accessible buses and the extra pay involved. As explained in Chapter 8, a method was devised for factoring up the reported wheelchair ridership to estimate the real ridership.

### 2.5.2 Dispatcher's Trouble Log

Trouble was defined as any problem on the road which involved the lifts. The drivers were directed to radio in all trouble occurrences, giving the nature of the problem, the bus number, and the time the delay occurred. The trouble occurrences were then recorded by the dispatcher on a trouble log. Sometimes the problem could be solved directly by the driver with the advice of the dispatcher over the radio. Often a supervisor or repair person had to be sent to assist the driver. If neither of these methods worked, the bus would then be taken out of service and replaced for the remainder of the run.

### 2.5.3 Daily Bus Availability Data

A fully missed run was defined as a scheduled accessible run operated with either an inaccessible bus or an accessible bus with an inoperative lift. Because of equipment difficulties, fully missed runs were a fairly common phenomenon. Fully missed runs were compiled from daily bus availability data called in to the central dispatcher from the divisional garages. Partially missed runs were estimated from the trouble logs.

### 2.5.4 User Survey and Travel Diaries

The user survey was a comprehensive home interview which included socio-economic, travel pattern, and attitudinal questions. In addition, each user also was asked to keep a detailed travel diary of all lift bus trips for three weeks. Users were defined as anyone in a wheelchair who had ridden the accessible buses at least once. Not all of the users could be located; only 16 surveys were administered. Of these, 10 were non-institutionalized users and six were institutionalized. Also, only 9 of the 16 made any accessible bus trips during the three week period in which diaries were kept. Obviously, data based on such a small sample has severe limitations.

### 2.5.5 Non-User Survey

A survey was distributed to wheelchair persons who had never ridden on the accessible buses. The survey was distributed non-randomly through hospitals and agencies, and through BSDA. A random sample telephone survey was impractical because of the low prevalence of wheelchair users in the total population.

### 2.5.6 Able-Bodied Rider Surveys

On board surveys of regular transit riders (without wheelchairs) were conducted twice: once immediately before project implementation and again after about two months of operation. The first survey elicited 407 responses and the second, 512 responses. Questions concerned the riders' opinions about accessible service, impact on their travel patterns, and delay experienced due to wheelchair passengers. Riders were also asked if they had given up a seat or assisted a handicapped person.

### 2.5.7 Driver and Supervisor Surveys

BSDA drivers and supervisors were also surveyed twice, once before the project and again after two months of project operation. In the first survey, 328 drivers (about 25% of all BSDA drivers) and all 29 BSDA supervisors submitted completed survey forms. In the second survey, 126 drivers of accessible buses and all 29 supervisors responded. The surveys were used to measure the feelings of drivers/supervisors toward accessible service, their confidence in using the lift, and the impact of accessibility on their job.

### 2.5.8 Bus Maintenance Master Record and Status Master Record

The Bus Maintenance Master Record was compiled for each bus. It provided a complete calendar of lift-related repair work undertaken by BSDA. This record included the date, mileage, repairs effected, labor hours and labor and parts costs. This data was used to build a complete picture of maintenance cost trends, frequency of repairs, component failure characteristics and impacts relating to vehicle mileage.

The Bus Master Record provided a complete history of the availability of accessible vehicles on a daily basis. In actuality, the high rate of failures experienced, and saturation of the repair facilities, restricted its usefulness. The Master

Record was also used on a limited basis to obtain data on the comparative times for lift and non-lift repairs. The Master Record was compiled from the Daily Ready Bus Sheets prepared by the operating divisions. Since the divisions did not keep these as permanent records, special arrangements were made at BSDA to obtain them for the appropriate period.

### 2.5.9 User Follow-Up Survey

A follow-up survey was administered during Phase III to users of the service. This survey is described fully in Chapter 12.

## 2.6 REMAINDER OF REPORT

The remainder of this report addresses each of the issues mentioned earlier in Section 2.4. Chapter 3 sets the stage for the evaluation analysis by outlining the demonstration setting. Chapters 4 and 5 provide a detailed description of the project operations and a summary of the planning that was done to implement the service. Then, a description of the wheelchair lifts and the resultant service performance of the buses is given by Chapter 6. This is followed by additional information concerning the supply aspects of the service, operations and service reliability, in Chapter 7. Chapter 8 deals with the demand or resultant ridership by persons in wheelchairs. Chapter 9 presents available cost information and analyzes the economics of the service. Chapter 10 provides an assessment of the impact of the service on users, BSDA operators and supervisors and the general public who rode the accessible buses with the users. Chapter 11 summarizes the conclusions reached in the report and discusses the transferability of the results. Finally, Chapter 12 contains the Phase III addendum.

All survey instruments and pertinent data collection forms are included for reference purposes in the appendices of the report.

# CHAPTER 3

# DEMONSTRATION SETTING

## 3.1 GEOGRAPHIC AND DEMOGRAPHIC CHARACTERISTICS

The St. Louis Standard Metropolitan Statistical Area (SMSA) had a population of 2,363,000 in 1970. The SMSA is composed of the City of St. Louis and six adjoining counties, four of which are in Missouri and two of which are across the Mississippi River in Illinois (Figure 3-1).

The population of the SMSA is largely concentrated in the City of St. Louis and three of the six counties--St. Louis County (MO), Madison County (IL), and St. Clair County (IL). Founded in the 1700's, the City itself has followed a typical urban pattern of growth, decay, and urban renovation. By 1970, it's population had shrunk to 622,000 persons. Extensive suburbanization around St. Louis has occurred, and, as a result, adjacent St. Louis County had a 1970 population of 951,000. Madison and St. Clair Counties have also undergone suburbanization and together have a population of 535,000 persons. The combined population of these four areas is 2,100,000 persons. The remaining 260,000 residents of the SMSA are spread among the remaining three counties, which are far more rural in nature.

The BSDA operates principally in the City of St. Louis, St. Louis County, and Madison and St. Clair counties in Illinois. Monroe County, Illinois is also in the BSDA service area (and not in the SMSA) but, having a small population, receives only limited transit service and none of the accessible bus routes* (Figure 3-1).

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*St. Charles County (MO) is not a BSDA member, but does receive a small amount of BSDA transit service. It is not included as a BSDA member in Figure 3-1, nor is it included in the demographic statistics for the BSDA service area.

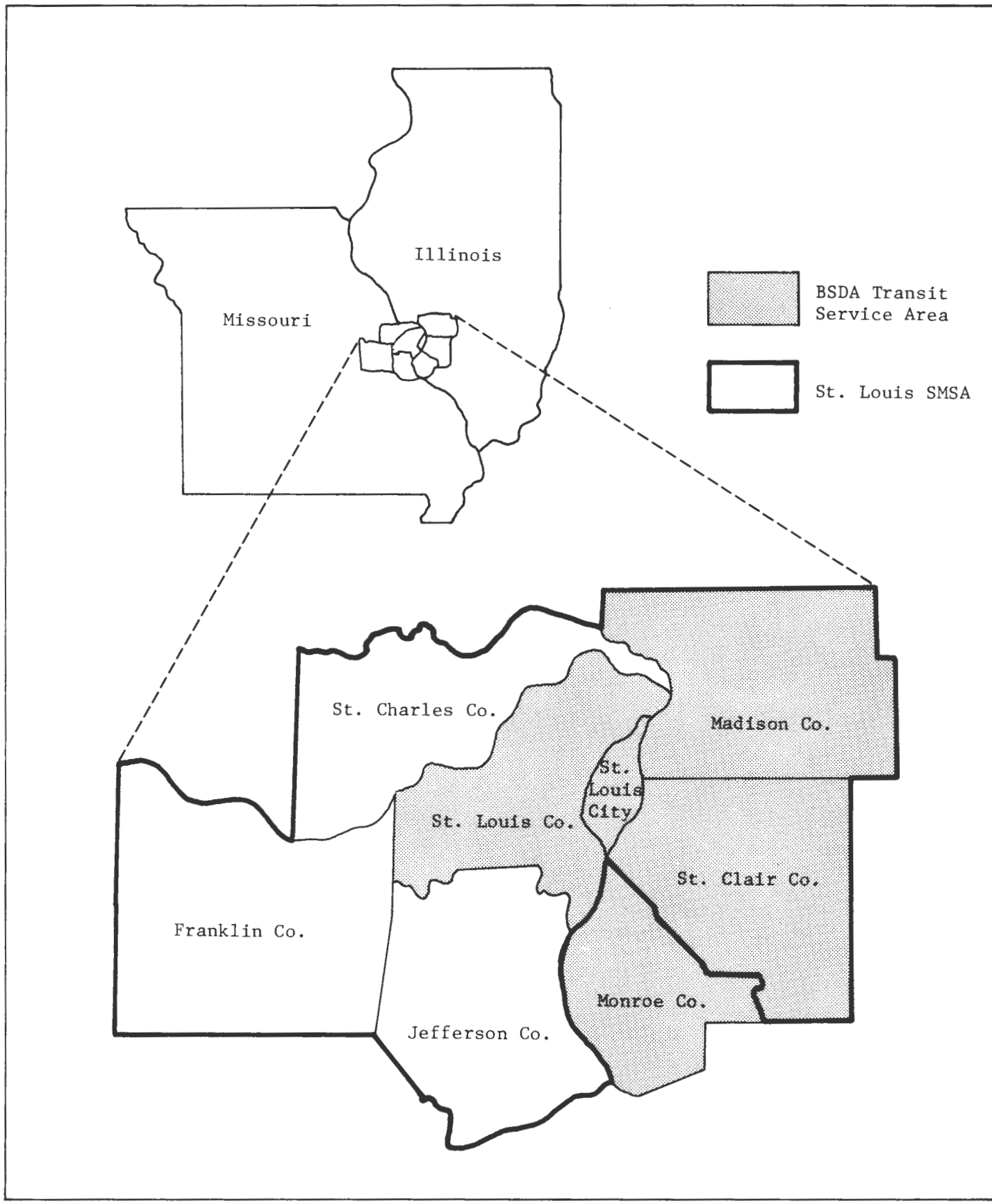


FIGURE 3-1 ST. LOUIS SMSA AND BSDA SERVICE AREA

Thus, the demographic data in this section has been gathered for the BSDA service area excluding Monroe County. Where the data was not available at this level, SMSA data was used for descriptive purposes.

A number of demographic characteristics for the St. Louis area are shown in Tables 3-1, 3-2, and 3-3. The population age distribution for the BSDA service area in 1970 was very close to national averages; 10% of the population is 65 years of age or greater, and 29% is 14 years of age or less. Within the City of St. Louis, those 65 or over constituted 14.7% of the population and those 14 and under about 26%. Thus, the distribution of the city population is skewed toward the older age group in comparison to the BSDA service area and to national averages.

The income distribution in 1975 for the St. Louis SMSA is shown in Table 3-2. Twenty-one percent of the families and unrelated individuals in the SMSA had incomes below $6,000/year, while 40.7% had incomes above $15,000/year. This distribution is close to national averages, although slightly skewed toward the higher income cohorts. As a result, in 1975 the average family and unrelated individual income for the St. Louis SMSA was $14,799, compared to the national average of $13,186.

The profile of auto availability by occupied housing units in the St. Louis SMSA (Table 3-3) is also similar to the national average. Approximately 18% of the occupied dwelling units in the SMSA had no auto available. This figure is higher in St. Louis City, where 38% of the occupied dwelling units had no auto available.

| AGE GROUP | ST. LOUIS CITY | ST. LOUIS COUNTY | BSDA SERVICE AREA | UNITED STATES (1970 CENSUS) |
|---|---|---|---|---|
| Under 5 yrs. | 49,973 (8.0%) | 78,536 (8.3%) | 175,413 (8.3%) | 17,069,801 (8.4%) |
| 5 - 9 | 54,951 (8.8) | 100,115 (10.5) | 211,375 (10.0) | 19,914,769 (9.8) |
| 10 - 14 | 59,333 (9.5) | 106,430 (11.1) | 225,611 (10.7) | 20,727,616 (10.2) |
| 15 - 19 | 54,530 (8.8) | 87,859 (9.2) | 192,536 (9.1) | 19,101,921 (9.4) |
| 20 - 24 | 48,570 (7.8) | 64,500 (6.8) | 150,275 (7.1) | 16,460,166 (8.1) |
| 25 - 34 | 64,388 (10.4) | 124,103 (13.1) | 250,182 (11.9) | 24,791,855 (12.2) |
| 35 - 44 | 60,069 (9.6) | 120,541 (12.7) | 244,147 (11.6) | 23,166,160 (11.4) |
| 45 - 54 | 67,667 (10.9) | 114,051 (12.0) | 243,136 (11.5) | 23,369.372 (11.5) |
| 55 - 59 | 35,990 (5.8) | 44,979 (4.7) | 107,000 (5.1) | 9,957,384 (4.9) |
| 60 - 64 | 35,575 (5.7) | 36,878 (3.9) | 95,193 (4.5) | 8,534,901 (4.2) |
| 65 - 74 | 55,882 (9.0) | 46,870 (4.9) | 133,819 (6.3) | 12,395,928 (6.1) |
| 75 and over | 35,358 (5.7) | 26,491 (2.8) | 80,212 (3.8) | 7,722,053 (3.8) |
| TOTAL | 622,236 (100.0%) | 951,353 (100.0%) | 2,108,899 (100.0%) | 203,211,926 (100.0%) |

Source: 1970 Census Data

TABLE 3-1 TOTAL POPULATION BY AGE COHORT: BSDA SERVICE AREA (1970)

| INCOME GROUP | ST. LOUIS SMSA: FAMILIES AND UNRELATED INDIVIDUALS | NATIONAL INCOME DISTRIBUTION FOR FAMILIES AND UNRELATED INDIVIDUALS |
|---|---|---|
| $0 ≤ - 2,000 | 25,000 (3.3%) | (5.3%) |
| 2,000 - 3,999 | 78,000 (10.2) | (11.7) |
| 4,000 - 5,999 | 63,000 (8.2) | (10.2) |
| 6,000 - 7,999 | 68,000 (8.9) | (9.3) |
| 8,000 - 9,999 | 65,000 (8.5) | (8.7) |
| 10,000 - 11,999 | 52,000 (6.8) | (8.2) |
| 12,000 - 14,999 | 103,000 (13.5) | (11.6) |
| 15,000 - 24, 999 | 221,000 (28.9) | (24.0) |
| 25,000+ | 90,000 (11.8) | (10.8) |
| TOTAL | 765,000 (100%) | (100%) |
| MEAN INCOME | $14,799 | $13,186 |

(1) Numbers rounded to nearest thousand

(2) 1970 Census Data

Source: Census Series P-60, No. 105, Table 19

TABLE 3-2 INCOME DISTRIBUTION FOR THE ST. LOUIS SMSA (1975 CENSUS ESTIMATES)

| AUTOS AVAILABLE | OCCUPIED HOUSING UNITS | | | |
|---|---|---|---|---|
| | ST. LOUIS CITY | ST. LOUIS COUNTY | ST. LOUIS SMSA | NATIONAL DISTRIBUTION (1970 CENSUS) |
| None | 82,125 (38.1%) | 18,125 (6.4%) | 132,687 (18.0%) | (17%) |
| 1 | 101,990 (47.4) | 126,862 (44.9) | 348,746 (47.4) | (48) |
| 2 | 27,645 (12.8) | 118,660 (42.0) | 221,471 (30.1) | (29) |
| 3 or more | 3,719 (1.7) | 18,999 (6.7) | 33,212 (4.5) | (6) |
| TOTAL | 215,479 (100%) | 282,646 (100%) | 736,116 (100%) | (100%) |

Source: 1970 Census

TABLE 3-3 AUTO AVAILABILITY BY OCCUPIED HOUSING UNITS

## 3.2 THE BSDA TRANSIT SYSTEM*

BSDA assumed responsibility for the transit system in 1963, buying out over 15 private transit operations. Since then, BSDA has steadily upgraded its bus fleet and has reduced the average vehicle age to four years. The overall fleet is very mixed; it includes General Motors, Flxible, and AM General models in lengths of 31, 35 and 40 feet and both 96 and 102 inch widths. BSDA also operates Argosy and Flxette small buses. Due to a greatly increased base of funding in recent years, there has been a substantial increase in the amount of service. Fares have been decreased. As a result of these actions, ridership has continually increased over the last five years. Table 3-4 shows the service, cost, fare and ridership trends since 1971.

Overall, BSDA owns 1,139 vehicles and operates 87 local routes, 57 express routes, and 17 community oriented services and shuttles. The peak requirement is 798 buses, while base service requires 326 buses.

The system carries approximately 245,000 passengers each weekday. The routes are served from five stations, two of which are in Illinois. Major repair and maintenance work is performed at a central facility in St. Louis. Parking and storage of buses is mainly outdoors (90%).

Local funding to support the BSDA comes from a 0.5% sales tax in St. Louis County and City, and from 1/16 of the sales tax revenues in Madison, Monroe and St. Clair Counties under the Illinois Downstate Public Transportation Act. In addition to these funds,

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*A description of the overall BSDA organization and operations is provided in Chapter 5.

| FISCAL YEAR(1) | MILES OPERATED(3) | PERCENT CHANGE | OPERATING COST (3) | PERCENT CHANGE | RIDERSHIP (BOARDING)(3) | PERCENT CHANGE | OPERATING COST PER RIDER | BASE FARE |
|---|---|---|---|---|---|---|---|---|
| 1971 | - | - | - | - | 61.1 | - | - | .45 |
| 1972 | 19.1 | - | - | - | 54.9 | -10.1 | - | .45 |
| 1973 | 18.9 | -1.5 | - | - | 52.2 | -4.9 | - | .25 |
| 1974 | 20.4 | +8.0 | $27.10 | - | 54.6 | +4.6 | $0.50 | .25 |
| 1975 | 22.3 | +9.6 | 33.30 | +22.9 | 58.8 | +7.7 | 0.57 | .25 |
| 1976 | 24.2 | +8.7 | 38.40 | +15.3 | 62.3 | +6.0 | 0.62 | .25 |
| 1977 | 25.7 | +6.0 | 45.80 | +19.3 | 65.1 | +4.5 | 0.70 | .25 |
| 1978 | 27.6 | +7.6 | 55.30 | +20.7 | 68.0 | +4.5 | 0.81 | .25 |
| 1979(2) | 30.1 | +9.1 | 65.80 | +19.0 | - | - | - | .25 |

Notes: (1) Fiscal Year period begins on July 1.
(2) 1979 Budget Estimate (includes special service and pilot projects)
(3) Figures are in units of $10^6$ (millions)

Source: 1985 Mass Transit Program - Final Report

TABLE 3-4 BSDA SERVICE, COST AND RIDERSHIP TRENDS

certain county funds are used to support local neighborhood services. FY'79 projections called for total operating revenues of about $14 million and a deficit of about $49 million (see Table 3-5).

## 3.3 WHEELCHAIR USERS IN ST. LOUIS

There is no direct information available from surveys or other sources on the exact number of people in St. Louis who use wheelchairs. However, a reasonable estimate has been made using secondary sources. The estimation methodology is based on prevalence rates for the wheelchair population. Application of the rates to a relatively large population provides a reasonable estimate of the number of wheelchair users. The methodology was first described in detail in an UMTA report (Ref. 1) published in August 1976. This methodology has since been modified and expanded as a result of more recent work. (Ref. 2)

Using the updated methodology, estimates have been made of institutionalized and non-institutionalized wheelchair users, both elderly and non-elderly. The estimates, which are presented in Table 3-6, were made for the BSDA service area, and for the area within one quarter mile of the accessible routes*. The calculations indicate approximately 7,400 wheelchair users in the St. Louis four-county area, about 1,863 of whom live within 1/4 mile of the accessible routes. It is important to note that only about 1,000 of those wheelchair users close to the routes are non-institutionalized.

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*The estimate was made on the basis of the maximum number of accessible routes (17) operated by BSDA. The routes are described in Chapter 4.

| | |
|---|---|
| **OPERATING REVENUE** | |
| Passenger Revenue | $13,878,000 |
| Other Revenue | 769,900 |
| Total Operating Revenue | $14,647,900 |
| **OPERATING EXPENSES** | |
| Total Operating Expenses | $65,690,480 |
| County Project Reimbursement | ( 1,700,000) |
| Net Operating Expense | $63,990,480 |
| **EXCESS OF OPERATING EXPENSE OVER OPERATING REVENUE** | $49,342,580 |
| **NON-OPERATING INCOME** | |
| Missouri Sales Tax | $28,194,716 |
| Illinois Downstate Operating Assistance | 6,420,664 |
| Federal Operating Assistance | 13,824,900 |
| Other Non-Operating Income | 902,300 |
| **TOTAL NON-OPERATING INCOME** | $49,342,580 |

TABLE 3-5 PROJECTED FY 1979 BSDA BUDGET

| | NON-INSTITUTIONALIZED WITH CHRONIC CONDITIONS | INSTITUTIONALIZED IN LONG-TERM CARE FACILITIES | TOTAL |
|---|---|---|---|
| PREVALENCE RATE | 0.0019 (1) | 0.0016 (2) | 0.0035 |
| BSDA SERVICE AREA TOTAL (3) | | | |
| Elderly (65+) | 2,204 (4) | 2,362 (5) | 4,566 |
| Non-Elderly | 1,803 | 1,012 | 2,815 |
| TOTALS | 4,007 | 3,374 | 7,381 |
| 17 ACCESSIBLE ROUTES SERVICE AREA (¼ mi.) (6) | | | |
| Elderly (65+) | 556 | 468 | 1,024 |
| Non-Elderly | 455 | 384 | 839 |
| TOTALS | 1,011 | 852 | 1,863 |

(1) Per reference 2.

(2) Effective rate computed from information in Reference 2 based on non-institutionalized population.

(3) Estimated population of 2,108,899.

(4) Per Reference 2, 55% of the non-institutionalized in wheelchairs are elderly.

(5) Per Reference 2, 70% of institutionalized persons are elderly. Same percentage assumed to apply to those institutionalized persons in wheelchairs.

(6) Based on an estimated population of 532,331 within ¼ mile of all 17 accessible bus routes provided by EWGCC.

TABLE 3-6 ESTIMATES OF NUMBER OF PERSONS USING WHEELCHAIRS

The use of national prevalence rates to estimate the number of wheelchair users in any local area requires a similarity between the local and national population characteristics. A comparison of the national and St. Louis area estimates of the disabled population between the ages of 16-64, taken from the 1970 census, is shown in Table 3-7. The St. Louis SMSA reported 5.5% of its population in this category, compared to the national SMSA average of 5.76%. St. Louis City had 7.4% of its population so classified - slightly higher than the national central city average of 6.2% but still comparable. On this basis, it is believed that the above estimates of the number of wheelchair users are accurate enough for evaluation purposes.

## 3.4 EXOGENOUS EVENTS

The only significant exogenous variable which impacts on the demonstration is the weather. Weather is an important constraint on the ability of the handicapped, particularly wheelchair users, to get around. The major weather conditions which affect wheelchair users are snow, ice, rain and cold. Weather conditions also impact adversely upon the condition and use of the accessibility equipment.

Table 3-8 presents a summary of average weather statistics for St. Louis. For comparative purposes, Table 3-9 shows temperature, and snow and ice levels for St. Louis and for six other major U.S. cities.

The winter of 1977-78 in St. Louis was far more severe than average, as indicated by the data in Table 3-10. The total snowfall for the four month period from December, 1977 to March, 1978 was about 59 inches, which is far above the historical average of 15 inches. The temperature over the same period was well below normal, with February a full 14 degrees below the historical average. The effect this had upon the demonstration will be discussed in Chapter 8.

| | ST. LOUIS CITY | ST. LOUIS SMSA | METROPOLITAN AREAS CENTRAL CITIES | UNITED STATES |
|---|---|---|---|---|
| Total Population | 622,236 | 2,363,017 | 63,796,943 | 203,211,926 |
| Disabled Population: 16-64 yrs. | 46,486 | 131,801 | 3,952,728 | 11,710,139 |
| Percent of Total Population Disabled: 16-64 yrs. | 7.4% | 5.5% | 5.76% | 6.2% |

Source: 1970 Census

TABLE 3-7 DISABLED POPULATION: 16-64 YEARS OF AGE

| | JAN. | FEB. | MAR. | APR. | MAY | JUNE | JULY | AUG. | SEP. | OCT. | NOV. | DEC. | ANNUAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Normal Monthly Ave. Temp. (F) | 31.3 | 35.1 | 43.3 | 56.5 | 65.8 | 74.9 | 78.6 | 77.2 | 69.6 | 59.1 | 45.0 | 34.6 | 55.9 |
| Normal Monthly Minimum Temp. (F) | 22.6 | 26.0 | 33.5 | 46.0 | 55.5 | 64.8 | 68.8 | 67.1 | 59.1 | 48.4 | 35.9 | 26.5 | 46.3 |
| Normal Monthly Precipitation (in inches) | 1.85 | 2.06 | 3.03 | 3.92 | 3.86 | 4.42 | 3.69 | 2.87 | 2.89 | 2.79 | 2.47 | 2.04 | 35.89 |
| Average Number Days with Precipitation 0.1 inch or more | 7 | 8 | 10 | 11 | 10 | 9 | 9 | 7 | 9 | 8 | 8 | 9 | 105 |
| Average Total Snow & Ice Pellets (inches) | 4.2 | 3.8 | 4.4 | .3 | Trace | - | - | - | - | Trace | 1.2 | 2.9 | 16.8 |
| Average Percent of Possible Sunshine | 52 | 51 | 55 | 57 | 63 | 69 | 69 | 67 | 65 | 61 | 48 | 42 | 59 |

Source: U.S. National Oceanic and Atmospheric Administration, Local Climatological Data

TABLE 3-8 ST. LOUIS WEATHER STATISTICS

| SELECTED CITIES | NORMAL AVE. TEMP. | NORMAL PRECIPITATION (INCHES) | AVE. NUMBER OF DAYS WITH PRECIPITATION .01 IN. OR MORE | AVE. ANNUAL SNOW & ICE PELLETS (INCHES) | AVE. ANNUAL PERCENT OF POSSIBLE SUNSHINE |
|---|---|---|---|---|---|
| St. Louis | 55.9 | 35.89 | 105 | 16.8 | 59 |
| Los Angeles | 61.7 | 14.05 | 36 | Trace | 73 |
| Denver | 51.9 | 12.95 | 86 | 58.7 | 70 |
| Atlanta | 61.5 | 48.34 | 115 | 1.6 | 61 |
| Chicago | 50.6 | 34.44 | 122 | 39.7 | 57 |
| New York | 54.5 | 40.19 | 121 | 29.6 | 59 |
| Seattle | 51.1 | 38.79 | 164 | 16.1 | 48 |

Source: U.S. National Oceanic and Atmospheric Administration, Local Climatological Data

TABLE 3-9 COMPARISON OF WEATHER STATISTICS IN SELECTED CITIES

| MONTH | MEAN TEMP. | | AVERAGE GROUNDCOVER | | SNOWFALL (1) (INCHES) | |
|---|---|---|---|---|---|---|
| | 1977-78 | Average | 1977-78 | Average | 1977-78 | Average |
| December | 30.6° | 34.6° | 1.09" | NA(2) | 11.7" | 2.9" |
| January | 19.6° | 31.3° | 4.54 | NA | 22.9 | 4.2 |
| February | 21.1° | 35.1° | 10.43 | NA | 9.3 | 3.8 |
| March | 37.9° | 43.3° | 6.03 | NA | 15.4 | 4.4 |

(1) Snowfall includes ice pellets
(2) NA = Not available from data collected

Source: NOAA Environmental Data Service, Local Climatological Data, Monthly Summaries

TABLE 3-10 WEATHER STATISTICS FOR ST. LOUIS: DECEMBER, 1977 - MARCH, 1978

# CHAPTER 4

# PROJECT DESCRIPTION

This chapter provides a description of the changes which were made to the BSDA transit system to accommodate the accessible buses. A description of the planning and implementation process associated with thse changes is presented in Chapter 5.

For evaluation purposes, the project was divided into three distinct phases, because the number of accessible routes and scheduled buses were quite different in each phase. Figure 4-1 shows the amount of accessible service in each phase. The major part of the evaluation concerned Phases I and II, which are primarily discussed in this chapter. Phase III is treated only in the addendum given by Chapter 12.

The following discussion provides the details regarding the routing and scheduling of the accessible vehicles during Phase I and II. The level of service on the accessible routes is also presented in this chapter.

## 4.1 ROUTES AND SCHEDULES

In developing the routing for the accessible vehicles, BSDA emphasized a widespread geographical distribution, in conjunction with the selection of lines with high ridership and service to those locations expected to be major trip generators. The result of this strategy is shown in Figure 4-2, a map of the Phase II accessible bus network. During Phase II, a total of 17 routes were accessible. In addition, 5 of these routes had separate express routes, some of which only operated in the peak. There was practically no wheelchair ridership on the express portion of the routes, however. For this reason, the express portions are not shown as separate routes but are combined with their respective local route. All analysis is based on a total of only 17 routes.

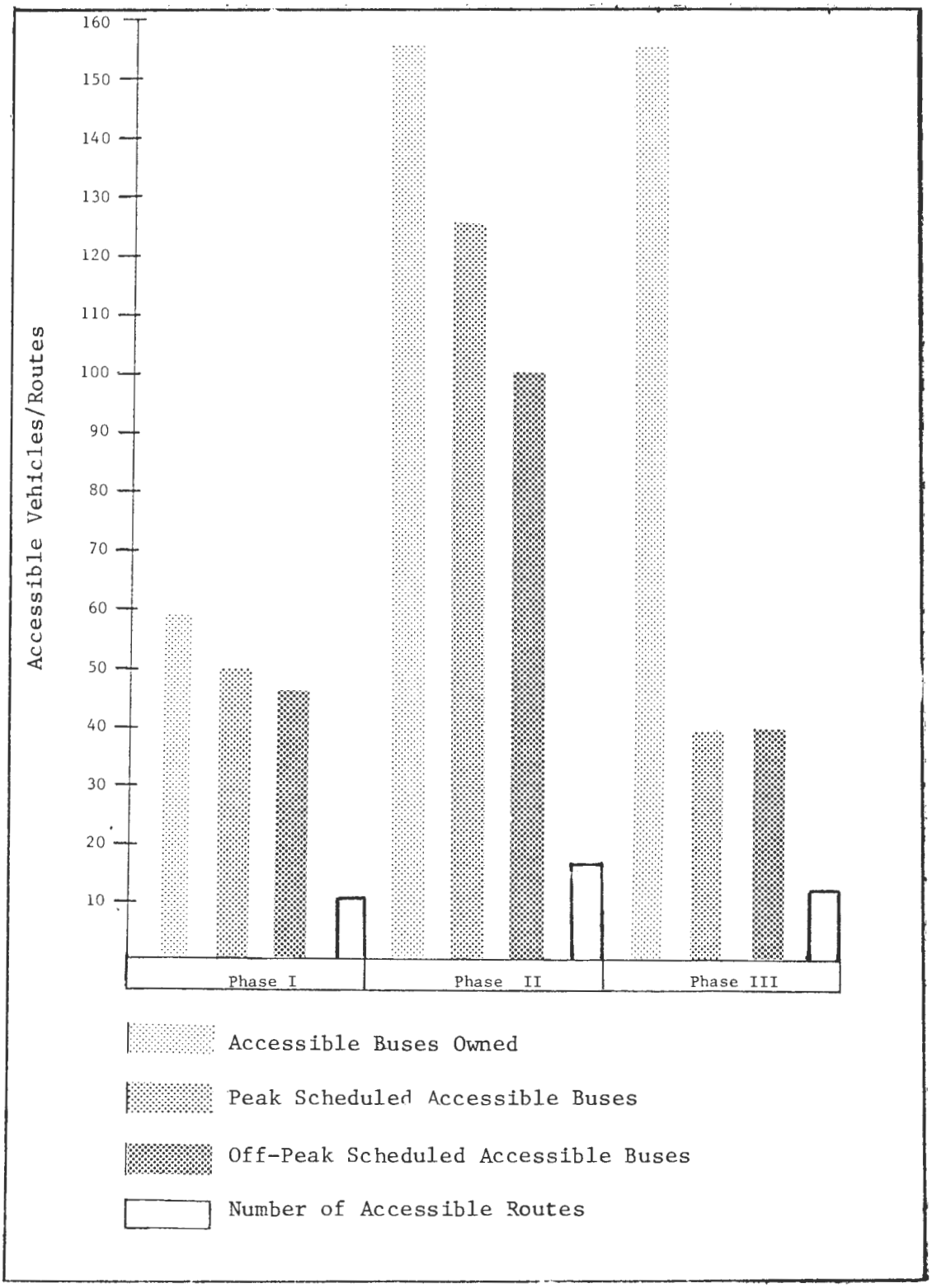
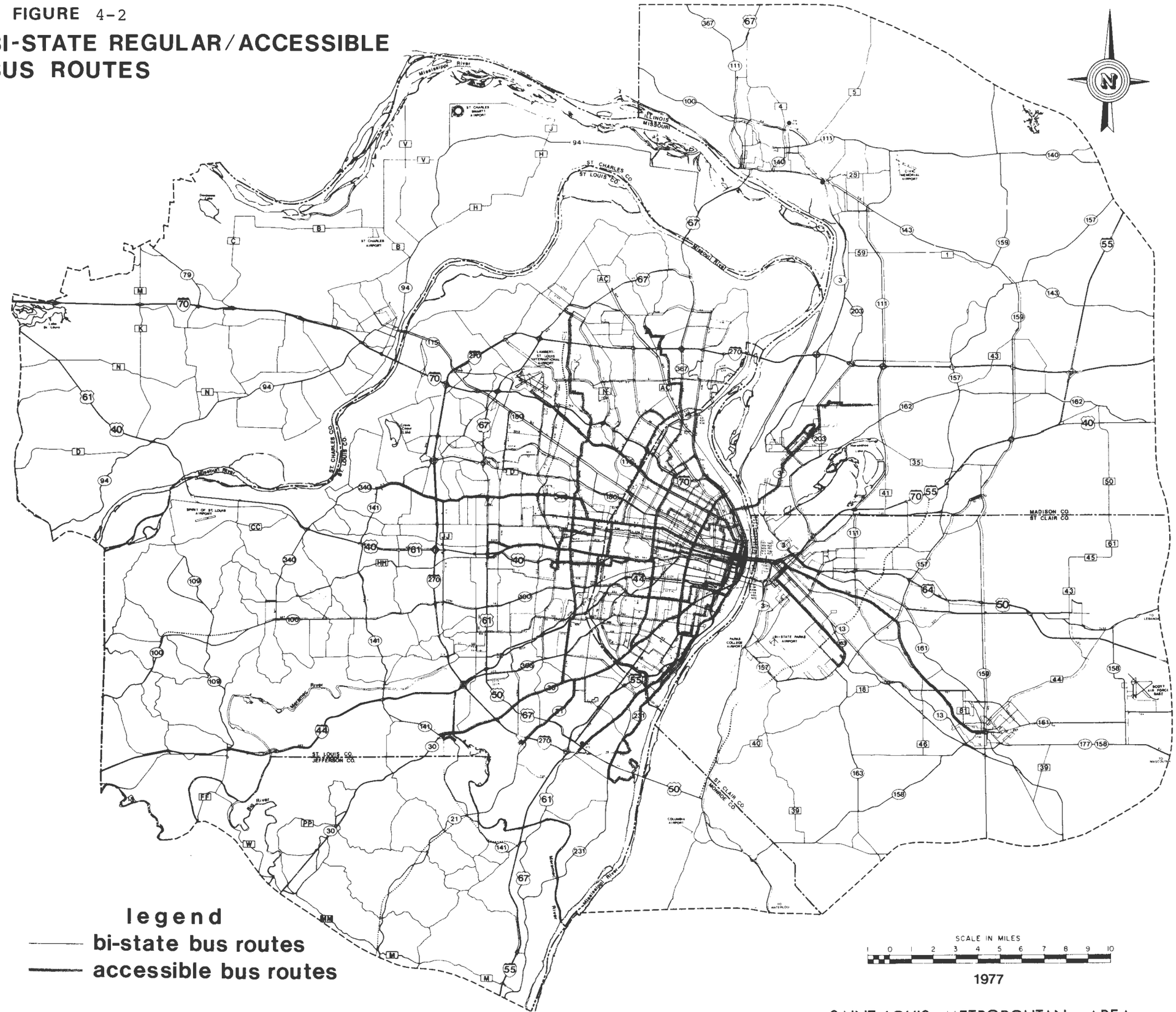



FIGURE 4-1 PHASES OF ACCESSIBLE BUS PROJECT

FIGURE 4-2

# BI-STATE REGULAR/ACCESSIBLE BUS ROUTES




**legend**

bi-state bus routes

accessible bus routes

1977

SAINT LOUIS METROPOLITAN AREA

BSDA opted for a partially accessible system, in which all buses on any accessible route were not necessarily lift-equipped. The exact percentage of bus trips on any route which would be accessible depended on the time of day, the run time, and on interlining.*

Table 4-1 summarizes the scheduled assignments of accessible vehicles in both Phase I and II. In Phase I, 48 of the 60 vehicles were assigned (i.e., scheduled) during the base period and 51 in the peak. Thus, during Phase I, only 15% of the accessible vehicles were available as spares, and the accessible buses were heavily utilized even in off-peak hours, which is the time when maintenance is normally performed. These scheduling requirements were reduced somewhat (to a 25% spares ratio) during the latter part of Phase II.

Table 4-2 shows the percent of major generators in the St. Louis metropolitan area which were served in Phase II by accessible and conventional (non-accessible) transit routes; also shown are the number of generators having no transit service at all. The accessible routes reached a total of 69 major medical, shopping, and educational facilities, or 27% of all such facilities in the St. Louis area. This was about half of the number of facilities served by the non-accessible routes. Thus, the accessible routes had good areawide coverage and a large number of destination choices. Table 4-3 shows the actual number of buses allocated to each route in Phase II.

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*Interlining is the practice of assigning a specific bus or driver to operate on more than one route during the course of a day.

| | Phase I | Phase II |
|---|---|---|
| Date of Service Initiation | August, 1977 | November, 1977 |
| Phase Duration (Months) | 3½ | 9 |
| Accessible Fleet Size (No. of Vehicles) | 60 | 157 |
| Accessible Vehicles Scheduled (Peak) | 51 | 126[2] |
| Percent of Total Peak Fleet Accessible | 6% | 16% |
| Accessible Vehicles Scheduled (Base) | 48 | 102[2] |
| Percent of Total Base Fleet Accessible | 15% | 31% |
| Percent Spares (Peak) | 15% | 25% |
| Average Weekday Ridership by General Public on All Accessible Routes | 78,500 | 113,400 |
| Average Weekday Ridership on Accessible Routes as a Percentage of Total BSDA System | 33% | 48% |
| Total Number of Accessible Routes | 10 | 17[1] |
| Percent of Total BSDA Routes With Accessible Service | 11% | 20% |
| Accessible Trips as a Percentage of Total Trips on Accessible Routes (Weekday Only) | 60% | 71% |

(1) Excludes express portions

(2) As scheduled in July, 1978

TABLE 4-1 SUMMARY OF BSDA ACCESSIBLE BUS ASSIGNMENTS

| FACILITY TYPE | NUMBER OF GENERATORS SERVED BY: ACCESSIBLE BUS ROUTES No. | % | NON-ACCESSIBLE ROUTES No. | % | NO BUS ROUTES No. | % | TOTAL |
|---|---|---|---|---|---|---|---|
| Shopping Centers | 29 | (19%) | 95 | (62%) | 29 | (19%) | 153 |
| Medical Facilities | 27 | (43%) | 28 | (44%) | 8 | (13%) | 63 |
| Higher Education Facilities | 13 | (34%) | 16 | (42%) | 9 | (24%) | 38 |
| TOTAL | 69 | (27%) | 139 | (55%) | 46 | (18%) | 254 |

TABLE 4-2 COVERAGE OF MAJOR GENERATORS BY BSDA TRANSIT (PHASE II)

| LINE | ACCESSIBLE BUSES ALLOCATED(1) A.M. PEAK (2) | P.M. PEAK (3) | BASE PERIOD |
|---|---|---|---|
| Grand | 10 | 10 | 8 |
| Kingshighway | 7 | 10 | 6 |
| Belleville-St. Louis | 7 | 8 | 6 |
| Forest Park | 10 | 10 | 9 |
| Lee (Inc. Northside Exp.) | 10 | 9 | 6 |
| Delmar-Forsyth | 7 | 6 | 6 |
| Cherokee (Inc. Afton & Watson Exp.) | 14 | 11 | 9 |
| Olive (Inc. Creve Coeur Exp.) | 11 | 12 | 9 |
| Natural Bridge | 9 | 9 | 8 |
| Carondelet | 5 | 5 | 5 |
| Alta-Sita | 4 | 4 | 3 |
| Tower Grove | 6 | 5 | 5 |
| Broadway | 9 | 10 | 8 |
| City Limits | 4 | 4 | 3 |
| McKinley Bridge | 4 | 5 | 3 |
| Cross County | 6 | 6 | 6 |
| St. Louis Ave. | 2 | 2 | 2 |
| TOTAL SCHEDULED ACCESSIBLE BUSES | 125 | 126 | 102 |
| TOTAL ALL SCHEDULED BUSES | 789 | 789 | 332 |
| % OF ALL SCHEDULED BUSES WHICH WERE ACCESSIBLE | 16% | 16% | 31% |

(1) As scheduled in July, 1978
(2) 7:00-9:00 A.M.
(3) 3:30-6:00 P.M.

TABLE 4-3 PHASE II ASSIGNMENT OF ACCESSIBLE BUSES

## 4.2 LEVEL OF SERVICE

Level of service is defined herein to include both the percentage of bus trips scheduled with accessible vehicles, and the headway between accessible vehicles. Complete statistics on both of these variables are shown in Table 4-4 for Phase I and in Table 4-5 for Phase II. These are taken from the published schedules and reflect the service which BSDA attempted to provide, but do not reflect actual performance.

In Phase I, the average percentage of accessible bus trips for all 10 routes was 60%, although this percentage varied by time of day and route. Accessible headways on a given route tended to remain the same throughout the entire day. This was because of the relatively constant number of accessible vehicles scheduled. As overall headways shortened in the peak, due to the additional scheduling of inaccessible buses, the percent of all bus trips which were accessible would go down. Likewise, in the evening or on weekends when headways were generally much higher, the percent of bus trips operated by accessible equipment would go up. Evening service was about 80% accessible, while PM peak service was only 42% accessible. Most travel by wheelchair users actually occurred between the hours of 7:00 a.m. and 6:00 p.m., when the average accessibility was 52%. This figure better describes the utility of the accessible service from the point of view of the user than the overall figure of 60%.

In Phase I, the bus routes had a variety of levels of service. The Kingshighway, Belleville - St. Louis and City Limits routes all had fewer than 30% accessible trips in the evening peak period. In contrast, several routes had 100% or close to 100% accessible service before 7:00 a.m. or after 6:00 p.m. Scheduled accessible headways varied from a low of about 12-17 minutes on Forest Park, the most popular route, to over an hour during the evening peak on the City Limits route.

| ROUTES | PERCENT OF TRIPS OPERATED WITH AN ACCESSIBLE BUS | | | | | HEADWAY BETWEEN ACCESSIBLE BUSES | | | TOTAL ACCESSIBLE TRIPS (TWO-WAY) | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Before 7 | 7-9 | 9-3:30 | 3:30-6 | After 6 | 7-9 | 9-3:30 | 3:30-6 | NO. | % of All Trips |
| FOREST PARK | 100% | 91% | 89% | 60% | 100% | 12 | 12 | 17 | 74 | 87 |
| ALTA SITA | 60 | 62 | 70 | 50 | 90 | 24 | 28 | 30 | 36 | 68 |
| CARONDELET | 57 | 57 | 58 | 60 | 71 | 30 | 26 | 25 | 39 | 61 |
| KINGSHIGHWAY | 60 | 45 | 39 | 21 | 53 | 24 | 32 | 37 | 32 | 40 |
| BELLEVILLE - ST. LOUIS | 45 | 25 | 42 | 29 | 79 | 30 | 28 | 25 | 40 | 42 |
| GRAND | 100 | 47 | 61 | 40 | 71 | 17 | 17 | 19 | 56 | 58 |
| NATURAL BRIDGE | 44 | 67 | 100 | 67 | 100 | 20 | 19 | 19 | 49 | 80 |
| DELMAR-FORSYTH | 50 | 30 | 43 | 55 | 73 | 40 | 32 | 25 | 35 | 50 |
| CITY LIMITS | 40 | 37 | 62 | 28 | 90 | 40 | 39 | 75 | 26 | 57 |
| McKINLEY BRIDGE | 50 | 60 | 75 | 33 | 80 | 40 | 32 | 37 | 31 | 61 |
| AVERAGE FOR ALL ACCESSIBLE ROUTES | 59% | 52% | 62% | 42% | 80% | | | | 418 | 60% |

TABLE 4-4 PHASE I LEVEL OF SERVICE

Table 4-5 presents the level of service data for Phase II. The percent of accessible bus trips on Kingshighway went from 40% to 57%; Belleville - St. Louis from 42% to 54%; Grand from 58% to 72%; Delmar - Forsyth from 50% to 62%; and McKinley Bridge from 61% to 76%.

During Phase II, the average percentage of accessible bus trips on the 17 routes increased to 71%, although the two peaks were still less than 60% accessible. Between 7:00 a.m. and 6:00 p.m. the headways for accessible trips on most routes were between 12 and 30 minutes.

In summary, the scheduled accessible operations, particularly in Phase II, provided fairly widespread geographical coverage and fairly good level of service, as measured by the percent of bus trips accessible and by accessible headways.

| ROUTE | PERCENT OF TRIPS OPERATED WITH AN ACCESSIBLE BUS | | | | | HEADWAY BETWEEN ACCESSIBLE BUSES | | | TOTAL ACCESSIBLE TRIPS (TWO-WAY) | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Before 7 | 7-9 | 9-3:30 | 3:30-6 | After 6 | 7-9 | 9-3:30 | 3:30-6 | No. | % |
| FOREST PARK | 100 | 91 | 89 | 59 | 100 | 12 | 13 | 15 | 74 | 86 |
| ALTA SITA | 83 | 62 | 64 | 41 | 100 | 24 | 28 | 21 | 41 | 65 |
| LEE | 75 | 58 | 68 | 50 | 100 | 17 | 23 | 25 | 47 | 69 |
| BROADWAY | 86 | 75 | 95 | 78 | 100 | 20 | 19 | 21 | 48 | 89 |
| TOWER GROVE | 100 | 86 | 89 | 54 | 75 | 20 | 23 | 21 | 43 | 78 |
| CARONDELET | 57 | 57 | 58 | 60 | 71 | 30 | 26 | 25 | 39 | 61 |
| KINGSHIGHWAY | 80 | 54 | 46 | 50 | 93 | 17 | 21 | 15 | 54 | 57 |
| OLIVE | 75 | 71 | 61 | 58 | 73 | 24 | 21 | 21 | 48 | 66 |
| CHEROKEE | 53 | 62 | 92 | 60 | 83 | 12 | 16 | 17 | 66 | 73 |
| BELLVILLE-ST. LOUIS | 64 | 24 | 58 | 48 | 93 | 24 | 21 | 15 | 54 | 54 |
| GRAND | 100 | 59 | 74 | 54 | 94 | 12 | 13 | 12 | 76 | 72 |
| NATURAL BRIDGE | 56 | 62 | 96 | 85 | 100 | 15 | 16 | 14 | 60 | 83 |
| DELMAR-FORSYTH | 50 | 55 | 58 | 55 | 87 | 20 | 21 | 25 | 47 | 62 |
| CITY LIMITS | 60 | 25 | 62 | 33 | 90 | 60 | 39 | 50 | 27 | 56 |
| McKINLEY BRIDGE | 75 | 80 | 87 | 42 | 100 | 30 | 28 | 30 | 39 | 76 |
| CROSS COUNTY | 33 | 100 | 92 | 83 | 100 | 30 | 32 | 30 | 24 | 86 |
| ST. LOUIS AVE. | 100 | 60 | 100 | 60 | 100 | 40 | 43 | 50 | 18 | 82 |
| TOTAL | 70% | 58% | 74% | 56% | 91% | | | | 805 | 71% |

NOTE: As originally scheduled in November of 1977.

TABLE 4-5 PHASE II LEVEL OF SERVICE

# CHAPTER 5

# PROJECT PLANNING AND IMPLEMENTATION

BSDA went through a lengthy planning period before the accessible service began. During this time period the decision was made to offer accessible service, the buses were purchased, and a number of implementation activities were carried out. This chapter discusses:

- How BSDA made the decision to purchase accessible buses.
- What problems were foreseen by BSDA and how they intended to resolve these problems.
- The implementation activities, including service plans, training, labor relations, and marketing.

## 5.1 TRANSPORTATION PLANNING ORGANIZATIONS AND ROLES

Transportation planning in the St. Louis area is largely concentrated in BSDA and the East-West Gateway Coordinating Council (EWGCC). These two agencies have played the major role in planning the regional public transportation network and in planning for the elderly and handicapped. A description of these two agencies and their respective roles is useful in understanding how the planning for the accessible service began.

The BSDA was created in 1949 by an interstate compact between Illinois and Missouri to plan for the overall development of the area. It is governed by a non-paid, ten member commission appointed by the governors of the two states. The transit system is by far the most substantial responsibility of the BSDA. The overall organizational structure in 1976, when the accessibility decision was reached, is shown in Figure 5-1 (reference 3). The research and planning function, including the Elderly and Handicapped program was concentrated in the Program Development

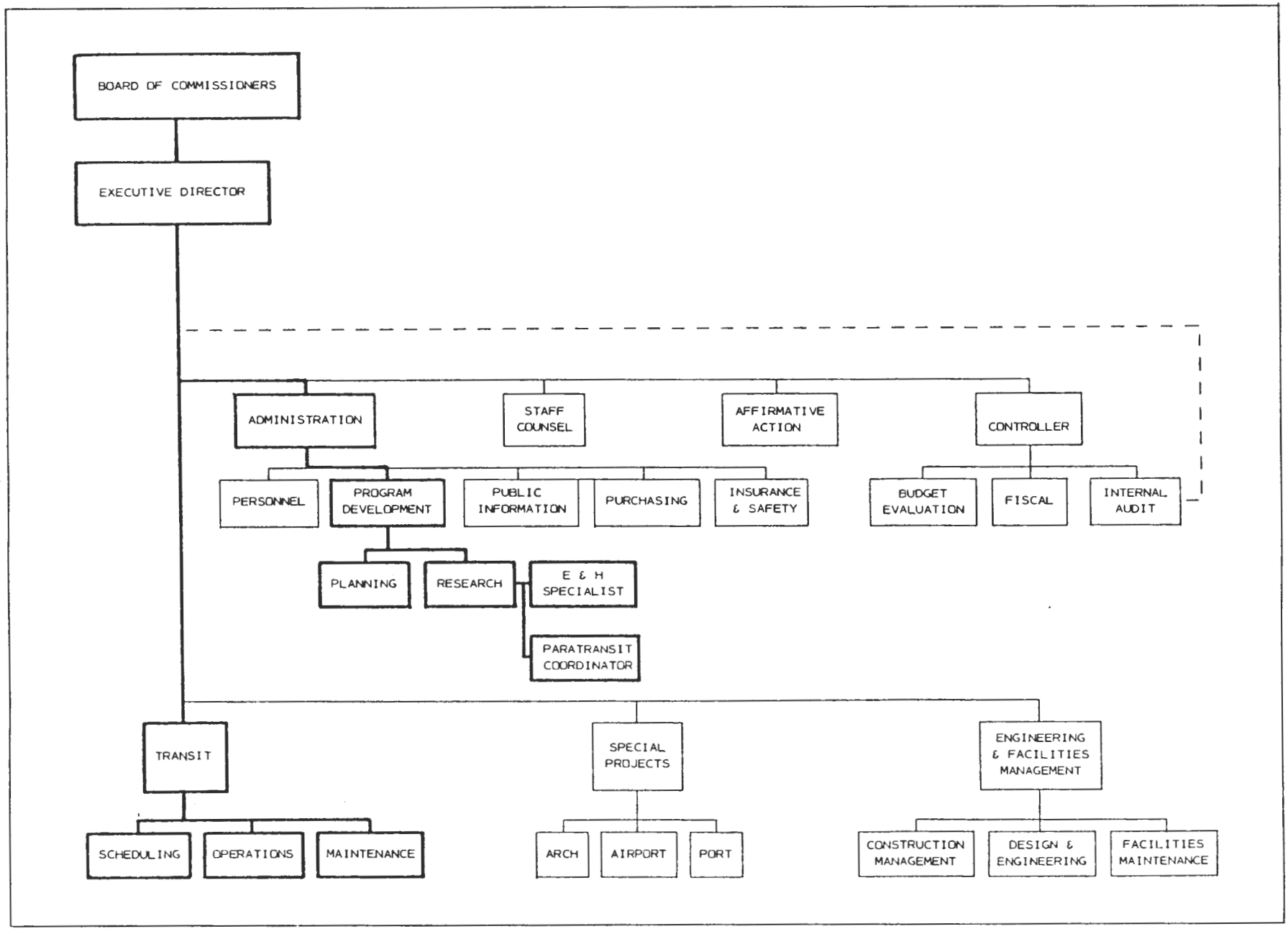


FIGURE 5-1 Bi-State Development Agency Organizational Structure

Division under the Department of Administration. The planners therefore reported directly to the Executive Director rather than to the transit division, an arrangement separating them from actual day-to-day operations.

The EWGCC is the designated Metropolitan Planning Organization (MPO) for the St. Louis region. It's Board of Directors is composed of city, county and regional representatives; representatives of the two state highway and/or transportation departments, the Chairman of the BSDA, and six citizens from the region. The EWGCC is responsible for the planning, coordination, and development of a balanced, regional multi-modal transportation system. It is responsible for the preparation of a number of annual products, including the Transportation Improvement Program (TIP), the Transportation Systems Management Element (TSME) and the Unified Planning Work Program (UPWP).

Much of the EWGCC's planning activities are centered upon long-range efforts such as the development of a regional transit network, five year capital programs, and elderly and handicapped transportation plans. The relationship of the EWGCC and BSDA has been informal, although several projects have been undertaken jointly, particularly in the area of elderly and handicapped transportation planning. Most short term items, such as route improvement proposals, have historically been developed by BSDA; EWGCC has only played a small role in such activities, concentrating instead upon overall regional policies and approaches to issues. Both EWGCC and BSDA played a role in the planning and implementation of the accessible bus project, with BSDA taking the lead through its short term planning efforts.

## 5.2 THE ACCESSIBILITY DECISION

The decision to purchase accessible buses was formally made in November of 1976. At the time both, BSDA and EWGCC were aware of the significance of this step; however, the decision was not reached without a substantial amount of research and discussion.

Many community groups, government agencies and BSDA divisions contributed to the decision by a series of internal discussion, memorandum, meetings, and public hearings. Each of the various inputs to the decision making process are described below.

### 5.2.1 EWGCC Input

The EWGCC was responsible for preparing elderly and handicapped studies and liaison with the elderly and handicapped Technical Advisory Committee. Although EWGCC never prepared a formal alternatives analysis on accessible fixed route transit, it did issue two reports prior to November, 1976 which gave demographic data on handicapped transportation. A report issued in June, 1976, which reflected the view of the Advisory Committee, concluded that: "most elderly and handicapped persons desire door-to-door and personally attended transit services..."

However, it also recommended that "all new vehicles purchased should carry special equipment for better accessibility...," including in its outline specification "two sets of doors, one set with ramp/lift." In late March, 1976 the Advisory Committee formally voted support for BSDA's efforts to procure totally accessible full-size vehicles for fixed route services and also endorsed a preliminary plan for an advance reservation paratransit service.

### 5.2.2 Public Inputs

Public inputs arose mainly through a public hearing on grant applications for the purchase of buses and related equipment. On January 21, and 22, 1976, hearings were held on an application (IT-03-0026) for 200 buses and related equipment. This was in fact a re-hearing since an on-site inspection in April 1975 had led to a determination by UMTA that BSDA was not in compliance with Title 6 (non-discrimination in federally assisted programs) of the Civil Rights Act of 1964. UMTA had, therefore, informed BSDA that they must hold a new hearing and that, subject to review of the transcript of the re-hearing, the grant would be approved.

The proceedings at the re-hearing were taken up with questions concerning service levels to disadvantaged communities and discriminatory hiring practices. While this may not seem relevant for this report, it is illustrative of BSDA's image among some sections of the community as old-fashioned, autocratic and unresponsive. BSDA was concerned with this image, which they desired to change in some manner. This provided an impetus towards innovative program development.

At the re-hearing the subject of accessible fixed route buses was raised by local representatives of the National Paraplegia Foundation. Plans for accessible buses in Los Angeles and Seattle were mentioned, extracts from the UMT and Rehabilitation Acts quoted, and the potential to seek injunctive relief mentioned. One of the Foundation's members stated an intent to remain in contact with BSDA and subsequently submitted an informational package to BSDA on July 30, 1976, which included the National Paraplegia Foundation's position, the Test of Equivalency, and the newly approved SCRTD* accessible bus specifications.

Further public input occurred at a second set of public hearings on August 16, and 17, 1976 on additional grants (MO-05-0001 and IT-03-0030) to purchase 181 buses and related equipment; and 14 accessible vehicles for an E/H paratransit program. Some tension was also evident at this hearing because the final specifications for the previous grant of 200 buses had not yet been released by BSDA. Over 100 persons attended the meeting of the 17th; 45 people made oral presentations. Approximately 30 persons addressed the subject of the handicapped; 80% were in favor of total BSDA accessibility. Testimony included that of the Speaker of the Missouri House of Representatives. From the transcript it also appears that at least two BSDA Commissioners favored the concept (Ref. 4).

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*Southern California Rapid Transit District.

A point was raised from the floor that after the proposed bus purchases, the BSDA fleet would be quite young--approximately four years average age. If, therefore, inaccessible buses were purchased, it would greatly constrain the options available to BSDA in providing accessibility in the near-term.* The Vice-Chairman of BSDA also indicated that at that time no final decision had been made on whether the specifications for the outstanding bid of 200 vehicles (IT-03-0026) would have accessibility mandated or optional. As with the previous hearings the possibility for legal action was raised by concerned consumer groups. Although a final decision was not made at this hearing, the pressure placed on BSDA by the consumers did contribute to the final decision for accessibility.

### 5.2.3 Missouri and Illinois State Input

During the concept formulation stage, there does not seem to have been any significant input from the state authorities and legislatures other than the individual hearing inputs noted. As late as November, 1976, opposition to accessible fixed route service was being voiced by some Illinois Department of Transportation (IDOT) personnel. In addition, Illinois statutes at that time restricted vehicle width to 96". This was a hindrance to BSDA, since their specifications required a 102" wide bus. If this statute had remained in force, none of the accessible vehicles could have been operated in Illinois at all. However, in April, 1977, HB2022 was introduced in the Illinois legislature to legalize the 102" width and this was eventually passed in the fall of 1977. In the interim, BSDA received temporary permission from IDOT to operate the wider accessible buses.

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*Retrofitting with lifts would have been difficult, expensive and time consuming. This possibility does not in fact appear to have been discussed at all.

### 5.2.4 BSDA Decision Process

Beginning with the January, 1976 public hearing, the BSDA staff debated the issue of transit accessibility. A series of memorandum were written by various parts of the BSDA organization. These memos discussed both the pros and cons of both accessible transit and the perceived alternative--paratransit. In addition, the staff came up with a series of suggestions for dealing with the "cons" or negative aspects of accessibility, to be employed if lifts were actually purchased.

The major points raised by the BSDA staff were:

PRO ACCESSIBILITY

- Provides handicapped a feeling of independence.
- Does not require the advance notice which a paratransit system would.
- Would be more equitable than paratransit.
- Would increase bus ridership.
- Would not require the additional operating costs of a paratransit system.
- Would not inconvenience other passengers due to low demand.
- Loss in seating capacity (for wheelchair stations) would not be critical.
- Avoidance of potential legal action.
- Possibility of future federal mandate for accessibility.
- Would help to establish a progressive image for BSDA.
- Would satisfy consumer pressure.

## AGAINST ACCESSIBILITY

- Inherent limitations of handicapped people to reach bus stops and use accessible vehicles, particularly in bad weather.
- Potential delays in boarding handicapped passengers. Buses cannot always pull to the curb.
- Some handicapped would need personal assistance from the driver.
- High capital costs relative to benefits.
- Loss of seating capacity.
- Paratransit services would still be needed.
- Unproven reliability of lifts.
- Possible negative public reaction.

BSDA staff came up with a series of suggestions for dealing with the problems which they foresaw if the lift buses were actually purchased. Some of these suggestions survived as ongoing operating policy once the accessible buses were in operation. Other suggestions were discarded when the problem they were designed to remedy never arose. These suggestions are summarized below.

- Modify schedules to allow adequate time for random delays caused by wheelchair boardings.
- Train all BSDA operators in lift operation, possibly in in-vehicle assistance techniques, and possibly in first aid.
- Establish detailed procedures for emergency evacuation of wheelchair passengers in the event of on-board fire or serious accident.
- The BSDA Operations and Maintenance Divisions estimated that 20% of the systems' 16,000 bus stops were unsafe for wheelchairs. In addition, extensive illegal parking in bus stops was also anticipated. Consequently, BSDA foresaw the need for in-street wheelchair boardings in some cases.

- More road supervisors might be required for accessible routes.

- Wheelchair access to passenger shelters would need to be considered.

- On-board operating procedures would be needed to guide bus operators in dealing with wheelchair passengers. In particular, operators might have to handle unique problems as a result of passenger disability and/or lift malfunction.

- Some persons in wheelchairs may not be able to deposit fare because of arm dexterity limitations. Operators are forbidden to handle money, however. This problem should have been resolved in the BSDA operators manual.

- Counter possible adverse public reactions to running delays caused by wheelchair passengers by developing special public relations materials.

- Provide fold-down seats in the wheelchair securement area to partially compensate for the displaced seating capacity.

- Require that all accessible buses be 102" wide and make required changes in the farebox location and design. Both of these suggestions were felt to be needed to allow turning room for the wheelchairs.

- Possibly install power steering to compensate for the extra weight of the lift.

- Require Transafe bumpers to help limit damage to the lifts caused by front end collisions.

- Require that flashing emergency lights go on when the lift is in operation.

- Develop inspection and preventive maintenance procedures.

- Hire 2 extra mechanics per 100 accessible buses to perform lift repairs.

It is evident from the foregoing list of perceived pros, cons, and suggestions, that while many technical factors were considered, the evaluation of them was relatively subjective. This is understandable given the lack of experience with fixed route

accessible services and with paratransit services on a scale necessary to serve a metropolitan area of this size. The policy decision by the Board of BSDA to implement a pilot program of accessible fixed route services was therefore the result of a number of reasons rather than specific technical data. Major factors in this reasoning included:

- A commitment by some of its board members to accessibility as a desirable goal.
- A commitment to elderly and handicapped program activities, as demonstrated by the development of a 10-point program including the hiring of a research specialist, and implementation of reduced fares.
- A desire to rid the agency of a conservative, autocratic, non-responsive image.
- The fear of litigation if inaccessible buses were purchased.
- A feeling that paratransit would require high operating expenses and lift buses would require very low marginal operating costs.
- A feeling that an accessible fixed route component would be needed in a long-range integrated transit system open to handicapped.

Therefore, at a board meeting on November 12th, 1976, the decision was made to purchase 60 accessible buses. This represented half of the 40' long, 102" wide buses ordered at that time. Subsequently another 97 accessible buses were ordered which represented all of the 40', 102" buses in the second order. This was done to allow a larger program for evaluation purposes. It should be emphasized that the operation was always viewed as a pilot program. A permanent commitment to full fixed route accessibility was not made by the Board.

## 5.3 IMPLEMENTING THE ACCESSIBILITY PROGRAM

Following the November 12th decision, many activities were necessary to turn the program into an operating reality. Schedules and operating procedures were developed or finalized, training and sensitivity programs were undertaken and a marketing program was developed. The overall schedule of these events is shown in Figure 5-2.

### 5.3.1 Development of Routes and Schedules

BSDA's primary concern in developing the initial route structure was to provide the best overall coverage of its service area and runs. The staff ranked potential routes based on the number of elderly residing within 1/8 of a mile. Elderly were used as a proxy for wheelchair users, data on which was not available. Certain routes were discounted because of problems with bus length, mixed express/local operation, or interlining.

The decisions as to which routes to serve with accessible buses were made internally by BSDA. BSDA felt that its personnel had the most direct knowledge of route operations and that its accessible bus program was an extension of existing service and not a new program. The agency did not, therefore, submit its plans to any citizens' groups.

The new schedules presented two problems: 1.) how to maintain on-time runs despite the anticipated delays for wheelchair riders; and 2.) how to avoid increased costs resulting from schedule modifications. BSDA anticipated the following potential problems:

- Increased stopping time could cause late running and overcrowding in peak hours.
- Longer run times could require additional layover time.

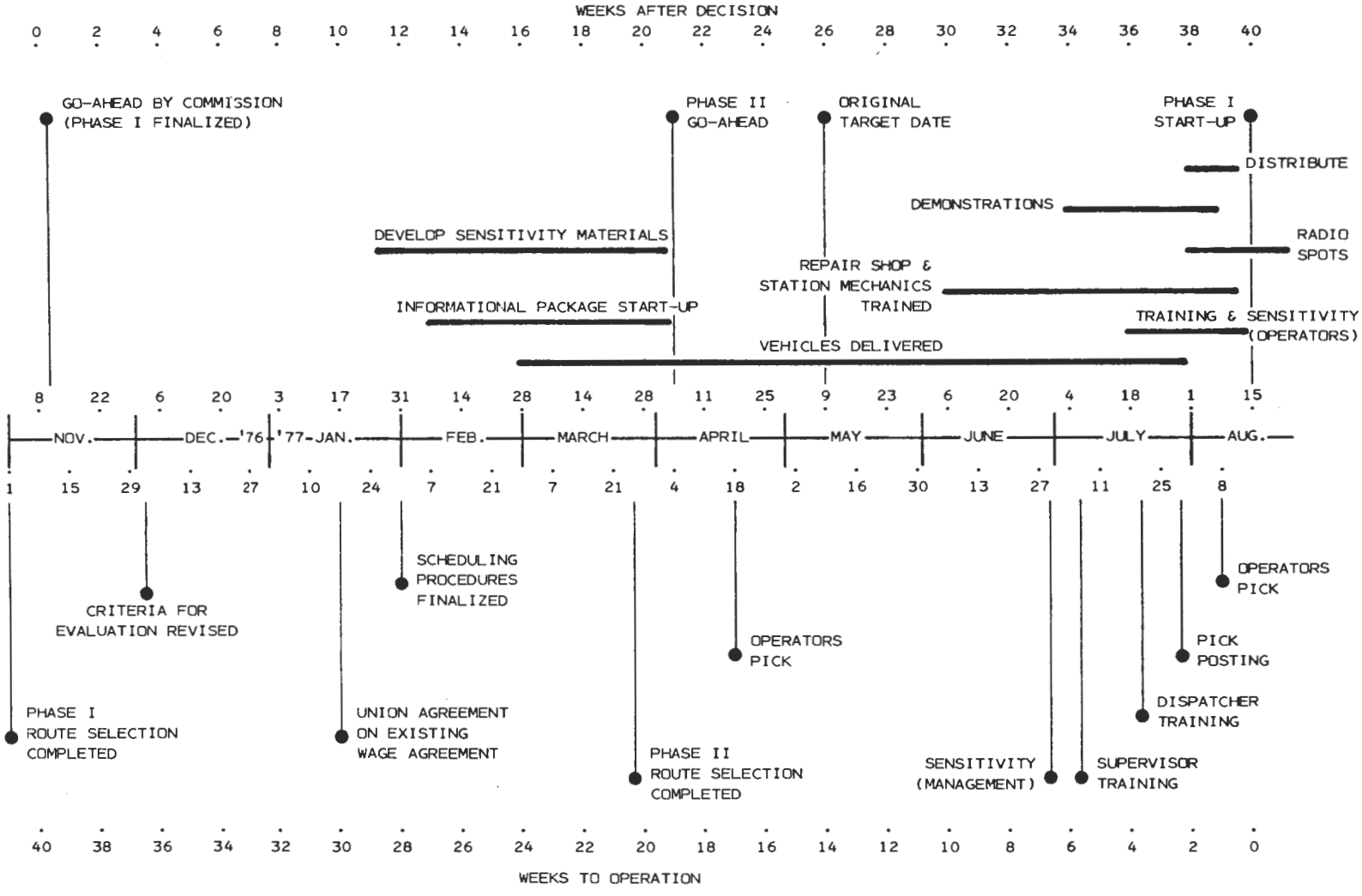


FIGURE 5-2 PROGRAM IMPLEMENTATION SCHEDULE

- Loss of interlining capability could increase the number of buses needed.
- Shortage of buses might require driver shifts to be performed on the road rather than at the garage, thus decreasing deadhead mileage but increasing platform hours.
- Equitable distribution of runs on branching routes would require more buses.

The degree to which these problems actually materialized is discussed in later chapters. Most, however, have not been of major significance, due, in large part, to the low wheelchair ridership.

The BSDA staff considered a number of scheduling options to allow for the extra boarding/alighting time anticipated for wheelchair riders. Since neither the number of riders, their distribution on routes or their daily occurrence could be predicted, it was decided that the only practical approach to maintaining scheduled service was to ensure adequate layover time at the end of each bus trip. The BSDA union agreement calls for a minimum of three minutes at one end of a round trip, and this is approached on most routes at some time during the daily schedule. The average time is approximately 12 minutes, as shown in Table 5-1. To insure that any delays due to wheelchair boarders could be absorbed while still allowing adequate recovery time in the schedule, BSDA increased the number of scheduled vehicle hours on the accessible routes at the beginning of each phase. Because there were other service adjustments made at the same time, the total increase in service hours cannot be ascribed solely to accessibility. BSDA did, however, make an estimate of the Phase I schedule increases due to accessibility. This increase is shown in Table 5-2.

Overall BSDA attributed a 2.7% increase in paid platform hours to accessibility. The change in running time hours accounted for over sixty percent of the increase and was primarily due to increases in the amount of layover time allowed. The substantial number of added relief hours was due to the utilization pattern of

| ROUTE | LAYOVER - PER TRIP (In minutes) MIN | MAX | AVG |
|---|---|---|---|
| 3016 - City Limits | 3 | 31 | 10 (1) |
| 3050 - Broadway | 3 | 30 | 11 (1) |
| 4140 - Broadway-Barracks Express | - | -- | -- |
| 3041 - Lee | 5 | 49 | 11 |
| 4041 - Northside Rapid | - | -- | -- |
| 3052 - Forest Park | 5 | 32 | 13 |
| 3020 - Cherokee | 3 | 51 | 14 |
| 4120 - Affton Express | - | -- | -- |
| 4220 - Watson Road Express | - | -- | -- |
| 3073 - Carondelet | 3 | 37 | 16 |
| 3070 - Grand | 3 | 37 | 9 (1) |
| 3095 - Kingshighway | 3 | 41 | 10 (1) |
| 3104 - Natural Bridge | 3 | 36 | 13 |
| 3119 - St. Louis Avenue | 4 | 25 | 10 |
| 3047 - Cross County | 3 | 37 | 10 (1) |
| 3097 - Delmar-Forsyth | 3 | 28 | 13 |
| 3091 - Olive | 4 | 30 | 12 |
| 4191 - Olive-Creve Coeur Express | - | -- | -- |
| 3021 - Tower Grove | 5 | 40 | 15 |
| 3530 - McKinley Bridge | 3 | 35 | 10 (1) |
| 3560 - Belleville-St. Louis | 3 | 37 | 10 (1) |
| 3706 - Alta Sita | 1 | 32 | 8 (1) |

[1] Per one-way trip

TABLE 5-1 LAYOVERS FOR BSDA ACCESSIBLE BUS ROUTES

| ROUTE | % CHANGE IN RUNNING TIME HOURS | % CHANGE IN RELIEF HOURS | % CHANGE IN PLATFORM HOURS |
|---|---|---|---|
| Forest Park | +3.34% | +1.13% | +4.47% |
| Alta Sita | 0.64 | 0.06 | 0.70 |
| Carondelet | 3.98 | 0.65 | 4.63 |
| Kingshighway | 3.70 | 1.47 | 5.17 |
| Belleville-St. Louis | 0.47 | 0.96 | 1.43 |
| Grand | 2.57 | 0.09 | 2.66 |
| Natural Bridge | -0.17 | 1.08 | 0.91 |
| Delmar-Forsyth | 1.57 | -0.03 | 1.54 |
| City Limits | -0.86 | -0.62 | -0.24 |
| McKinley Bridge | -0.48 | 3.68 | 3.20 |
| Average | 1.74% | 0.98% | 2.72% |

TABLE 5-2 PHASE I INCREASE IN PLATFORM HOURS ATTRIBUTED TO THE ADVENT OF ACCESSIBILITY

Source: BSDA

the limited accessible fleet. When changing drivers, vehicles had to remain on route rather than returning to the garage, as is normally the case. Consequently, relief drivers had to go to the route end to make the changeover, which took longer than usual. This added time is directly attributable to the partially accessible nature of the program, and would not occur in a fully accessible system.

The estimated 2.7% increase in platform hours resulted in a total of 245 additional vehicle-hours of service per week on the ten accessible lines in Phase I. BSDA estimated the same percent increase for Phase II, resulting in 519 extra paid platform hours per week. An additional 24,435 vehicle hours of service, due to the accessible vehicles, were thus scheduled by BSDA over the first 12 1/2 months of the project.

### 5.3.2 Development of Service Procedures

Between August, 1976 and November, 1977, BSDA produced a manual to govern its treatment of the elderly, wheelchair users, the blind, the deaf, the mentally handicapped and those with seizures and other medical problems. Another manual defined the basic operating procedures for the accessible service. (Ref. 5&6)

Some salient points from these manuals include:

- The kneeler feature found on all accessible buses was to be used during lift operation whenever the bus was away from the curb. If at a curb, the kneeler was not to be used, for fear that the lift would jam against the curb.

- Wheelchair persons were to be the last to board or alight at each stop. This particular procedure was changed during the course of the project in response to consumer advice. By allowing wheelchairs to board first, the wheelchair could be maneuvering into the hold-down while others were boarding, thus saving time.

- Only wheelchairs were allowed on the lift, due to lack of headroom at the outer end of the platform. Attendants were required to assist the wheelchair user onto the lift platform, then to enter the vehicle from the rear door while the wheelchair was waiting on the lift. The driver or a passenger would have to manually open the rear door from inside.

- In the event that both wheelchair positions were occupied, the driver was not allowed to let another wheelchair board. The wheelchair user would have to wait for the next accessible bus.

- At obstructed stops, the alighting wheelchair passenger was given the option of alighting in the street or of waiting for the next stop.

- The bus operator was not expected to assist the wheelchair passenger physically.

- Passengers using the fold-down seats in the area designated for wheelchairs could be requested but not compelled to give up their seat for a boarding wheelchair user.

In general, the procedures have worked well enough, considering the equipment problems and low ridership.

### 5.3.3 Staff and Operator Training

Because the accessible runs were part of the normal operators' pick, BSDA had to provide training for all of its 1,250 operators. This training was compulsory and was paid for at the regular rate and not the less expensive training rate.

Under BSDA's program, 15 senior operators from the instruction pool were given two days of instruction covering operating procedures, sensitivity, evacuation and mechanical aspects of the program. These instructors then trained the rest of the staff. For training materials, BSDA's Elderly and Handicapped Specialist developed a narrated slide show (15 minutes) and a program of 45 minutes of instruction on the bus. The 45 minutes covered emergency situations and all operational aspects of the lift.

The narrated slide show was a key ingredient in the staff sensitivity training. The slide show covered such topics as:

- Attitude--be patient, friendly, helpful.
- Wheelchair use and lift use procedures.
- Kneeling feature.
- Securement in the wheelchair station.
- Special disabilities--physical disability or informity, mental handicap, cerebral palsy, deafness, blindness, partial sight.
- Self esteem and dignity.

The entire staff was trained over a three week period. Training was also given to the supervisors, with extra emphasis on evacuation procedures, transferring passengers to seats, two-man hoists, etc.

Training of the mechanics and repairmen started in June of 1977. They were given on-the-job training in the main shop and 2.5 hour demonstrations and lectures at the stations. BSDA personnel worked with the bus manufacturer's service crews. Mechanics and repairmen were also exposed to the sensitivity program and basic operational sequences of the lift equipment.

### 5.3.4 Labor Relations

In the early spring of 1977, BSDA's operators expressed a series of concerns about additional work and responsibility required of the drivers who would be operating accessible vehicles. These concerns were resolved satisfactorily by management, through the training program, which was designed to reassure the operators about lift operations; and through informal negotiations. In addition, as mentioned earlier, changes were made in schedules. No wage increases were established for the accessible buses because the impact on the drivers' duties was anticipated to be marginal.

### 5.3.5 Marketing

BSDA's total marketing effort consisted of bus demonstrations, printing of new schedules, pamphlets, direct mailings, and advertising. The costs of the marketing program are given in Section 9.2.1.

Prior to start-up, approximately 35 demonstrations of the wheelchair buses were conducted at social service agencies and at public places such as shopping centers. These demonstrations were conducted on weekends, for maximum exposure to the general public as well as potential patrons. BSDA estimates that approximately 150 wheelchair persons boarded the buses during this period.

New route schedules were printed and distributed prior to start-up. Accessible routes on the new schedules were printed in red instead of black; in addition, accessible trips were marked with a star (*) and the international accessibility symbol was printed in the top left-hand corner of the schedule. The new schedules were packaged in a booklet/folder that explained the use of the system.

As part of the outreach to the general ridership, BSDA devoted the August, 1977 issue of its monthly pamphlet "Going Your Way" to the accessible pilot program. "Going Your Way" has a standard printing of 100,000 copies and is distributed on the buses.

Other distributions of printed materials included mailings through BSDA's standard mailing list of 30,000 persons and organizations and an informational package that was sent to all local elected representatives. The information package was also sent to specialized publications oriented towards the E/H target population.

BSDA advertised extensively on the radio and more modestly in the newspapers and on T.V. The agency has a standing schedule on the 5 major and 11 minor or special interest radio stations (e.g., ethnic, rock or classical music). Each of the 5 major stations plays at least 1 BSDA spot per day in prime time; the agency also buys approximately 30 spots per day for 1 week per month from the 11 other stations. Approximately 40% of all aired spots for the period of August through November 1977 were for the accessible bus program.

# CHAPTER 6

## DESCRIPTION OF WHEELCHAIR LIFTS AND IN-SERVICE PERFORMANCE

This chapter focuses on the design features of the wheelchair lift used on the BSDA buses, and the performance of this equipment on the vehicles when used in revenue service. The discussion of performance includes consideration of the maintenance requirements associated with the lift, and presents data on the availability of lift equipped vehicles over the first 12-1/2 months of operations. Also included is an analysis of garage assignments vs. availability, lift failures, lift design modifications and maintenance efforts. These analysis areas are intended to address the following evaluation issues:

- How did the lifts operate?
- How reliable were the lifts?
- Why did the lifts break down?
- What preventive maintenance was required?
- What was the trend of downtime?

The following chapter will address the reliability of the accessible service from the user's point of view.

### 6.1 VEHICLES AND ACCESSIBILTY EQUIPMENT

The specific design features of the wheelchair lift, as specified by BSDA, included:

- Front entry door location for lift
- Minimum door width (clear opening) of 32.5 inches
- Passive* lift mechanism not interfering with driver visibility

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*A passive lift installation is one that does not interfere with the normal use of the steps when the lift is not being operated.

- Lift to be TDT* design or approval equal
- Complete cycle time for lift not more than 60 seconds
- Adjustable cycle time (mechanic only) from 15 to 30 seconds
- Automatic devices to lock step in place
- Design to prevent accumulation of water, air or dust in the mechanism
- Audible and visual lift deployment warning signals near lift
- Emergency lighting interconnected to the lift mechanism
- Accelerator and brake interlocks with lift.

The vehicles purchased by BSDA through a competitive bidding procedure were manufactured by Flxible Corp. and designated as model number 53102. Overall dimensions were 40 feet in length and 102 inches wide. In addition to the lifts, the vehicles included some new mechanical features dissimilar to those already in the BSDA fleet, including a new engine and transmission; the installation of driver controlled, passenger activated, "push type" rear doors; and a kneeler feature.

The seating specifications for the accessible buses included provision for the placement and securement of two wheelchairs. The seating configuration for the lift equipped buses is shown in Figure 6-1. With two wheelchairs in place the number of available seats is 41. Without the wheelchairs, the maximum seating capacity in this configuration is 47 seats, based upon the use of

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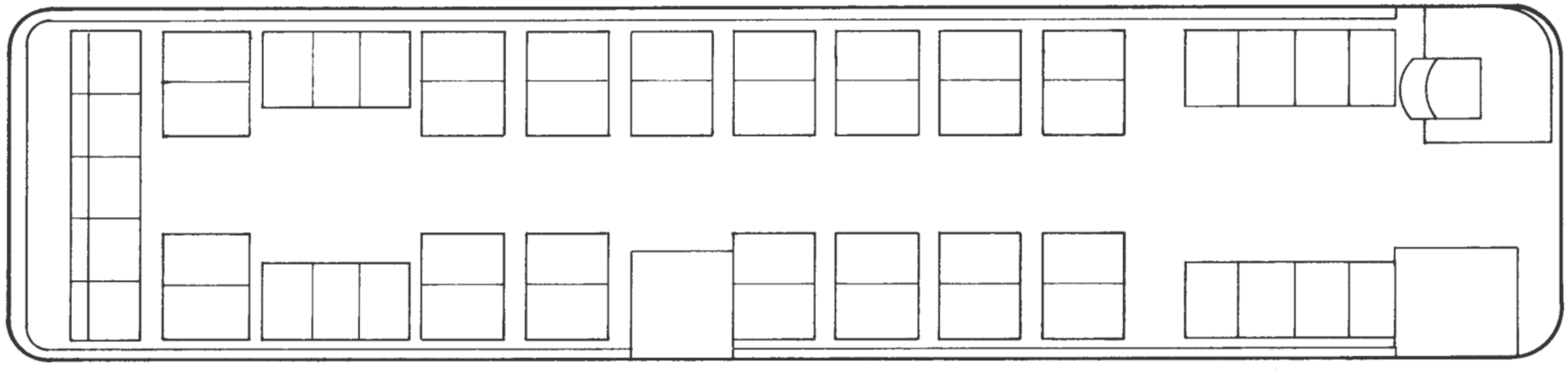
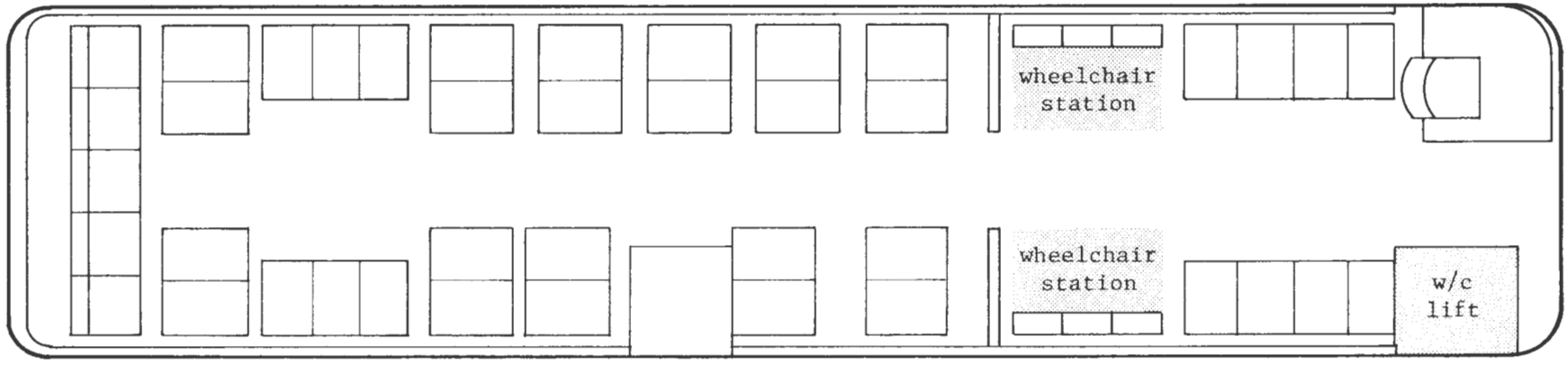
* Transportation Design and Technology Inc. (TDT) of San Diego were the first to design and manufacture a passive lift that could be installed as original equipment or retrofitted in the front doorway of a transit bus. The lift's essential design features are shown in Figure 6-3.



Regular Bus With 49 Seats




Wheelchair Bus With 47 Seats, or 41 Seats and 2 Wheelchair Stations

FIGURE 6-1 BSDA BUS CONFIGURATIONS

the six fold-down seats at the wheelchair locations. The standard BSDA seating configuration for these vehicles would provide 49 seats; thus, the use of accessible buses resulted in a loss of 2 seats. The standard BSDA configuration for non-accessible buses is also presented in Figure 6-1 for comparison.

Details of the wheelchair accommodations are shown in Figure 6-2. A triple longitudinal fold-down seat is provided on either side of the bus directly behind the front longitudinal seats. The swinging arm wheelchair restraint is attached to the underside of the fold-down seat. The substantial modesty panel ahead of the first row of transverse seats provides a restraint against rearward motion of the wheelchair. Safety belts attached to the modesty panel also provide for wheelchair passenger restraint.

The wheelchair lift is a passive installation using a mechanical design and major components supplied by TDT. Installation of the lifts in the vehicles was performed by Flxible on their production line. This was the first significant factory installation of lifts by any of the major bus manufacturers. Flxible assumed complete warranty responsibility for the installation and, in fact, made several modifications of their own to the installation. The modifications included a one piece hydraulic manifold of Flxible's own design in place of TDT's multiple unit, and Flxible's own solid state control sequencing system.

The general principle of operation of the lift may be seen in Figure 6-3. The platform is formed from two components:

A) An extending ramp which is stored under the steps. (The ramp has its own hydraulic cylinder and slides.)

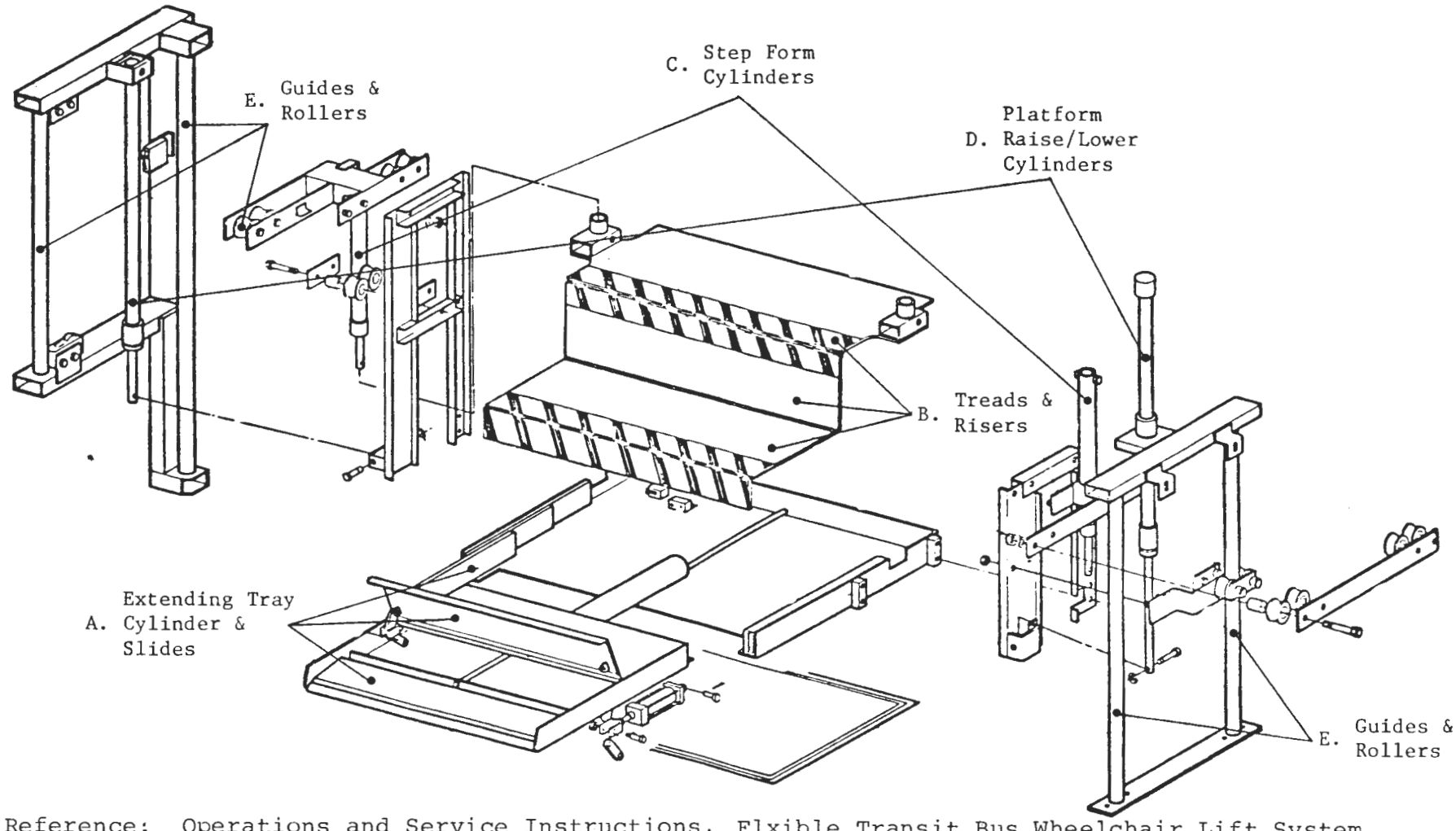
B) The treads and riser which form the first and second steps.

General view of station showing tip-up seat, rotating arm, and rear bulkhead panel with safety belt attachment.

Tip-up seat as deployed when station is not occupied by a wheelchair.


Detail of signalling system and signage at wheelchair station.

FIGURE 6-2 VIEWS OF WHEELCHAIR STATION




Reference: Operations and Service Instructions, Flxible Transit Bus Wheelchair Lift System S1-WOL-001, 6-20-77

FIGURE 6-3 MAJOR LIFT MECHANICAL COMPONENTS

The treads and riser are collapsed into a flat surface by the hydraulic cylinders (C) so that in conjunction with the ramp (A), a flat one-piece platform is created. The platform may be raised or lowered between the bus floor and ground level by the hydraulic cylinders (D), constrained by the guides and rollers (E). The extending ramp has an automatic barrier which is normally in the raised position and can only be selected "down" when the lift is at the "down" or "stow"* positions. Figure 6-4 shows the overall sequence and configurations described.

## 6.2 ASSIGNMENT OF VEHICLES TO GARAGES

All BSDA buses are operated from 3 large garages in St. Louis and 2 smaller garages at Belleville and East St. Louis in Illinois. Major repair facilities are at a separate location on Park Avenue in St. Louis. At all the facilities, access to the underside of the bus is via pits, as BSDA does not have hoists available. The pit greatly restricts access to the front stepwell area where the lift mechanism is situated; consequently, three pits at the central repair facility at Park Avenue were specially modified with side bays to provide more room to work on the lifts. No such facilities exist at the five garages. In practice, these arrangements have proved inadequate because of the large volume of repairs that the lifts have required.

The assignment of buses to specific garages has an impact on the availability of buses and the conduct of required maintenance work. Table 6-1 provides data, based on the overall bus schedules and fleet requirements for July 1978, on the assignment of buses to specific garages, and the resulting impacts of those assignments. From the data, two important factors can be derived:

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*The "stow" position refers to the stored position of the ramp under the steps.


Bus knelt with lift in stowed position.


Bus knelt with lift deploying. Note raised safety barrier.

Bus knelt with lift raised to floor level. Note raised safety barrier.

FIGURE 6-4 STAGES OF WHEELCHAIR LIFT DEPLOYMENT

| GARAGE | NON-ACCESSIBLE BUSES | | | | | | ACCESSIBLE BUSES | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | ASSIGNED BUSES | AM PEAK | BASE | PM PEAK | PEAK[1] TO BASE RATIO | SPARES[2] RATIO | ASSIGNED BUSES | AM PEAK | BASE | PM PEAK | PEAK[1] TO BASE RATIO | SPARES[2] RATIO |
| DeBaliviere | 243 | 206 | 79 | 209 | 2.64 | 16% | 40 | 32 | 27 | 32 | 1.19 | 25% |
| N. Broadway | 210 | 180 | 60 | 176 | 3.00 | 17% | 51 | 41 | 32 | 41 | 1.28 | 24% |
| S. Broadway | 197 | 164 | 49 | 163 | 3.35 | 20% | 51 | 41 | 34 | 41 | 1.20 | 24% |
| E. St. Louis | 72 | 60 | 24 | 60 | 2.50 | 20% | 8 | 6 | 5 | 7 | 1.40 | 14% |
| Belleville | 51 | 43 | 11 | 45 | 4.09 | 13% | 7 | 5 | 4 | 5 | 1.25 | 40% |

[1] Ratio of PM peak buses scheduled to base period buses scheduled.

[2] Spare vehicles as percent of PM peak requirements.

TABLE 6-1 BUS ASSIGNMENT DATA (July, 1978)

- o the peak to base ratio, which will have an impact on the size of the driver labor force and the time utilization of that labor.

- o the spares ratio, which is a direct measure of the number of spare vehicles as a percentage of the required number of vehicles.

The bus assignment data show that the accessible buses have a much lower peak to base ratio than non-accessible buses. This is a result of BSDA scheduling practices, in which a very large proportion of the accessible buses were kept in service during the base period. The result was higher utilization of the accessible buses as compared to the non-accessible buses. This high level of utilization also increased vehicle mileage, and indicates that the vehicles were not readily available for maintenance service during the off-peak hours.

The spares ratio for the accessible buses were generally higher than for the non-accessible buses. (BSDA's scheduling resulted in a different margin of spare accessible buses at the Illinois garages. This is primarily due to the small number of vehicles and the consequently larger impact of individual bus requirements. The assignments presented in Table 6-1 reflect BSDA policy as of July 1978.) Even so, BSDA found that the resulting spares ratios were totally inadequate, and they substantially reduced the scheduling requirements in Phase III to provide a much larger spares ratio.

## 6.3 AVAILABILITY OF ACCESSIBLE BUSES

An accessible bus is considered available when the bus can be placed in service with the wheelchair lift in fully operable condition. Data on the availability of accessible buses for the period from January, 1978 through August, 1978 were compiled from BSDA records. Figure 6-5 presents a graphical summary of that data for each individual garage. The number of accessible vehicles assigned to the garage and the scheduled requirements for

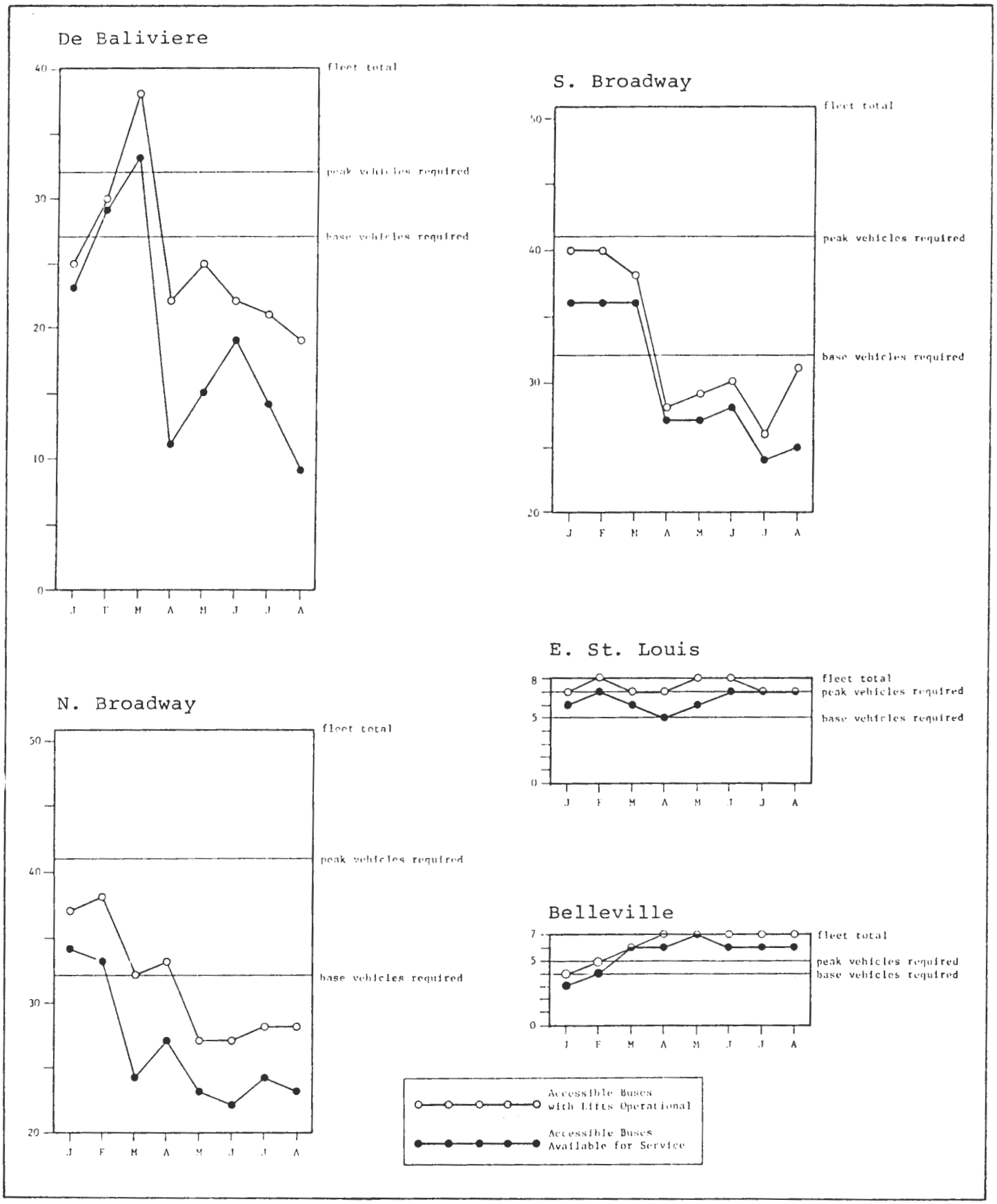


FIGURE 6-5 ACCESSIBLE BUS AVAILABILITY BY BSDA GARAGE: JANUARY - AUGUST, 1978

peak and base service are displayed. The number of available vehicles for each month is shown by the solid circles in the figure. In many instances the accessible buses were not available for reasons unrelated to the lifts. This information is also plotted in Figure 6-5 by displaying the number of accessible buses with lifts in operating conditions. By using both data curves, the graphs provide a convenient display of the impact of lift malfunctions in comparison to other types of accessible bus malfunctions. A summary of the overall availability of the BSDA accessible vehicle fleet for the same period is presented in Figure 6-6.

The three BSDA garages with the largest number of accessible vehicles never had sufficient vehicles available to meet their peak requirements (with the exception of a single month at the De Baliviere garage). There was also a definite trend of a reduction in the numbers of available vehicles, including a particularly rapid decline in March and April 1978, indicating that none of the three garages could even operate the base period accessible schedule. The data from the two garages with small numbers of accessible vehicles assigned show dramatically different results. For these two garages the trend was one of uniform or slightly increasing availability over the same time period. They were also able to operate sufficient numbers of accessible vehicles to meet their base period requirements virtually all through the time period. The difference between the garages with small and large numbers of accessible vehicles is attributed to a number of factors which cannot be accurately quantified. Physical congestion at the larger facilities, variations in schedule requirements compared to the number of buses available, and personnel motivation are all possible factors.

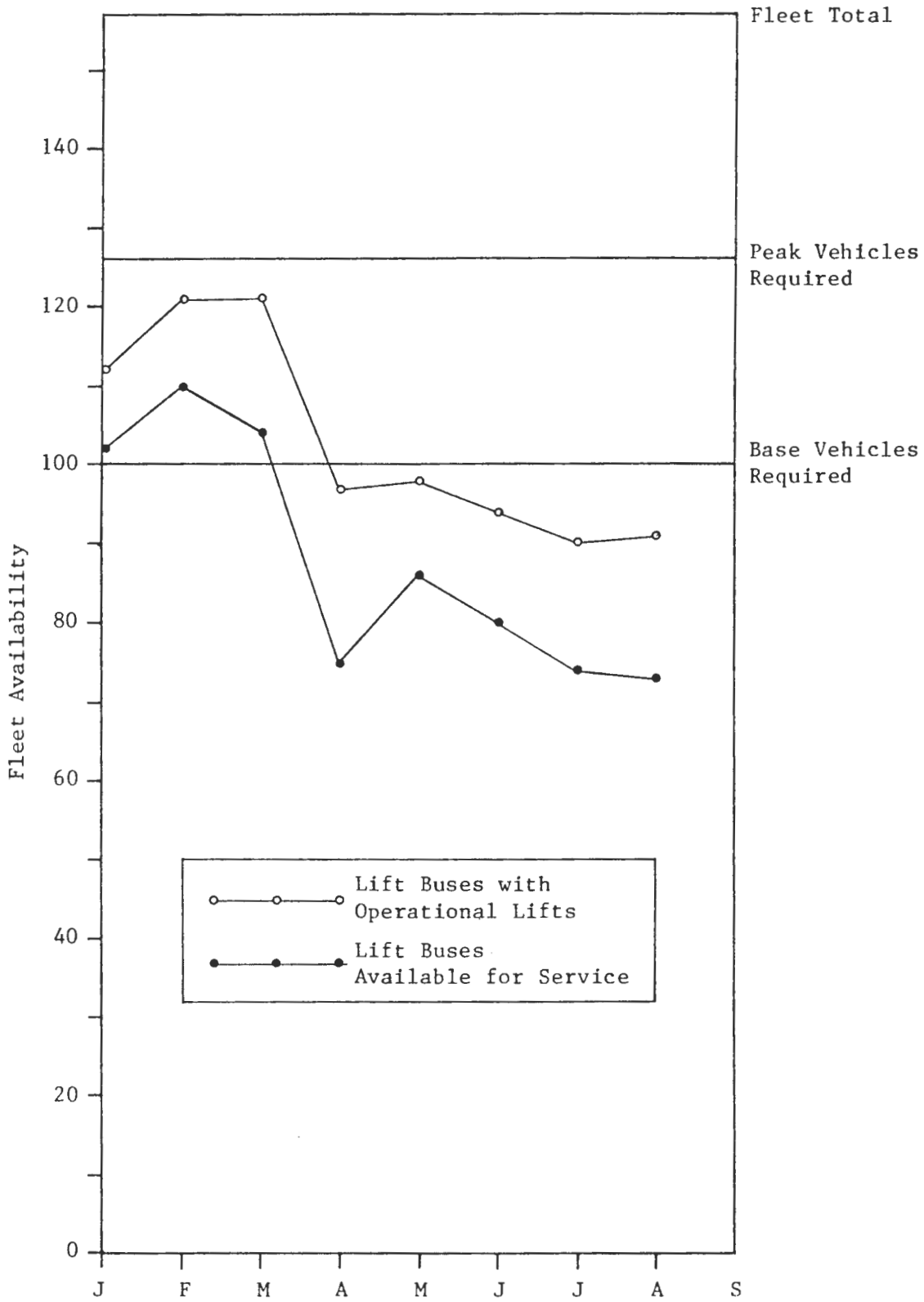


FIGURE 6-6 OVERALL ACCESSIBLE BUS AVAILABILITY: JANUARY - AUGUST, 1978

One aspect of the availability issue which has a great bearing on the results of lift problems discussed in this chapter deals with the bolting of the lifts in place. This procedure, which completely disabled the lift, was used to prevent a condition known as drifting. Drifting, described in Section 6.5, could create substantial hazards and lead to accidental damage to the lifts. The bolting of the lift temporarily resolved the problem, allowing the bus to be used in regular service as a non-accessible vehicle. When a large number of accessible vehicles started having problems with their lifts, garage personnel, attempting to keep a sufficient number of buses on hand, would bolt up the malfunctioning lifts. Thus, these (non-accessible) vehicles could be sent out on the routes or kept as readily available spares.

The availability data show that three of the garages had severe problems in maintaining their overall schedules. For example, the North Broadway division garage was assigned a total of 210 non-accessible and 51 accessible buses. Their peak vehicle requirement to operate all routes amounted to 221 vehicles; therefore, they had a total of 40 spare vehicles. Referring to Figure 6-5, it can be seen that the number of accessible vehicles alone that were unavailable for accessible service at North Broadway was in the range of 20 to 30 vehicles. If all of the vehicles with lift problems were sent off to the repair facility, the North Broadway garage would be operating with an unacceptably low number of spare vehicles. Thus, to maintain some reasonable level of normal service, it is obvious that the garages found it necessary to bolt a number of lifts, and to use the malfunctioning buses in non-accessible service and some scheduled accessible service.

The only reliable available data on the bolting of lifts is from the beginning of January 1978. This data, which is presented in graphical form in Figure 6-7, clearly indicates the magnitude of lift bolting. The available data does not allow a distinction of the individual vehicles on which lifts were bolted at each garage.

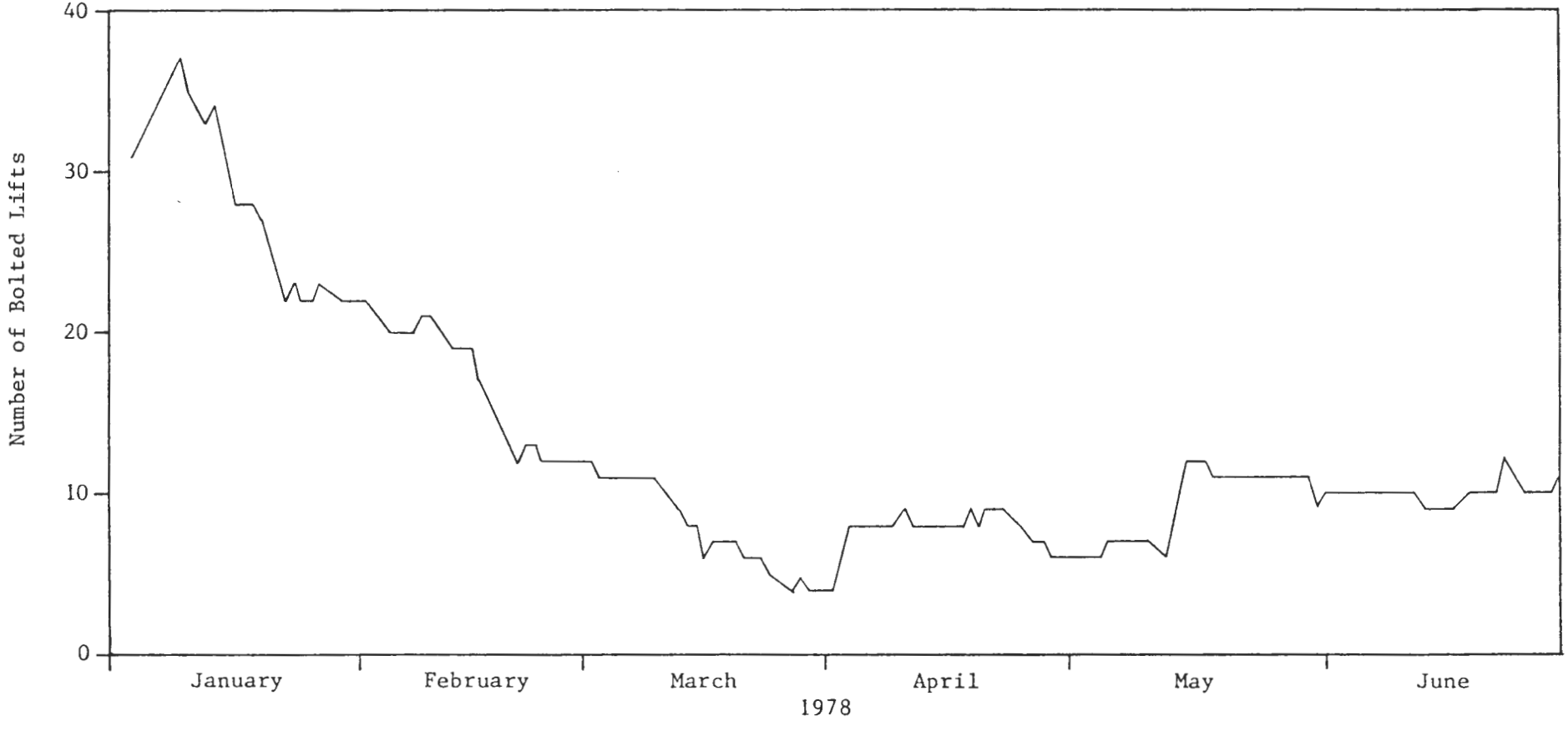


FIGURE 6-7 NUMBERS OF BUSES WITH BOLTED LIFT: JANUARY - JUNE, 1978

Thus, in interpreting the data presented on availability, it should be remembered that a part of the lift unavailability was due to bolting, and was not always indicative of a lift failure on the road.

## 6.4 PREVENTIVE MAINTENANCE ON LIFTS

A six-step preventive maintenance program for the wheelchair lift was outlined by Flxible in their Operation and Service Instructions for the buses. These instructions were first prepared on June 20, 1977 and were subsequently revised on March 6, 1978 (Ref. 7). The required preventive maintenance tasks and intervals as presented in the revised instructions are shown below:

| PREVENTIVE MAINTENANCE TASK | | RECOMMENDED INTERVAL |
|---|---|---|
| 1. | Test Operation of Lift (Check for binding, physical damage, leaks and jerky operation, repair as necessary). | Daily |
| 2. | Check Reservoir Fluid Level (Check with ramp in stowed position, and lift system de-activated). | Daily (Use only API Service SE Engine Oil) |
| 3. | Clean and Lubricate Lift Track Assembly and Step Hinges and Lock Linkage. | Weekly |
| 4. | Inspect for damaged or loose wires, tubing, or connections, and physical damage. | Weekly |
| 5. | Replace Hydraulic Filter Element | Every 6 months |
| 6. | Drain and Refill Hydraulic Fluid and conduct servicing and operating test. | Every 6 months (Use SAE10W, API Service Engine Oil) |

The first task was later increased in Flxible's Operator's Manual to a visual examination every four hours as a result of the drifting problem. The most critical maintenance activity was lubrication of the lift track assembly (Task 3 above).

Originally, a dry graphite-type lubricant was recommended for the assembly, but, in the light of experience, a heavier grease was used.

Since the BSDA preventive maintenance schedule is geared to a mileage base, BSDA developed a schedule based upon 1,500, 9,000 and 27,000 mile intervals to integrate lift work with their other programs. These corresponded roughly to 2 week, 3 month and 9 month intervals. Initially BSDA made substantial time allowances for the work. Five minutes was allowed for cycling and 30 and 60 minutes for the 1,500 and 9,000 mile inspections. Subsequent to June 30, 1978 the daily cycling was eliminated and 5 and 10 minutes were allowed for the 1,500 and 9,000 and 27,000 mile inspections respectively. This markedly reduced the attributable preventive maintenance costs.

## 6.5 DESIGN MODIFICATIONS TO LIFTS

As stated earlier, the lift system was modified from the original TDT design by the manufacturer. Flxible assembled the lifts directly into the buses on the production line and assumed all direct warranty and responsibility. As a result of the operational problems encountered, Flxible carried out 13 further modifications to the lift design after the vehicles reached the BSDA property. The major modifications are summarized here because they are indicative of the developmental nature of the lifts. The low availability of the accessible buses was clearly related to these developmental problems.

The first and most significant design problem was drifting of the ramp and step sections of the lift. The ramp section was supposed to remain in a stored or stowed position under the steps when the lift was not in use. The outward drifting movement of the ramp section constituted a definite safety hazard since it projected out from the bus. The downward drifting presented a potential road hazard due to grounding and a passenger hazard due to the

increased step height thereby created. A number of design modifications were made to try and solve this problem, none of which have proved entirely successful during the evaluation period. The modifications included:

1) Installation of an electrical circuit time delay, allowing the pump to operate for two to three seconds, thereby building up pressure in the ramp extend cylinder and consequently preventing ramp movement. This time delay was estimated to have cured 50% of the ramp drifting problem.

2) Installation of a higher pressure (300 lb.) check valve in the hydraulic system. This modification was not made on all vehicles because the higher pressures led to an increased rate of hydraulic pump failures.

3) Installation of a positive stow lock. This modification involved a mechanical locking device to hold the ramp in place. The lock was successful in preventing drift. However, it was found that in certain instances the lock would fail to disengage, resulting in damage to the lift upon activation. A further modification was required to add a microswitch which would prevent lift activation unless the stow lock was disengaged. This modification had been made on 108 buses by the end of July, 1978. Flxible planned to make this modification on all accessible buses.

4) Installation of an automatic recovery system has also been tested. The system recycles the lift to a fully stowed position once it is sensed that the ramp has moved more than one-half inch. The system was installed in one bus in November, 1977 and remained in operation until May, 1978 when the bus was involved in a serious traffic accident. Since the system performed well for more than 35,000 miles, plans were made for installation of ten additional units for extended testing.

A second significant design problem related to the inability of certain wheelchair users to move onto the lifts due to the thickness of the lift entry edge. This problem had been noted in a number of other communities which were using TDT lift designs with a similar edge configuration. The design modification was a simple one involving installation of an edge with more taper, which reduced the entry angle and force required to wheel onto the lift.

A third design problem involved failures of the ramp track stops which constrain the ramp from moving further once it is fully extended. This problem was attributed (by TDT) to the lift control system designed by Flxible. The design modification to solve this problem was also a simple one involving the installation of additional ramp track stops to alleviate the loading on the existing stops.

There were also a large number of relatively minor design problems relating to weather protection of lift components, wiring and mechanical installation of the lift, and improved maintenance. Two other minor safety related problems involved a potential hazard with the cylinder towers and the loosening of handrails mounted on the lift. Even though all these problems are designated as minor ones, their resolution involved taking vehicles out of service, thereby reducing overall accessible vehicle availability.

## 6.6 ANALYSIS OF LIFT PROBLEMS AND FAILURES

The modifications previously described were solutions to specific identifiable problems in the basic design of the lift. In this subsection, the focus is on the general nature and characteristics of all types of lift problems and failures, including any changes in the patterns over time. The analysis of lift problems and failures was complicated by the following factors:

- The design modifications to the lifts were accomplished gradually over a period of time and in some instances only a portion of the vehicle fleet was modified.

- The two phases of accessible bus service created a wide disparity in the mileage and initial utilization between the first 60 vehicles delivered and the subsequent 97 vehicles.*

To the extent possible, both of these factors have been considered in the following analyses and presentation of results. Unless otherwise noted, the data for all results presented in this section are from the BSDA repair records file.

One major indicator of vehicle reliability was the number of times that a vehicle had been sent to a repair facility. The number of visits to correct or repair the lifts for all 157 accessible buses have been aggregated and are presented in Figure 6-8. The upper part of the figure provides a complete profile of lift repair visits for each bus in the accessible fleet. The data for Group A and Group B are noted separately because of the accumulated mileage differences. On the average, the buses in Group A had accumulated approximately 55,000 miles by the end of September, 1978, whereas those in Group B had accumulated approximately 40,000 miles. The data presented show a highly irregular pattern of repair visits for all vehicles but with a significant trend of more repair in Group A. The lower half of Figure 6-8 presents the

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*The first 60 vehicles delivered were used in the initial phase of the accessible bus program which has been designated as Phase I. This group is referred to as Group A while the second group of 97 vehicles delivered subsequently is referred to as Group B.

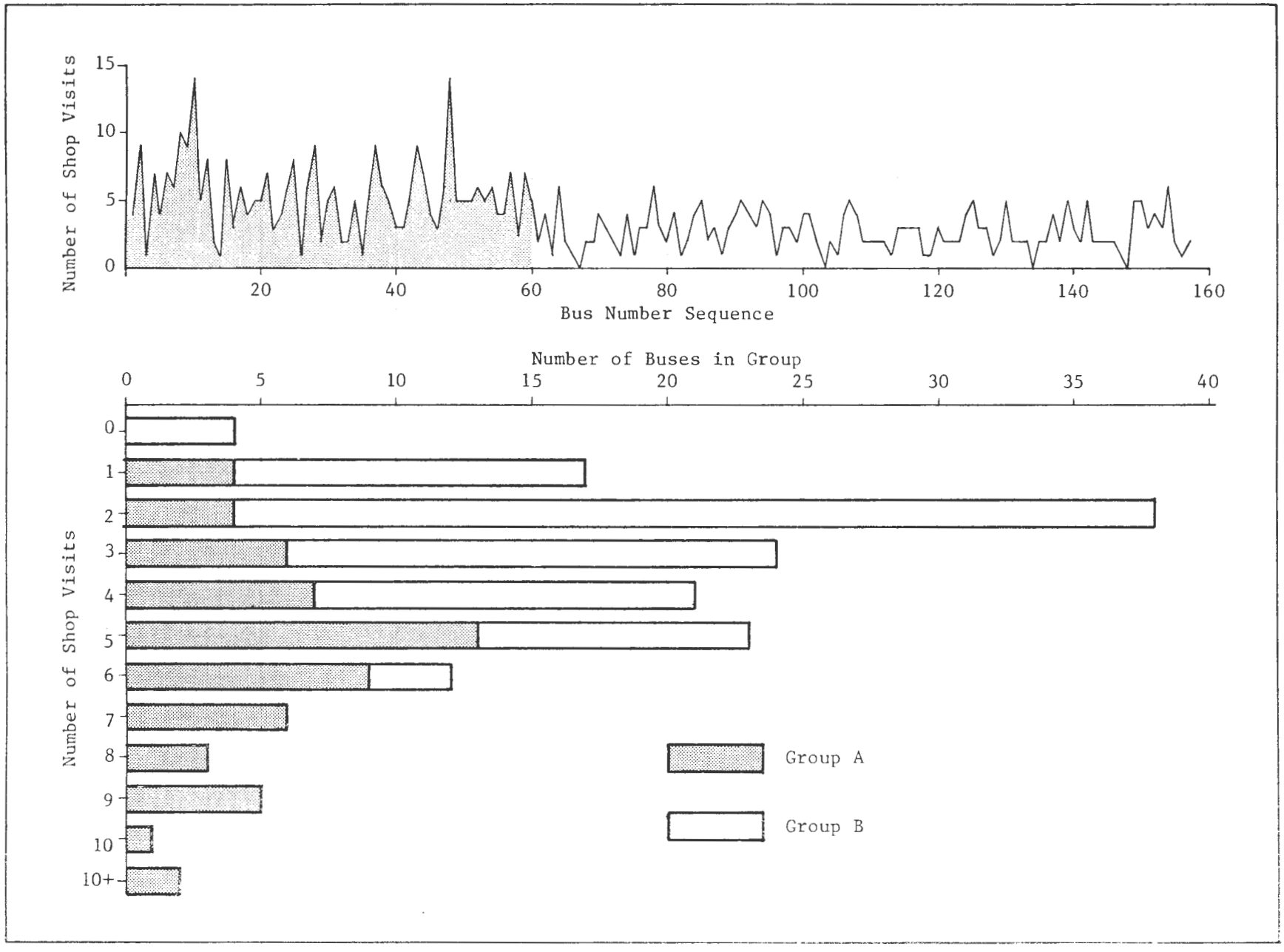



FIGURE 6-8 SUMMARY OF FLEET REPAIR FREQUENCY

same data except that the buses have been divided into categories based upon the number of visits to the repair facility. Here the trend is much more evident, showing clearly that Group B has had substantially less problems. The cumulative results for both groups of vehicles are presented in Table 6-2. On a per bus basis, Group A vehicles were sent to the repair facility at a rate twice that of Group B. When the data is normalized by the average mileage, the ratio of repair visits is reduced to 1.5. It should be noted that on one repair visit there may have been more than one lift problem which had to be fixed.

The results of the above analysis of the repair data clearly indicate that Group A buses definitely had a higher proportion of lift problems and failures. This conclusion holds even when the mileage effects are factored out. The major reason for this result is attributed to the fact that the lift installation still had substantial development problems when it was introduced into service. The first 60 units put into service provided a test of the installation, and helped pinpoint and solve some of the development problems. This can be further substantiated from the more detailed analysis of lift failures which follows.

The bolting of the lifts had an impact on the above conclusions since a vehicle could accumulate mileage without use of the lift. This effect is not believed to be significant since the number of lifts in bolted condition averaged about 10 vehicles after February 1978 (refer to Figure 6-7). This number is a small percentage of the total accessible fleet. It is not known whether the bolted lifts were proportionally distributed between Group A and B buses. Another unknown factor is the rate at which the design modification programs were introduced and whether they too were proportionally distributed between the two groups of buses.

| BUS GROUP | A | B | TOTAL |
|---|---|---|---|
| # BUSES IN GROUP | 60 | 97 | 157 |
| # SHOP VISITS | 326 | 261 | 587 |
| # VISITS/BUS | 5.43 | 2.69 | 3.74 |
| RATIO TO GROUP A | 1.0 | 0.496 | 0.689 |
| AVERAGE MILEAGE | 55,000 | 40,000 | 46,000 |
| RATIO TO GROUP A PER MILE | 1.0 | 0.682 | 0.824 |

TABLE 6-2 RELATIVE FREQUENCY OF REPAIR

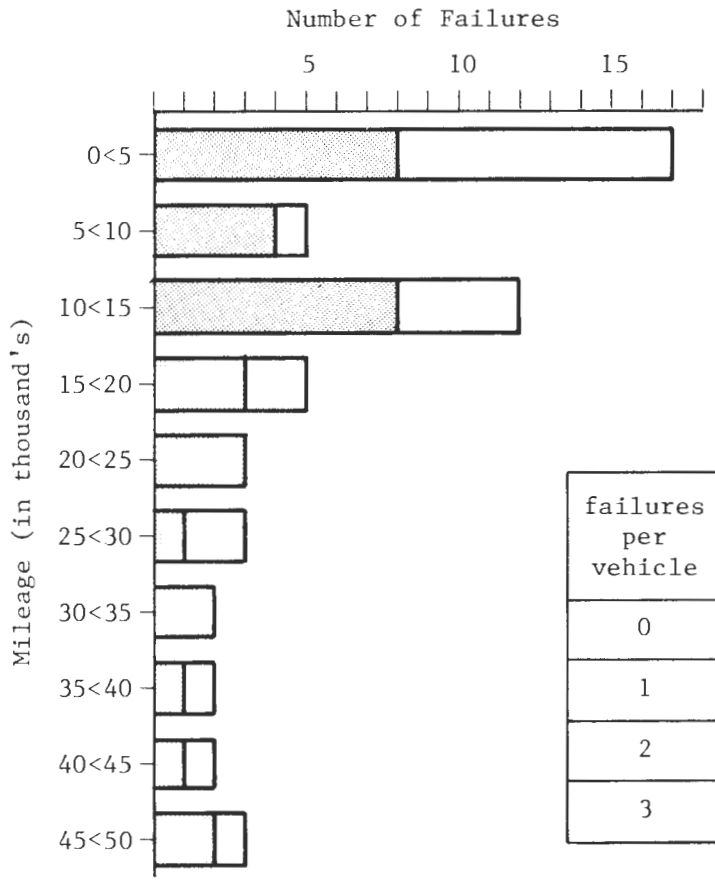
### 6.6.1 Detailed Description of Lift Failures

The lift failures as described in the BSDA repair records have been categorized into three areas -- electrical, hydraulic and mechanical systems. Table 6-3 presents a summary of the number of repairs of some major components in each category. The number of components replaced in each category verifies the serious problems that BSDA had with lift failures. In the mechanical category, there were more than 1.5 major component failures for each accessible vehicle.

In the category of electrical systems, most failures involved the control box circuit board assembly and the five micro-switches which control the movement of the lift. A detailed analysis of the failures of both components was performed; the results are presented in Figures 6-9 and 6-10. In both instances the failures are presented in terms of the mileage at which the failure occurred and by groups of ten vehicles. The results of the analysis for both mileage and bus group are strikingly similar. There was a high instance of failures at the lower mileages indicating that the components were not reliable in the particular vehicle environment. The analysis of failures by bus group clearly indicates that Group A buses were afflicted by more failures. The control box failures indicate a continuing failure rate at higher mileages which is approximately the same for both groups of buses. The continuing failure rate appears to be significant but not serious. The data for the micro-switches (Figure 6-10) shows a much higher failure rate at low mileages. The ramp extend micro-switch was the most prone to failure, a condition which can be attributed to its exposure to dirt and moisture.

| | NUMBER OF REPAIRS |
|---|---|
| **ELECTRICAL SYSTEMS** | |
| Control Box/Circuit Board | 53 |
| Microswitches | 45 |
| **HYDRAULIC SYSTEMS** | |
| Ramp Extend Cylinders | 32 |
| Hydraulic Manifold | 7 |
| Pump Related | 29 |
| **MECHANICAL SYSTEMS** | |
| Slides | 107 |
| Skid Pan | 157 |
| Sensitive Edge | 56 |

TABLE 6-3 SUMMARY OF SOME MAJOR COMPONENT REPAIRS




| failures per vehicle | Group | | total for fleet |
|---|---|---|---|
| | A | B | |
| 0 | 35 | 76 | 111 |
| 1 | 20 | 19 | 39 |
| 2 | 5 | 2 | 7 |
| 3 | 0 | 0 | 0 |

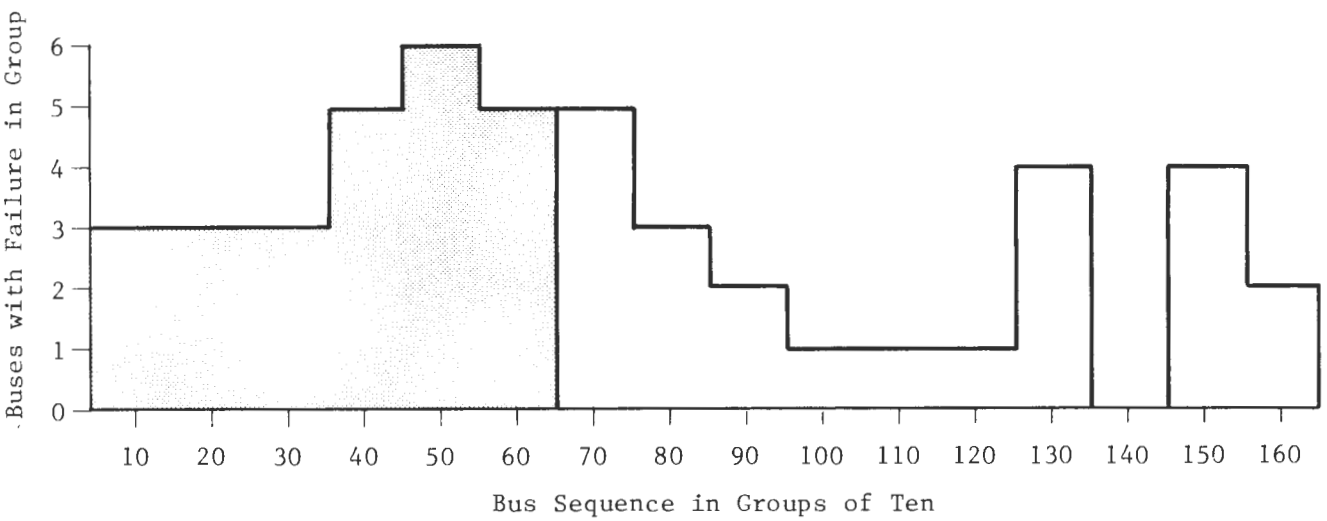
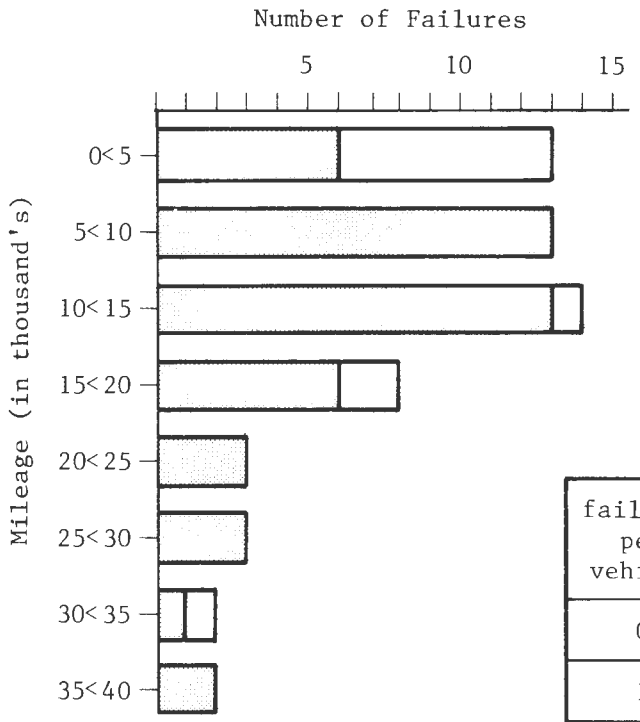



FIGURE 6-9 SUMMARY OF CONTROL BOX FAILURES




Group A

Group B

| failure per vehicle | Group | | total for fleet |
|---|---|---|---|
| | A | B | |
| 0 | 29 | 87 | 116 |
| 1 | 27 | 10 | 37 |
| 2 | 4 | 0 | 4 |
| 3 | 0 | 0 | 0 |

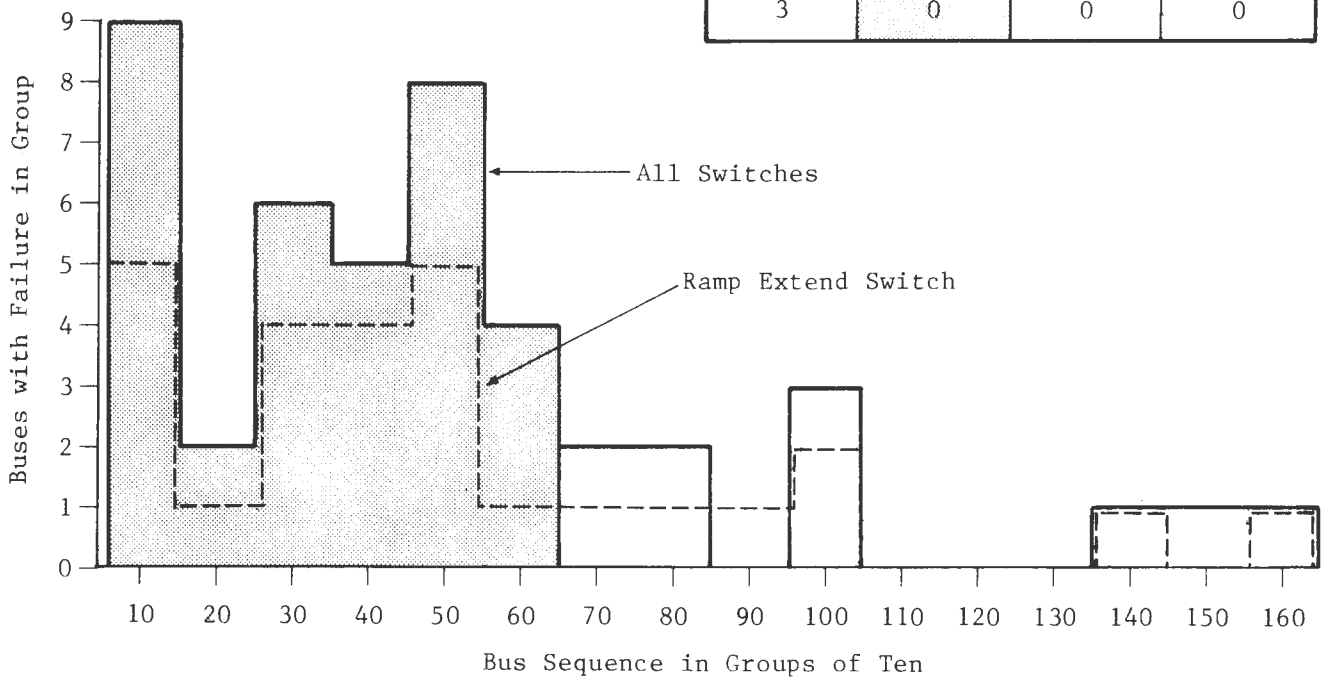
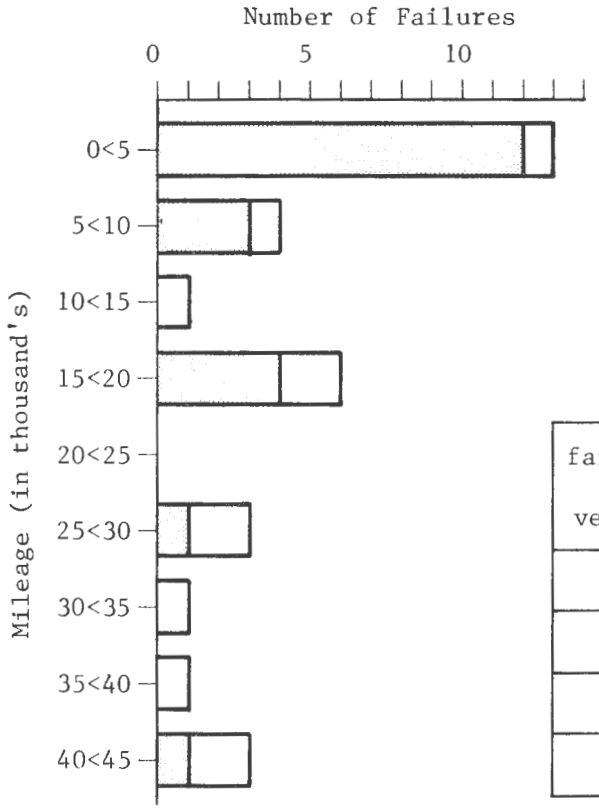



FIGURE 6-10 SUMMARY OF MICROSWITCH FAILURES

It is of interest to note that the change in failures between Groups A and B is more pronounced in the case of micro-switches. This is largely due to two factors. First, many of the later Group B vehicles were equipped with waterproofed switches on the production line. Second, a shortage of the waterproof switches led to Group A vehicles having their failed switches replaced with similar non-waterproof switches. Consequently, there were a number of subsequent failures. The overall results on electrical systems failures indicates that the reliability of the components was not adequate, leading to a substantial low mileage failure rate. The electrical component failure rate at higher mileage provides some evidence that the reliability problem still exists but has become manageable.

Various components of the hydraulic system were prone to failure including the ramp extend cylinder, and the hydraulic manifold. The ramp extend cylinder was the most failure-prone single component in the hydraulic system. A detailed analysis of these failures resulted in the data as presented in Figure 6-11. The data show a history of frequent low mileage failures, particularly for the Group A buses. There also appears to have been a continuing problem with a number of ramp extend cylinder failures as the vehicles accumulated more mileage. This is attributed primarily to two problems: 1) accidental damage caused when the positive stow lock failed to disengage (noted earlier under lift modifications) and; 2) overloads transmitted through the skid pan when it was damaged. The stow lock portion of the problem was corrected with a design modification involving installation of a micro-switch, but the accidental skid pan* damage leading to ramp extend cylinder failure appears to be an inherent lift design and installation problem. The cost of replacement of the cylinder (labor and parts) is estimated at $500; therefore, a continuing record of accidental damage is of serious concern.

*Skid pan refers to the sheet metal under the extending ramp and slide housings that forms an underside closure panel when the lift is in the stowed position. In repair records it was referred to as a pan, plate or tray.




Group A

Group B

| failures per vehicle | Group | | total for fleet |
|---|---|---|---|
| | A | B | |
| 0 | 42 | 86 | 128 |
| 1 | 16 | 9 | 25 |
| 2 | 1 | 1 | 2 |
| 3 | 1 | 0 | 1 |

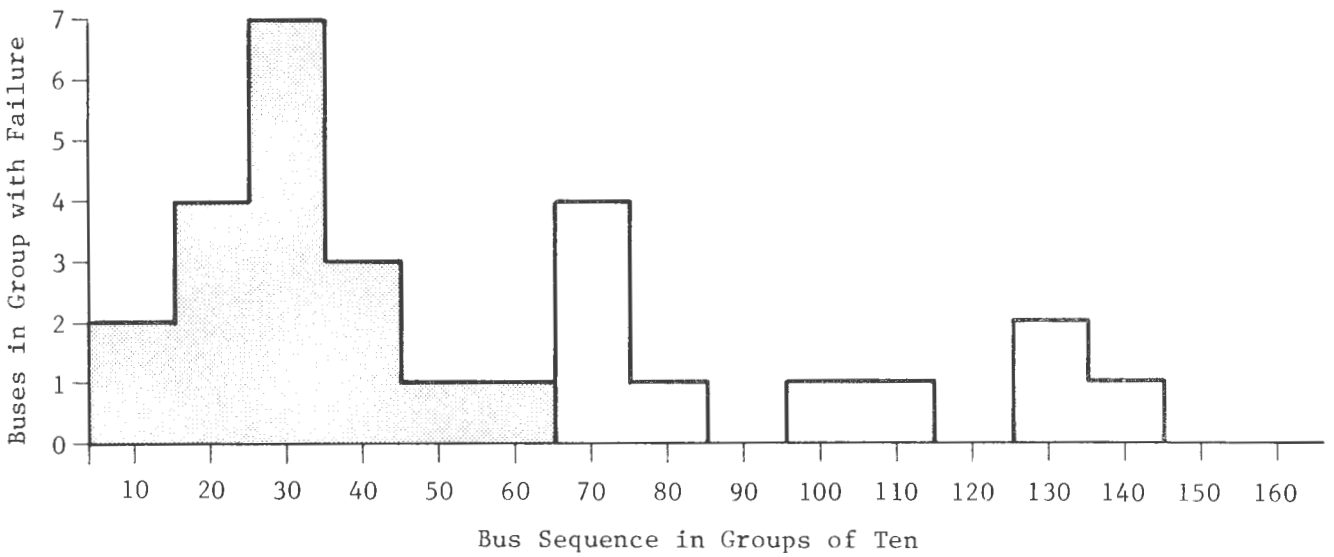



FIGURE 6-11 SUMMARY OF RAMP CYLINDER FAILURES

Another hydraulic component which is important because it is a high cost item is the hydraulic manifold. Replacement costs are estimated at $2,100 for labor and parts. The manifold was also subject to early development problems due to off center drilling by the supplier. This created an internal leakage problem which was suspected to be contibuting to the ramp drift problem. After the replacement of manifolds was completed there were further failures of seven units in service.

The major problem in the mechanical systems area was the problem of drifting. This problem was discussed extensively in the subsection on lift modifications. Another significant mechanical problem area involved the placement of the extending slides which support the outer platform. Analysis of the slide failure was complicated by association with other problems. In this case, approximately two-thirds of the repairs involving slide replacement also involved repairing damage to the skid pan. In those cases where the skid pan was not repaired, other damage was often reported, including bent steps and sensitive edge replacements. The results of a detailed analysis of slide replacements is presented in Figure 6-12. The data show that the rear slides were much more prone to failure than the front slides. This is attributed to their increased exposure to dirt and moisture. Design modifications to solve this problem included installation of mudflaps and a change in lubricant. The data presented in the figure do not give a clear indication of the effects of this modification. The distribution of slide failures for the first 60 vehicles does not have a strong correlation to the vehicle mileage. Further analysis on a per bus basis and considering only the first 45,000 miles provides a clearer picture. Table 6-4 shows that the incidence of front slide failure is only slightly lower for the second group while the rear slide failures were reduced by almost two-thirds. The modifications were obviously successful in reducing, but not eliminating, the problem.

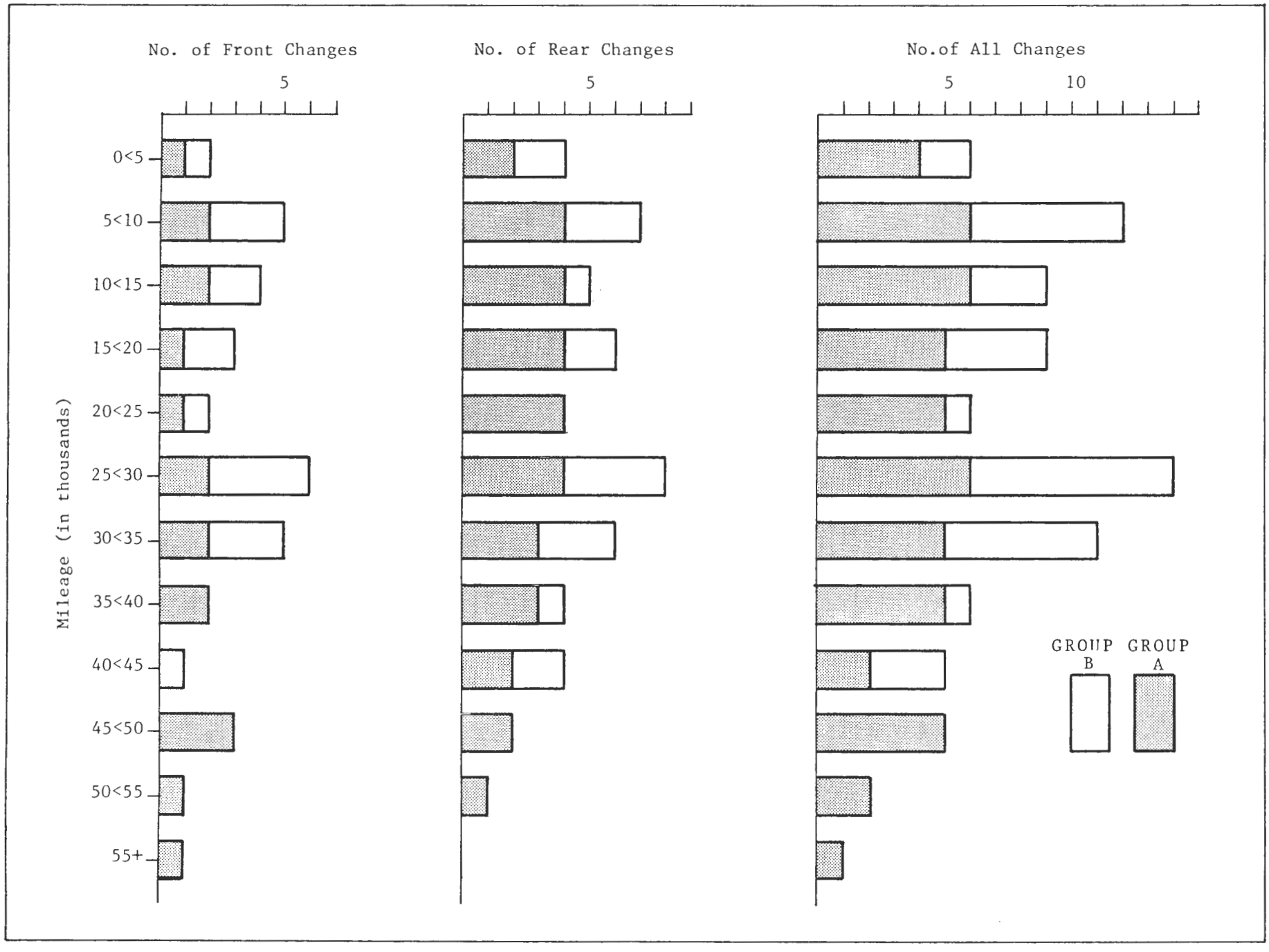



FIGURE 6-12 SUMMARY OF SLIDE CHANGE DATA

| BUS GROUP | A (60 BUSES) | | | B (97 BUSES) | | |
|---|---|---|---|---|---|---|
| SLIDE LOCATION | Front | Rear | TOTAL | Front | Rear | TOTAL |
| # CHANGES | 13 | 30 | 43 | 17 | 18 | 35 |
| # CHANGES/BUS | 0.216 | 0.500 | 0.716 | 0.175 | 0.186 | 0.361 |

TABLE 6-4 RELATIVE FREQUENCY OF SLIDE CHANGES IN FIRST 45,000 MILES

Repairs involving the skid pan have been a major item and Figure 6-13 shows the monthly distribution of the number of these repairs. The damage was usually caused by failure of the stow lock to disengage which resulted in distortion of the surrounding components. The increased number of repairs when more lifts were brought into operation is evident. There was a progressive decline in the number of repairs through the summer of 1978 although the number of lifts bolted up did not change substantially. (Figure 6-7). This improvement is attributed to the installation of a micro-switch on the stow lock (referred to in Section 6.5) which is intended to prevent accidental damage if the stow lock fails to disengage.

The extent of the skid pan problem may be seen in Figure 6-14, which shows that incidents occurred on more than 40% of the buses. The pan was straightened and welded rather than replaced and often this procedure occurred more than once. Figure 6-14 also shows the distribution of mileage at which the original repair was made and the mileage increment for subsequent repairs. This mileage increment is substantially lower than that for the original repair and is attributed to a loss in strength and rigidity due to the straightening and welding involved. This conclusion is reinforced by the fact that only one subsequent repair was required on vehicles where the skidpan was replaced rather than repaired.

Since the skidpan is a relatively expensive item ($360) and also requires several hours for replacement, the relatively small increase in time required for straightening and welding would appear to justify the saving in capital costs. The much higher frequency (about 5:1) with which subsequent repairs were required when the straightening process was used would, however, increase overall costs substantially. The reduced fleet availability produced by this high rate of repair was obviously a major factor in BSDA's lack of ability to provide service.

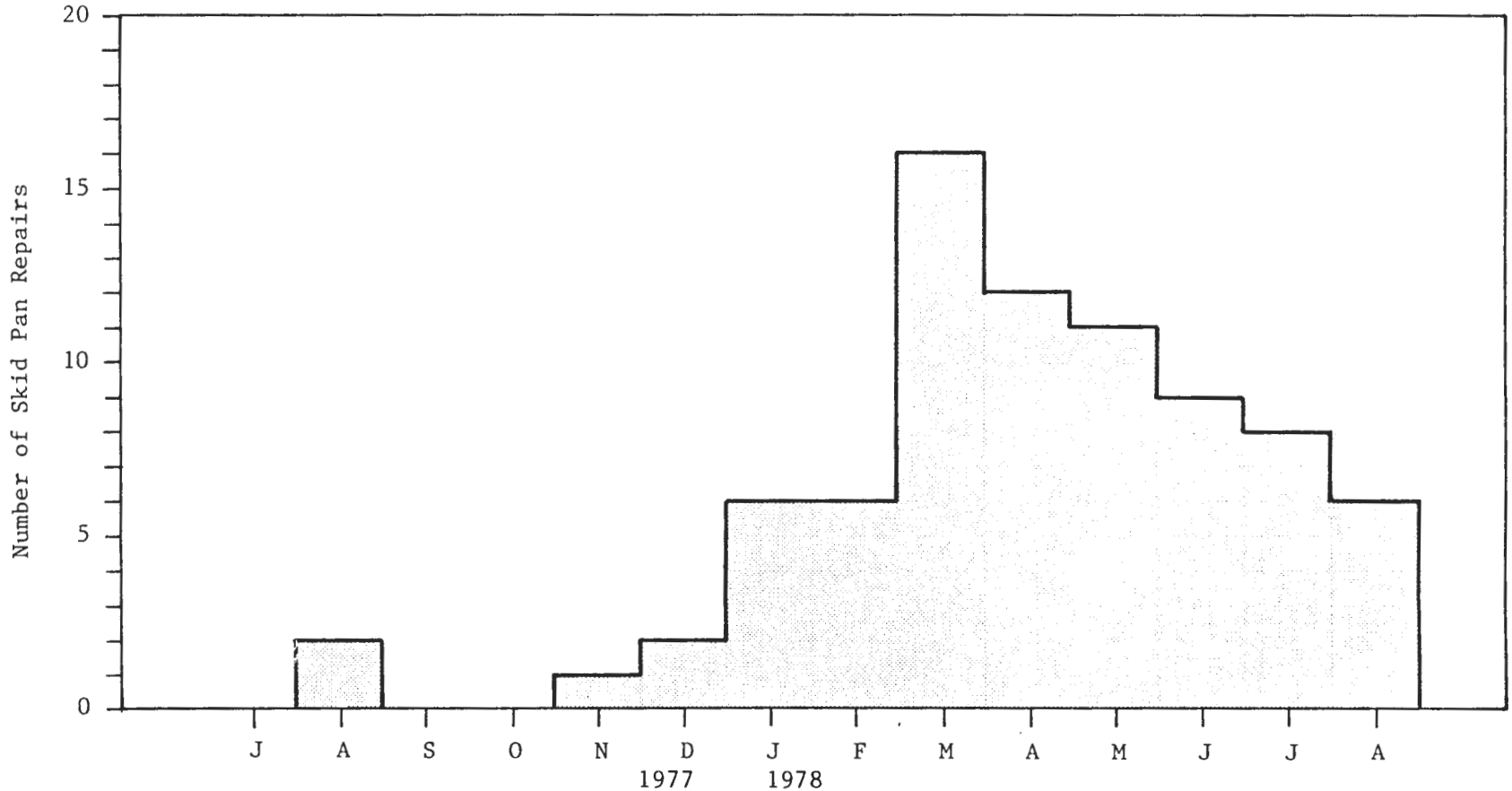



FIGURE 6-13 SKID PAN REPAIRS BY MONTH

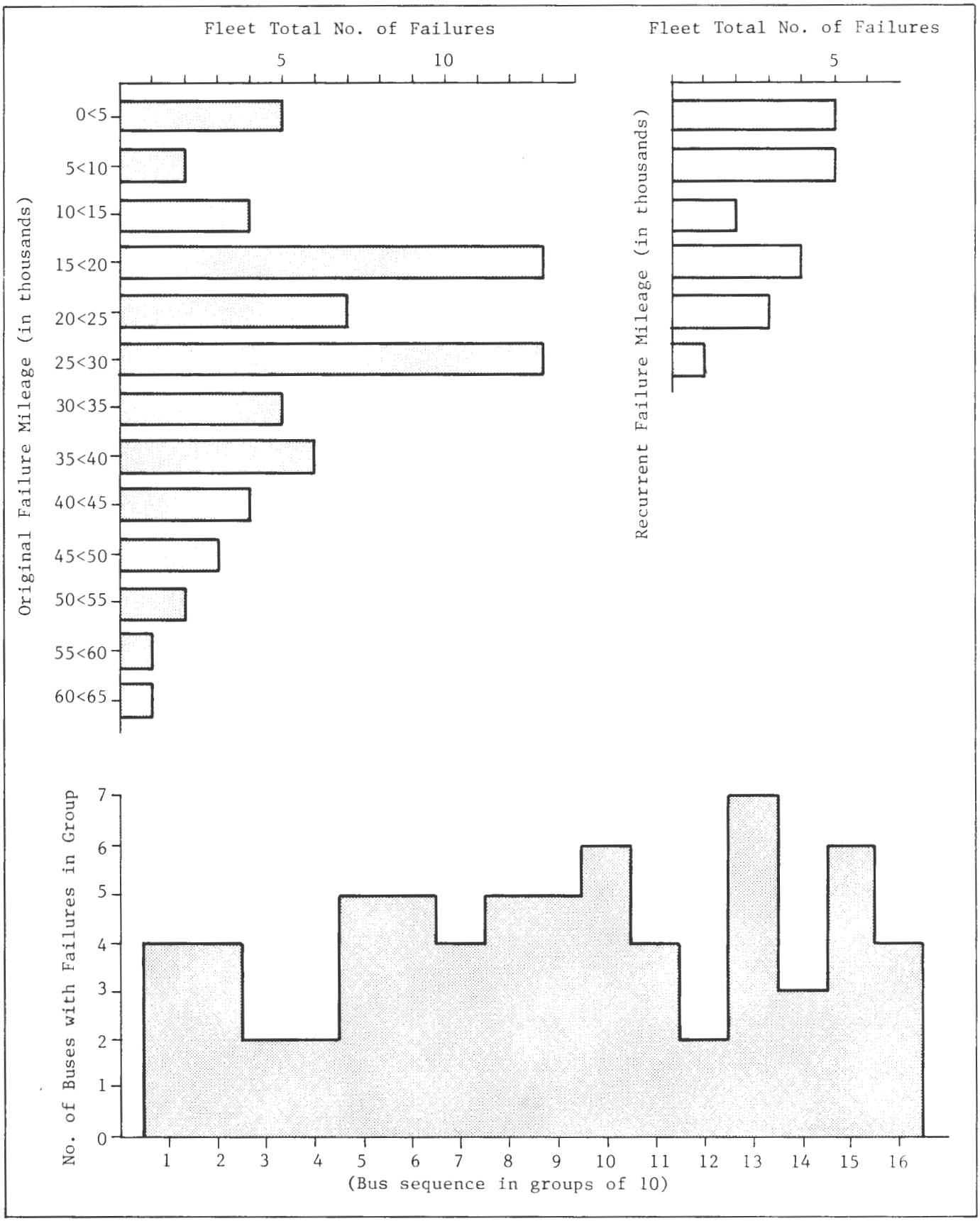



FIGURE 6-14 SUMMARY OF SKID PLATE REPAIRS

## 6.7 LIFT REPAIR LABOR EFFORT

The large number of lift related problems created a very substantial work load for the BSDA maintenance department. Maintenance procedures and facilities at BSDA required that all major repair work on the lifts would have to be accomplished at the central repair shop. The work on the lifts would be in addition to the normal repair work load associated with the entire bus fleet. In order to have a bus repaired, the division garage would have to send the bus to the central repair facility and wait until the bus repair was completed.

Figure 6-15 presents the number of lift repairs completed from July 1977 through September 1978. There was an initially high repair rate, a peak in September 1977, and a gradually decreasing rate thereafter. Evidently, the maintenance staff made a heroic attempt to handle the lift repairs early in the program but eventually became swamped with the backlog. The situation was compounded by the fact that the accessible buses could be operated in regular route service without the lifts working. As noted earlier, the three large garages in Missouri faced serious problems with the availability of buses which potentially affected their ability to meet regularly scheduled services. The garages were faced with the option of sending an operable bus with an inoperable lift to a repair facility for an undetermined period of time, or keeping the bus at the garage for regular service. The latter option was an obvious choice from an overall operations perspective and was often accomplished by bolting the lift in place until the bus could be released to the central repair facility. This practice was particularly in evidence during the early months of Phase II while solutions to the drifting problem were being sought.

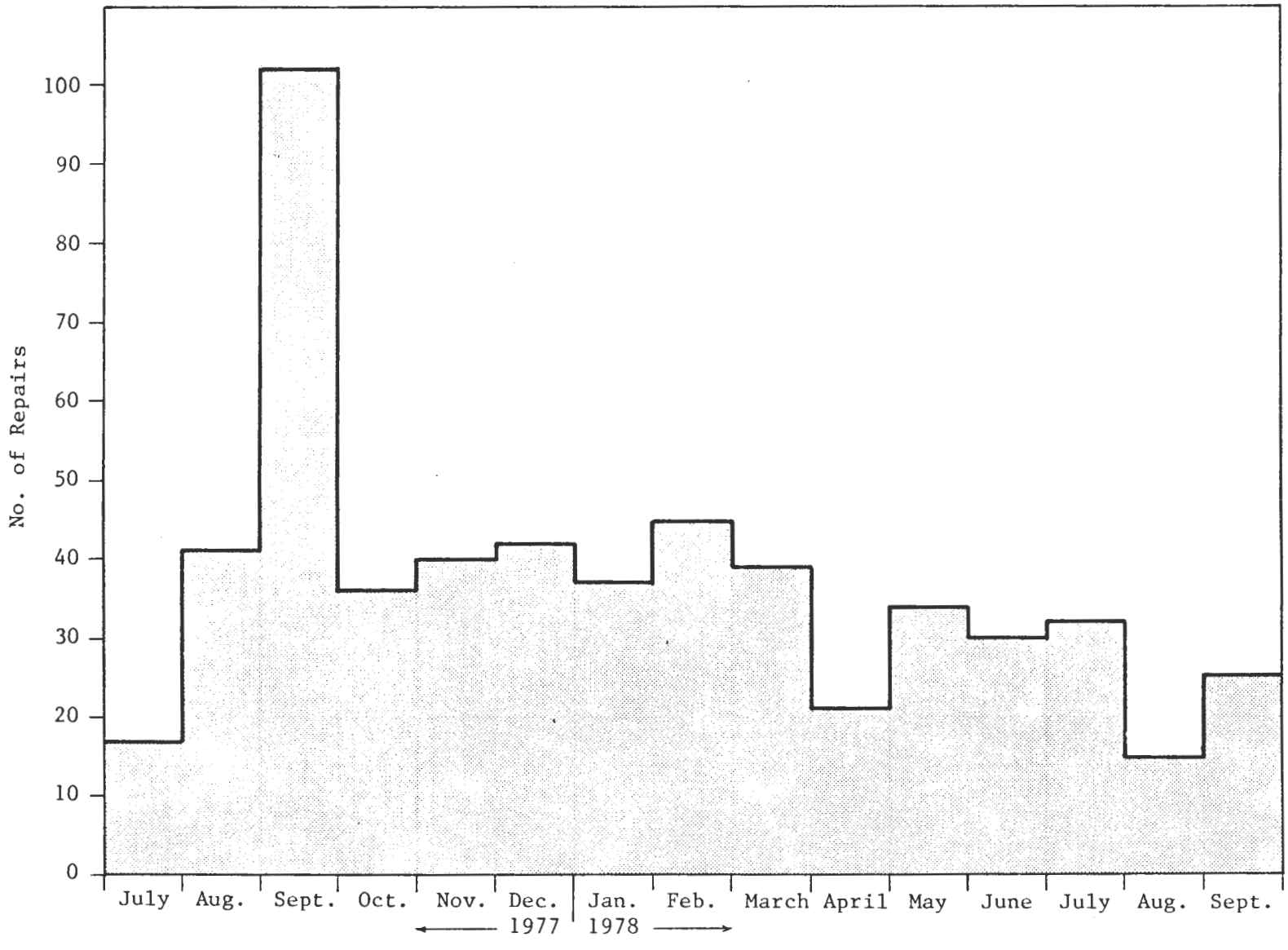



FIGURE 6-15 TOTAL NUMBER OF REPAIRS BY MONTH

BSDA initially estimated that it would require four extra repairmen for the lifts but as a result of the larger than estimated work load raised this requirement to six. There was, however, a natural tendency for recruitment to lag behind the requirement. This is shown by the build-up of assigned central repair shop staff shown in Figure 6-16 using dates supplied by BSDA. This does not, of course, represent the total labor effort involved which must include personnel assigned on a temporary basis, division garage personnel, supervisory personnel and overtime. BSDA's efforts, in fact, started with the delivery of the first vehicles in April 1977 and continued at an accelerating rate thereafter. The costs reported later in Chapter 9 reflect this total effort.

The level of effort to make lift repairs as measured by the number of days in the central repair shop was of a similar magnitude to other major repairs. This is shown by Table 6-5 which lists the number of repairs and days involved for August and September 1978. The distributions of lift and other repairs are generally similar but there is some tendency for the lift to take a longer time. This is evidenced by the fact that nearly twice as many lift repairs took over 10 days as other repairs. However, this could be influenced by a number of factors including delays due to parts shortages in addition to the complexity of the work involved.

The need to concentrate repairs at the central facility also increased the out of service time through the necessary procedures involved. Divisional garages notify the central shop in writing of the repair required by transmitting it through the internal BSDA mail. The shop foreman must then weigh all those requests and select those buses which can be most effectively dealt with based upon the existing work load of the central facility. Buses were then requested by telephone and, if available, were delivered by "shifters" from the divisional garages. This process could easily result in 24 to 48 hour delays even in situations where the

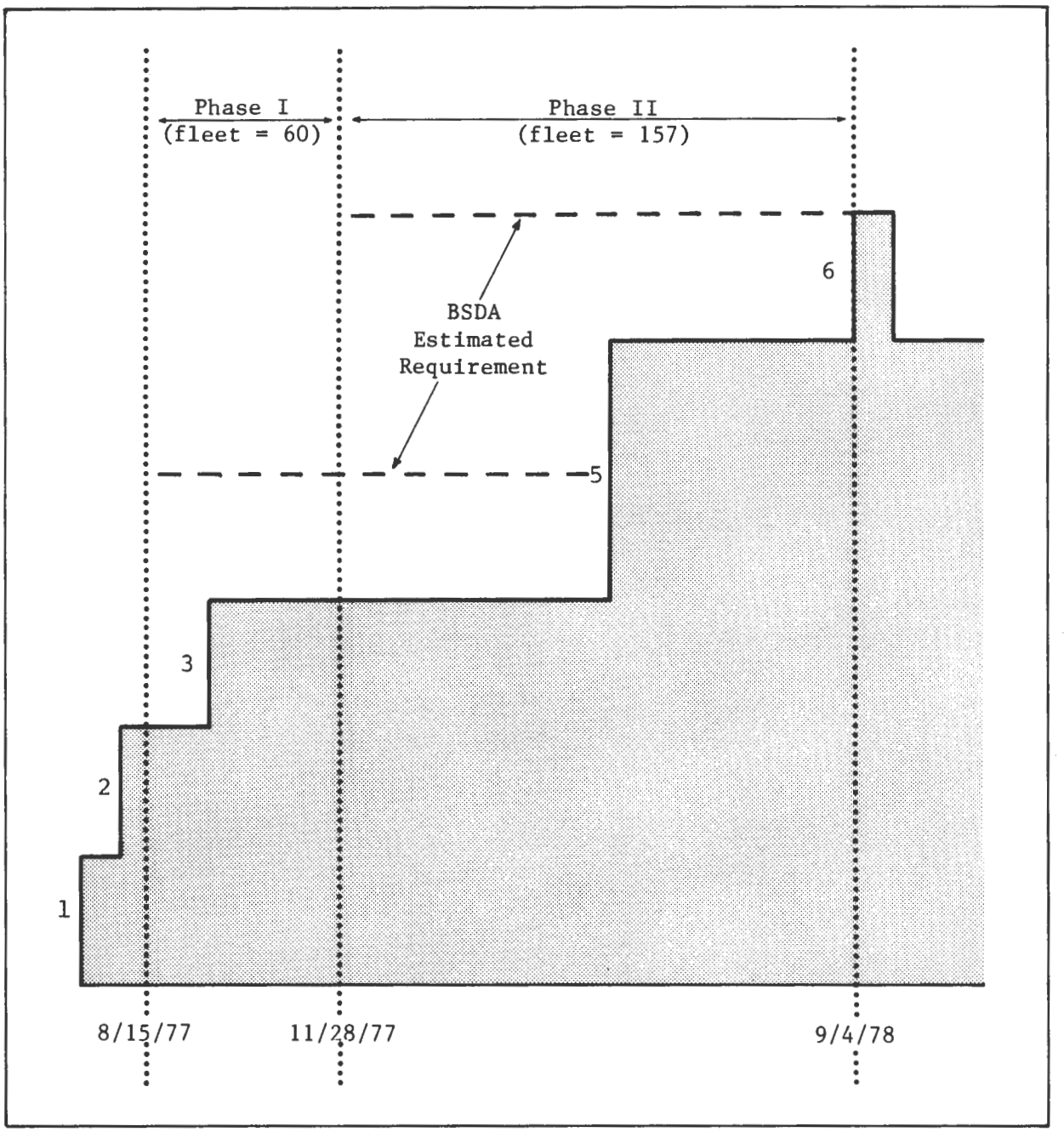



FIGURE 6-16 BUILD-UP OF REPAIR SHOP PERSONNEL

| DAYS IN CENTRAL REPAIR SHOP | LIFT-RELATED REPAIRS | | NON-LIFT REPAIRS | |
|---|---|---|---|---|
| | Number | % | Number | % |
| 0-2 | 15 | 29 | 26 | 28 |
| 3-5 | 12 | 23 | 29 | 32 |
| 6-10 | 10 | 19 | 23 | 25 |
| 11-15 | 7 | 13 | 5 | 5 |
| 16-20 | 3 | 6 | 0 | 0 |
| 21+ | 5 | 10 | 9 | 10 |
| TOTAL | 52 | 100 | 92 | 100 |

TABLE 6-5 ACCESSIBLE BUS FLEET REPAIRS COMPLETED FOR AUGUST-SEPTEMBER 1978

workshop had capacity available. According to repair shop personnel the division garages could withhold buses which were otherwise operable so that they could be ensured of meeting their regularly scheduled service requirements. The repair shop would then be faced with locating a substitute vehicle to ensure full utilization of facilities and staff. Under these circumstances there was a natural tendency to stockpile some buses to ensure that a supply of buses requiring repair was on hand.

# CHAPTER 7

# OPERATIONS AND SERVICE RELIABILITY

This chapter discusses the impact the accessible service had upon running time and the reliability of the accessible bus service from the user's point of view. The following specific issues are addressed:

- How reliable was the service?
- What kind of and how often did trouble occur with the lifts in service?
- How much delay in service was caused by the lifts?

## 7.1 IMPACT ON OPERATIONS

Accessibility was expected to increase route running times in two ways: first, it would add dwell time caused by the boarding and alighting of wheelchair users and second, it would increase on-road delay due to trouble occurrences with the wheelchair lifts. These two impacts added together represent the total delay attributable to accessibility.

### 7.1.1 Dwell Time

Dwell time refers to the time which a vehicle spends at stops. It is the sum of individual passenger boarding and alighting times. BSDA realized that a boarding or alighting wheelchair passenger would require substantially more time than the average ambulatory passenger. The total increase in dwell time on an accessible route would thus would be a function of the number of wheelchair trips made.

It was not possible to measure actual times in the field for boarding/ alighting wheelchair passengers, because of the low ridership and the resultant low probability of observing

wheelchair trips on random runs. In lieu of this, BSDA performed a special test to measure the boarding and alighting times for wheelchair individuals traveling independently or with an attendant. These tests were performed at BSDA facilities by wheelchair persons who boarded and alighted from a bus which was not in service. No proof can be given that these tests accurately duplicated street conditions; however, this data is all that is available.

Table 7-1 shows the test results, broken down for each specific portion of the boarding/alighting process. For example, initial deployment of the lift is estimated to take 15 seconds. The total time for one complete cycle of boarding and alighting is estimated at 3.75 minutes for an independent manual wheelchair passenger and 10.5 minutes for a wheelchair passenger with attendant. This latter estimate is so high because the ambulatory attendant is not allowed to use the lift. He or she must therefore board and exit through the rear door. This requires either a passenger or the driver to go and activate the "push type" rear door. The attendant must wait until the wheelchair is safely at the top of the lift cycle, then go to the rear door, enter, and walk up front to maneuver the wheelchair off the lift and to the seat.*

It is worth noting that the head room situation will progressively improve as the industry begins to use the newer Advanced Design Bus (ADB) or TRANSBUS. The lower floor and higher doors of those vehicles will allow greater headroom as indicated below:

| BUS MODEL | HEADROOM (Inches) |
|---|---|
| Conventional | 58-60 |
| Advanced Design Bus (ADB) | 69 |
| TRANSBUS | 77 |

---

*This procedure was established by BSDA as a precaution against possible accidents due to lack of headroom.

| | UNATTENDED PERSON IN WHEELCHAIR | PERSON IN WHEELCHAIR WITH ATTENDANT |
|---|---|---|
| Deploy Lifts | 15 seconds | 15 seconds |
| Boarding | 55 seconds | 210 seconds |
| Travel to Station | 30 seconds | 35 seconds |
| Secure at Station | 30 seconds | 45 seconds |
| Fasten Safety Belt | - | 50 seconds |
| TOTAL BOARDING | 130 seconds | 355 seconds |
| Deploy Lift | 15 seconds | 15 seconds |
| Alight | 60 seconds | 240 seconds |
| Stow Lift | 20 seconds | 20 seconds |
| TOTAL ALIGHTING | 95 seconds | 275 seconds |
| TOTAL DWELL TIME/TRIP | 225 Seconds (3.75 minutes) | 630 Seconds (10.5 minutes) |

AVERAGE (90.6% of trips are made by unattended persons) = 4.38 minutes/trip

Source: BSDA Estimates

TABLE 7-1 SAMPLE DWELL TIMES FOR WHEELCHAIR USAGE

Thus, wheelchair attendants will in the future be able to stand and enter the bus using the lift, with a substantial reduction in dwell time. Also, handicapped persons not in wheelchairs should be able to use the lifts.

The average time for boarding and alighting wheelchair users is 4.38 minutes per trip, assuming 90% of all trips are made by independent users (see Chapter 8). Thus, the estimated total delay caused by all wheelchair trips due to extra dwell time during Phases I and II was 150 hours (4.38 minutes x 2052 trips).

### 7.1.2 Trouble Occurrences

Trouble occurrences were the second major source of delay to normal route operations. Trouble occurrences were any type of on-road lift malfunction requiring driver or supervisor attention. Seven categories of trouble were defined according to the following code:

TROUBLE CODE

- A Lift stuck in step position--won't deploy
- B Lift stuck in other position--won't stow
- C Lift stuck on curb
- D Steps slipping
- E Automatic barrier doesn't function properly
- F Accident involving person in wheelchair
- G Securement device problem

In practice, the first four categories caused almost all of the trouble occurrences, as shown in Table 7-2. The actual weekly incidences of troubles A-D, as reported from the dispatchers trouble logs, are plotted in Figure 7-1. Table 7-2 also shows those various trouble occurrences averaged over increasing periods of time from the last five weeks of Phase II through to all 40 weeks of Phase II. The reduction in reported trouble occurrences

| ALL TROUBLE OCCURRENCES | | | WEEKLY RATE FOR MAJOR TROUBLE CATEGORIES | | | |
|---|---|---|---|---|---|---|
| Weeks* | Per Week | Per Scheduled Run | A | B | C | D |
| 0-40 | 38 | 0.025 | 6 | 25 | 1 | 5 |
| 5-40 | 33 | 0.022 | 4 | 22 | 1 | 5 |
| 10-40 | 31 | 0.021 | 4 | 22 | 1 | 4 |
| 15-40 | 30 | 0.022 | 5 | 20 | 1 | 4 |
| 20-40 | 28 | 0.019 | 4 | 19 | 1 | 4 |
| 25-40 | 28 | 0.019 | 4 | 20 | 1 | 3 |
| 30-40 | 28 | 0.019 | 4 | 19 | 1 | 3 |
| 35-40 | 23 | 0.015 | 2 | 16 | 1 | 3 |

Trouble Code Legend: A - Lift stuck in step position-won't deploy
B - Lift stuck in other position-won't stow
C - Lift stuck on curb
D - Steps slipping

*This column represents the time period, i.e. the first row is the average for the first 40 weeks of Phase II.

TABLE 7-2 AVERAGE OCCURRENCES OF TROUBLE DURING PHASE II

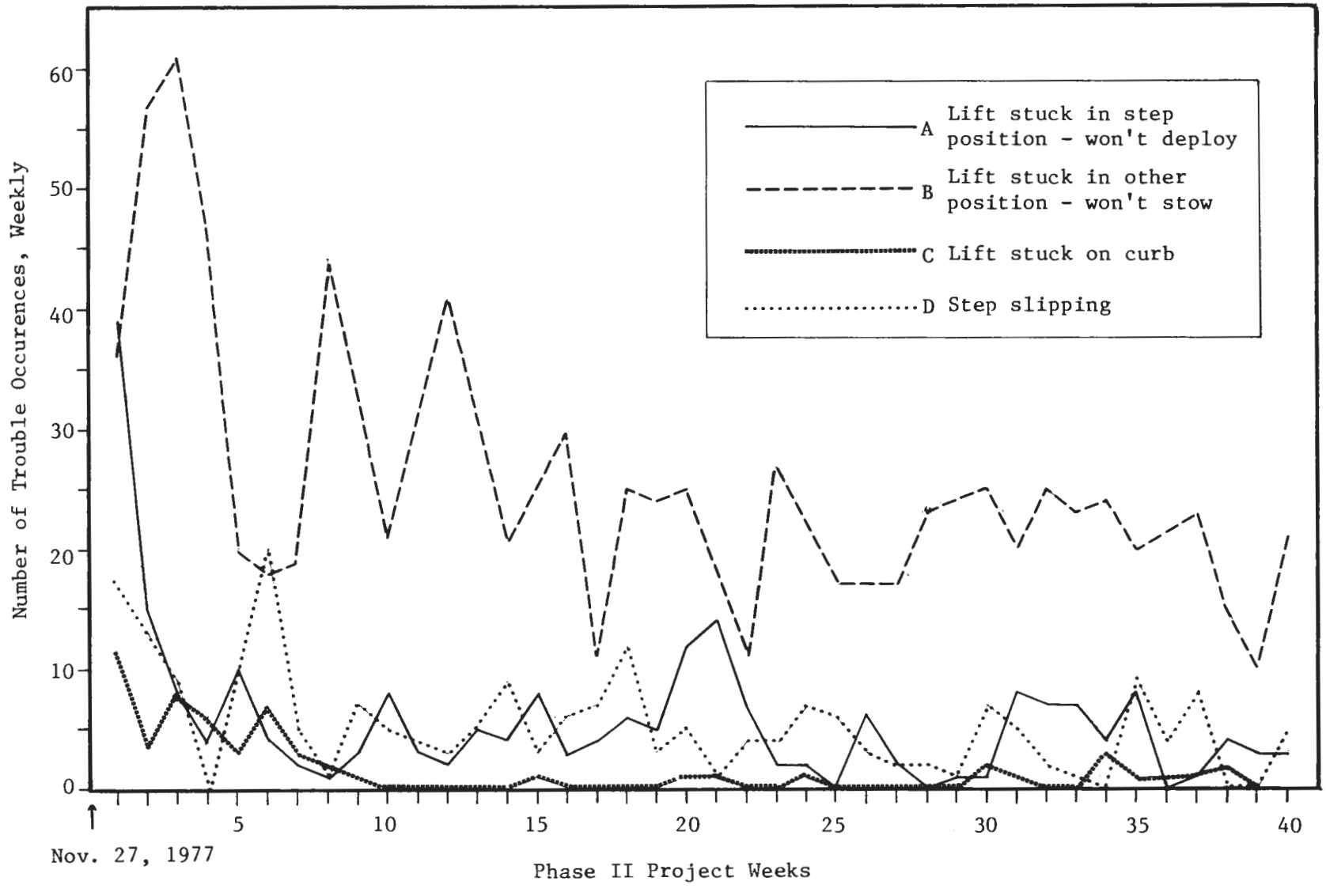



FIGURE 7-1 WEEKLY VARIATIONS OF TROUBLE OCCURRENCES DURING PHASE II

in both magnitude and as a proportion of the number of accessible runs is evident. This gradual decline in on-road trouble probably reflects both the decline in ridership and consequent use of the lifts, and the unavailability of the equipment due to continuous mechanical problems. Thus, fewer lift buses were on the road and this resulted in fewer on-road difficulties.

Of the four categories listed (and shown in Figure 7-2), the largest source of trouble is "Lift stuck in other position--won't stow." This could be caused by any number of malfunctions within the lift system, such as faulty microswitches, a faulty control box, or failed slides or hydraulic cylinders.

The total delay per week resulting from reported on-road troubles is given in Table 7-3. As with other aspects of the project, the learning process appears to have brought about a slow but steady decline in the incurred delay per reported trouble occurrence. Total reported delay was 359 hours for both Phase I and II, based upon the trouble log.

The distribution of the trouble occurrences was fairly uniform across the week and consistent with the number of runs scheduled. From Monday through Friday the variation was only $\pm$10 percent from the weekday average with Tuesday having the lowest incidence of trouble. Monday and Friday had the highest incidence of troubles. This pattern differs from expectations based upon ridership and use, in which Monday and Tuesday have the lowest ridership while Wednesday, Thursday, and Friday are some 12% higher than average. The effect of ridership would explain the tendency towards higher trouble incidence at the end of the work week. Regarding the increase of trouble occurrences on Mondays, it is assumed that they are related to accumulated problems arising from weekend usage.

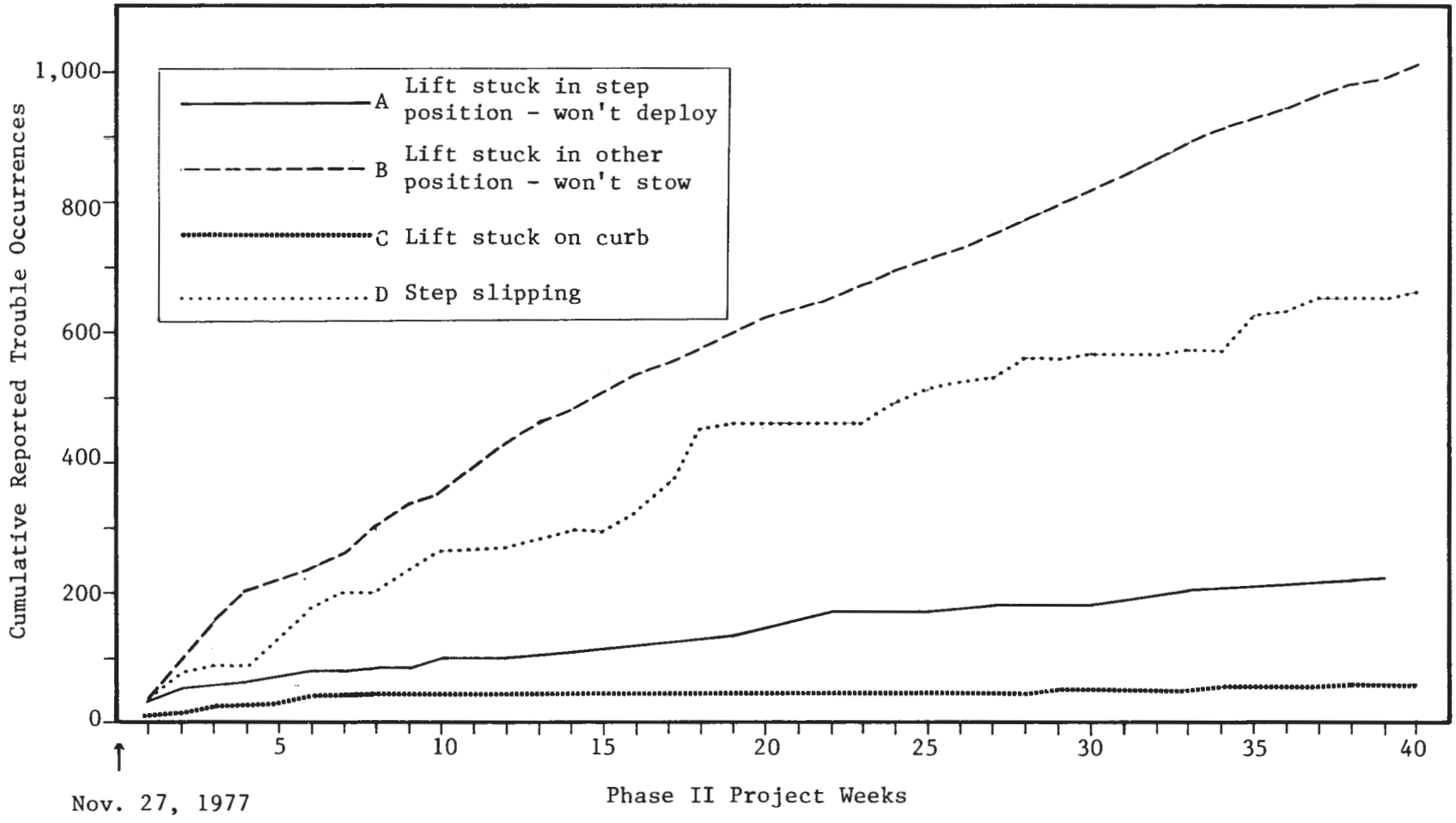



FIGURE 7-2 CUMULATIVE TROUBLE OCCURRENCES FOR PHASE II

| PHASE II PERIOD | AVERAGE WEEKLY DELAY | |
|---|---|---|
| (weeks) | minutes | minutes per trouble incident |
| 0-40 | 471 | 12 |
| 5-40 | 369 | 11 |
| 10-40 | 324 | 10 |
| 15-40 | 299 | 10 |
| 20-40 | 271 | 10 |
| 25-40 | 284 | 10 |
| 30-40 | 280 | 10 |
| 35-40 | 199 | 9 |

TABLE 7-3 DELAYS ATTRIBUTED TO ON-ROAD TROUBLES

The two principal means of rectifying trouble occurrences were to replace the bus or to call the central repair shop. These actions accounted for 90% of the recorded instances of trouble. Replacing the bus actually accounted for half of the situations, and, because of the time involved, accounted for over 70% of the delay time. Delay time for bus replacement averaged about 20 minutes per incident. It should be noted that the personnel time involved in the delays due to shop calls was actually higher than the reported delay time. This was due to the practice in which, once the shop had been alerted, a rendezvous would be arranged at some future enroute point whenever the bus was mobile. Thus, the schedule delay was minimized while still allowing adequate preparation and travel time for the shop personnel. BSDA estimates that an average of about 20 minutes should be added to the shop call delays to account for the personnel time involved.

### 7.1.3 Total En-Route Delay

The total en-route operating delay due to accessibility is defined herein as the sum of dwell time and trouble delay. As shown in the previous sections, the delays for both operational phases were:

| | |
|---|---|
| Total Estimated Dwell Time Delay (4.38 min./trip x 2052 trips) | = 150 hrs. |
| Total Reported Trouble Delay (from trouble logs) | = 359 hrs. |
| Total Estimated Delay | = 509 hrs. |

Several important conclusions can be drawn from this calculation.

1. Accessibility had an insignificant effect on BSDA's overall schedules. The amount of en-route delay introduced was roughly 500 vehicle hours over a 12 month period. During most of this period, the accessible vehicles were on the road about 2100 hours every weekday, or about 600,000 vehicle hours over the whole period.

2. Clearly the en-route delay would have been greater if the wheelchair ridership had been greater. However, the dwell time delays were only .025% of total on-road time for the accessible buses. Thus, a 40-fold increase in wheelchair trips could only increase the dwell-time delay to 1% of total vehicle hours.

3. BSDA's estimated 24,435 extra scheduled platform hours were far greater than the delay actually encountered. Since these extra hours contribute to the estimated costs attributed to accessible service, as explained in Chapter 9, these costs are therefore higher than they need to be.

These conclusions are based on system-wide averages. Clearly, specific runs could suffer significant delay as a result of a wheelchair trip or a trouble occurrence. There is obviously no way to predict these runs, and since their frequency is so small when compared to the total number of runs, these delays should simply be accepted as part of the normal operating delays.

BSDA also attempted a spot check of the actual delays encountered on the Kingshighway route during Phase I, but the results were inconclusive. Only three wheelchair trips were made in nearly 1,400 bus trips observed. The delay at the end of these three trips ranged from zero to six minutes, indicating that in some cases the drivers made up the time. Similar trips without wheelchairs ranged from three minutes early to five minutes late.

## 7.2 SERVICE RELIABILITY

Service reliability is a measure of the ability of BSDA to provide accessible bus service according to its published schedules. The two criteria used in this report to determine the reliability of the accessible bus service are fully missed runs and partially missed runs.

A fully missed run is one on which an accessible vehicle scheduled for that run does not leave the garage or commence the run in an accessible condition; or, is substituted for on the entire run by a non-accessible bus. A partially missed run is one on which the scheduled bus does not provide accessibility throughout the run due to malfunction of the lift and/or replacement by a non-accessible bus. In either case, a fully or partially missed run seriously impairs the ability of wheelchair riders to travel. In addition, partially missed runs, caused by malfunctions on the road, generally require immediate attention and often result in substantial delays. As subsequently discussed, there is some question regarding the accuracy of the reported missed run data.

Figure 7-3 shows the reported weekly incidence of fully and partially missed runs for the forty week period of Phase II operations through August of 1978. A substantial increase in the reported number of fully missed runs occurred during the spring of 1978 (Phase II project weeks 20-25). This was primarily due to the high incidence of skid pan repairs (see Figure 6-13). By late summer of 1978 the number of runs missed varied approximately between 300 to 400. In an average week, approximately 2,100 accessible runs were scheduled during Phase II, but during the last five weeks of the program approximately 16% of these were reported as missed entirely and another one percent were partially missed.

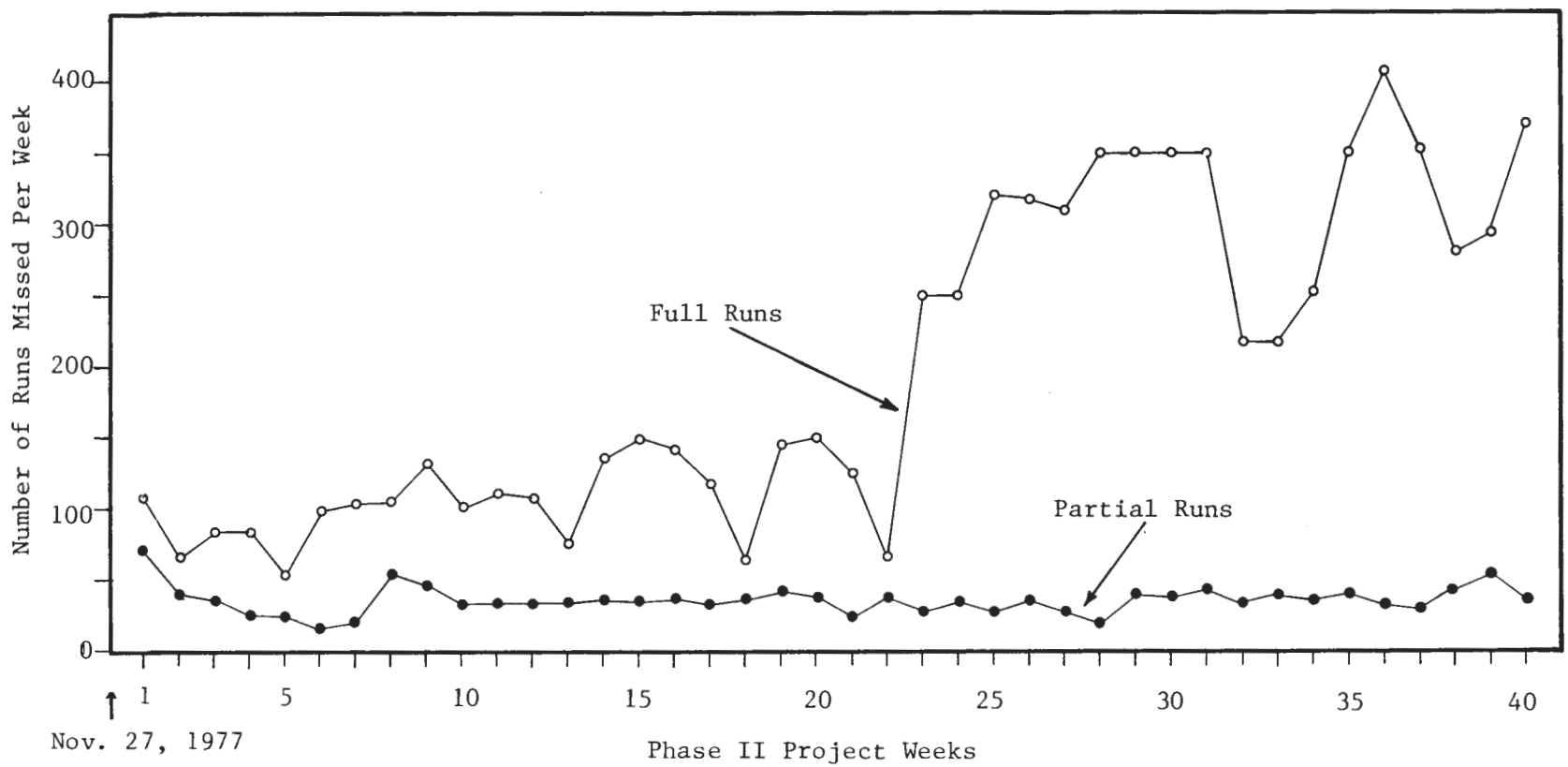



FIGURE 7-3 WEEKLY REPORTED MISSED RUNS DURING PHASE II

The incidence of trouble occurrences and partially missed runs might be expected to show a relationship. Figure 7-4 shows that the two data sets were somewhat correlated. After a sharp initial decline, the level of partially missed runs tended to remain constant, averaging about 35 per week. Major trouble occurrences exhibited a similar trend initially, but then appeared to be declining in the latter part of Phase II. These trends are probably reflective of the relatively low ridership demands.

It is suspected that the reported number of missed runs is not accurate. At the end of Phase II, BSDA only had 70-80 functioning accessible buses for a schedule which required 126 lift buses in the peak and 102 in the base period. Thus, only about 65% of the accessible buses needed in the peak and 70-80% of the accessible buses needed in the base period were available. Based on this information, it is difficult to believe that BSDA operated 84% of their scheduled accessible runs during this period. Although the "actual" number of missed runs could not be estimated from the available data, there is good reason to believe that they were considerably higher (maybe by a factor of two) than reported data. This is further substantiated by the fact that BSDA staff involved in the data collection reported it was difficult to obtain data on runs scheduled to start in the afternoon. The morning runs are based on the "ready bus" data supplied by the divisions, which is not the case for the afternoon runs.

Due to the problems encountered with the lift equipment and those not directly related to the lift equipment, the accessible service, particularly in Phase II, was considerably more unreliable than the service offered to the general public. Obviously, this was not conducive to attracting ridership as subsequently discussed in Chapter 8. Furthermore, the poor reliability of the lift equipment had a significant impact on the cost of accessible service, as shown later in Chapter 9.

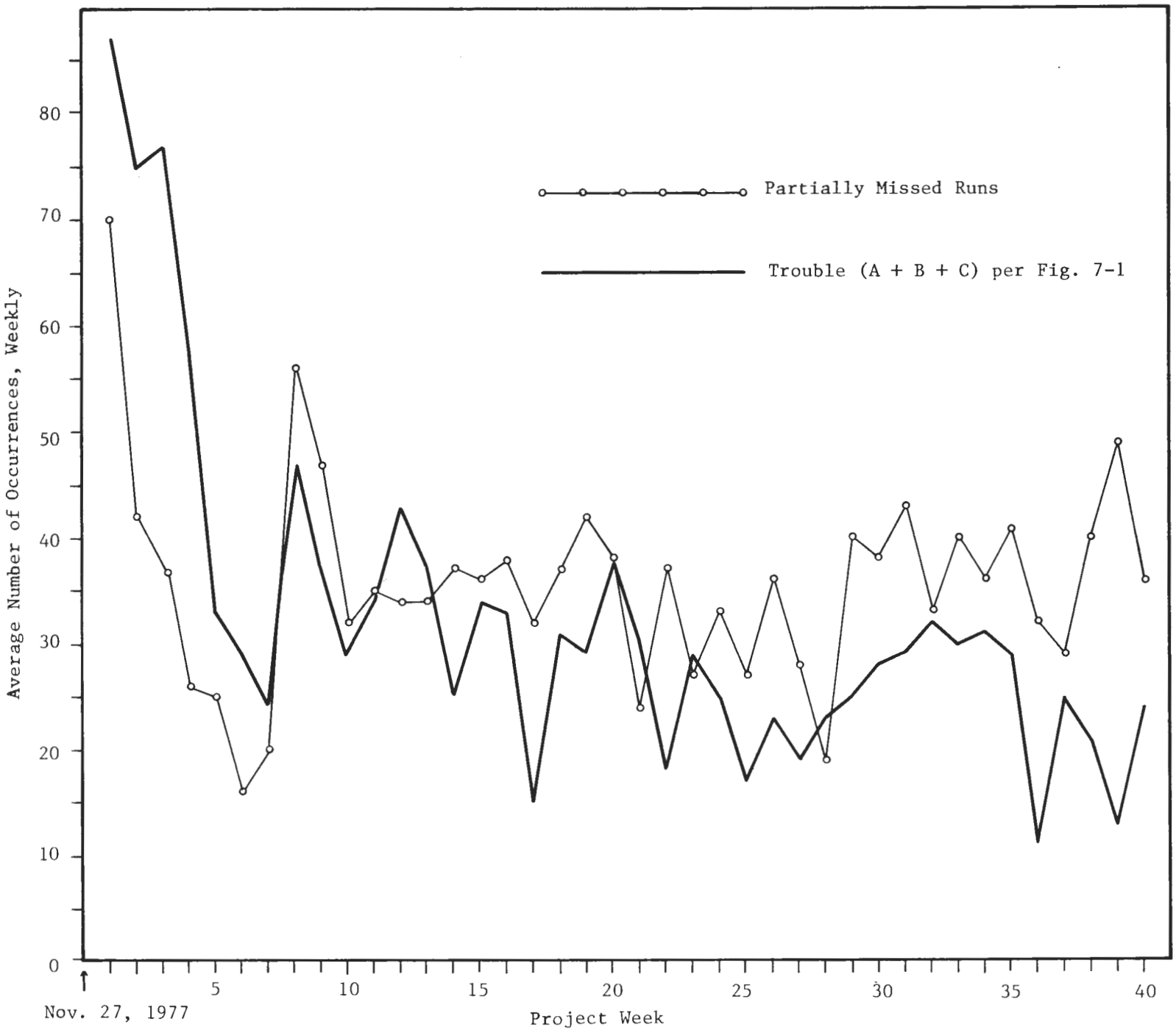



FIGURE 7-4 VARIATIONS OF TROUBLE OCCURRENCES AND PARTIALLY MISSED RUNS IN PHASE II

# CHAPTER 8

# TRAVEL BEHAVIOR

Travel behavior encompasses a number of important evaluation issues, which can be grouped into the following subject areas:

- o User* ridership
- o User trip characteristics
- o User attitudes
- o Characteristics and attitudes of non-users

Each of these issues are considered in the following discussion in the order given above.

## 8.1 USER RIDERSHIP

The number of wheelchair trips made on the accessible buses was of primary interest. After considering various alternatives, the following procedure was used to obtain a record of wheelchair trips**. Drivers were instructed to inform the dispatcher via radio of 1) the time of boarding, 2) location of pickup/drop off, 3) run, and 4) direction for each wheelchair trip. The dispatcher then recorded the information on the dispatchers log, which was subsequently transferred to the Daily Wheelchair Trip and Denial Record. Unfortunately, completely accurate data were

* The word "User" refers throughout this chapter to any person in a wheelchair who has ridden on the accessible buses at least once, and "non-user" refers to someone in a wheelchair who has never ridden on the accessible buses.

**In the following discussion, "trip" means a one-way unlinked trip by a person in a wheelchair. Transfers are counted as separate trips.

not obtained. Due to heavy radio traffic, recording errors, and other problems, all wheelchair trips were not listed in the Daily Wheelchair Trip and Denial Record. The actual amount of under-reporting of wheelchair trips could not be determined directly from the Trip Records; nor could other direct methods, such as on-vehicle checkers, be used to measure wheelchair ridership because of the low frequency of wheelchair trips. However, an estimate of the amount of under-reporting was made by using the following indirect method.

As part of the survey of users, travel diaries were kept by 16 respondents for a period of three weeks. The diaries recorded a total of 44 trips by the respondents; however, only 24 of these same trips were recorded on the Daily Wheelchair Trip and Denial Record. Based upon this admittedly limited sample, it is assumed that the estimated total number of trips is twice the number of reported trips. It is important to bear in mind that the actual number of trips could be either more or less than the estimated number of trips. The estimated number of trips is therefore derived from an assumption that of all wheelchair trips actually made, only 50% are finally recorded on the Wheelchair Trip and Denial Record. Lacking any additional data on the subject, the amount of under-reporting has been assumed to remain constant over the life of the project.

Table 8-1 presents both the reported and estimated total trips on a monthly basis. An estimated 2,052 trips (one-way unlinked) were made over the 12-1/2 months of Phases I and II, an average of 164 trips/month. A better perspective on the ridership data is given by Figure 8-1, a graphic representation of estimated ridership showing the results of trend line analysis.* These results indicate a slight decrease of about 1 trip/month, or 8%, over the 12-1/2 months. There are several possible reasons for this

---

*Least squares curve fit with standard error of estimate of $\pm$ 45 trips/month and $r^2 = 0.009$ which indicates a very poor data fit.

| MONTH | REPORTED TRIPS(1) | ESTIMATED TOTAL TRIPS (2) |
|---|---|---|
| August, 1977(3) | 93 | 186 |
| September | 79 | 158 |
| October | 95 | 190 |
| November | 81 | 162 |
| December | 96 | 192 |
| January, 1978 | 41 | 82 |
| February | 42 | 84 |
| March | 65 | 130 |
| April | 127 | 254 |
| May | 82 | 164 |
| June | 60 | 120 |
| July | 91 | 182 |
| August | 74 | 148 |
| TOTALS | 1,026 | 2,052 |
| MONTHLY AVERAGES | 82.1 | 164.2 |

(1) Based on tabulations of trip records by ARI

(2) To account for reporting inaccuracies these are twice the reported trips.

(3) Service initiated on August 15th

TABLE 8-1 WHEELCHAIR RIDERSHIP

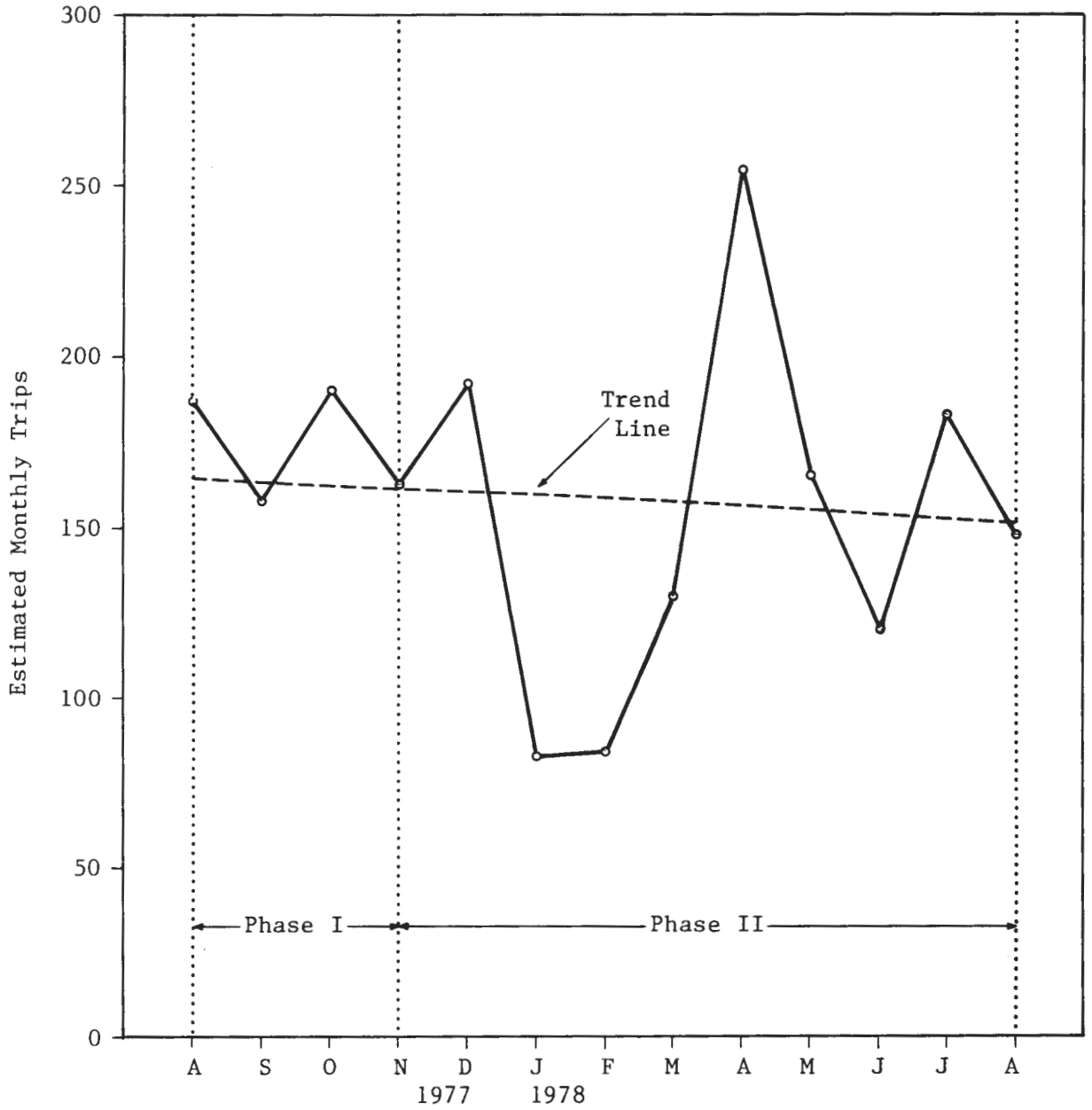



FIGURE 8-1 MONTHLY RIDERSHIP TREND

apparent ridership decline. First, as shown in Figure 8-1, ridership decreased substantially in the winter months. This, as discussed in more detail later, can be attributed to the relatively severe snow conditions during the 1977-78 winter. Following the winter, there was a substantial ridership peak in April, 1978. While it is not known what caused this, one might speculate that perhaps trips postponed due to the bad weather of the previous months were taken in April.

Secondly, as also discussed in more detail later, if one discounts the ridership data of January through April because of weather-related circumstances, and then compares data for the following four months of Phase II to that obtained during Phase I, it can be observed from Figure 8-1 that there was a decreasing trend in ridership. This could have been due to the decreasing reliability of the service or to other factors. Higher ridership in earlier months may have been due to curiosity, or to experimentation with the service. Many of the users had alternate means of transportation available. Users may have decided after riding the lift buses a few times that it could not replace their alternate transport mode.

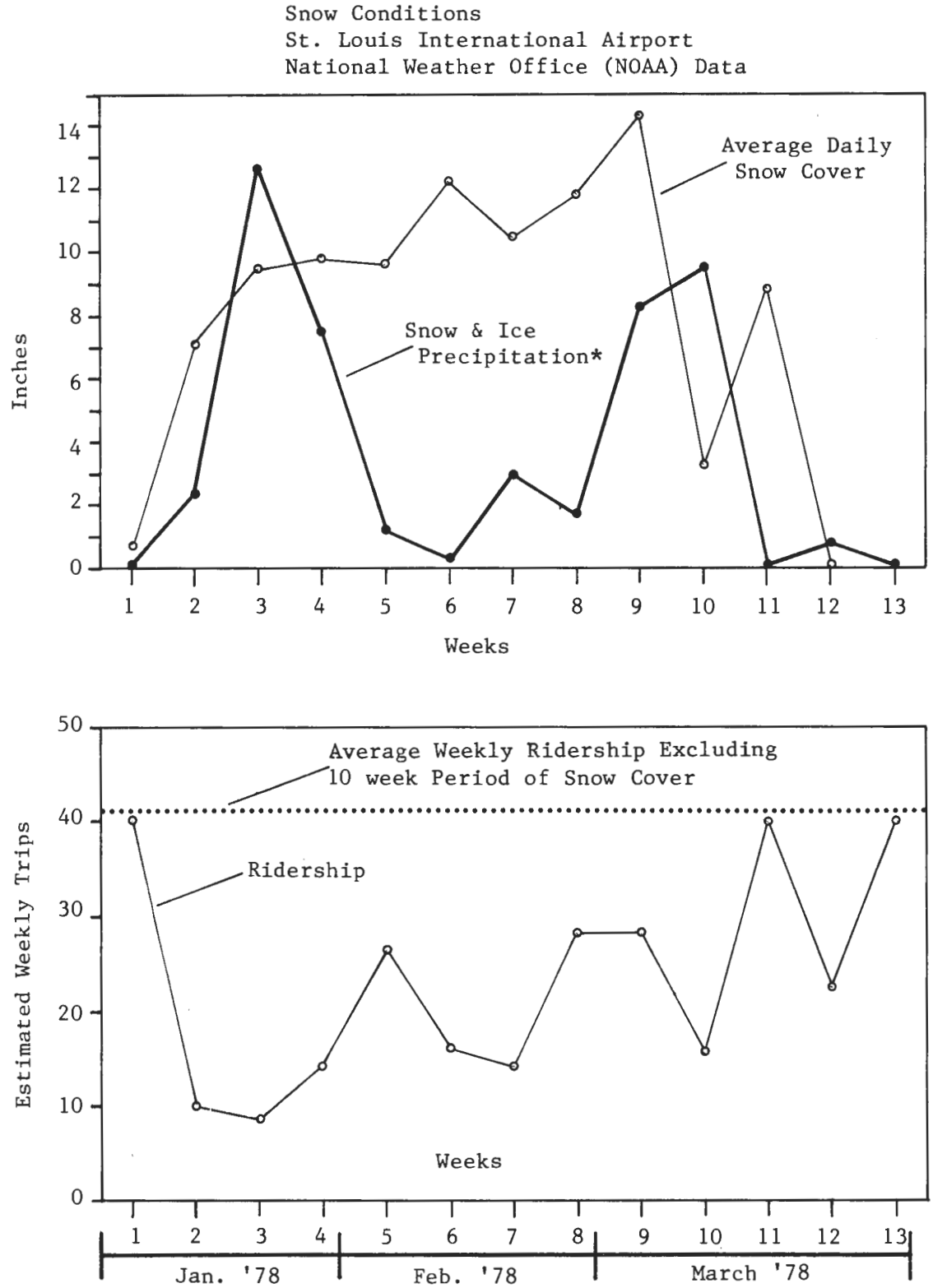
As pointed out in Section 8.1.3, a few individuals made a majority of the reported wheelchair trips. Since individual users may change their trip-making patterns in response to individual events in their lives, such as job or family changes, the apparent ridership decline may reflect, for example, no more than one person moving away or changing the destination of a specific activity.

Finally, increases in the amount of trip under-reporting may account for the apparent decline, but this cannot be substantiated.

### 8.1.1 Effect of Weather

As pointed out earlier in Chapter 3, St. Louis experienced a severe winter in 1977-78 with record amounts of snow, which could have caused difficulties for a person in a wheelchair traveling to a bus stop. Also, since St. Louis is not accustomed to large snowfalls, there is considerably less equipment available for effective snow removal, when compared to most northern cities. In order to ascertain the effect of the winter conditions on ridership, snow conditions recorded at the St. Louis airport are given in the upper half of Figure 8-2 on a consecutive weekly basis for the three winter months with major snowfall. Snow cover extended for 10 weeks, reaching peaks of 12 and 14 inches. The first major storm of the season, in the middle of January, 1978, resulted in a weekly total of 12.6 inches of snow. In the following week, 7.5 inches of snow fell. Later, during the first part of March, 8.2 and 9.5 inches of snow were recorded in two consecutive weeks.

The bottom half of Figure 8-2 shows the estimated weekly ridership over the three month winter period. A substantial decrease in ridership can be observed at the time of the first heavy snowfall. Thereafter, although snowy conditions continued, the ridership showed a variable but definite increasing trend. When the weekly ridership for the 10 week period of snow cover is excluded from the total 12-1/2 months of accessible operations, estimated ridership averaged 41.2 trips/weekly. During the 10 weeks of snow cover the average was only 20 trips/week, representing a 51% decrease. The initial severe snowfall of the season, 12.6 inches in one mid-January week, resulted in an 80% decrease in weekly ridership. Thus, as might be suspected, heavy snowfall did cause a substantial reduction in ridership.




*Weeks 1 and 2 show more snow cover than precipitation due to a ground accumulation from previous snowfalls.

FIGURE 8-2 ESTIMATED RIDERSHIP DURING WINTER CONDITIONS

When one considers that there was an exceptional snowfall over the winter period, particularly for an area not accustomed to handling it, it is significant that some persons in wheelchairs were still able to make some trips. Furthermore, after the impact of the first heavy snowfall and even with a continuous ground cover, there was a gradual tendency for ridership to increase toward average non-winter levels. This was perhaps due to users becoming acclimated to the snowy conditions, and to continuing snow removal efforts resulting in cleared sidewalks and pathways.

### 8.1.2 Comparison of Ridership Data

As shown earlier (Table 8-1), the combined ridership of Phase I and Phase II was estimated to be 164 trips/month. Over the 3-1/2 month period of Phase I, user ridership averaged 199 trips/month. For Phase II the service was expanded, but estimated ridership decreased to an averge of 151 trips/month. Some, but not all of this decrease was due to the winter conditions discussed earlier. When the monthly ridership data for the winter months of January, February and March are excluded, estimated ridership for the remaining six months of Phase II averaged 177 trips/month. This represents an 11% reduction compared to the monthly average for Phase I. A similar indication is given by trend line analysis* of all monthly data with the three snow months excluded. This analysis showed the number of estimated trips decreasing at a rate of 2.8 trips/month or 13% since the inception of service. The accuracy of this trend can be questioned due to data inaccuracies and scatter; however, when one notes that over the last four months of Phase II, estimated ridership averaged only 154 trips/month, it seems clear that not all of the reduction in ridership in Phase II can be attributed to winter weather.

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*Least squares curve fit with standard error of estimate +32 trips/month and $r^2 = 0.056$ which indicates a very poor data fit.

In Chapter 6, it was pointed out that due to equipment unavailability it was not possible to provide the expanded service levels intended for Phase II. This undoubtedly could have caused a reduction in ridership. In order to consider this in more detail, Table 8-2 represents a comparison of the estimated wheelchair ridership to the accessible buses that were (a) available for deployment and (b) scheduled.

During Phase I there were sufficient buses available to meet peak period requirements. In Phase II, however, peak requirements could not be met, and, in five out of nine months, base requirements could not be met. To relate the estimated ridership to the supply of accessible buses, Figure 8-3 gives the average monthly trips per maximum number of accessible buses deployed and scheduled.

In Phase I, the estimated average monthly trips/bus deployed was 3.40. During Phase II, excluding data from the three winter months of January, February and March, the average monthly trips per deployed bus was 2.20 or 35% lower than Phase I. The average monthly trips per scheduled bus was, in the same time period, 1.4 or 59% less than Phase I. Thus, on the average, the larger number of buses deployed and scheduled in Phase II were <u>not</u> as effective in attracting ridership as the smaller number of buses in Phase I.

In order to provide a perspective on user ridership levels, Table 8-3 presents a comparison between transit ridership by the general public and wheelchair users. Within the accessible service area, the estimated number of persons in wheelchairs (Table 3-6) was 0.35% of the general population; however, the average estimated wheelchair ridership was only .0055% of all transit ridership.

| MONTH | ESTIMATED USER TRIPS | MAXIMUM ACCESSIBLE BUSES DEPLOYED | MAXIMUM ACCESSIBLE BUSES SCHEDULED (PEAK) (1) |
|---|---|---|---|
| August, 1977 | 186 | 51 | 51 |
| September | 158 | 51 | 51 |
| October | 190 | 51 | 51 |
| November | 162 | 51 | 51 |
| December | 192 | 102 (2) | 126 |
| January, 1978 | 82 | 102 | 126 |
| February | 84 | 110 | 126 |
| March | 130 | 104 | 126 |
| April | 254 | 75 | 126 |
| May | 164 | 86 | 126 |
| June | 120 | 80 | 126 |
| July | 182 | 74 | 126 |
| August | 148 | 73 | 126 |

(1) During Phase II, peak period = 126 buses and base period = 102 buses.

(2) No data available--assumed to be same as January 1978.

TABLE 8-2 COMPARISON OF WHEELCHAIR RIDERSHIP TO AVAILABLE ACCESSIBLE BUSES

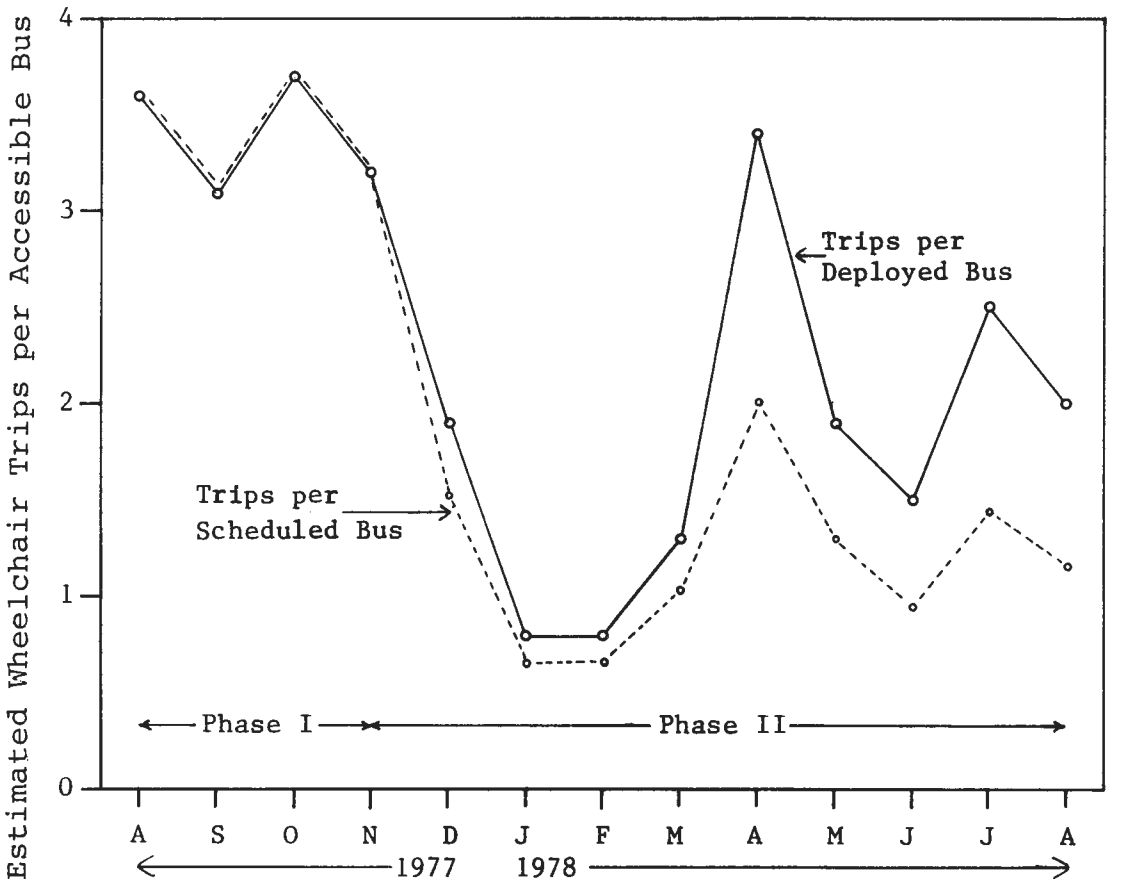


FIGURE 8-3 AVERAGE ESTIMATED TRIPS PER DEPLOYED ACCESSIBLE BUS AND PER SCHEDULED ACCESSIBLE BUS

| | GENERAL PUBLIC | WHEELCHAIR PERSONS |
|---|---|---|
| Service Area Population (1) | 532,331 | 1,863 |
| BSDA Ridership, Trips/Month | 2,721,600 (2) | 151 |
| Transit Trips/Capita/Month | 5.11 | .08 |
| Estimated Transit Modal Split | 10.3% (3) | .37% (4) |

(1) Persons within 1/4 mile of 17 accessible bus routes

(2) Based on average weekday ridership of 113,400 on the 17 accessible routes times 24 equivalent days in month

(3) Assumes general public total trip rate of 2.2/day

(4) Assumes total trip rate of 21.8 trips/month

NOTE: Calculations are based on assumptions and may not be entirely correct. The table illustrates only the wide difference in general public transit mode split and wheelchair user transit mode split.

TABLE 8-3 ACCESSIBLE BUS RIDERSHIP COMPARISONS (PHASE II ONLY)

Thus, on a per capita basis, the general public was 64 times more likely to use transit than wheelchair persons. Based on estimated modal splits, the general public made about 10.3% of their total trips on the accessible buses, whereas wheelchair users only made .37% of their total trips on the same buses.*

Obviously, the preceding comparisons indicate that wheelchair user ridership rates were considerably below those of the general public. For a number of reasons--the pioneering aspect of the service, the preliminary nature of the data, and the problems encountered with the lift equipment--it is too early to conclude that this is a representative trend. Judgment on whether the experience to date in St. Louis is or is not typical for accessible bus service must await comparisons to future ridership statistics from other accessible bus projects.

### 8.1.3 Individual Users

It was considered very important to estimate the number of individual or unduplicated users. To obtain this data, drivers were asked in October 1977 to include the wheelchair rider's handicapped half-fare card ID number with the other information radioed to the dispatcher. Between that date and August 31, 1978 (the end of Phase II), only 191 or 22% out of a reported 854 trips had corresponding ID numbers. A total of 26 different unduplicated users were indicated by this data, since 26 different ID numbers were found.

---

*These calculations assume that all trips made on the 17 routes are made by nearby residents. Also transfers are counted twice. For these reasons, the 10.3% modal split may be overstated somewhat.

In order to more precisely estimate the number of unduplicated users, a special analysis was made of all of the trips reported in Phases I and II to assign them to a specific user. Working in conjunction, ARI and BSDA personnel allocated each reported trip to a specific user, wherever possible, based on observed repetitions of origin, destination, route traveled, and time of day. Where possible, ID numbers were also used to identify different users. For example, the daily wheelchair trip records showed quite a few trips on the Forest Park line between the vicinity of 8th and Locust and 17th and Pine. It was known by BSDA that all these trips were made by BSDA ID No. 05772, and occasionally this ID number would be recorded on such a trip, thus confirming BSDA's information. Conversely, two trips were recorded as going in or out of Pontoon Beach, an address which, as far as could be ascertained, did not closely adhere to any other established trip pattern. Thus, these two trips were assigned to a different user.

A total of 40 different, unduplicated users were identified in this way covering 943 trips (92%) out of 1026 reported trips. The frequency distribution is shown in Figure 8-4.

Not all trips could be assigned to a specific user, however, for two reasons.

- A total of 10 trips out of, or into, Koch Hospital did not have corresponding ID numbers. Many of the Koch residents are in wheelchairs; it is therefore impossible to tell whether these trips were all made by the same person, or by different people.

- A total of 73 trips were made to and from scattered origins and destinations which did not fit into any of the recognizable travel patterns of the 40 identified users, and which did not have corresponding ID numbers. It is impossible to tell whether these were made by some of the already identified users, or by different, as yet unidentified users. These trips were therefore not assigned to any user. However, it is probable that

| USER NO. | NO. OF TRIPS (PHASES I & II) |
|---|---|
| 1 | 211 |
| 2 | 207 |
| 3 | 81 |
| 4 | 61 |
| 5 | 55 |
| 6 | 43 |
| 7 | 37 |
| 8 | 34 |
| 9 | 28 |
| 10 | 26 |
| 11 | 20 |
| 12 | 20 |
| 13 | 12 |
| 14 | 9 |
| 15 | 9 |
| 16 | 8 |
| 17 | 8 |
| 18 | 7 |
| 19 | 6 |
| 20 | 6 |
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| 26 | 3 |
| 27 | 3 |
| 28 | 3 |
| 29 | 3 |
| 30 | 3 |
| 31 | 2 |
| 32 | 2 |
| 33 | 2 |
| 34 | 2 |
| 35 | 2 |
| 36 | 2 |
| 37 | 1 |
| 38 | 1 |
| 39 | 1 |
| 40 | 1 |
| TOTALS | 943 |

FIGURE 8-4 TRIP FREQUENCY DISTRIBUTION OF UNDUPLICATED USERS

these 73 trips do not represent any large number of new, different, unduplicated users. The major reason for this is that, as mentioned below, several of the frequent users who had already been identified tended to utilize different routes and to go to different places. It is therefore possible that some of the unidentified trips were actually made by users already in the group of 40 identified users. In view of this uncertainty these 73 trips have been left out of the user calculations.

Thus, the results of the separate user analysis can be summarized as:

| | |
|---|---|
| 943 | trips assigned to 40 different users |
| 10 | trips made to or from Koch Hospital by unknown users |
| 73 | trips made to or from widely scattered origins or destinations for which users could not be identified |
| 1026 | total reported trips |

The 40 identified different users represent only 2.1% of the estimated wheelchair-using population residing within 1/4 mile of the 17 accessible routes; and only 0.54% of the wheelchair-using population in the entire BSDA service area. This clearly indicates a low level of market penetration.

The trip frequency distribution of Figure 8-4 shows that two persons rode often (greater than 200 times), another 10 persons rode with medium frequency (between 20 and 100 times), and the other 28 identified users rode relatively infrequently (12 or less times). The top three users made 499 trips, or 48.6% of the reported trips. If we assume that each user actually made twice as many trips as were reported, then only nine persons rode at a rate greater than one trip per week!

It was interesting to note that the frequent users did not always display the same origin-destination combinations. In fact, a relatively wide variety of trip patterns were displayed by some of the more frequent users. For example, user No. 4, who made 61 reported trips, appeared to be riding to and from Kingshighway and Oakland (the location of Forest Park Community College); Kingshighway and Hodiamont; Hospital Drive Plaza; Mackland and Oakland; Goodfellow and Delmar; Kingshighway and Delmar; Nottingham and Laclede; Delmar and Debalivere; Westroads Shopping Center; Oakland and Graham; Art Hill; Euclid and Forest Park; Highway 40; 18th and Market; 7th and Locust; and Tamm and Oakland. Thus, we can say that this user traveled on the accessible buses to and from a fairly wide variety of locations.

Certain of the users made all or most of their trips during a few select months of the project. That is, they appeared to use the service at certain points in time, but then to discontinue or curtail usage. Some persons used the project heavily in the beginning of the service, curtailing use as time went on. Other users did not begin to ride until well into the project, and then increased their usage with time. Finally, some users were fairly consistent in their usage all the way through the project period. To illustrate this, the number of reported trips per month for the top five users are shown in Figure 8-5. These changes in travel patterns may reflect natural changes in users' needs for transportation as job, home, or personal activities change; or it may reflect a reaction to the variations in reliability and/or usefulness of the accessible bus service.

Some individual users required the assistance of an attendant to make a trip. Analysis of trip records shows that approximately 10% of the total reported trips were made with an attendant. Although it was not possible to make an exact determination, it was surmized that a majority of the trips with an attendant were made by institutionalized persons. Thus, even though a decided

| | TRIPS/MONTH | | | | |
|---|---|---|---|---|---|
| USER NO. | 1 | 2 | 3 | 4 | 5 |
| Aug. '77 | 5 | 18 | | 23 | |
| Sept. '77 | 3 | 27 | | 19 | |
| Oct. '77 | 24 | 28 | | 8 | |
| Nov. '77 | 31 | 17 | 1 | 3 | 2 |
| Dec. '77 | 12 | 19 | 13 | | 9 |
| Jan. '78 | 2 | 12 | 5 | | 5 |
| Feb. '78 | 0 | 3 | 9 | 1 | 11 |
| Mar. '78 | 15 | 7 | 18 | | 8 |
| Apr. '78 | 25 | 28 | 23 | 7 | 10 |
| May '78 | 12 | 20 | 10 | | 5 |
| June '78 | 13 | 13 | | | |
| July '78 | 36 | 7 | | | 2 |
| Aug. '78 | 33 | 8 | 2 | | 3 |
| TOTAL | 211 | 207 | 81 | 61 | 55 |

FIGURE 8-5 TRIPS PER MONTH FOR THE FIVE MOST FREQUENT USERS

majority of the users did not require the assistance of an attendant, i.e., they were capable of traveling alone, it is significant that some users were able to make trips even though they lacked the capability to travel alone. The actual percent of unduplicated users needing an attendant could not be determined from the available data.

### 8.1.4 Ridership by Route

Table 8-4 is a comparison of wheelchair and general public ridership for each of the 17 accessible bus routes. Generally, wheelchair ridership did not correlate with the ridership patterns of the general public. That is, routes that were the most popular for the general public were not necessarily so for the wheelchair users. However, because only a few users made such a large percentage of the trips, the route data reflects no more than the preferences of a few individuals. For example, one individual who made frequent trips rode the Alta Sita route. Although this route ranked 10th in terms of general public ridership, it ranked 3rd in terms of wheelchair ridership. Thus, one cannot conclude that the relative route ridership of users (attractiveness) would stay the same if there were a substantial increase in the number of riders.

Table 8-4 also shows the preliminary evaluation made by BSDA of the potential attractiveness of the Phase I routes. The evaluation was made prior to initiation of service. It was based upon the consideration of such factors as census data pertaining to elderly and handicapped persons, half-fare ridership per revenue mile, and known points of interest to elderly and handicapped persons. As one might suspect when there is no historical data available and the resultant ridership is relatively low, the preliminary projection did not always agree with the reported route ridership. For example, the Forest Park route was considered to have excellent potential and it did have the highest number of average wheelchair trips/month. On the other hand, the Grand route (highest general public ridership) was also considered to have excellent potential, but it ranked 11th in average wheelchair trips/month.

| LOCAL ROUTES | AVERAGE WEEKLY RIDERSHIP | REPORTED WHEELCHAIR TRIPS (1) | AVERAGE ESTIMATED TRIPS/MONTH(2) | RANK ORDER FOR TRIPS/MONTH | PRELIMINARY EVALUATION OF ROUTE POTENTIAL (3) |
|---|---|---|---|---|---|
| Grand * | 16,061 | 36 | 5.8 | 11-12 | Excellent |
| Kingshighway * | 13,009 | 59 | 9.4 | 7 | Very Good |
| Belleville-St. Louis * | 10,638 | 48 | 7.7 | 10 | Good |
| Forest Park * | 8,758 | 231 | 37.0 | 1 | Excellent |
| Lee | 8,686 | 113 | 25.1 | 2 | -- |
| Delmar-Forsyth* | 8,452 | 32 | 5.1 | 13 | Good |
| Cherokee | 8,315 | 36 | 8.0 | 9 | -- |
| Olive-Creve Coeur | 8,256 | 37 | 8.2 | 8 | -- |
| Natural Bridge* | 7,124 | 36 | 5.8 | 11-12 | Good |
| Carondelet* | 3,168 | 79 | 12.6 | 6 | Good |
| Alta Sita* | 4,463 | 151 | 24.2 | 3 | Poor |
| Tower Grove | 4,108 | 74 | 16.4 | 4 | -- |
| Broadway | 3,647 | 72 | 16.0 | 5 | -- |
| City Limits* | 3,202 | 5 | 0.8 | 14 | Good |
| McKinley Bridge* | 1,634 | 3 | 0.5 | 15 | Good |
| Cross County | 1,402 | 2 | 0.4 | 16 | -- |
| St. Louis Ave. | 438 | 0 | 0 | 17 | -- |

(1) Only totals 1014 due to 12 trips considered as other and difficulties interpreting driver logs.
(2) Accounts for number of months each route operated with accessible buses.
(3) Estimated by BSDA for Phase I routes prior to operation.

* Asterisked routes were operated with lift buses in Phase I.

TABLE 8-4 RIDERSHIP BY ROUTE

### 8.1.5 User Ridership by Time-of-Day

It was possible to show the time-of-day distribution of the wheelchair transit trips. Because so many trips were made by so few users, it is difficult to draw any definite conclusions from the data, which is shown in Table 8-5. However, it is interesting to note the peaks at 7-8 a.m. and 1-2 p.m. As shown in Figure 8-6, the distribution is somewhat like the general public distribution, excepting the 1-2 p.m. peak. A larger, more representative sample of wheelchair transit trips might show a time-of-day distribution closer to that of the general public.

## 8.2 TRIP DENIALS AND DIFFICULTIES ENCOUNTERED

A "denial" occurred whenever a person using a wheelchair was at a bus stop at the appropriate time for a scheduled bus trip but could not board. A denial could occur for any number of reasons including:

- The driver attempted to operate the lift, but the lift malfunctioned.
- The driver knew or suspected that the lift was inoperative and therefore declined to pick the passenger up.
- The lift was inoperative and/or bolted shut.
- The scheduled accessible trip was being operated by a non-accessible vehicle (i.e. a missed run).
- The passenger attempted to board a bus trip or even a route which was not scheduled to be accessible.*

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*Not all wheelchair passengers traveled by the schedules. Some would simply go to a stop and attempt to board the first accessible bus. If a scheduled inaccessible bus came along while the passenger was waiting, they might request to board and a "denial" might be recorded.

| HOUR BEGINNING | PERCENT OF WHEELCHAIR TRIPS BOARDED |
|---|---|
| AM 4:00 | .4 |
| 5:00 | .9 |
| 6:00 | 3.8 |
| 7:00 | 11.1 |
| 8:00 | 3.6 |
| 9:00 | 6.5 |
| 10:00 | 3.6 |
| 11:00 | 4.2 |
| PM 12:00 | 6.9 |
| 1:00 | 11.4 |
| 2:00 | 7.8 |
| 3:00 | 9.6 |
| 4:00 | 7.2 |
| 5:00 | 6.5 |
| 6:00 | 6.9 |
| 7:00 | 4.0 |
| 8:00 | 2.0 |
| 9:00 | 2.2 |
| 10:00 | .2 |
| 11:00 | .7 |
| 12:00 | .4 |
| | 100.0 |

Source: Tabulation of 551 trip records (53% of total reported trips).

TABLE 8-5 RIDERSHIP BY TIME OF DAY

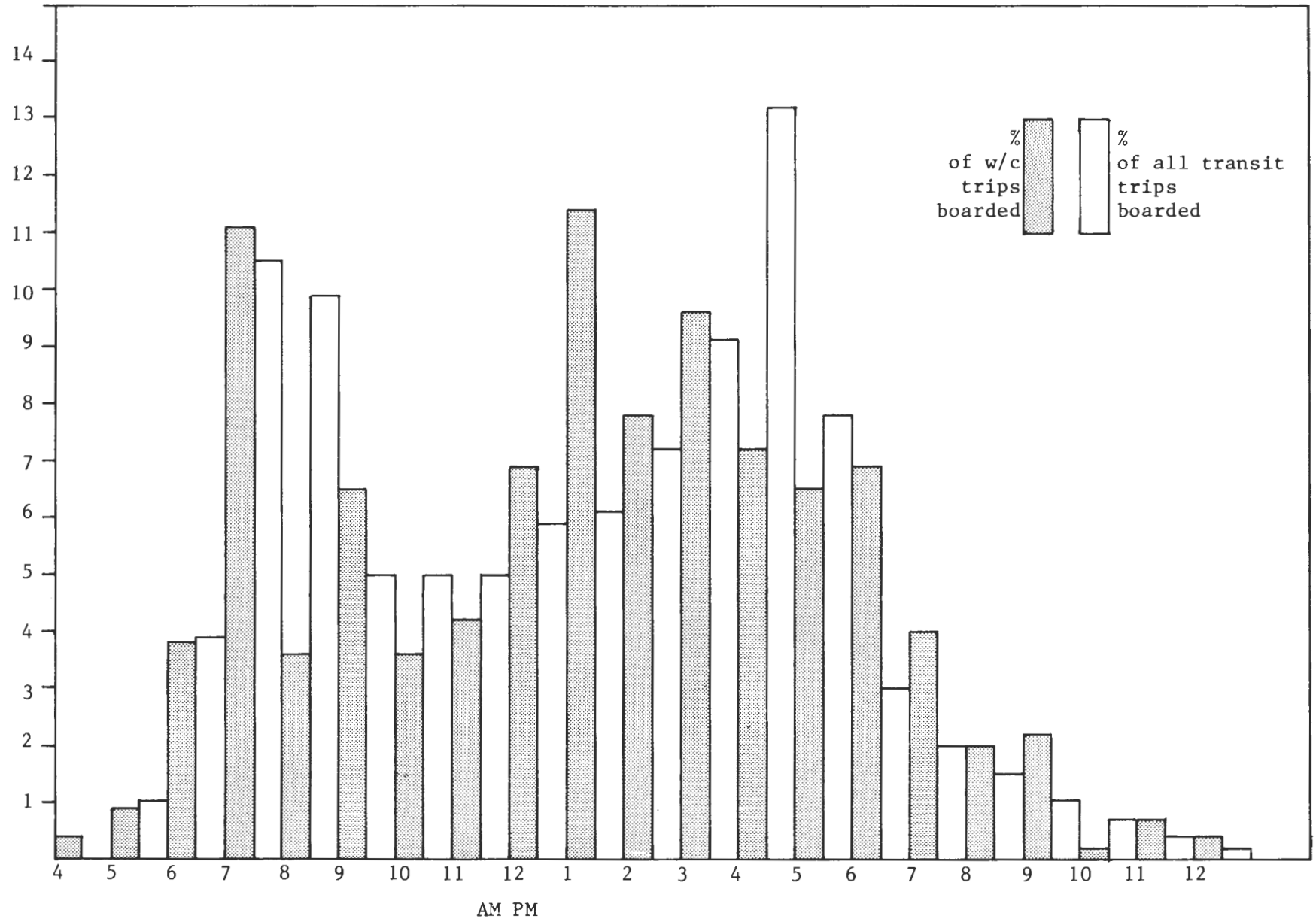


FIGURE 8-6 COMPARISON OF RIDERSHIP BY TIME OF DAY

- The bus was too crowded to admit a wheelchair.
- Both wheelchair positions were already occupied.
- For some other reason, the passenger could not board.

In practice, almost all reported denials were ascribed to problems with lift operation. There was one recorded instance of the bus being too crowded, but there were no instances of a denial because both wheelchair positions were filled.

Following a denial, a wheelchair user could wait for another bus, cancel the trip, or find another way to travel. Also, a few semi-ambulatory wheelchair persons were able to board the bus without using the lift if they were accompanied by an attendant. BSDA was well aware of the denial problem and went to great lengths to accommodate the denied passengers. BSDA actions which were employed at various times included:

- The operator or supervisor carrying the passenger on or off the bus.
- The supervisor driving the person to their destination in the supervisors car.
- Buses were "specialed out" to pick the person up, sometimes at great expense.

These actions sometimes placed a considerable strain on the BSDA operations personnel.

As with the trip data, all denials were supposed to be radioed to the dispatcher by the driver, giving time, route, location and reason for denial. The dispatcher recorded the information for ultimate transcription to the Daily Wheelchair Trip and Denial Record. Unfortunately, it is clear that accurate denial data was <u>not</u> obtained by this procedure.

The trip denials reported by the drivers are given in Table 8-6. These data show that 116 denials were reported over the 12-1/2 months from the start of service, an average of 9.3 denials/month. Table 8-6 also shows denials as a percentage of reported trips. On an overall basis, reported denials were 11.3% of reported trips. During Phase II, reported denials increased in frequency. Even without taking into account under-reporting of denials, this high percentage was not conducive to attracting new riders or holding existing ones. The denials seem to be one factor contributing to the decrease of ridership in Phase II.

Several other sources indicated that more denials occurred than were reported; and that users experienced considerable difficulty when attempting to use the service. For example, as part of the detailed survey of users, travel diaries were kept by 16 users for a period of three weeks. They reported 12 trip denials along with the 44 trips that were taken. None of these 12 denials actually turned up on the Daily Wheelchair Trip and Denial Record. Although this sample is too small to draw rigorous conclusions from, it does show that denials were under-reported.

Furthermore, as part of the travel diary, users were requested to record the kind of trouble they may have encountered while making the trip. Out of a sample of 40 trips for which this information was reported, 78% involved some kind of trouble, as shown by Table 8-7. Note that over one-third of the reported troubles were due to "lift malfunction--boarded with delay" which would not have been considered as a denial.

The 16 users who responded to the home interview survey* were asked how often they had been denied entry over the 10 month period from the start of service and what they did about it.

*Because of the small sample size, results do not provide a statistically valid representation of all users.

| MONTH | REPORTED (1) DENIALS | DENIALS AS PERCENTAGE OF REPORTED TRIPS |
|---|---|---|
| August, 1977 (2) | 1 | 1.1 |
| September | 0 | 0 |
| October | 3 | 3.2 |
| November | 7 | 8.6 |
| December | 12 | 12.5 |
| January, 1978 | 10 | 24.4 |
| February | 6 | 14.3 |
| March | 11 | 16.9 |
| April | 31 | 24.4 |
| May | 13 | 15.9 |
| June | 11 | 18.3 |
| July | 8 | 8.8 |
| August | 3 | 4.1 |
| | 116 | |
| Monthly Average | 9.3 | 11.3% |

(I) Based on tabulations of trip records by ARI

(2) Service initiated on August 15

TABLE 8-6 TOTAL REPORTED TRIP DENIALS

| | |
|---|---|
| No trouble | 22% |
| Lift malfunction - waited for another bus | 20% |
| Lift malfunction - boarded with delay | 30% |
| Lift Bus Late - trip delayed | 7.5% |
| Problem with wheelchair securement device | 2.5% |
| Other (1) | 18% |
| | 100% |

(1) Other reasons included cases where the lift was blocked up, or the driver knew the lift was inoperative. Several respondents were able to board the buses without the lift, with the aid of the driver, an attendent, or other passengers.

Source: User Diaries (N=40 trips, 8 respondents)

TABLE 8-7 TROUBLE REPORTED BY USERS ON LIFT BUSES

Thirteen of the 16 users indicated that they had experienced at least one denial and four indicated more than 10 denials. Their reactions to the denials varied, but the most common reaction was to wait for the next accessible bus. Several trips were cancelled, or the user went home and took a car, or was driven by a BSDA supervisor. None of the respondents indicated shifting to a taxi as a result of a denial.

Based upon the preceding discussion, it seems reasonable to conclude that the service reliability and dependability was poor, particularly in Phase II. Although it was not possible to estimate the actual number of denials, there is reason to believe that it is greater than the reported average of 12 denials/month. Furthermore, the home interview survey indicated that 80% of the users had been denied a trip at least once and 25% had been denied more than 10 times. Also, the survey indicated that users experienced troubles and delays on at least 30% of their trips in addition to the problem of denials. Though the survey results are not necessarily representative, it seems difficult to dispute that a majority of the users experienced some type of difficulty or denial when attempting to use the service--a much different experience than the general public had in riding the same accessible buses.

Thus, it can be concluded that equipment problems were a major factor reducing ridership in Phase II. Furthermore, these problems undoubtedly inhibited any potential increases in ridership which could have resulted from the expanded service levels of Phase II.

## 8.3 WHEELCHAIR TRIP CHARACTERISTICS

This section presents the following information on the wheelchair trips: 1) travel time, 2) alternate mode, 3) trip purpose, 4) access mode and 5) access distance. The information was obtained from travel diaries kept by 16 users for three consecutive weeks.

No data was gathered on non-transit trips. The weekly periods varied by individuals from June to September 1978. Despite efforts to obtain a larger sample size (see Chapter 2), this sample is too small to be statistically representative of the entire user group. Furthermore, only 10 of the surveyed users were non-institutionalized; the other 6 were institutionalized. Since perhaps 90% of all reported trips may have been made by non-institutionalized persons,* this would mean that the results provided by the diaries are disproportionally skewed toward institutionalized user characteristics.

Over the three week period that the diaries were kept, a total of 44 transit trips were made by 9 of the 16 respondents. In the following discussion, indication of a lesser number of trips means that requested information was not obtained for all trips.

### 8.3.1 Travel Time

Travel time refers to the time it took a user to travel between origin and destination. It includes delays encountered and the time taken to wheel to and from bus stops. Figure 8-7 gives the distribution of travel times for the reported sample of wheelchair trips. Twenty-four percent of the trips took two or more hours, including two trips that took four hours. These excessively long travel times were primarily due to troubles that the users encountered with the service (see Table 8-7 earlier). In comparison, Table 8-8 shows the weighted travel time for the general ridership on the BSDA system.** These data indicate that

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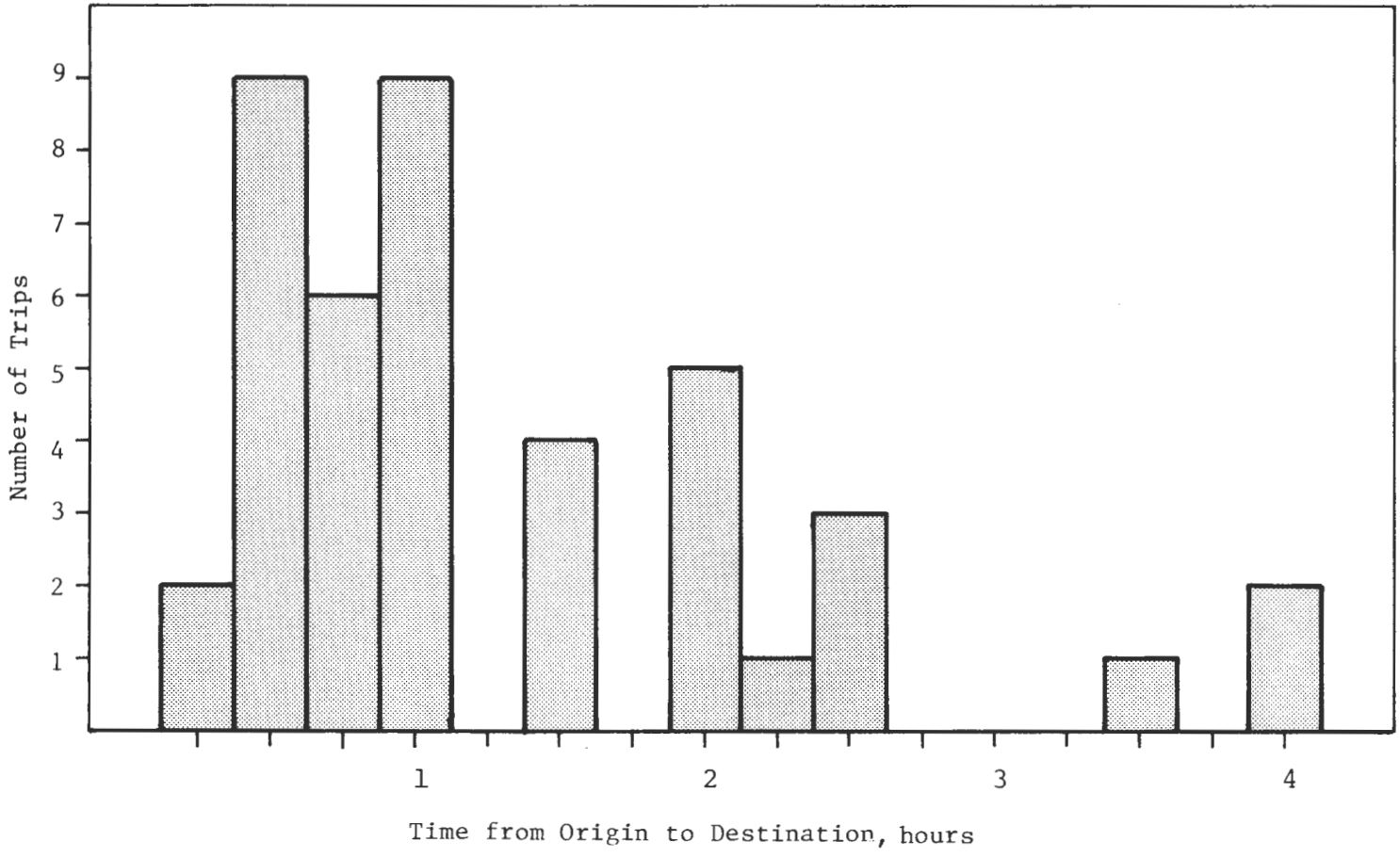
*Assumes all trips which required an attendant were made by institutional users, i.e., 10% of trips were made by institutionalized users.

**Home-based peak period trips only. Weighted travel times were the only available data. Such data refers to the out-of-vehicle travel time weighted by a factor greater than one to represent the increased dislike which people attribute toward waiting and walking.




Source: Travel Diaries (42 trips- 8 respondents)

FIGURE 8-7 **WHEELCHAIR USER TRAVEL TIME DISTRIBUTION**

| Weighted Travel Time (Minutes) | Percentage of Total Trips | | | | |
|---|---|---|---|---|---|
| | Minority Areas | Non-Minority Areas | Transit Dependent Areas | Non-Transit Dependent Areas | All Areas |
| 0 - 5 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 6 - 11 | 1.3 | 0.2 | 1.1 | 0.1 | 0.7 |
| 12 - 17 | 5.3 | 5.0 | 6.7 | 2.9 | 5.2 |
| 18 - 23 | 5.5 | 5.9 | 6.0 | 5.3 | 5.7 |
| 24 - 29 | 13.0 | 4.8 | 12.6 | 2.2 | 8.4 |
| 30 - 35 | 11.5 | 8.1 | 12.9 | 4.7 | 9.6 |
| 36 - 41 | 16.1 | 9.6 | 16.1 | 7.0 | 12.4 |
| 42 - 47 | 13.2 | 12.4 | 14.9 | 9.6 | 12.7 |
| 48 - 53 | 10.8 | 9.1 | 10.7 | 8.5 | 9.8 |
| 54 - 59 | 5.9 | 7.3 | 6.1 | 7.6 | 6.7 |
| 60 - 65 | 4.9 | 6.5 | 3.6 | 9.1 | 5.8 |
| 66 - 71 | 2.2 | 6.7 | 1.9 | 9.1 | 4.8 |
| 72 - 77 | 2.0 | 4.4 | 1.4 | 6.2 | 3.4 |
| 78 - 83 | 1.6 | 4.6 | 1.2 | 6.5 | 3.3 |
| 84 - 89 | 1.2 | 3.7 | 0.7 | 5.3 | 2.6 |
| 90 or More | 5.5 | 11.7 | 4.1 | 15.9 | 8.1 |
| | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 |
| Percent under 30 minutes | 25.1 | 15.9 | 26.4 | 10.5 | 20.0 |
| Percent under 60 minutes | 82.6 | 62.3 | 87.1 | 47.9 | 71.2 |
| Average Time (Minutes) | 42.2 | 53.1 | 39.9 | 60.9 | 48.3 |

Source: Existing Service Impact Study, Dalton, Dalton, Little, Newport, prepared for BSDA August 17, 1977; TABLE VII, page VII-4.

TABLE 8-8 WEIGHTED TRANSIT TRAVEL TIMES HOME-BASED TRIPS PEAK PERIOD (TOTAL BSDA SYSTEM)

71% of all BSDA transit trips took less than 60 minutes and that the average travel time for riders was 48.3 minutes on a weighted basis (somewhat higher than actual travel time). Based on table 8-6, only 42% of the wheelchair trips took less than 60 minutes and the average travel time was 73.9 minutes. Thus, the sample indicates that wheelchair users had to spend considerably more time taking a transit trip than the general public did.

### 8.3.2 Alternate Mode

The sampled users were asked to indicate what their alternative mode might be if an accessible bus were not available. Table 8-9 gives the alternate mode for 37 trips indicated by the user sample. Approximately 30% of the trips would not have been made, and a majority (65%) would have been made by automobile. No trips were indicated as being diverted from taxis or social service agency transportation.

It is interesting to point out that one of the users in the sample was also capable of boarding without the lift. Her practice was to take a bus with a working lift when it came along, but if the lift was inoperable (or if the bus did not have a lift), she would get out of her chair and drag the chair onto the bus with her. Thus, her alternate mode to accessible bus was, technically speaking, inaccessible bus. This rider's trips are not included in Table 8-9.

### 8.3.3 Trip Purpose

As part of their travel diaries, the user sample was asked to indicate the purpose of each trip from a given list of nine possibilities. Table 8-10 gives the purpose indicated for 44 trips reported by the user sample. The highest ranked trip purpose was work related (work plus sheltered occupation) which accounted for almost a third (30%) of all trips. This was closely

| | |
|---|---|
| Auto Passenger | 54% |
| Auto Driver | 11% |
| Walk/Wheel with Assistance | 5% |
| Taxi | 0% |
| Social Agency Transportation | 0% |
| Would not make Trip | 30% |
| | 100% |

Source: Travel Diaries (37 trips - 8 respondents)

TABLE 8-9 ALTERNATE MODE TO ACCESSIBLE BUS

| | | |
|---|---|---|
| 1. | Work | 14% |
| 2. | Sheltered Occupation | 16% |
| 3. | Shopping | 11% |
| 4. | Personal Business | 2% |
| 5. | Social/Recreation | 25% |
| 6. | Home | 27% |
| 7. | Rehabilitation | 0% |
| 8. | School | 0% |
| 9. | Other | 5% |
| | | 100% |

Source: Travel Diaries (44 trips - 9 respondents)

TABLE 8-10 ACCESSIBLE BUS TRIP PURPOSES

followed by trips for social/recreational purposes which were 25% of the total trips. It is interesting to note that trips to hospitals or doctors could have been indicated as "personal business" or "other", yet these two purposes only accounted for 7% of the trips. Thus, it can be inferred from the limited sample results that the users took significantly more work and social/recreational related trips than medical trips.

### 8.3.4 Access Mode

Data was gathered in the travel diary on each user's mode of access to/from the bus stop. Although this data did not turn out to be very useful, it is shown in Table 8-11. Only two access travel modes were reported by the respondents; wheel unattended and wheel with assistance. Each of these modes were used for about one-half of the reported trips. Other modes such as taxi or auto were not used by the user sample. It was not determined whether the assistance was provided by an attendant or a companion traveling with the passenger.

Earlier it was indicated that attendants provided assistance for approximately 10% of the user trips reported by the drivers.* The travel diaries indicated a much higher percentage because the sample had a disproportionately high number of institutionalized users and not all of the assistance may have been provided by attendants. Thus, the access mode information given by Table 8-11 may be misleading and its usefulness is questionable.

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*This statistic was first mentioned at the beginning of Section 8.3. The data source is a special count on the Wheelchair Trip and Denial Records, carried out by BSDA personnel.

### 8.3.5 Access Distance

Table 8-12 presents the distance the user sample indicated that they traveled to board the accessible buses and the distance from where they alighted to their final destination. These results show that one-half of the access links were one block or less; however, the results are skewed because one of the users (who accounted for 16% of the access links) actually lived 11 blocks from the nearest bus stop. Thus, even though the user sample indicates that most users traveled one or less blocks to use the service, there were some users who managed to travel greater distances.

## 8.4 USER CHARACTERISTICS

In order to obtain information concerning the characteristics of the users, a detailed home interview survey was administered to the same group of 16 users who kept the travel diaries. The survey was administered in June and July of 1978, approximately 10 months after initiation of accessible bus service. It is necessary to reiterate that because of the small sample size, the survey results are not a statistically valid representation of the entire group of users, and cannot be used to draw any major conclusions. Also, the sample had a disproportionately high number of institutionalized users, since 6 out of 16 (38%) were institutionalized compared to an earlier approximation that 10% of the total user group were institutionalized.

In the user sample, there were seven women and nine men. One user was 19 years old, eight were between 30 and 45 years, and seven were between 60 and 75. Four of the elderly users were institutionalized. Two of the users rode often. One, who was institutionalized, claimed to make one trip per week. This would have amounted to about 50 trips by the time of the survey. The other one, who lived 11 blocks from the nearest bus stop, was the

| | |
|---|---|
| Wheel Unattended | 52% |
| Wheel with Assistance | 48% |
| All other Modes | 0% |

Source: Travel Diaries (69 access links - 8 respondents)

TABLE 8-11 ACCESS MODE

| | No. of Access/ Egress Links | Percent |
|---|---|---|
| 0 Blocks to or from Bus Stop | 15 | 22% |
| 1 Block to or from Bus Stop | 19 | 28% |
| 2 Blocks to or from Bus Stop | 5 | 7% |
| 3 Blocks to or from Bus Stop | 4 | 6% |
| 4 Blocks to or from Bus Stop | 14 | 21% |
| 11 Blocks to or from Bus Stop* | 10 | 16% |
| TOTALS | 67 | 100% |

Source: Travel Diaries (8 respondents)

*All trips made by just one user

TABLE 8-12 DISTANCE WHEELED TO OR FROM BUS STOP

single most frequent user of lift buses. As shown in Figure 8-4, this man (hereafter referred to by the pseudomym, "Ted Brown") made 211 reported trips during Phases I and II.*

Six other wheelchair users stated that they had made between 4 and 12 transit trips by the time of the survey, and the rest had only ridden once or twice. Although 6 of the 16 users had not made any trips in the three months preceding the survey, all of them said "yes" or "maybe" to, "Do you intend to keep using the buses?"

The users were asked about their physical characteristics and abilities. Seven had been in a wheelchair longer than ten years. Only two, including Ted Brown, used electric wheelchairs. Fifteen stated that they were in good health. Nine said that they could wheel about independently, but four had only limited use of their arms. Seven of the users, including five of the institutionalized, stated that they never traveled alone (i.e., without a companion) on the buses. Only six said that they always traveled alone.

The respondents were queried on their self-perceived abilities to get around out-of-doors. On the average, they stated they could wheel an average of 3.3 blocks alone in good weather; 2.0 blocks in cold or rainy weather; and .56 blocks the day after a three inch snow. Although a small sample, the answers clearly point up the <u>great</u> impact bad weather has on a wheelchair person's ability to go outside. This survey question tends to support the conclusions reached earlier on the effect of weather on ridership.

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*Note that the second most frequent user, who made 207 trips, could not be identified and located, and is not one of the 16 surveyed users.

Most of the users lived 1 block or less from a bus stop served by an accessible route. Three users lived 4-5 blocks away; one, who did not make any transit trips during the period of the travel diary, lived 2 miles away. Ted Brown was the exception, as he lived and usually went, 11 blocks to the bus stop.

Four of the users were full-time workers. A fifth, Ted Brown, was both a full-time student and a full-time worker at various times during the life of the project. A sixth was in sheltered employment. The rest were either unable to work or were retired, including all of the institutionalized users. The four full-time workers were all professionals.

Several users had access to other transportation. Five had driver's licenses, six owned cars (including four of the workers) and, excluding the institutionalized users, only two came from zero-car households. It is important to emphasize the availability of the automobile to the respondents, for it clearly provided them with a good alternative to the accessible buses.

Four users stated they made use of human service agency transportation programs. Six stated they could afford to take a taxi, one user had ridden once on a taxi in the previous month, and one user had ridden 40 times.* Seven users said it was physically very easy or moderately easy to use taxis, while the rest said it was difficult or impossible.

Six users had incomes greater than $10,000/year, including the four full-time workers and two others who were retired and had pensions/investments. The other ten users (including all of the institutionalized users) had incomes below $6,000/year. Many of these people were living on social security.

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*This was the user attending sheltered employment. The taxi was presumably subsidized by the employing agency.

In summary, the users surveyed were a fairly diverse group and they represented at best some, but not necessarily all, of the characteristics of a typical user group.

## 8.5 USER ATTITUDES

### 8.5.1 User Problems

Users were asked on the home interview survey to score a series of possible or actual problems in using the buses. The problems are ranked in Table 8-13. The two most important problems are "being denied entry because the lift was not working" and "lack of curb cuts." That denials are a problem is not surprising (see Section 8.2); the importance of curb cuts, however, and by implication the entire sidewalk environment, is brought out clearly in the survey. Previous surveys of the handicapped have shown that home-to-bus barriers are important, and this survey confirms those findings.

Other problems which were considered to be important included bad weather, lack of bus shelters, and buses not stopping at the curb. Many problems which were in the survey appeared relatively unimportant, such as lift cycle time, maneuvering in the bus, crowds, feeling safe on the lift or using the wheelchair restraint arm.

### 8.5.2 Improvements Recommended by Users

Users were asked to rank a set of recommended improvements. The collective results are given by Table 8-14. The improvement which was ranked highest was that, "all BSDA routes should be accessible." Other important suggestions were more curb cuts, better snow removal, and a better designed lift. Their recommendations may indicate a real desire on the part of the users to travel more on buses; on the other hand, it may also reflect an "advocate" attitude in favor of accessibility.

| RANK ORDER | PROBLEM | AVERAGE ORDINAL (1) VALUE |
|---|---|---|
| 1. | Being denied entry because the lift was not working | 2.25 |
| 2. | Lack of curb cuts | 2.25 |
| 3. | Bad weather | 2.0 |
| 4. | Lack of bus shelters | 2.0 |
| 5. | Buses not stopping at the curb | 1.8 |
| 6. | Getting over the lip and on to the lift platform | 1.6 |
| 7. | Buses not arriving on time | 1.4 |
| 8. | Difficulty getting schedules | 1.4 |
| 9. | Driver assistance and courtesy | 1.3 |
| 10. | Attitude of other passengers | 1.3 |
| 11. | The wheelchair restraint arm does not secure the chair from moving | 1.3 |
| 12. | Both wheelchair stations already occupied by a handicapped person | 1.25 |
| 13. | Other passengers being delayed while I use the lift | 1.2 |
| 14. | Maneuvering to the wheelchair station | 1.2 |
| 15. | Adjusting the restraint arm | 1.2 |
| 16. | Crowds in the aisle | 1.2 |
| 17. | Feeling safe on the lift | 1.1 |
| 18. | People seated on the fold down seats in the wheelchair station | 1.1 |
| 19. | The length of time needed to get on or off a bus using a lift | 1.0 |

(1) 3 = Serious problem; 2 = Moderate problem; 1 = Little or no problem

TABLE 8-13 RELATIVE IMPORTANCE OF PROBLEMS AS PERCEIVED BY WHEELCHAIR USERS OF BSDA ACCESSIBLE BUSES

| RANK ORDER | RECOMMENDED IMPROVEMENT | ORDINAL(1) VALUE |
|---|---|---|
| 1. | All Bi-State routes should be accessible | 2.75 |
| 2. | There should be more curb-cuts and adequate snow removal from sidewalks and roads | 2.4 |
| 3. | A better designed lift | 2.3 |
| 4. | Door-to-door service in addition to accessible buses | 2.3 |
| 5. | All buses on accessible routes should have lifts | 2.1 |
| 6. | Door-to-door service instead of accessible buses | 2.0 |
| 7. | Less crowding on the lift buses during rush hour | 1.9 |
| 8. | Drivers should help more | 1.6 |
| 9. | A better designed interior on the lift buses | 1.4 |
| 10. | Better wheelchair positions in the lift buses | 1.4 |
| 11. | An escort service when you want to go on the lift buses | 1.4 |

(1) 3 = Very Important
2 = Moderately Important
1 = Not Very Important

Source: Home Interview Surveys (16 respondents)

TABLE 8-14 RELATIVE IMPORTANCE OF IMPROVEMENTS RECOMMENDED BY WHEELCHAIR USERS OF BSDA ACCESSIBLE BUSES

"All buses on accessible routes should have lifts" was only ranked as moderately important. "Door-to-door service in addition to accessible buses" was also moderately important. Escort services, interior improvements, and additional driver assistance were all of lesser importance.

## 8.6 CHARACTERISTICS AND ATTITUDES OF NON-USERS

In order to determine the characteristics and attitudes of persons in wheelchairs who had not ridden on the accessible buses (non-users), 62 non-institutionalized and 233 institutionalized persons were located and surveyed. A truly random sample survey was felt to be too difficult to perform within the scope of the evaluation. Based on an estimated non-institutionalized wheelchair prevalence rate of .0019 and a household size of 2.7, about 19,500 households might need to be contacted to generate a sample size of 100 non-users in wheelchairs. Thus, a non-random sample was generated by distributing the surveys through the following agencies/groups: Veteran's Hospital at Jefferson Barracks, United Cerebral Palsy, Division of Vocational Rehabilitation, Koch Hospital and Chor-Bus.

These samples represent 4.4% and 19.6% of the estimated wheelchair-using non-institutionalized and institutionalized population in the BSDA service area, respectively. Since institutionalized persons constitute 79% of the non-user sample but only 24% of the total wheelchair population, the results are biased towards the institutionalized non-users. For this reason, separate results are presented for each group.

When evaluating the responses to the two non-user surveys, it should be kept in mind that survey respondents were selected, out of necessity, in a non-random manner. Because of this sampling method, the accuracy of the results cannot be stated with statistical precision.* Nevertheless, this survey does give important data, previously unavailable, on the characteristics and attitudes of both the instutionalized and non-institutionalized non-user wheelchair populations in St. Louis.

## 8.6.1 Characteristics of Non-Users

Table 8-15 provides a detailed tabulation of the characteristics of persons in wheelchairs who did not use the BSDA service (non-users) based on survey results. A large majority of the persons had been in wheelchairs over five years. About half (48%) of the non-institutionalized persons had limited or no use of their arms whereas almost all (98%) of the institutionalized had this condition. Only 1% of the institutionalized persons could wheel about independently while 39% of the non-institutionalized persons had that mobility. This lack of mobility would clearly present some difficulty to any possible use of accessible buses.

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*The accuracy of the results depends upon the amount of bias that the sampling method has introduced. If this bias is assumed to be negligible, then the following confidence interval could be assigned to a percentage, X, which is calculated from the survey responses:

| FOR NON-INSTITUTIONAL NON-USERS | FOR INSTITUTIONALIZED NON-USERS |
|---|---|
| $X \pm 13\%$ | $X \pm 6.5\%$ |

This means, for example, that if for both groups of non-users, 50% responded "yes" to a yes/no question (i.e., X=50%), the true (or actual) percent would lie between 37 and 67 percent for the non-institutionalized non-users, but between 43.5 and 56.5 percent for the institutionalized non-users (in at least 95 out of 100 random samples of the entire wheelchair population).

| | NON-INSTITUTIONALIZED PERSONS (N=62) | INSTITUTIONALIZED PERSONS (N=233) |
|---|---|---|
| | Percents (1) | |
| 1. Length of Time in Wheelchair | | |
| a) Less than one year | 1.6 | 0 |
| b) Between one year and three years | 6.5 | 0 |
| c) Between three and five years | 3.2 | 3.9 |
| d) Over five years | 88.7 | 96.1 |
| 2. Use of Arms | | |
| a) Full use and strong enough to independently wheel about | 38.7 | 1.3 |
| b) Full use, but not strong enough to wheel myself about; | 12.9 | .9 |
| c) Limited use; | 40.3 | 71.7 |
| d) No use | 8.1 | 26.1 |
| 3. Good General Health | | |
| a) Yes | 95.0 | 89.3 |
| b) No | 5.0 | 10.7 |
| 4. Sex | | |
| a) Male | 52.5 | 47.3 |
| b) Female | 47.5 | 52.7 |
| 5. Age | | |
| a) Less than 16 | 1.6 | .4 |
| b) 16-19 years | 1.6 | .4 |
| c) 20-29 years | 43.5 | 0 |
| d) 30-39 years | 32.3 | .4 |
| e) 40-49 years | 11.3 | .4 |
| f) 50-59 years | 3.2 | 4.3 |
| g) 60-64 years | 1.6 | 3.0 |
| h) 65-74 years | 3.2 | 47.6 |
| i) 75 or older | 1.6 | 43.3 |

(1) Except for round off error, percentages for each item totals 100.

Source: Non-User Survey

TABLE 8-15 CHARACTERISTICS OF PERSONS IN WHEELCHAIRS WHO DID NOT USE BSDA SERVICE

| | | NON-INSTITUTIONALIZED PERSONS (N=62) | INSTITUTIONALIZED PERSONS (N=233) |
|---|---|---|---|
| 6. | Personal Income (per year) | | |
| | a) Less than $3,999 | 23.2 | 96.1 |
| | b) $4,000 - $5,999 | 8.9 | 0 |
| | c) $6,000 - $7,999 | 5.4 | 0 |
| | d) $8,000 - $9,999 | 3.6 | 0 |
| | e) $10,000 - $14,999 | 0 | 0 |
| | f) $15,000 - $19,999 | 3.6 | 0 |
| | g) More than $20,000 | 1.8 | 0 |
| | h) No response | 53.6 | 3.9 |
| 7. | Occupation | | |
| | a) Full-time worker | 9.7 | .4 |
| | b) Unemployed, looking for full-time work | 1.6 | 0 |
| | c) Part-time worker | 3.2 | 0 |
| | d) Full-time rehabilitation | 1.6 | 0 |
| | e) Sheltered employment | 3.2 | 0 |
| | f) Student | 53.2 | .4 |
| | g) Homemaker | 1.6 | 0 |
| | h) Retired | 1.6 | 3.5 |
| | i) Unable to work | 24.2 | 95.6 |
| 8. | Wheelchair Tires | | |
| | a) Pneumatic | 26.7 | 98.3 |
| | b) Hard Rubber | 73.3 | 1.7 |
| 9. | Diameter of Smaller Set of Wheels | | |
| | a) 5 inches | 32.2 | 99.1 |
| | b) 8 inches | 67.8 | .9 |
| 10. | Power of Chair | | |
| | a) Manual | 91.9 | 99.6 |
| | b) Electric | 3.2 | .4 |
| 11. | Footrest Extension on Chair | | |
| | a) Yes | 79.0 | 53.2 |
| | b) No | 21.0 | 46.8 |

TABLE 8-15 (Cont'd.)

| | NON-INSTITUTIONALIZED PERSONS (N=62) | INSTITUTIONALIZED PERSONS (N=233) |
|---|---|---|
| 12. Headrest Extension or Reclining Back on Chair | | |
| a) Yes | 19.4 | 47.6 |
| b) No | 80.6 | 52.4 |
| 13. Frequency With Which Respondent Travels Outside of Home Independently Without Assistance | | |
| a) Always | 8.1 | 0 |
| b) Sometimes | 25.8 | 2.6 |
| c) Never | 66.1 | 97.4 |
| 14. Distance Which Respondent Can Wheel Outside Independently | | |
| A. In Good Weather | | |
| a) No distance | 30.2 | 40.2 |
| b) Less than one block | 14.0 | 53.7 |
| c) One block | 7.0 | 1.7 |
| d) Two blocks | 9.3 | 1.3 |
| e) Three or four blocks | 11.6 | 0 |
| f) Five blocks or more | 27.9 | 3.1 |
| B. In Rainy or Cold Weather | | |
| a) No distance | 54.5 | 90.5 |
| b) Less than one block | 4.5 | 7.8 |
| c) One block | 11.4 | 1.3 |
| d) Two blocks | 11.4 | .4 |
| e) Three or four blocks | 6.8 | 0 |
| f) Five blocks or more | 11.4 | 0 |
| C. With Three Inches of Snow on the Ground | | |
| a) No distance | 84.1 | 97.8 |
| b) Less than one block | 13.6 | 1.7 |
| c) One block | 0 | 0 |
| d) Two blocks | 2.3 | 0 |
| e) Three or four blocks | 0 | 0 |
| f) Five blocks or more | 0 | .4 |
| 15. Licensed and Able to Drive a Car | | |
| a) Yes | 17.7 | 0 |
| b) No | 87.3 | 100 |

TABLE 8-15 (Cont'd.)

| | | NON-INSTITUTIONALIZED PERSONS (N=62) | INSTITUTIONALIZED PERSONS (N=233) |
|---|---|---|---|
| 16. | Owns a Car | | |
| | a) Yes | 19.4 | 0 |
| | b) No | 80.6 | 100 |
| 17. | If Respondent Does Not Own a Car, Frequency With Which Auto is Available to be Driven In | | |
| | a) Always | 20.8 | 0 |
| | b) Usually | 31.3 | 0 |
| | c) Sometimes | 37.5 | 0 |
| | d) Never | 10.4 | 100 |
| 18. | Frequency of Calling Social Service Agency for a Ride | | |
| | a) Very often | 1.6 | 0 |
| | b) Occassionally | 3.3 | .4 |
| | c) Never | 95.1 | 99.6 |
| 19. | Can Respondent Afford Taxis when Needed | | |
| | a) Yes | 43.5 | 0 |
| | b) No | 56.5 | 100 |
| 20. | Frequency of Taxi Use In Last Month | | |
| | a) None | 89.8 | 100 |
| | b) Once | 5.1 | 0 |
| | c) 2-3 trips | 1.7 | 0 |
| | d) 4-10 trips | 1.7 | 0 |
| | e) 10 or more trips | 1.7 | 0 |
| 21. | Ease of Transferring from Wheelchair into Taxi | | |
| | a) Very easy | 10.3 | 10.5 |
| | b) Moderately easy | 34.5 | 0 |
| | c) Difficult | 25.9 | 21.1 |
| | d) Impossible | 29.3 | 68.4 |
| 22. | Taxi Drivers Are | | |
| | a) Very helpful and courteous | 24.1 | 16.7 |
| | b) Moderately helpful and courteous | 62.1 | 16.7 |
| | c) Not very helpful or courteous | 13.8 | 66.7 |

TABLE 8-15 (Cont'd.)

| | | NON-INSTITUTIONALIZED PERSONS (N=62) | INSTITUTIONALIZED PERSONS (N=233) |
|---|---|---|---|
| 23. | Does Respondent Ever Use Private Chair-Car or Ambulette Service | | |
| | a) Yes | 6.5 | 1.7 |
| | b) No | 93.5 | 98.3 |
| 24. | Distance from Home to Nearest Bus Stop On Accessible Route | | |
| | a) Right in front of my home | 8.1 | 92.2 |
| | b) Less than a block | 9.7 | 3.7 |
| | c) One block | 12.9 | 0 |
| | d) Two blocks | 8.1 | 0 |
| | e) Three blocks | 3.2 | 0 |
| | f) Four or five blocks | 4.8 | .5 |
| | g) Six or more blocks | 9.7 | 0 |
| | h) Not sure--don't know | 43.5 | 3.7 |
| 25. | Respondent Learned About Lift Buses Through* | | |
| | a) Radio | 6.6 | 4.0 |
| | b) TV | 14.8 | 1.3 |
| | c) Newspaper/Magazine | 9.8 | 8.9 |
| | d) Bus Demonstration | 23.0 | 49.3 |
| | e) Social Agency | 16.4 | 7.1 |
| | f) Word of mouth | 16.4 | 25.8 |
| | g) Saw bus on street | 3.3 | 3.1 |
| | h) Other | 9.8 | .4 |

*Although the respondents weren't asked whether or not they were aware of the service, all of the answers to question 25, except (h), imply that the respondent had been aware of the service prior to the survey. Thus, we can conclude that the vast majority did know about the service.

TABLE 8-15 CHARACTERISTICS OF PERSONS IN WHEELCHAIRS WHO DID NOT USE BSDA SERVICE (Cont'd)

The respondents were about equally divided between the sexes. Eighty-seven percent of the non-institutionalized persons were 20-49 years of age. This probably reflects the fact that many of these respondents were handicapped students at Southern Illinois University. A majority of the institutional persons (73%) were elderly and had annual incomes less than $4,000 (96%). Forty-one percent of the non-institutionalized persons had annual incomes of $10,000 or less with 23% having incomes of $4,000/year or less.

In regard to occupation, as might be expected, practically all (96%) of the institutionalized persons were unable to work. About one-half of the non-institutionalized persons were students.

With respect to wheelchair equipment characteristics, practically all of the institutionalized persons had manually powered chairs with pneumatic tires and 5 inch diameter front wheels. Most of the non-institutionalized persons (92%) also had manually powered chairs; however, a majority used chairs with hard rubber tires (73%) and 8 inch diameter front wheels (68%). Both groups tended to have footrest extensions. About half of the institutionalized persons (48%) had a headrest extension, whereas only one-fifth (21%) of the non-institutionalized persons had that feature.

Few of the respondents indicated that they always traveled outside their residence without some type of assistance. Practically all of the institutionalized person (97%) never traveled alone and two-thirds of the non-institutionalized persons (66%) never traveled alone. This tends to indicate that if large numbers of persons in wheelchairs were to use accessible buses, many would require some form of assistance. The distance that persons could wheel outside independently was clearly a function of the weather. Most could wheel a reasonable distance in good weather; however, a majority indicated that they could wheel no distance at all in rainy, cold or snowy conditions.

None of the institutionalized persons were licensed or able to drive an automobile and none owned an automobile. Slightly under one-fifth of the non-institutionalized persons were licensed to drive and owned an automobile. Most of the non-institutionalized persons (90%) did have access to an automobile at least some of the time; whereas all of the institutionalized persons never had an automobile available for their use. This tends to indicate that non-institutionalized persons in wheelchairs have more mobility opportunities than their counterparts in institutions.

Only a few of the respondents had ever called a social service agency for transportation. A little over one-half of the non-institutionalized persons (57%) could afford a taxi, but 90% had not used a taxi in the previous month. In contrast none of the institutionalized persons could afford or had taken a taxi in previous months. A majority of the non-institutionalized persons (70%) could transfer into a taxi with varying difficulty; however, most of the institutionalized persons (68%) found that impossible. Most non-institutionalized persons (76%) felt that taxi drivers were at least moderately helpful and courteous, whereas the majority of the institutionalized persons (68%) did not share that opinion. Only a very few of the respondents ever used a private chair-car or ambulette service.

A high percentage of the institutionalized persons (92%) indicated that there was an accessible bus stop right in front of their residence. This reflected the fact that 200 of the 233 institutionalized respondents were from Koch Hospital, which is located right on an accessible bus stop. A little over one-half (56%) of the non-institutionalized persons lived six or less blocks from an accessible bus stop and 18% lived a block or less from such a stop. It is interesting to note that 44% of the non-institutionalized persons were not sure or didn't know how far they lived from an accessible bus stop.

The respondents learned about the BSDA accessible service in a variety of ways. Bus demonstration seemed to be the most common for both groups. Even though BSDA concentrated most of its accessible bus publicity campaign on radio and TV, only 5% and 21% of the non-institutionalized and institutionalized persons, respectively, had learned about the system by these media.

### 8.6.2 Reasons For Not Using Accessible Buses

The survey asked the non-users to evaluate the importance of 17 given reasons for not using the accessible bus service. Table 8-16 gives the results for the non-institutionalized persons. The four most important reasons given by this group were 1) the inability to go out without help, 2) the lack of need for accessible buses, because other transportation is available, 3) the lack of curb cuts and 4) the difficulty of traveling to bus stops. Since the majority of the non-institutionalized persons had some access to an automobile it is understandable why they consider the availability of other transportation as the second most important reasons for not using accessible buses. All three of the other important reasons relate to mobility difficulties. Inclement weather was ranked fifth in order of importance.

The important conclusion to be drawn from this is the limited need for accessible transit vehicles. Either the handicapped person already has (automobile) transportation or their handicap introduces mobility difficulties which prevent completion of the functional requirements of (fixed-route) transit use. In either case, the addition of lift-equipped transit vehicles has only limited value.

The four reasons which the non-institutionalized persons ranked least in importance were 1) a dislike of going out in public, 2) crowded buses, 3) not feeling safe on the buses or lifts and 4) inability of the buses to maintain published schedules. Also low in importance was the unreliability of the lifts.

| RANK ORDER | REASON | AVERAGE ORDINAL VALUE (1) |
|---|---|---|
| 1. | I cannot go out at all without help. | 3.61 |
| 2. | I don't need accessible buses. I have other transportation available. | 3.49 |
| 3. | Lack of curb-cuts near my home or destination. | 3.14 |
| 4. | It is too difficult for me to travel on sidewalks or roads to reach the bus stop. | 2.93 |
| 5. | Bad weather such as rain, snow or cold. | 2.53 |
| 6. | Accessible routes don't go near my home. | 2.28 |
| 7. | Bus transportation takes too long or is too inconvenient compared to a car. | 2.22 |
| 8. | Accessible routes go near my home but don't go near my destination. | 2.22 |
| 9. | I can't get on the bus lifts very easily. | 2.19 |
| 10. | Cars parked in the bus stop prevent me from reaching the bus. | 1.92 |
| 11. | I have trouble obtaining the schedule of accessible buses. | 1.81 |
| 12. | I am afraid to try the buses because I have heard bad things about them. | 1.70 |
| 13. | The lifts are unreliable and sometimes don't work. | 1.70 |
| 14. | The buses are unreliable and don't keep to the published schedule. | 1.6 |
| 15. | I don't feel safe on the lifts or on the buses. | 1.58 |
| 16. | Buses are too crowded when I want to use them. | 1.47 |
| 17. | I don't like going out in public. | 1.29 |

(1) 5 = Very Important 1 = Not Important

Source: Non-User Survey (62 respondents)

TABLE 8-16 RELATIVE IMPORTANCE OF REASONS FOR NOT USING ACCESSIBLE BUSES - NON-INSTITUTIONALIZED NON-USERS

Table 8-17 presents ranked results for institutionalized persons. The four most important reasons given by this group were 1) inclement weather, 2) inability to go out without help, 3) lack of curb cuts and 4) the inability to get on the lifts easily. All of these reasons relate to mobility difficulties. Since almost all of the institutionalized persons had limited or no use of their arms, compared to 48% of the non-institutionalized persons, it is easy to understand why inability to get on lifts easily was considered an important factor.

The four reasons which the institutionalized persons ranked least in importance were 1) the lack of nearby accessible bus routes, 2) the lack of need for accessible buses, because other transportation is available, 3) a dislike of going out in public and 4) crowded buses. These persons ranked "don't need accessible buses, because of other transportation" low because 90% of them do not have access to an automobile. The institutionalized persons tended to rank service reliability problems somewhat more important than non-institutionalized persons, but in general they also did not consider this to be a relatively important reason for not using the service.

Thus, an important overall conclusion is that both institutionalized and non-institutionalized persons in wheelchairs who had not ridden the system considered the most important reasons for not doing so to be primarily related to their mobility difficulties, and in the case of non-institutionalized persons, their access to automobiles. Service reliability problems were not considered a major reason for non-use.

### 8.6.3 Suggested Improvements by Non-Users

The survey asked the non-users to evaluate a list of 12 possible improvements. Table 8-18 ranks the answers of the non-institutionalized persons. The three improvements that were

| RANK ORDER | REASON | AVERAGE ORDINAL VALUE (1) |
|---|---|---|
| 1. | Bad weather such as rain, snow or cold. | 3.97 |
| 2. | I cannot go out at all without help. | 3.86 |
| 3. | Lack of curb-cuts near my home or destination. | 3.76 |
| 4. | I can't get on the bus lifts very easily. | 3.61 |
| 5. | It is too difficult for me to travel on sidewalks or roads to reach the bus stop. | 3.48 |
| 6. | Accessible routes go near my home but don't go near my destination. | 3.47 |
| 7. | I don't feel safe on the lifts or on the buses. | 3.33 |
| 8. | Cars parked in the bus stop prevent me from reaching the bus. | 3.24 |
| 9. | I am afraid to try the buses because I have heard bad things about them. | 3.15 |
| 10. | The lifts are unreliable and sometimes don't work. | 3.11 |
| 11. | I have trouble obtaining the schedule of accessible buses. | 3.00 |
| 12. | Bus transportation takes too long or is too inconvenient compared to a car. | 3.00 |
| 13. | The buses are unreliable and don't keep to the published schedule. | 2.93 |
| 14. | Buses are too crowded when I want to use them. | 2.69 |
| 15. | I don't like going out in public. | 2.60 |
| 16. | I don't need accessible buses. I have other transportation available. | 2.52 |
| 17. | Accessible routes don't go near my home. | 1.97 |

(1) 5 = Very Important 1 = Not Important

SOURCE: Non-User Survey (233 respondents)

TABLE 8-17 RELATIVE IMPORTANCE OF REASONS FOR NOT USING ACCESSIBLE BUSES - INSTITUTIONALIZED NON-USERS

| RANK ORDER | SUGGESTED IMPROVEMENT | ORDINAL VALUE (1) |
|---|---|---|
| 1. | All sidewalks should have adequate curb-cuts. | 4.16 |
| 2. | Dial-A-Ride should be available in addition to lift-equipped buses. | 3.93 |
| 3. | There should be adequate snow removal during winter so that I can reach the bus stops. | 3.91 |
| 4. | Every vehicle in the BSDA fleet should have a lift and all routes should be accessible. | 3.58 |
| 5. | Every vehicle on the accessible bus routes should have a lift. | 3.55 |
| 6. | Bus drivers should help more. | 3.47 |
| 7. | There should be more bus shelters. | 3.43 |
| 8. | There should be an escort service for when I want to use the lift buses. | 3.35 |
| 9. | The lift on the buses should be better designed. | 2.98 |
| 10. | Dial-A-Ride (door-to-door service) should be available instead of lift-equipped buses. | 2.80 |
| 11. | There should be less crowding on the lift buses. | 2.54 |
| 12. | The interior of the lift buses should be designed better. | 2.28 |

(1) 5 = Most Important, 1 = Least Important

SOURCE: Non-User Survey (62 respondents)

TABLE 8-18 RELATIVE IMPORTANCE OF SUGGESTED IMPROVEMENTS - NON-INSTITUTIONALIZED NON-USERS

most important were: 1) adequate curb cuts, 2) that dial-a-ride should be available in addition to fixed route accessible buses and 3) adequate snow removal. The suggested improvements which ranked fourth and fifth in order of importance primarily advocated that all fixed route buses should be equipped with lifts. The users (Table 8-14) tended to rank the improvements similarly except that users considered having lifts on all fixed route buses as most important.

The three improvements ranked least in importance by the non-institutionalized persons were 1) better interior design, 2) a reduction in crowded conditions on buses and 3) that dial-a-ride should be available instead of fixed route accessible buses. Ranking the latter improvement low corresponds to the higher importance this group placed on fixed route accessible buses.

Table 8-19 presents similar results for institutionalized non-users. The three most important improvements were: 1) better designed lifts, 2) adequate snow removal and 3) adequate curb cuts. Since this group has difficulty maneuvering their wheelchairs by themselves, it is understandable why they ranked better designed lifts as the most important improvement. The other two most important improvements were also ranked high by both non-institutionalized non-users and users.

The three improvements ranked least in importance by the institutionalized non-users were 1) a reduction in crowded conditions on buses, 2) more help from bus drivers and 3) that dial-a-ride should be available instead of fixed route accessible buses. The first and third improvement were also considered least important by non-institutionalized persons.

| RANK ORDER | SUGGESTED IMPROVEMENT | ORDINAL VALUE(1) |
|---|---|---|
| 1. | The lift on the buses should be better designed. | 4.28 |
| 2. | There should be adequate snow removal during winter so that I can reach the bus stops. | 4.20 |
| 3. | All sidewalks should have adequate curb-cuts. | 4.07 |
| 4. | Every vehicle on the accessible bus routes should have a lift. | 4.01 |
| 5. | Dial-A-Ride should be available in addition to lift-equipped buses. | 3.91 |
| 6. | There should be an escort service for when I want to use the lift buses. | 3.75 |
| 7. | There should be more bus shelters. | 3.64 |
| 8. | Every vehicle in the BSDA fleet should have a lift and all routes should be accessible. | 3.55 |
| 9. | The interior of the lift buses should be designed better. | 3.51 |
| 10. | Dial-A-Ride (door-to-door service) should be available instead of lift-equipped buses. | 3.51 |
| 11. | Bus drivers should help more. | 3.49 |
| 12. | There should be less crowding on the lift buses. | 3.27 |

(1) 5 = Most Important, 1 = Least Important

SOURCE: Non-User Survey (233 respondents)

TABLE 8-19 RELATIVE IMPORTANCE OF SUGGESTED IMPROVEMENTS - INSTITUTIONALIZED NON-USERS

### 8.6.4 Conclusions

The results of the user and the non-user surveys should be used with care. The user survey was particularly small, and most users did not ride very often; and the non-user survey was non-random and was biased towards institutionalized persons. Therefore, the surveys cannot rigorously support hypothesises about the nature of wheelchair persons and their travel habits. Thus, survey results can only provide general information which requires further substantiation.

Generally, the non-users tended to consider that the most important improvements were adequate curb cuts and snow removal, more fixed route buses with lifts, and dial-a-ride service in addition to fixed route accessible buses. Institutionalized non-users, due to limited ability to use their arms, placed great importance on better designed lifts. In contrast, improvements considered the least important included a reduction in crowded conditions on buses, and the availability of dial-a-ride instead of fixed route accessible buses. Clearly, the non-users were in favor of accessible fixed route bus service, even though they had not used and did not necessarily intend or have the ability to use the lift buses.

There is no evidence in the surveys that non-users would become users if the suggested improvements were made, or that users would ride more often.

Although the user sample was too small to compare in a meaningful way with the non-user sample, we can see certain similarities between the two groups; as indicated below (also see Table 8-20):

- Majorities of both groups (user and non-users) have access to automobiles. This mode provides the most attractive and useful alternative to accessible transit.

- Both groups have limited abilities to reach bus stops and negotiate sidewalk environments. Both groups are substantially affected by bad weather.

- Both groups repeatedly emphasized the problems with the sidewalk environment and suggested curb cuts and adequate snow clearance as major improvements.

On the other hand, the two groups indicated certain differences, such as:

- Users felt that lift malfunctions and trip denials were the greatest problems in using the buses, while non-users biggest problems appeared to be that they could not go out at all without help.

- Institutionalized non-users (who generally have more limited arm use) believed they would have difficulty getting on to the lift, whereas others did not.

- The user's desire to see all BSDA service made accessible was greater than the non-users.

No conclusions about socio-economic and other differences between the two groups can be drawn because of the limited user sample size. To further explore the differences between the group of users and two kinds of non-users, Table 8-20 was prepared to compare the rankings of improvements. A similar table could not be prepared for user problems and reasons for not riding since different questions were asked.

Table 8-20 shows that:

- All 3 groups favored adequate curb cuts and snow removal.

- Users ranked 100% accessibility first, but non-users placed it further down the list.

- None of the groups had serious problems with the bus interior, crowding, better wheelchair positions, escort service, bus shelters, and bus drivers.

- A better designed lift was ranked very low by the non-institutionalized non-users. They were presumably unaware of the problems with the lift and therefore did not see it as a big problem.

| SUGGESTED IMPROVEMENT | RANK ORDERED BY Non-Users Non-Institutionalized | Non-Users Institutionalized | Users |
|---|---|---|---|
| 1. All sidewalks should have adequate curb-cuts. | 1 | 3 | 2 |
| 2. Dial-A-Ride should be available in addition to lift-equipped buses. | 2 | 5 | 4 |
| 3. There should be adequate snow removal during winter so that I can reach the bus stops. | 3 | 2 | 2 |
| 4. Every vehicle in the BSDA fleet should have a lift and all routes should be accessible. | 4 | 8 | 1 |
| 5. Every vehicle on the accessible bus routes should have a lift. | 5 | 4 | 5 |
| 6. Bus drivers should help more. | 6 | 11 | 8 |
| 7. There should be more bus shelters. | 7 | 7 | N.A. |
| 8. There should be an escort service for when I want to use the lift buses. | 8 | 6 | 11 |
| 9. The lift on the buses should be better designed. | 9 | 1 | 3 |
| 10. Dial-A-Ride (door-to-door service) should be available instead of lift-equipped buses. | 10 | 10 | 6 |
| 11. There should be less crowding on the lift buses. | 11 | 12 | 7 |
| 12. The interior of the lift buses should be designed better. | 12 | 9 | 9 |
| 13. Better wheelchair positions in the lift buses. | N.A. | N.A. | 10 |

N.A. = Not Asked

TABLE 8-20 COMPARISON OF RECOMMENDED IMPROVEMENTS

# CHAPTER 9

## PRODUCTIVITY AND ECONOMICS

The costs of the accessible bus service are of considerable importance. Total costs include the capital and start-up costs, properly depreciated, and the operating costs. Operating costs are those solely due to presence of the lift on the bus. They do not include normal costs of operating the bus, such as the driver's salary.

The operating costs were difficult to ascertain exactly. Judgment was involved in determining what costs were applicable and in isolating those costs. Also, because this chapter only covers the first 12 1/2 months of operation, there are some uncertainties in segregating start-up from on-going costs. The following discussion attempts to establish the best possible cost information and pertinent cost ratios, based upon the data available.

The evaluation issues to be addressed in this section include:

- The capital cost of the lifts.
- The start-up costs.
- The marketing and advertising costs.
- The cost of maintenance and repairs.
- The operating costs.
- The total costs.
- The cost-effectiveness ratios.

## 9.1 CAPITAL COSTS

Two types of capital costs were identified. These were the costs of the lifts and related modifications on new vehicles; and the cost of adding special garage facilities to maintain the vehicles.

### 9.1.1 Vehicles

BSDA made two separate purchases of new buses in 1976-1977. In the first group, 60 accessible and 60 non-accessible buses were purchased. The vehicles were identical except for the lifts and associated modifications. Later, BSDA received a second order of 97 accessible and 103 inaccessible buses. Thus, the marginal cost of a bus with a lift could be calculated as follows:

| Vehicle Numbers | 7362-7421 | 7422-7518 |
|---|---|---|
| Bid Date | October 5, 1976 | March 14, 1977 |
| No. of Accessible Vehicles | 60 | 97 |
| Unit Cost-Lift Equipped | $72,304 | $77,008 |
| Unit Cost-Without Lift | $67,304 | $70,693 |
| Marginal Unit Cost | $ 5,000 | $ 6,315 |

Flxible has since phased out this transit model in favor of the all new ADB (Model 870), which uses a different lift system. This, together with inflation and the experience gained by the manufacturer, have increased the costs of lifts considerably. As part of its vehicle purchase, BSDA ordered very few spare parts, and none which were associated with the lifts. Thus, the capital costs in the BSDA program are not a reliable guide for other transit systems purchasing accessible equipment.

### 9.1.2 Special Maintenance Facilities

BSDA had to have three special pits installed in their central repair facility specifically to work on the lifts. The sum of $5,250 was quoted by BSDA as the cost of these facilities. Although these pits could also be used to service non-lift equipped buses, they were ordered as part of the project and the full cost has therefore been assigned to the accessible project.

### 9.1.3 Total Capital Costs

Based upon the preceding discussion, the capital costs for the accessible bus project were:

| | |
|---|---|
| Accessible Equipment on Vehicles | $912,555 |
| Maintenance Facility Modifications | 5,250 |
| Total added Capital Cost | $917,805 |
| Average Capital Costs/Bus | $5,846 |

## 9.2 START-UP COSTS

Start-up costs for the project were considered to include four items: 1) marketing and publicity, 2) maintenance preparation, 3) driver training and 4) professional staff time.

### 9.2.1 Marketing and Publicity Costs

As discussed in Chapter 5, a fairly extensive marketing and publicity effort was made to promote use of the accessible buses. The media campaign involved radio, newspapers and other publications. Table 9-1 provides supporting details for the total expenditures of $35,174. In addition, marketing activities included personal staff appearances in support of the media campaign. These costs have been subsequently accounted for under professional staff costs.

| | | | |
|---|---|---|---|
| RADIO COMMERCIALS | | | $19,346.33 |
| 8/8/77 - 8/15/77 | 212 spots | | |
| | | - $9,568.51 | |
| 8/16/77 - 8/20/77 | 60 spots | | |
| 1/11/78 - 1/28/78 | 204 spots | | |
| | | - $9,777.82 | |
| 1/28/78 - | 192 spots | | |
| NEWSPAPER ADVERTISEMENTS | | | $11,604.14 |
| 7/31/77 - 8/7/77 | | - $5,394.09 | |
| 11/21/77 - 11/28/77 | | - $6,210.05 | |
| PUBLICATIONS | | | $ 4,223.26 |
| 10,000 "How to Ride" booklets | | - $3,633.24 | |
| Reduced Fare Slipsheets | | - 340.02 | |
| Miscellaneous News Releases | | - 250.00 | |
| TOTAL EXPENDITURES | | | $35,173.73 |

TABLE 9-1 START-UP MARKETING AND PUBLICITY COSTS

### 9.2.2 Maintenance Preparation Costs

As part of the effort to prepare the lifts for operating service, BSDA estimated that the initial inspection of the equipment and training of shop personnel required four weeks of straight time plus four hours daily overtime for a foreman and repairman, respectively. The effort needed to prepare the lift equipment for service was estimated to require four repairmen from April 1977 to August 1977, when service was initiated. Based upon prevailing BSDA labor rates (including 17% overhead), maintenance preparation labor costs totaled $31,010.

### 9.2.3 Driver Training Costs

Driver sensitivity and operational training for the accessible buses involved one hour per driver at their regular pay rate. The training included 1) viewing a 15 minute audio-visual presentation concerning sensitivity and, 2) 45 minutes on vehicle operational procedures and role playing activities. All BSDA drivers were required to take the training prior to Phase I. BSDA estimated the total training cost at $16,322. To date, no additional training sessions have been conducted.

### 9.2.4 Administrative Staff Costs

Substantial staff time was required to implement the accessible bus project. However, it was difficult to differentiate this staff effort from other on-going planning and/or elderly and handicapped activities (i.e. paratransit services, etc.) Furthermore, it was difficult to divide staff effort into start-up activities and on-going operational activities. Finally, it was difficult to separate out the staff time spent on this evaluation, which, properly speaking, should not have been included in either start-up or operating costs. With these reservations in mind, BSDA estimated that the administrative staff effort for start-up activities cost a total of $14,040.

### 9.2.5 Total Start-Up Costs

Based upon the results presented in the preceding sections, the total start-up costs for the accessible bus project, as identified by BSDA, were:

| | |
|---|---|
| Marketing and Publicity Costs | $35,174 |
| Maintenance Preparation Costs | 31,010 |
| Driver Training Cost | 16,322 |
| Administrative Costs | 14,040 |
| TOTAL | $95,546 |

TABLE 9-2 TOTAL START-UP COSTS

## 9.3 OPERATING COSTS

Operating costs were those expenditures needed in daily operations of accessible buses. These have been defined as:

- Cost of extra platform hours which BSDA added to the schedule in anticipation of delays from wheelchair riders.
- Cost of repair work on the lifts.
- Cost of preventive maintenance on the lifts.
- Cost of administrative staff time devoted to the accessible bus project.
- Cost of accidents attributed to the lifts.

### 9.3.1 Service Hour Costs

As discussed in Chapter 7, BSDA claims to have scheduled 24,435 extra platform hours during Phases I and II. This represents a substantial 2.7% increase in total platform hours. The hours are

multiplied by the applicable driver hourly rates and 17% overhead to yield the cost:

| PHASE | ADDITIONAL HOURS | COSTS |
|---|---|---|
| I | 3,675 @ $8.58*/hr. | = $ 31,532 |
| II | 20,760 @ $8.75*/hr. | = $181,650 |
| Total | 24,435 @ $8.75*/hr | = $213,182 |

The extent to which these service hour costs were needed is debatable. The BSDA scheduling department felt that some increases in layover time were needed on certain routes to compensate for potential delays caused by wheelchair passengers. As discussed in Chapter 7, the 24,435 platform hours were substantially greater than the estimated 509 hours of delay which actually occurred. Thus, about 98% of the extra platform hours were not needed. Although BSDA did make these schedule adjustments and did incur the cost, a somewhat lower estimate of what accessibility would cost, for other systems, can be made by reducing or eliminating service hour costs on the assumption that schedule adjustments are not needed. This point will be discussed further below.

### 9.3.2 Lift Repair Costs

Repair of malfunctioning lifts involved considerable effort by BSDA maintenance personnel and resulted in significant costs. Much of the cost is claimed by BSDA to be covered under Flxible's warranty provisions. Table 9-3 presents the lift repair costs with a breakdown betweeen warranty and non-warranty costs. These costs were calculated as follows. From their payroll records, BSDA estimated the total labor hours needed to repair the lifts.

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*Note that service hours are costed at marginal not average cost.

| | WARRANTY COSTS | | | NON-WARRANTY COSTS* | |
|---|---|---|---|---|---|
| | PARTS | BSDA LABOR | TOTAL | BSDA LABOR | TOTAL COSTS |
| August, 1977 | $ 9,470 | $ 2,132 | $11,602 | $ 7,747 | $ 19,349 |
| September | 11,538 | 5,692 | 17,230 | 3,874 | 21,104 |
| October | 8,320 | 2,560 | 10,880 | 4,123 | 15,003 |
| November | 5,627 | 3,104 | 8,731 | 5,001 | 13,732 |
| December | 8,530 | 2,707 | 11,237 | 7,813 | 19,050 |
| January, 1978 | 10,784 | 4,029 | 14,813 | 5,817 | 20,630 |
| February | 6,492 | 5,160 | 11,652 | 4,817 | 16,469 |
| March | 10,033 | 4,531 | 14,564 | 6,093 | 20,657 |
| April | 3,120 | 2,431 | 5,551 | 10,809 | 16,360 |
| May | 8,255 | 2,842 | 11,097 | 11,914 | 23,011 |
| June | 8,412 | 2,680 | 11,092 | 8,786 | 19,878 |
| July | 8,875 | 3,000 | 11,875 | 9,439 | 21,314 |
| August | 4,660 | 1,957 | 6,617 | 11,624 | 18,241 |
| TOTALS | $104,116 | $42,825 | $146,941 | $97,857 | $ 244,798 |

* No significant Non-Warranty Parts Costs.

TABLE 9-3 LIFT REPAIR COSTS

Using prevailing average labor rates plus 17% overhead, the total labor cost was computed. BSDA labor and parts claimed under warranty were totaled from bus repair records kept by BSDA. Non-warranty labor costs were then computed by subtracting the warranty labor costs from total labor costs. To date, BSDA has not identified any appreciable parts costs other than those claimed under the warranty.

It is important to point out that Flxible must have undoubedly absorbed a substantial amount of lift repair costs that were not processed through the BSDA accounting system. This information was not available from Flxible; consequently, the repair costs reported do not include any costs which were directly incurred by Flxible.*

As shown in Table 9-3, the lift repair costs that were identified for the first 12 1/2 months of operation totaled $244,798, with 60% of this total claimed under warranty provisions.

Figure 9-1 gives the trend of monthly repair costs. As might be expected, costs tended to increase in Phase II because the fleet was expanded. In order to account for this, Figure 9-2 presents similar information on the basis of accessible bus mileage. After a sharp decline in Phase I, total lift repair costs have tended to stabilize at about $.035/mile as shown by the Phase II trend line. Non-warranty repair costs, however, have shown a steadily increasing trend.** There was an 86% increase in the non-warranty

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* Informed sources guessed that $300,000 to $400,000 may have been spent for lift repair and/or modification by Flxible.

**Least squares curve fit with standard error of estimate ± 0.305 cents/mi. and $r^2 = 0.47$ which indicates a moderate data fit.

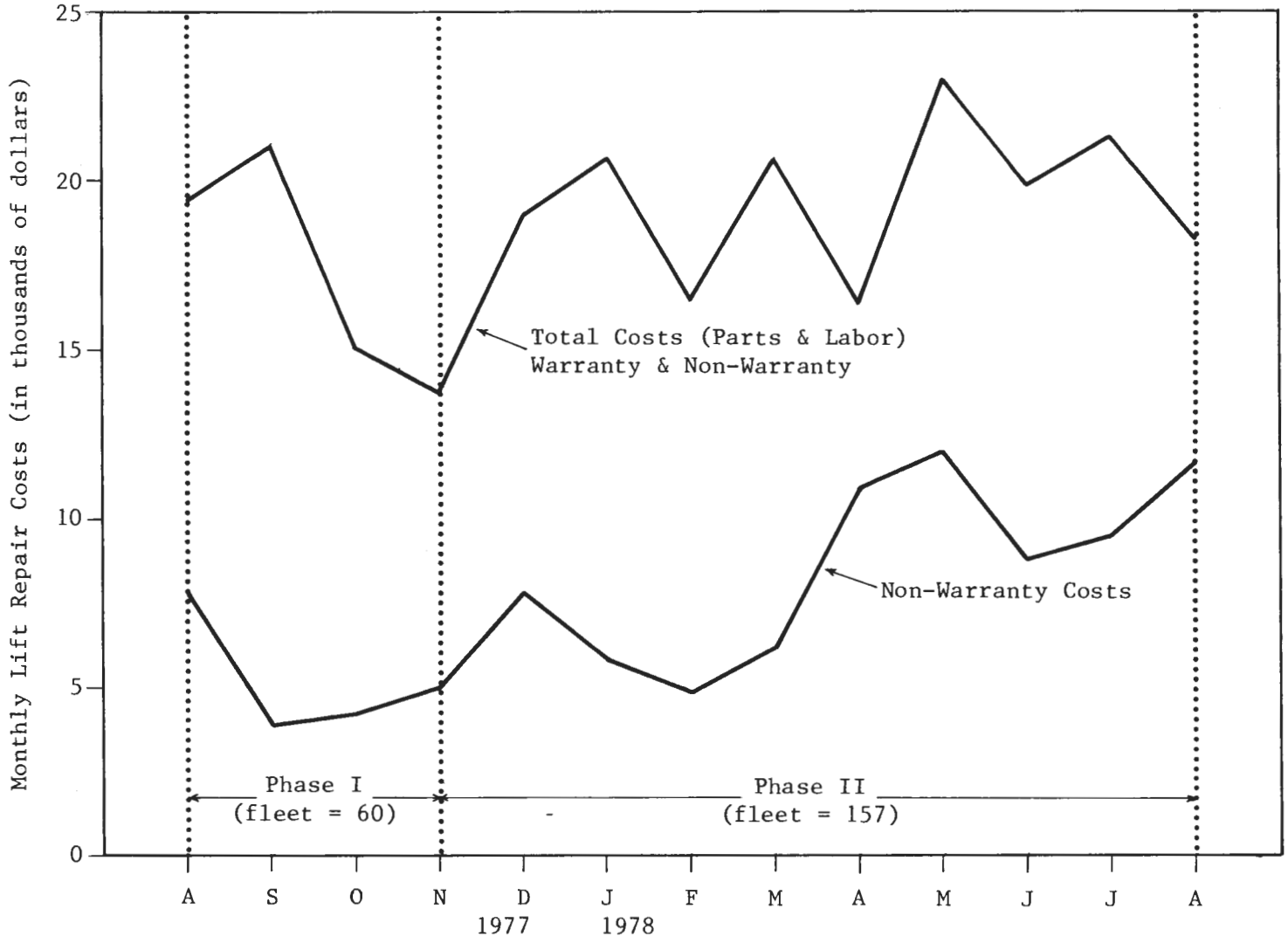


FIGURE 9-1 TREND OF MONTHLY REPAIR COSTS FOR LIFT EQUIPMENT

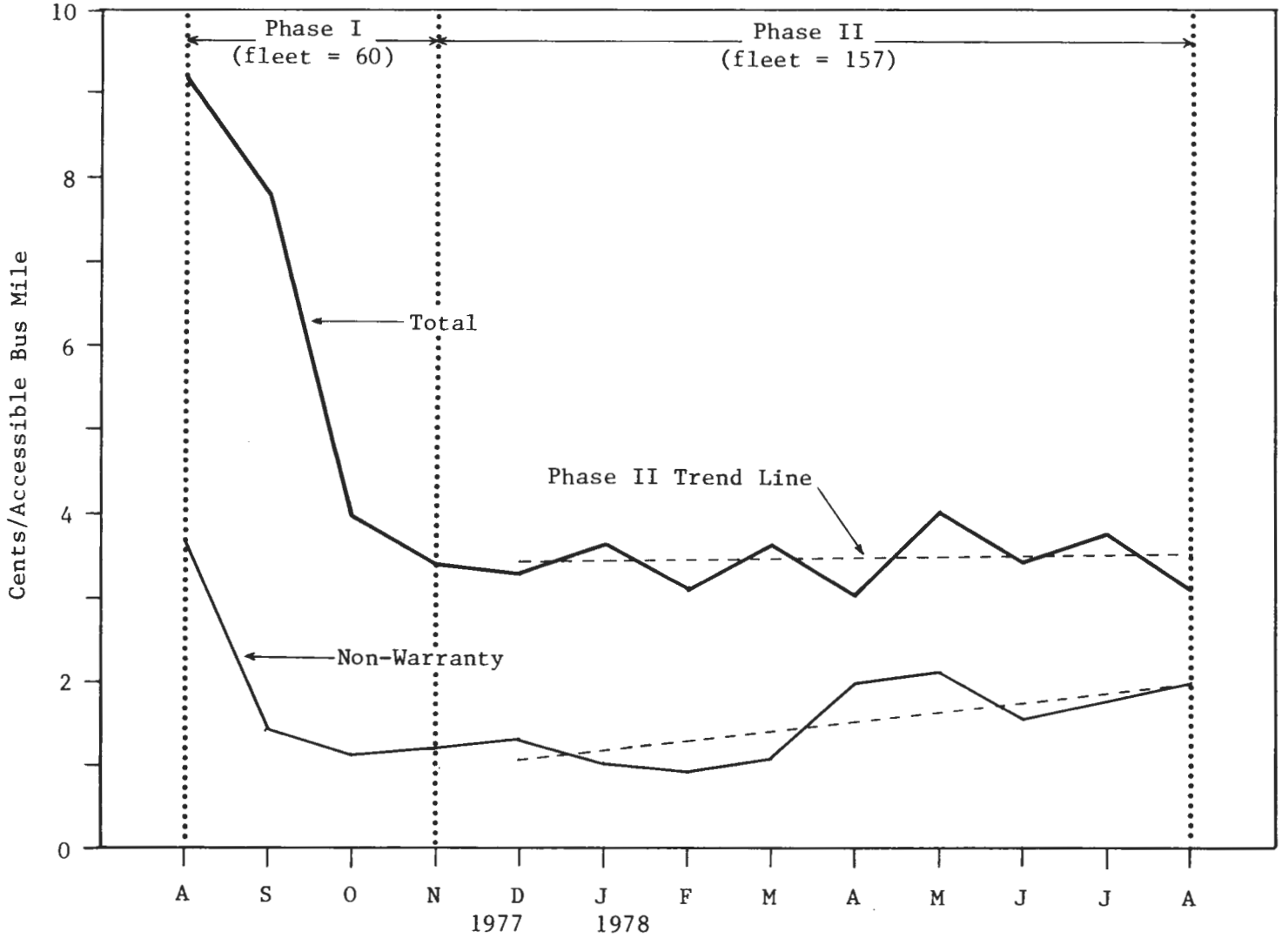


FIGURE 9-2 REPAIR COST PER MILE FOR LIFT EQUIPMENT

lift repair cost/mile during Phase II. These costs were about $.02/mile by the end of Phase II. In reviewing this data, it should be kept in mind that the rate of repair, and hence of repair cost, was limited by the repair shop capacity. Even greater repair costs would have been incurred during Phase II if the repair shop had not been saturated and all required repairs were made.

Figure 9-3 shows the cost/mile for non lift-related repairs on all 40 ft. Flxible buses.* There was an increasing trend in repair cost, which is to be expected when a new fleet of vehicles is phased into operation. Figure 9-4 gives the ratio of lift repair cost/mile to non lift repair cost/mile. This ratio leveled off at about 0.33 during the last five months of Phase II. Thus, preliminary results indicate that the accessible buses caused a 23% increase in BSDA repair costs not covered under warranty, and a 33% increase in total repair costs.

As more experience is gained with the lift equipment, the costs of repairing them may decrease for the following reasons:

1. As shown in Chapter 6, some components of the lifts experienced low mileage failures that did not recur. Apparently, these failures were due to quality control problems or design problems during manufacture. With more extensive prototype development and pre-implementation testing, these problems will probably not be repeated.

2. It is anticipated that the problem of the steps and platform drifting may be resolved with the completion of the design modification to the stow-lock microswitch and the automatic recovery device installation. This would provide a substantial improvement in equipment reliability and availability.

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*Originally it was intended to obtain non-lift repair costs for just the accessible buses; however, due to a computer coding error it was found that some charges for the accessible buses were incorrectly assigned to the non-lift equipped buses. This made it necessary to use the total for all 40 ft. buses in order to obtain reasonable results.

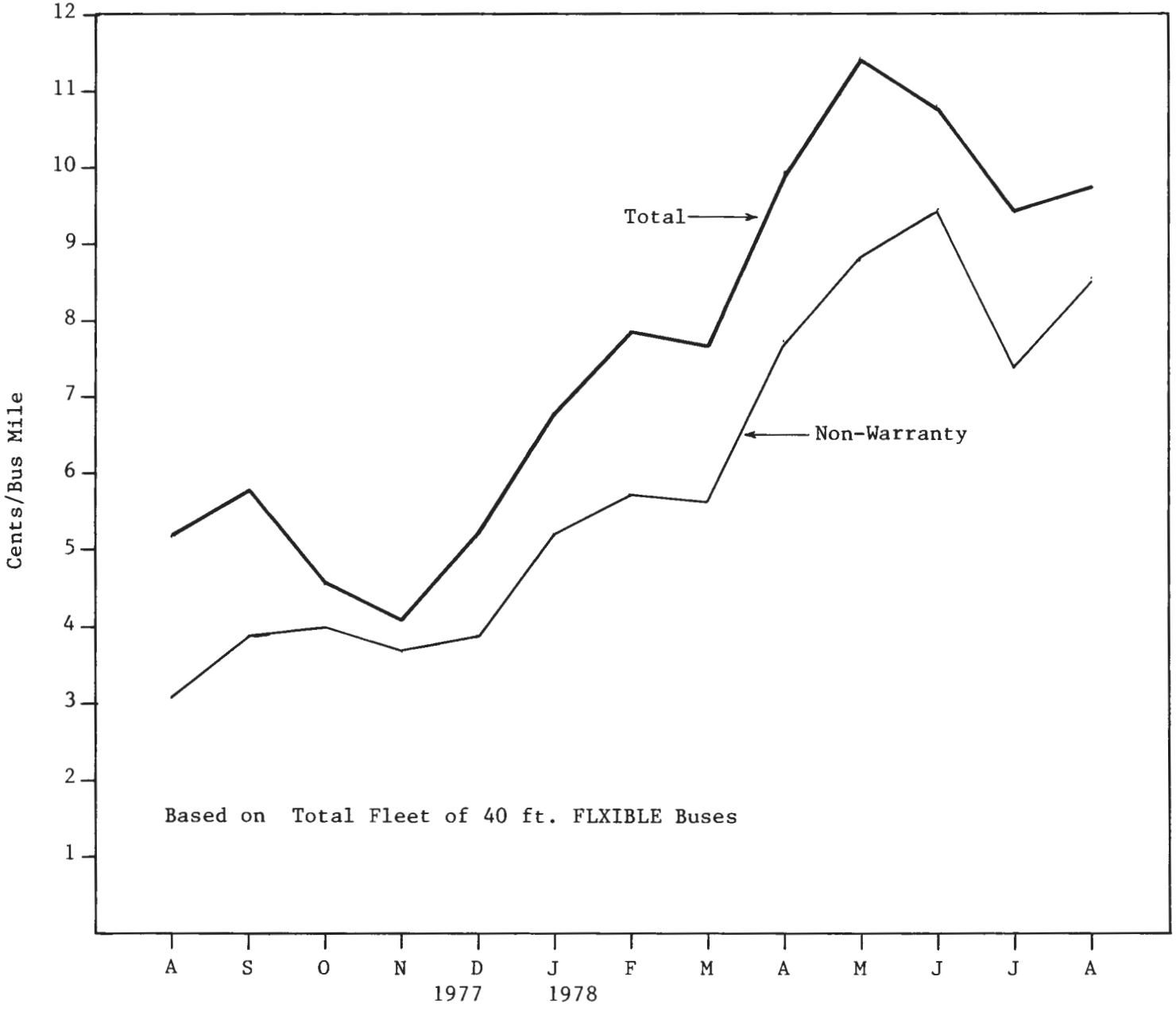


FIGURE 9-3 COST PER MILE OF NON-LIFT RELATED REPAIRS

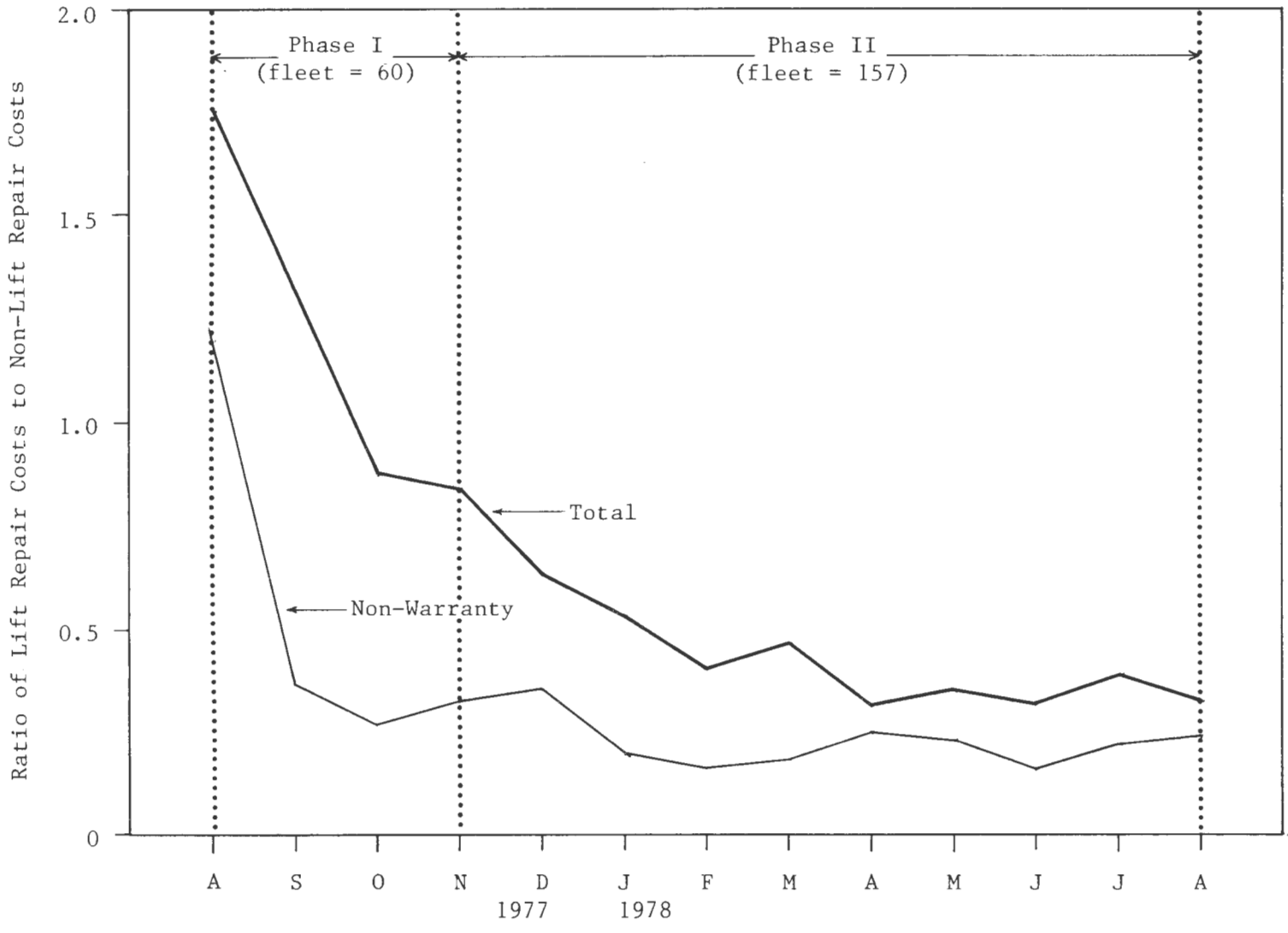


FIGURE 9-4 COMPARISON OF LIFT TO NON-LIFT REPAIR COSTS PER MILE

At this time it is not possible to predict the magnitude of future reductions in repair cost; however, a preliminary analysis indicated that at least $84,623 of the total $244,798 repair costs (or 35%) could be eliminated.

### 9.3.3 Preventive Maintenance Costs

The lift system required some routine preventive maintenance. BSDA did not keep actual records of the labor time required to do this, as it was carried out by the regular division staff in conjunction with many other duties. The amount of time which should have been spent on preventive maintenance can be estimated from the recommended procedures and intervals described in Section 6.4:

August 1977 - June 1978

| | | | |
|---|---|---|---|
| 1) | Daily Lift Cycling | (5 min/lift) | 4,775 hrs. |
| 2) | 1500 Mile Inspection | (30 min) | 3,140 hrs. |
| 3) | 9000 Mile Inspection | (60 min) | 1,046 hrs. |
| | | TOTAL | 8,961 hrs. |

Based upon prevailing BSDA labor rates plus 17% overhead, this work amounted to a cost of $83,875 with the daily cycling of the lift (by maintenance personnel) accounting for 53% of the total. Thus, for the first 10 1/2 months of operation, preventive maintenance averaged close to $8,000/month. Starting in July 1978, BSDA, as a result of experience, substantially reduced lift preventive maintenance by eliminating daily cycling, and reducing the 1500 and 9000 mile inspections to 5 and 10 minutes respectively. As a result, preventive maintenance costs were only $344/month for July and August 1978. It follows then that for the first 12 1/2 months of operation, preventive maintenance totaled $84,563 in total allocated costs; however, these are not actual out of pocket costs, but rather an artificial costing of the estimated time involved in preventive maintenance.

### 9.3.4 Administrative Staff Costs

Because the project was a demonstration, and considerable BSDA staff effort was involved with the evaluation process, it was difficult to ascertain the staff time which was only related to operation and not to the evaluation. Costs of evaluation were not properly considered as a cost of the service. BSDA prorated their staff involvement in operations as follows:

| STAFF POSITION | PERCENTAGE OF TIME |
|---|---|
| Elderly and Handicapped Specialist | 50% |
| Paratransit Coordinator | 50% |
| Clerk/Typist | 100% |
| Research Administrator | 50% |
| Planning Director | 10% |
| Research Assistant | 25% |
| Training Director | 10% |
| Chief Instructor | 10% |
| Transit Director | 10% |

Based upon appropriate salaries and overhead, the administrative staff costs totaled $68,183 for Phases I and II.

### 9.3.5 Accident Liability Costs

Accident data for BSDA operations during 1977 could not be obtained from the insurer, Transit Casualty. In January 1978, BSDA instituted a new risk management program which included a degree of self insurance and figures thereafter are available. Table 9-4 shows that between January and August of 1978, there were 4 accidents involving wheelchair persons and 25 involving ambulatory passengers, all relating to the lifts. The ambulatory accidents were caused by passengers tripping upon drifing steps and did not all result in actual claims. The average cost per claim for the four wheelchair accidents was $1,120 and for the ambulatory accidents was $186. However, a number of the cases are still open. Final costs will probably rise above the amounts quoted. The costs include both expenses (e.g., medical

| MONTH (1978) | NUMBER OF ACCIDENTS | | | BSDA COSTS ($) | | |
|---|---|---|---|---|---|---|
| | Non-Wheelchair* | Wheelchair | Total | Non-Wheelchair | Wheelchair | Total |
| January | 1 (1) | | 1 | 0 | | 0 |
| February | 5 (3) | | 5 | 300 | | 300 |
| March | 4 (2) | | 4 | 338 | | 338 |
| April | 2 (1) | 1 | 3 | 558 | 2,175 | 2,733 |
| May | 1 (1) | 1 | 2 | 0 | 703 | 703 |
| June | 4 (1) | 1 | 5 | 830 | 1,000 | 1,830 |
| July | 3 (1) | | 3 | 265 | | 265 |
| August | 5 (1) | 1 | 6 | 309 | 600 | 909 |
| TOTAL | 25 (11) | 4 | 29 | 2,600 | 4,478 | 7,078 |

*Figures in parentheses are the number of accidents in which no expense or claim was involved.

TABLE 9-4 LIFT RELATED ACCIDENT CLAIMS, JANUARY - AUGUST 1978

examinations) as well as claims settlements. BSDA has estimated the accident costs for Phases I and II at $11,444. In comparison, BSDA reported 3,586 other passenger claims for its total operation over the first seven months of 1978. The cost of these latter claims was not available when this report was prepared.

### 9.3.6 Excluded or Inapplicable Costs

Several other items were not included in the operating costs because BSDA did not experience the cost or because the amount of money involved was negligible. These items included:

- On-going driver training.
- Extra fuel consumption or tire wear on the accessible vehicles.
- Value of supervisor's time.
- On-going marketing.

As discussed in Chapter 10, the results of the driver survey indicated a possible need for additional training. Also, drivers hired since August 1977 have received no training. This points out that some provision should be made by BSDA to conduct training on a regular basis. Since this was not done in Phase I and II, no operational costs are included.

There is no reason to believe that the fuel consumption of the accessible vehicles is significantly different from inaccessible vehicles. This was substantiated by comparing average data for the months of January and August of 1978. For these months, the lift equipped buses averaged 3.32 m.p.g. compared to 3.33 m.p.g. for comparable buses without lifts.

During Phase II, the accessible buses averaged 3,610 miles/bus/month compared to 3,293 for comparable buses without lifts. The 10% higher mileage reflects a higher utilization rate and would have been even higher if all the buses had been

available for service. Some investigators have claimed that the front tires wear out faster due to the weight of the lift. No data was available to substantiate these reports, since separate records of tire wear were not kept. Obviously, the increased mileage cited above would result in some additional tire wear over a given time period.

It is possible that some portion of the total cost of road supervisors should be attributed to the project, but no separate records were kept so that this could not be accurately determined. Recalling from Chapter 7 that there were about 38 trouble occurrences per week related to lift problems and allowing 32 minutes per occurrence (20 minutes more than the average delay of 12 minutes) would require a total of 20 supervisor hours per week attributable to the lifts. Since this is less than 2% of the supervisors' time, it seems reasonable to consider this as negligible.

During Phases I and II, no extra costs were identified for marketing and publicity other than those presented earlier under start-up costs. Some activities were carried on as part of the overall effort for the system, but it was not possible to segregate these costs. It is suspected, however, that on-going marketing costs would be considerably lower than start-up costs.

### 9.3.7 Total Operating Costs

The preceding sections have tried to estimate the total value of the time and materials which went into the on-going operations of the accessible service, excluding start-up and capital costs. However, it is clear that these total value calculations do not necessarily represent actual marginal (out-of-pocket) costs to BSDA, since they include the time of regular BSDA staff members who were not hired specifically because of the lift buses. In fact, the operating costs can be broken into two groups: out of pocket costs which BSDA wouldn't have incurred without the

accessible buses, and non-out-of-pocket costs which BSDA would have incurred anyway, but which did go toward the accessible bus program. Also, it is questionable whether the schedule adjustments made by BSDA, which accounted for the service hour costs, were needed.

To reflect these issues three different types of operating costs have been calculated. They are defined as follows:

1. Total allocated costs include the total value of all labor and materials which went into the accessibility program. These costs most accurately represent the true value of the program at BSDA.

2. Marginal (out-of-pocket) costs exclude items for which BSDA did not make an expenditure above and beyond normal budgets. Excluded items include administrative staff and lift preventive maintenance costs, as the employees involved already worked for BSDA. Lift repair costs covered under the manufacturers warranty are also exluded. Non-warranty repair costs are included in the marginal costs since BSDA did hire new mechanics solely to work on the lifts.

3. Marginal costs excluding service hour costs. A calculation representing what the marginal cost would have been if BSDA had not added in any additional platform hours, specifically for accessibility, as discussed in 9.3.1. This is done to represent the fact that the service hour costs were probably not needed. An ultimate answer to the questions of how many additional platform hours are really needed on accessible routes cannot be given on the basis of this evaluation. The option of not adding any additional service hours is one which many other transit systems may wish to consider, at least until wheelchair ridership increases significantly above the levels experienced by BSDA.

Table 9-5 shows the operating costs and the impact of the three methods of calculation. Whereas fully allocated operating costs are $622,170, for Phases I and II, marginal costs are $322,483, and marginal costs excluding service hours are $109,301. Although there is no one "right" cost figure, the highest cost figure - the fully allocated costs - best represent the time and effort put in

| COST ITEM | FULLY ALLOCATED COSTS[1] | % OF TOTAL | MARGINAL (OUT OF POCKET) COSTS | OUT OF POCKET COSTS EXCLUDING SERVICE HOUR COSTS |
|---|---|---|---|---|
| 1. Service Hours | $213,182 | 34.3 | $213,182 | —[5] |
| 2. Lift Repair | 244,798 | 39.3 | 97,857[2] | $ 97,857[2] |
| 3. Lift Preventive Maintenance | 84,563 | 13.6 | —[3] | —[3] |
| 4. Administrative Staff | 68,183 | 11.0 | —[4] | —[4] |
| 5. Accident Liability | 11,444 | 1.8 | 11,444 | 11,444 |
| TOTAL | $622,170 | 100.0 | $322,483 | $109,301 |
| Phase I Cost/Month | $ 42,589 | | $ 22,113 | $ 7,495 |
| Phase II Cost/Month | $ 52,567 | | $ 27,232 | $ 9,230 |

1. Based on BSDA estimates - Phases I and II.(12.5 month period)
2. Excludes warranty costs.
3. No extra personnel hired for preventive maintenance.
4. No extra administrative staff hired specifically for lifts.
5. Based on the assumption that additional service hours were not needed.

TABLE 9-5 OPERATING COST--PHASE I AND II

by BSDA on the project. However, the point of calculating out of pocket costs and out of pocket costs excluding service hours is to better show what accessibility might cost at other transit systems.

With some assumptions regarding prorating of certain cost categories, it was estimated that approximately 76% of the total operating cost given in Table 9-5 could be attributed to Phase II service. On this basis, it follows that fully allocated operating costs averaged $42,589/month in Phase I compared to $52,567/month in Phase II. Since the service was expanded in Phase II, it is not surprising that there would be a corresponding increase in total monthly operational costs, but with a reduction in per vehicle cost.

In FY 1978, BSDA reported an annual operating cost which averaged about $2.00/mile. Based upon the fully allocated operating costs given in Table 9-5, the added operating cost of the accessible buses averaged $0.10/mile over the 12 1/2 months of Phase I and II, increasing cost/mile by about 5%. Based upon the marginal (out-of-pocket) costs, about $0.05/mile was added, or a 2 1/2% increase in cost/mile. If BSDA had not increased their service hours for accessibility, the operating cost/mile would have increased by about $0.02 or 1%.

## 9.4 TOTAL PROJECT COSTS

Total project costs are the sum of operating costs and depreciated capital and start-up costs. They are presented in Table 9-6, for the entire 12.5 month period of Phase I and II. Capital costs have been depreciated in a straight line over 12 years. While there is no way to estimate what the actual life span of the lifts will be, 12 years is used to agree with the standard bus life span. Start-up costs have been depreciated over a (arbitrary) 6 year period. The start-up expenditures - advertising, training, etc. - may have to be incurred periodically. This is the justification for depreciating them.

| | ALLOCATED COSTS | MARGINAL (OUT-OF-POCKET) COSTS | OUT-OF-POCKET COSTS EXCLUDING SERVICE HOUR COSTS |
|---|---|---|---|
| 1. Depreciated Capital* | $ 79,671 | $ 79,671 | $ 79,671 |
| 2. Depreciated Start-Up** | 16,588 | 16,588 | 16,588 |
| 3. Operating Costs | 622,170 | 322,483 | 109,301 |
| TOTAL COSTS (12.5 month period) | $718,429 | $418,742 | $205,560 |

*Capital costs depreciated over twelve years. Cost shown is for a twelve-and-a-half month depreciation period.

**Start-up costs of $95,546 depreciated over 6 years.

TABLE 9-6 TOTAL COSTS OF THE ACCESSIBLE BUS PROJECT (PHASE I AND II)

Total project costs, including fully allocated operating costs, are $718,429 for the 12 1/2 month period of Phase I and II. Marginal costs were $418,742. Marginal costs without the service hours were $205,560.

## 9.5 COST-EFFECTIVENESS RATIOS

The net impact of the costs can best be determined through a comparison with the results of the project. Costs may be seen as worthwhile if the results are high, or as excessive if the results are minimal. The results of the project can be measured quantitatively as follows:

- The actual transportation provided, or wheelchair trips made on the accessible buses.
- The number of persons who directly used the service, measured by the number of individual users.

These two measures have been used in Table 9-7 to calculate the total cost/trip and the total cost/individual user. These ratios are shown only for the marginal costs and the marginal costs excluding service hours. No ratios are shown for total allocated costs, since these do not represent additional expenditures. The marginal total cost/trip was $204 and the marginal total cost/individual user was $10,469. Both figures are extremely high. The estimated average operating cost/trip on the BSDA system as a whole was only $.81.

An alternate way of calculating results is by those potentially able to use the project. Since an estimated 1,863 wheelchair-using persons resided within 1/4 mile of the 17 accessible routes, the total marginal cost/eligible user was $225. This compares to about $44.31 per person* for the public at large served by the same routes.

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* Calculated by 47.8% (17 routes as % of whole system) X $49,342,580 (FY'79 operating deficit) ÷ 532,331 (total population within 1/4 mile of 17 routes).

| | MARGINAL (OUT-OF-POCKET) COSTS | MARGINAL COSTS EXCLUDING SERVICE HOUR COSTS |
|---|---|---|
| 1. Total Cost | $418,742 | $205,560 |
| 2. Ridership (Trips) | 2,052 | 2,052 |
| 3. Total Cost/Trip | $ 204 | $ 100 |
| 4. Estimated Individual Users | 40 | 40 |
| 5. Total Cost/Individual User | $ 10,469 | $ 5,139 |

TABLE 9-7 COST-EFFECTIVENESS RATIOS (PHASE I AND II-12.5 months)

It should be clear that the cost-effectiveness ratios for this project are exceedingly high. The ratios, however, are very sensitive to the level of ridership. Increases in ridership would lower the ratios. It cannot be determined on the basis of the BSDA data alone what the levels of the cost-effectiveness ratios might be or to what levels ridership might increase if the service reliability were improved. Final evaluation on these points will have to await data from other systems.

# CHAPTER 10

# PROJECT IMPACTS

This chapter considers the impacts of the accessible bus service upon three groups: wheelchair users, BSDA drivers and supervisors, and able-bodied bus riders using the accessible buses. Each of these groups is discussed separately in the following sections.

## 10.1 IMPACT ON USERS

Earlier, in Chapter 8, it was shown that about 40 different persons in wheelchairs had used the accessible service and that only a few had used the service frequently. The accessible service presumably did have a significant impact on the lives of the few regular users. However, it is unlikely that the service had a significant impact on the infrequent users.

To measure the actual impact of the service, the 16 home interview survey respondents were asked whether the lift buses had had a substantial impact on them. Nine, or 56% of the respondents stated "yes." Of these, only 2 respondents had ridden frequently; none of the other seven respondents claiming substantial impact had ridden more than once or twice, during the ten months of the project up to the time of the survey.

It is therefore necessary to qualify the respondents answers. One or two transit trips during a ten month period should not result in a substantial impact. Respondents may have felt better, knowing the service was available; and they may have been encouraged by seeing some progress towards eliminating barriers. Also, the respondents may have felt obligated to answer "yes", even though they were not substantially impacted. The transportation accessibility issue for some handicapped persons may not be actual use of the service, especially every-day use, but rather the psychological value of knowing the lifts are on the buses.

Of the two respondents who did travel often, one was a resident of Koch Hospital. Generally, this person would make a round trip each week, boarding the bus at the hospital and staying on the vehicle until it returned to the hospital. In this way, the accessible vehicle acted as a means of entertainment and a way to leave the hospital for a few hours. We can presume that these trips had a beneficial and theraputic value to the rider.

Ted Brown was the only respondent known to have attempted extensive travel on the buses. His primary trip was between home and work. However, during the summer of 1978, Ted stopped working in order to return to school. When he traveled, Brown wheeled eleven blocks in an electric wheelchair to a bus stop, boarded a bus, and later usually made a transfer to a second bus to complete his trip. Ted made other transit trips as well, with lesser frequency, to recreational facilities and for personal business. He is unemployed and is a single parent of two small children.

The accessible service has had a major impact on Ted's life. According to his statements, he was able to re-enroll in college because of the buses. Before the introduction of the accessible buses, Brown had been driven around frequently by friends (for pay) or by his ex-wife. The buses enabled him to reduce drastically the amount of transportation assistance he needed from others, relieving him of an unpleasant dependency.* Because he had extensive experience on the buses and was willing to communicate with BSDA, he became well-known to the Agency and was an important source of consumer feedback.

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* This information on Ted Brown is based on personal telephone calls conducted on 10/22/78 and again on 10/26/78.

One or two other persons, known to BSDA, attempted using the lift buses for regular, every-day travel, but gave this up because of the poor reliability of the service. BSDA had no other evidence regarding the impact of the accessible buses on wheelchair users. An objective evaluation would indicate that the total number of people positively impacted by the program was quite low, and that most users did not come to depend on the service. One person did benefit substantially from it, however, and despite great difficulties in using the buses--including long delays, low reliability and two accidents--that person came to rely on the buses as a major mode of transportation, with consequent benefits to his life.

In summary, the tangible benefits resulting from this project were very limited, particularly in light of the project costs. Although the handicapped users tend to say they benefit from the service, they generally don't use it. Likewise, their most important desired improvement to the service is 100% accessibility, despite evidence that they will not necessarily use the extended service. It may be that the handicapped's greatest benefits from this accessibility project were psychological, rather than mobility-related.

## 10.2 IMPACT ON DRIVERS/SUPERVISORS

The impact of the accessible buses on the drivers and supervisors was measured in two surveys. The first survey was administered four to five days prior to the Phase I start-up, but after the driver training period. The timing permitted BSDA to assess both the drivers' attitudes towards the service as well as their evaluation of the training sessions. The second survey was administered in October 1977, after two months of project operation. This survey was designed to test how driver attitudes had changed in response to actual service.

The first survey produced 328 responses, representing about 25% of the BSDA drivers. Reflecting the fact that all the drivers had received the same special training, 61% of the respondents felt comfortable using the equipment and 78% felt they had been adequately trained. When asked their feelings about operating a lift vehicle, 34% felt it would be more work, 80% felt it would be more responsibility and 43% felt it would be more troublesome. Only 12% thought it would be no problem.

Drivers were also asked about the kneeling feature. About 13% of the respondents stated they had never operated the kneeling feature. An additional 33% of the drivers were reluctant to use the kneeler because of potential equipment failure and another 29% were reluctant to use it because it was potentially time-consuming. Only 34% were not relucant to use the kneeler.

In view of the potential need for the kneeling feature, not only as an adjunct to lift operation but also as an aid to the semi-ambulatory handicapped, these driver attitudes can be considered as potential barriers to safe and reliable service.

The post-implementation survey was administered in October 1977 to all 29 supervisors and 126 drivers then operating accessible runs. The supervisor survey was designed to determine whether supervisor workloads had been increased, the number of lift calls, and the kinds of duties performed by the supervisors on the buses. The driver survey, on the other hand, asked why the driver picked an accessible run, if he or she would do so again and what their continued feelings were about the lifts and the service.

Most (59%) of the supervisors stated that the accessible service had increased their workload. Estimates of the total number of hours spent on calls related to the accessible buses in the first two months of operation varied from zero to 21 hours. Table 10-1 shows the specific actions which the supervisors performed. Many

| | YES | NO | NO RESPONSE |
|---|---|---|---|
| "Have you at anytime been called upon to actually assist a person in a wheelchair in any of the following ways:" | | | |
| a. Boarding the lift from curb level or street level: | 45% | 52% | 3% |
| b. Depositing fare in the farebox: | 3% | 90% | 7% |
| c. Adjusting or positioning restraining arm: | 21% | 72% | 7% |
| d. Fastening or unfastening seat belt: | 14% | 79% | 7% |
| e. Alighting from lift: | 38% | 59% | 3% |
| Have you at anytime been called upon to assist the operator in any of the following ways: | | | |
| a. Activating the lift: | 76% | 14% | 10% |
| b. Stowing the lift: | 93% | 3.5% | 3.5% |
| c. Replacing lift panel buttons: | 21% | 62% | 17% |
| d. Removal of jammed lift from curb: | 90% | 10% | -- |

TABLE 10-1 RESPONSES TO SUPERVISOR SURVEY (N= All 29 BSDA Supervisors)

supervisors helped with activating or stowing the lift, or removing a jam against the curb. Some supervisors had helped passengers to board/alight or to use the restraining arm/seat belt. Although some (28%) had had occasion to call another supervisor to assist with a lift, most supervisors (90%) felt that their training with the accessible buses had helped.

The post-implementation driver survey asked drivers if they had intentially picked an accessible run. Eighty percent had chosen the accessible run on purpose, but had made their choice for reasons unrelated to accessibility--such as days off, straight daylight hours, or other reasons relating to the run itself. Significantly, 18% stated they had not received sensitivity training, despite BSDA's contention that all drivers had received such training. An additional 21% who did receive sensitivity training stated that it did not prove helpful to them in assisting elderly or wheelchair passengers.

Almost all the drivers stated that not more than one wheelchair boarded their run every day. Of the operators surveyed, 63% said that a lift had malfunctioned on a vehicle which they had operated. Finally, 11% of the respondents stated that even after two months of operation, they still did not feel completely comfortable with the lift, primarily because of equipment unreliability.

In summary, accessible bus operations did not appear to have as substantial an effect on drivers as it did on supervisors.

## 10.3 IMPACT ON ABLE-BODIED RIDERS

The phrase "able-bodied rider" is used to describe all riders who did not utilize the lifts. Two on-board surveys of able-bodied riders were administered: one immediately before project implementation (August 11, 1977) and the second after two months of project operation (October 17, 1977).

The first survey began with a brief explanation of the new service, including a description of the lift and the wheelchair securement device. A total of 407 respondents were asked several questions about how they thought the service would affect them. 54% of the respondents stated they would tolerate no more than five minutes added to their trip due to wheelchair lift use before they would discontinue riding or change routes. Cross tabulations of responses indicated that those making work trips were the most sensitive to travel time increases and were the most likely to change modes. About 17% said they preferred to ride on a bus reserved strictly for the able-bodied; 75% of these respondents were persons making work trips. Ninety percent of the respondents expected no change in the number of times they would use the bus each week. Nine percent did state that they anticipated changing to auto because of accessible service; however, there is no evidence that this occurred.

In general, attitudes toward wheelchair users as bus passengers were positive, with 96% of the able-bodied respondents indicating they would be willing to offer assistance to a wheelchair patron if asked and 95% indicating a willingness to give up their seat if needed for wheelchair securement.

Prior to implementing the project, therefore, the majority of the able-bodied passengers showed favorable attitudes toward the new service and a willingness to endure small travel time delays as a result of the service. This favorable attitude must, however, be tempered by the fact that they believed the wheelchair ridership would be low.

The post-implementation survey continued to demonstrate the same generally favorable attitudes. Complete answers are given in Table 10-2. Considering the extremely low wheelchair ridership, a fairly high percentage (17%) of the respondents had ridden with a wheelchair passenger, and ten percent had even given up a seat to

| QUESTION | YES | NO | REFUSED/NA |
|---|---|---|---|
| 1. "Did you know you were on an accessible trip?" | 80% | 20% | |
| 2. "Has the accessible feature had any effect on which trips or routes you use?" | 13% | 85% | 2% |
| 3. "Have you ever ridden this route when a wheelchair passenger boarded?" | 17% | 83% | |
| 4. "Should wheelchair passengers be allowed to ride BSDA buses?" | 93% | 5% | 2% |
| 5. "Would you give up your seat so that a wheelchair could use the hold-down area?" | 94% | 5% | 1% |
| 6. "Have you ever given up your seat to a wheelchair passenger?" | 10% | 87% | 3% |
| 7. "Has this new accessible service caused you any unreasonable delays?" | 9% | 89% | 2% |

Source: Post Implementation On-Board Survey (512 respondents)

TABLE 10-2 ATTITUDES OF ABLE-BODIED RIDERS

allow the wheelchair to use the hold-down space. Only five percent believed that wheelchairs should not be allowed on buses and another five percent said they would not give up their seat. Approximately 13% felt the service had had an effect on their route or trip choice, but only nine percent felt that they had been caused any unreasonable delays.

Thus, in summary, able-bodied passengers were not apparently against the new service. This attitude did not change when the service was implemented. Very few people suffered delays or expressed uncooperative attitudes, although one could assume this is due to the very low frequency of wheelchair ridership.

# CHAPTER 11

# CONCLUSIONS

## 11.1 INTRODUCTION

A few caveats are needed on the limitations of the evaluation. The St. Louis project was the first major factory installation of lifts in transit buses, and the reliability of the equipment in revenue service was low. Substantial efforts by BSDA and Flxible to improve the equipment met with only limited success. Thus, the project results are not necessarily representative of what would happen in a properly functioning accessible bus project.

It is not possible to state on the basis of this evaluation whether unreliability will continue to be a chronic problem. Since the BSDA lift buses were delivered in 1977, both U.S. bus manufacturers have introduced the new Advanced Design Buses, and the lift manufacturers have also made design changes. Final evaluation of lift equipment must wait until data is available from other systems.

The poor reliability of the equipment had an impact on the usefulness of the accessible service. Wheelchair riders either reduced or eliminated their trips on the buses. Thus, overall wheelchair ridership did not develop to its full potential. The extent to which wheelchair persons would have ridden on the accessible buses had the equipment worked perfectly cannot be determined from the evaluation and will have to await results from the other accessible bus programs.

Finally, this was the first opportunity for wheelchair users to use regularly scheduled transit service. As such, it represented a significant new "mainstreaming" experience for them. When one considers the newness of the service and the potential adjustment involved in using it, it may take longer periods of time for the

benefits of the accessible service to reach their full impact upon the wheelchair population of St. Louis. The first months of operations covered by this report represent too short a period to judge what the eventual transit trip making habits of the St. Louis wheelchair population will be, and it is important to keep this perspective in mind when considering the project results.

## 11.2 SUMMARY OF FINDINGS

A summary of the most significant findings from the preceding chapters of this report are as follows:

1. Accessibility was an outgrowth of the short-range plans of the BSDA, and was not a result of a formal planning process.

   The key actor in the development of the accessible bus service was BSDA, which decided to obtain accessible buses primarily because it felt that it was "important to do something" about the problem of transportation for the handicapped. The decision, thus, was not based upon a formal planning process, and did not develop from any rigorous alternatives analysis, consultative process, or other conventional planning framework.

   Although BSDA had decided upon the routes to be made accessible prior to its decision to purchase accessible buses, it did not have a specific plan for implementing this decision. The route selection procedure was done internally by BSDA, with no consumer input. There is no indication, however, that this procedure was ineffective, nor that added inputs or formal planning would have produced a better route structure.

   Using an internal procedure for developing the accessible bus system, BSDA did not rely heavily upon citizen groups for assistance. There was an Elderly and Handicapped Technical Advisory Committee, but its role was limited. Furthermore, the committee had no formal authority, and was not connected directly to the BSDA, which limited its involvement.

2. BSDA developed a number of pre-implementation programs designed to promote the effective use of the accessible buses.

Once BSDA committed itself to accessibility, it had to carry out a series of implementation steps. These included procedures manuals, driver training and sensitivity programs, demonstrations of accessible buses, pamphlets and mailings, and radio, television, and newspaper advertising. In the few short months between the implementation decision and start-up of the service, BSDA developed and carried out a comprehensive pre-implementation program.

3. Extensive equipment problems resulted in unreliable service causing considerable inconvenience for users and reduced ridership.

In retrospect, the lift equipment was put into service before it was fully developed and tested, resulting in extensive problems. These problems were compounded by other types of problems,which normally happen when phasing in new vehicles.Despite vigorous and costly efforts by BSDA and the vehicle manufacturer, it was not possible to maintain published schedules, especially during the expanded operations of Phase II. Reported trip denials averaged 16% of reported trips in Phase II and reached 24% in two monthly periods. Due to possible under-reporting of denials, the users probably experienced even greater difficulty than these numbers indicate. The survey of users indicated that 80% of the users had been denied a boarding at least once, and 25% had been denied at least 10 times. Furthermore, the survey indicated that users experienced troubles and delays due to equipment problems on at least 30% of their successful trips. It seems difficult to dispute that a majority of the users experienced the exasperating situation of being denied a planned trip or experiencing a delay in their trip due to equipment problems. This is a much different experience than the public has when using transit. In conclusion, unreliable service was a major factor which reduced ridership and inhibited potential ridership increases.

4. Heavy winter snows reduced ridership.

As might be suspected, the unusually heavy snowfall of the 1977-78 winter reduced wheelchair ridership. The initial snowfall of the season, 12.6 inches in a week, resulted in an 80% decrease in weekly ridership. During the entire 10 week period of snow cover it was estimated that there was a 51% decrease

in ridership. This pattern of ridership loss during the winter months was repeated in the 78-79 winter. When one considers that the St. Louis area was not accustomed to handling the exceptionally large amounts of snow which occurred, it is significant that some persons in wheelchairs were still able to make some trips.

5. Ridership was estimated to average 164 trips/month and this was substantially lower than comparable trip rates by the general public.

Due to reporting difficulties, an exact count of the number of trips made by persons in wheelchairs could not be obtained, but, based upon limited information from users, the number of trips made were estimated to be twice the number of reported trips. On this basis, ridership averaged 164 trips/month over the first 12 1/2 months of operation. In Phase I, the first 3 1/2 months of operation, the average was 199 trips/month. Then, although service levels were expanded in Phase II, the average ridership decreased to 151 trips/month. As mentioned earlier, this reduction was largely attributed to two factors: severe winter snow conditions and, more importantly, unreliable service.

Tabulations by BSDA established that there were 40 unduplicated users of the lifts. This represents only 2.1% of the estimated 1,863 wheelchair persons within 1/4 mile of the 17 accessible routes. In addition, most of these users rode the lift buses infrequently. As a result, only 3 different users accounted for close to 50% of all reported trips.

6. The user survey results, though not statistically valid, did generate a number of valuable pieces of information.

- Total travel times (origin to destination) for persons in wheelchairs using the accessible service were much longer than comparable times for the general public using BSDA service. This was primarily due to problems with the lifts particularly when a wheelchair user was forced to wait for the next scheduled accessible bus.

- When asked about alternative modes, 65% of the users indicated that an automobile would have been used. But 30% indicated that the trip would not have been made.

- User comments concerning the accessible service highlighted reliability and mobility problems.

  The users, when asked to rank 19 potential problems with the service, indicated that being denied entry because the lift was not working and the lack of adequate curb cuts were the two most serious problems facing them. It is not surprising that denials are a problem, given the data regarding vehicle availability, mechanical failures, and missed trips.

  The importance of curb cuts, and by implication the entire sidewalk environment, is brought out clearly in the survey. This implies that user mobility and the use of the accessible buses might increase if the home-to-bus environment is improved. Other important problems related to mobility were bad weather and the lack of bus shelters.

- The most important improvement cited by users was that all BSDA routes be made accessible.

  This recommendation may indicate a real desire on the part of the users to travel more on buses; on the other hand, it may also reflect an "advocate" attitude toward accessibility. The second most mentioned improvement was that there be more curb cuts, and better snow removal; these correspond to the mobility problems cited above by the users.

7. The non-users, when asked to cite their reasons for not using the buses, emphasized problems related to mobility difficulties.

Unlike users, who had tried the accessible service and had experienced a wide range of problems, the non-users did not cite poor reliability as a primary reason for not using the service. Instead, their reasons emphasized a number of mobility problems. For the non-institutionalized, the first five reasons cited were inability to go out, availability of another mode, lack of curb cuts, inability to use the lifts easily, and difficulty in traveling on sidewalks and streets.

Improvements desired by the non-institutionalized non-users included curb cuts, better snow removal, and an available dial-a-ride service in addition to fixed route accessibility. The institutional population suggested better lift designs, snow

removal, and curb cuts as the most important changes.

In conclusion, the non-users placed their emphasis on mobility concerns and not lift reliability. Furthermore, they seemed to be unanimously in favor of accessible fixed route service even though they had not actually used it.

8. The BSDA drivers on accessible routes and supervisors were not substantially affected by the service.

Almost all the drivers stated that not more than one wheelchair user boarded their bus each day. Other data indicate that 63% had experienced a lift malfunction at one time or another, but overall, none had had considerable problems with the service. Eleven percent of the drivers were still uncomfortable using the lifts which, although only a small percentage, can represent a problem. A truly good service should not have any drivers who are uncomfortable or reluctant to use the equipment. In view of the need to rely upon each driver for safe and reliable lift operation, the driver training program at BSDA appears to have been less than entirely effective; this is further highlighted by the drivers' contention that 18% had not received the drivers' sensitivity training course.

Most of the BSDA supervisors (90%) felt that their pre-implementation training had helped, and had experienced no major problems conducting their work. They found that they were able to assist with most malfunctions and respond quickly and adequately to most driver aid calls.

9. The able-bodied riders were generally in favor of the accessible bus service, and few had experienced any inconvenience when riding on the accessible buses.

In the pre-implementation survey given to the able-bodied riders, 54% stated that they would not tolerate delays of more than 5 minutes; in a cross-tabulation, it was found that those most sensitive to travel time increases were those making work trips. Overall, most of the able-bodied riders surveyed felt that they would not be affected by the service, perhaps reflecting an anticipation of low ridership by wheelchair persons. After implementation, a second survey was taken of the able-bodied riders, and it was found that 17% had taken a trip that included a wheelchair rider. Only

9% of those surveyed felt that they had had any unreasonable delays due to accessibility. Thus, in summary, able-bodied passengers were apparently negligibly affected by the service, and expressed favorable attitudes towards its continuation.

10. Operating costs and total costs were very high.

Allocated operating costs for the accessible service consisted of: additional service hours, lift repairs, lift preventive maintenance, administrative staff, and accident liability costs. These were estimated at $622,170 for Phases I and II when the value of all time and materials are included. Total costs were calculated by adding an annualized figure for capital and start-up expenses to the operating expenses. For Phases I and II, the total allocated costs were estimated at $718,429 when the value of all time and materials were included.

Although the allocated costs best represent the time and effort expended by BSDA, they include some costs which were either not out-of-pocket costs or were not necessarily required. For purposes of transferability, alternative cost calculations can be made. These show that the marginal (out-of-pocket) total costs were $418,742 and the marginal total costs excluding unneeded service hour costs were $205,560. Resulting cost effectiveness ratios were as follows:

Marginal (out-of-pocket) total cost ratio Phase I and II:

- o $204 per trip by persons in wheelchairs

Marginal total cost (excluding service hour costs) ratio Phase I and II:

- o $100 per trip by persons in wheelchairs

The cost/trip figures are substantially higher than the BSDA systemwide cost of $0.81 per trip. While the marginal operating costs were high on a per trip basis, they only represented less than 1% of the annual BSDA operating budget.

## 11.3 TRANSFERABILITY

During the first 12 1/2 months of accessible bus operations in St. Louis, the service was greatly hindered by lift equipment problems, which had an influence on ridership and operational costs. Because of this, the findings presented by this report in regard to ridership, marginal operating costs and cost ratios would perhaps not be transferable to other areas planning accessible fixed route service which might experience fewer equipment problems. Even if there were no appreciable equipment problems--and one can postulate that many, if not all, of the equipment problems could have been avoided by an improved lift design and rigorous pre-operational testing--it would be difficult to determine that the results are typical of what might be encountered elsewhere.

A number of project findings may be transferable to other areas, however. The single most important finding is that lift equipment should not be put into operation until it is fully developed and rigorously tested. A second important finding is the dampening effect of winter weather on wheelchair ridership. Northern cities with winters as bad as St. Louis will probably experience the same type of ridership loss. Southern cities, which have little or no snowfall, will probably not see this type of effect. Climate may prove to be one of the major factors influencing the feasibility of accessible buses in other cities around the country.

Other transferable results include the attitudes, opinions and characteristics of persons in wheelchairs who did not use the service; and the attitudes and opinions of able-bodied riders, drivers and supervisors. The user information obtained came from only a limited number of persons and does not present any statistically valid empirical data. However, it is helpful in providing at least some insight on user perspectives of the service.

# CHAPTER 12

# ADDENDUM: PHASE III SERVICE AND RESULTS

This chapter is presented as an addendum to the main body of the report. This addendum covers the period from September 5, 1978, when Phase III began, through the end of June, 1979. Since the majority of the evaluation activity was concentrated in Phase I and Phase II, this Phase III addendum contains only key data items which were readily available from BSDA's records. These data items include:

- Accessible vehicle availability
- Missed runs
- Trouble occurrences
- Ridership and denials
- Repairs
- Costs

BSDA's major reason for implementing Phase III was to reduce the number of scheduled accessible buses. The major equipment difficulties which BSDA faced in Phase II could not be successfully corrected while so much equipment was in operation. By reducing the scheduled accessible buses, BSDA hoped to permanently repair those buses not needed for service and to increase the reliability of those which were used in service.

## 12.1 PROJECT DESCRIPTION

In Phase III, the number of accessible routes was reduced to 12. In addition, the level of service was reduced, and only 40 accessible vehicles were required in both the peak and base periods, instead of the 126 and 102 vehicles required respectively in Phase II.

In developing Phase III, BSDA tried to preserve accessible service on those routes which had shown the most wheelchair ridership during Phases I and II. To some extent, they also tried to schedule the accessible runs at those times when the most frequent users rode. The route changes and base period buses assigned are shown in Figure 12-1. Accessible buses were discontinued on the five express routes and on the five least frequently used local routes. Service was provided throughout the operating day and on weekends.

### 12.1.1 Level of Service

The level of service was reduced substantially in Phase III. Table 12-1 shows the percent of trips on each of the 12 routes scheduled for an accessible bus, for both Phase II and Phase III. During Phase III a total of 613 one-way accessible bus trips were scheduled each weekday. This compares with a total of 1,616 on all 17 lines in Phase II, or a 62% reduction in service. The percentages of accessible service in Phase II and III were as follows:

| | Overall Percentage of Accessible Trips | |
|---|---|---|
| | Phase II | Phase III |
| Overall Daily | 71% | 31% |
| 9:00 a.m. - 3:30 p.m. Daily | 74% | 33% |
| Saturday | 92% | 36% |
| Sunday | 94% | 59% |

As a consequence, headways between accessible buses on the 12 Phase III routes were increased to about twice their Phase II level.

| ROUTE | PERCENT OF TRIPS OPERATED BY AN ACCESSIBLE VEHICLE | | | | | |
|---|---|---|---|---|---|---|
| | WEEKDAY (9:00 A.M. - 3:30 P.M.) | | SATURDAY | | SUNDAY | |
| PHASE: | II | III | II | III | II | III |
| Cherokee | 91 | 33 | 100 | 52 | 100 | 74 |
| Tower Grove | 89 | 31 | 100 | 58 | 100 | 69 |
| Broadway | 95 | 71 | 100 | 83 | 100 | 100 |
| Lee | 79 | 33 | 87 | 32 | 96 | 74 |
| Forest Park | 91 | 43 | 100 | 63 | 100 | 78 |
| Grand | 73 | 23 | 88 | 36 | 100 | 48 |
| Carondelet | 58 | 23 | 100 | 42 | 100 | 69 |
| Olive | 61 | 15 | 100 | 12 | 100 | 0 |
| Kingshighway | 51 | 32 | 100 | 0 | 100 | 67 |
| Natural Bridge | 96 | 39 | 100 | 38 | 100 | 5 |
| Belleville - St. Louis | 52 | 14 | 74 | 26 | 58 | 35 |
| Alta-Sita | 72 | 39 | 73 | 26 | 100 | 81 |

TABLE 12-1 COMPARATIVE ROUTE ACCESSIBILITY

| | Number of Vehicles Scheduled In The Base Period | |
|---|---|---|
| | Phase III | Phase II |
| Lines Continued | | |
| Broadway | 5 | 8 |
| Carondelet | 2 | 5 |
| Cherokee | 4 | 9 |
| Forest Park | 5 | 9 |
| Grand | 3 | 8 |
| Kingshighway | 5 | 6 |
| Lee | 3 | 6 |
| Natural Bridge | 4 | 8 |
| Olive | 2 | 9 |
| Tower Grove | 2 | 5 |
| Alta Sita | 3 | 3 |
| Belleville - St. Louis | 2 | 6 |
| TOTAL | 40 | 82 |

Lines Discontinued Under Phase III

Affton Express

Broadway Barracks Express

City Limits - Berkeley

Cross County

Delmar - Forsyth

McKinley Bridge

Northside Rapid

Olive - Creve Coeur Express

St. Louis Ave.

Watson Road Express

FIGURE 12-1 PHASE III PROJECT DESCRIPTION

## 12.2 LIFT PERFORMANCE

The beginning of Phase III coincided with the end of the original warranty period for the accessible buses. Because of the poor performance up to that time, BSDA and Flxible agreed to extend the warranty period to August 1, 1979 and to implement a special program to improve lift performance. As a result of this program, ten buses assigned to the St. Louis divisions were modified with the Automatic Recovery Device (ARD), referred to in Chapter 6.5, during the initial months of Phase III. Also, several buses had microswitches installed on the lift stowlocks and one bus was modified back to its original TDT design configuration. Thus, the fleet of accessible buses had a very mixed mechanical configuration. Five (5) buses had the ARD and no stowlock microswitch; 6 buses had both the ARD and the micro-switch; another 42 buses did not have the ARD or the microswitch and one bus had an entirely different hydraulic configuration. This diversity should be borne in mind when considering the overall performance of the lifts.

### 12.2.1 Bus Availability

The overall trend in accessible bus availability during Phase III is shown in Figure 12-2. During most of Phase III, about 70 to 80 buses, or about one-half of the total fleet of 157 accessible buses, had their lift working and were available for service. This should have been an adequate number of buses to meet the Phase III schedule requirement of 40 buses provided that buses could be properly allocated, at any given time, between the divisional garages. As subsequently discussed, because of allocation problems and other factors, some missed runs occurred in Phase III. As in the earlier phases of the program, non-lift related repairs represented a substantial portion (20%) of the problems with bus availability.

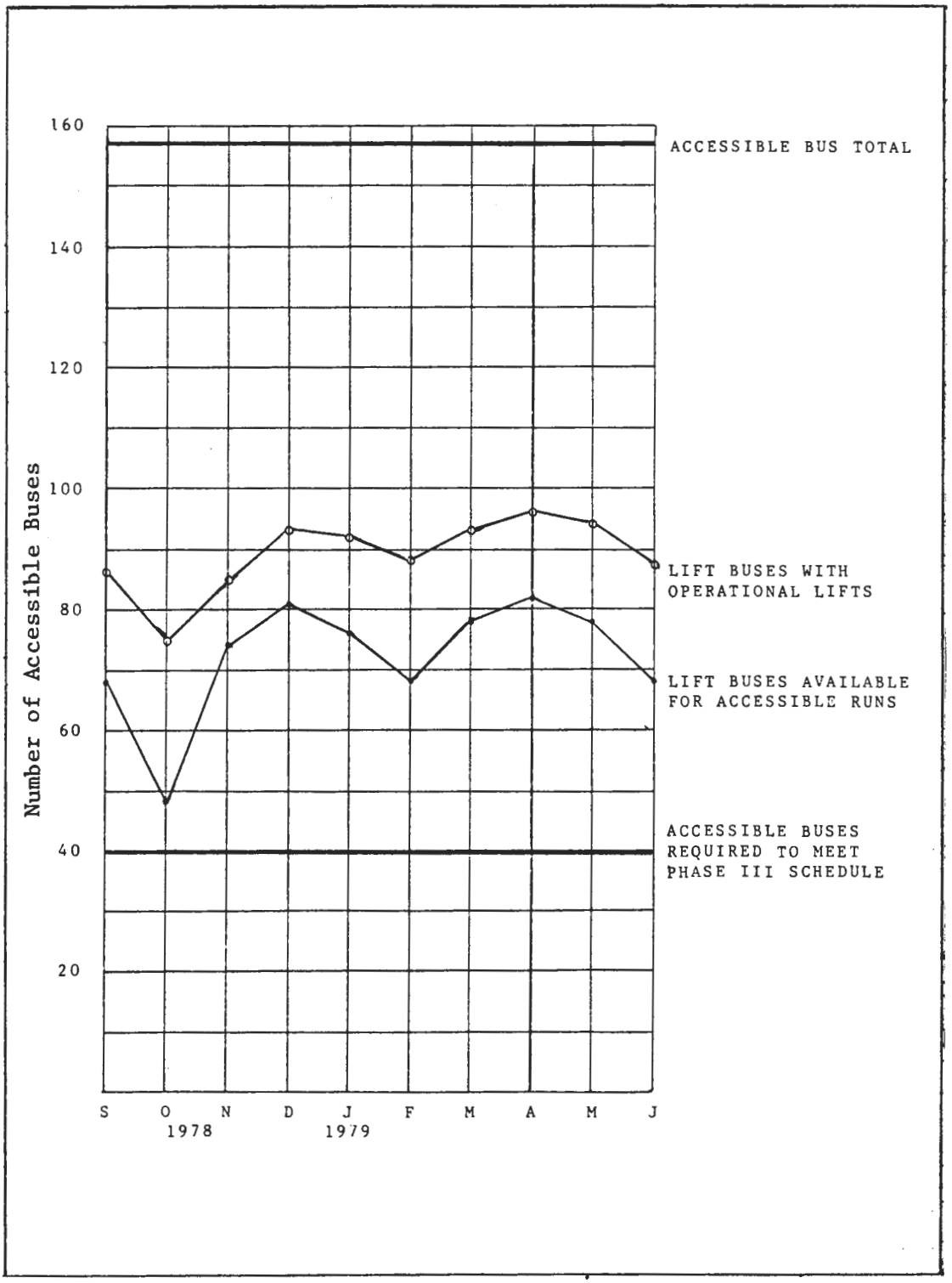


FIGURE 12-2 PHASE III AVAILABILITY OF ACCESSIBLE BUSES

After an initial period during which the ARD's were installed, there was a slow but steady improvement in availability through the spring of '79 until May, 1979 when availability again began to decrease. In fact, as will be seen later from the repair data, this trend resulted from a reduction of effort by BSDA rather than any mechanical, operational or environmental change in the system.

Overall, the ARD equipped buses have maintained a higher level of availability than the non-ARD buses at the St. Louis garages. Only one repair was required on all ten ARD equipped buses during the first five months of 1979. Generally these buses have had their lifts useable at all times. This contrasts with the position at the end of Phase II, before the ARD was installed, when four of these ten buses had their lifts bolted up and another three were reported as out of order.

The non-ARD equipped buses in the St. Louis garages were only 69% trouble-free during this same time period. Those buses without an ARD and without a stowlock microswitch were 56% trouble-free. The evidence from Phase III, therefore, shows that addition of ARD's and/or stowlock microswitches may be of value in increasing the reliability of this particular lift installation.

These figures should only be taken as illustrative of trends, however, and the conclusions as preliminary. Many operational factors-including the low lift useage, the sizes of the bus group studied, and garage assignment differences-makes a more exact analysis of the ARD and microswitch impact impossible. For example, the smaller Illinois garages continued to demonstrate a high bus availability and their unmodified lift buses were nearly trouble free during this period, presumably because the smaller numbers of buses at these garages allowed a more effective preventive maintenance program. Also trouble free was the one bus (stationed at the South Broadway garage) which had been modified by TDT to conform to their original design configuration.

### 12.2.2 Repair Characteristics

Examination of the Phase III repair records revealed a continuing level of minor repairs to wiring and hydraulic lines and also an increasing level of replacements to some major components of the lift system. Table 12-2 shows the number of replacements in Phases II and III for some major lift components. The volume of repairs to skid plates and ramp extension cylinders declined considerably in Phase III but was still appreciable. Also, replacements of the control panel circuit board assembly and the hydraulic manifold decreased markedly in Phase III. The number of replacements to the sensitive edge or mat, although reduced, were still at a high level. The audible alarm and the lift platform safety barrier hydraulic actuating cylinder both showed an increasing failure rate.

The major item of concern in Phase III, however, was the continuing high replacement rate of the extending platform slide assemblies. Figure 12-3 shows that many platform slide assembly replacements took place in Phase III. As in Phases I and II only slide changes that appear to have been caused by lift-related factors have been considered in this analysis. There is also an evident trend towards higher mileage intervals between slide replacements, presumably reflecting a beneficial impact of operational experience and the ARD/microswitch modification programs. Many of the Phase III slide replacements occurred on buses that up to that time had very good repair records. Thus, it may be that 50,000 - 100,000 miles will prove to represent the expected life of this component in the St. Louis environment. However, insufficient data exists on the useage of individual buses within the accessible fleet to fully define the modes and reasons for failure.

| | PERIOD | |
|---|---|---|
| LIFT COMPONENT | PHASE I & II<br>8/77 - 8/78<br>12.5 months | PHASE III<br>9/78 - 6/79<br>10 months |
| Slides * | 80 | 72 |
| Skid Pan | 86 | 24 |
| Sensitive Edge or Mat | 31 | 22 |
| Ramp Extend Cylinder | 30 | 10 |
| Circuit Board Assembly | 54 | 5 |
| Audible Alarm | 4 | 13 |
| Barrier Cylinder | 4 | 9 |
| Hydraulic Manifold | 7 | 0 |

*Covers change in slides only, or in cases where damage does not seem to have been induced by other problems such as skid pan repairs. Total slide changes would be about 20-30% greater than this figure.

TABLE 12-2 NUMBER OF TIMES LIFT COMPONENTS HAVE BEEN REPLACED

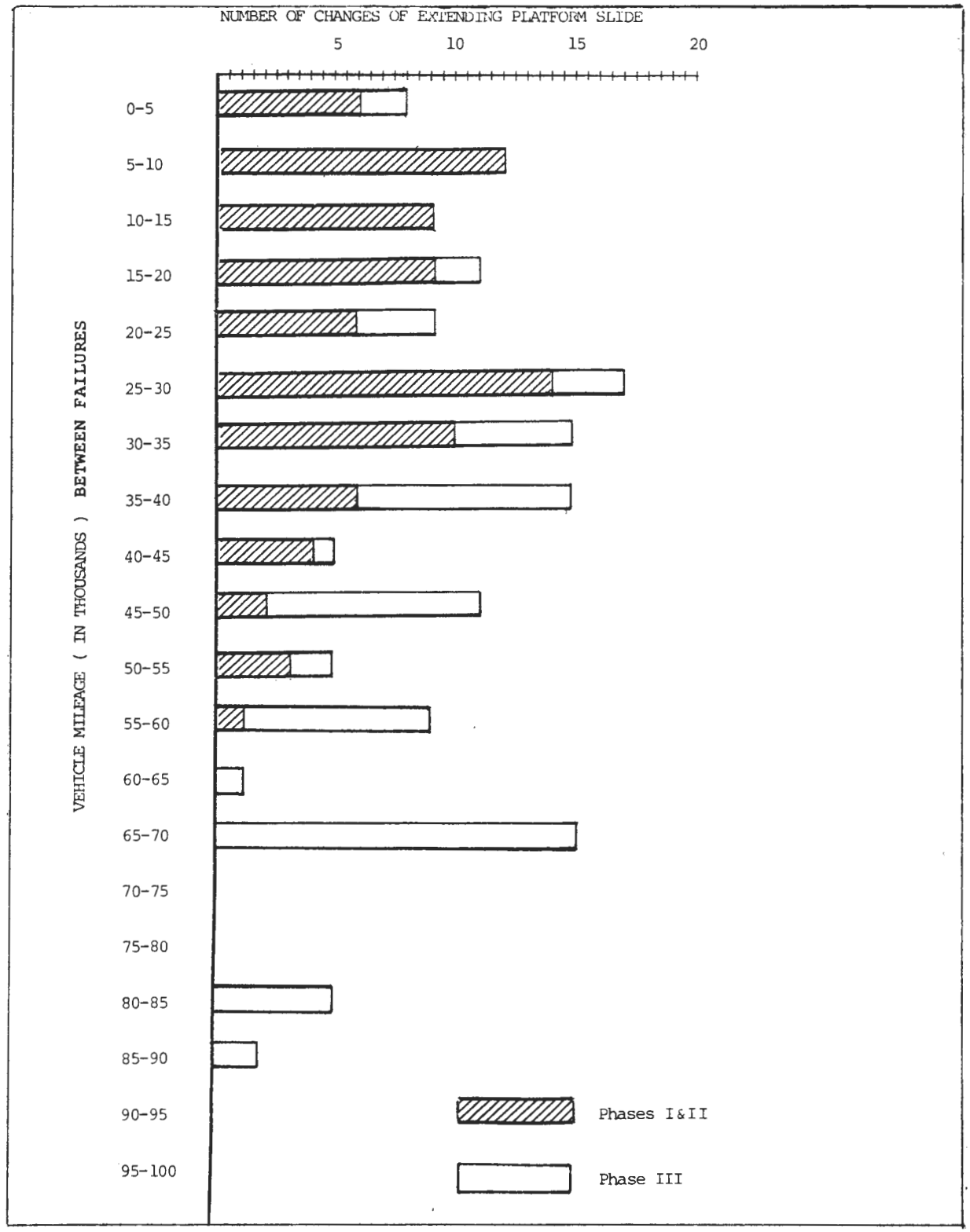


FIGURE 12-3 COMPARATIVE SLIDE CHANGE DATA

In addition to repairs of individual lift components, a continual effort has been expended on the hydraulic systems. Two items in particular may be noted. The power steering pump providing the system's hydraulic pressure continues to require constant attention to seals and other parts to combat wear induced leakages. This is presumably due in part to the high pressure relief springs originally installed to help combat the drifting problem. The second item was a check valve in the emergency handpump circuit, also installed to combat leakage problems. This item was undertaken as part of a Flxible sponsored campaign and was done as the buses came in for repairs.

Skid pan repairs occurred with 20% greater frequency on buses without the microswitch on the platform stow lock. All such skid pan repairs were on buses without the ARD. Again, this supports the possible value of these devices. There was also a large reduction in the repairs needed to straighten out the steps. Together with the continuing level of repairs to the sensitive mats and edges this tends to indicate that the major source of skid pan damage is now due to grounding and curbing rather than to stow locks jamming.

### 12.2.3 Lift Repair Effort

The labor effort attributed to the lift program and the number of repairs actually effected from September 1978 through June 1979 are shown in Table 12-3. Labor effort declined starting in the spring of 1979, although a considerable number of repairs were still effected through April. The effect of the marked decline in effort and repairs for May and June is reflected in the bus availability figures for those months (as shown in Figure 12-2) which also declined substantially, reversing the trend of earlier months.

| MONTH | NO. OF REPAIR PERSONNEL ASSIGNED TO LIFT WORK | REGULAR HOURS | OVERTIME HOURS | TOTAL HOURS | NO. REPAIRS CARRIED OUT |
|---|---|---|---|---|---|
| September '78 | 5 | 800 | 314 | 1,116 | 25 |
| October '78 | 4 | 704 | 394 | 1,098 | 14 |
| November '78 | 4 | 544* | 197* | 741* | 11 |
| December '78 | 5 | 800 | 0 | 800 | 17 |
| January '79 | 5 | 880 | 0 | 880 | 19 |
| February '79 | 4 | 640 | 0 | 640 | 30 |
| March '79 | 4 | 624 | 0 | 624 | 12 |
| April '79 | 3 | 504 | 0 | 504 | 26 |
| May '79 | 3 | 432 | 0 | 432 | 9 |
| June '79 | 6 | 950 | 316 | 1266 | 9 |
| TOTALS | | 6,878 | 1,221 | 8,101 | 172 |

*Reduced by 4 day mechanics strike

TABLE 12-3 PHASE III LIFT REPAIR LABOR EFFORT
(AS REPORTED BY BSDA)

## 12.3 OPERATIONAL RELIABILITY

As in earlier phases, operational reliability is defined in two ways: the number of trouble occurrences on the road with the lifts, and the number of missed runs.

### 12.3.1 Trouble Occurrences

On-the-road lift related trouble occurrences continued to be reported in Phase III in the same manner as in Phase II. Stuck lifts and drifting steps continued to be the significant causes of trouble. No reported trouble occurrences involved the automatic barrier, an accident, or the restraining arm. However, it is known that on at least one occasion, an incident with a faulty securement device occured.* Therefore, as with the ridership figures, it is presumed that there has been some under-reporting of trouble occurances.

Table 12-4 shows the percentage distributions of reported trouble causes for Phases II and III. These are very similar with some reductions in the lift aspects and more emphasis on the step slipping category. This may reflect the operational conditions of lower ridership and awareness of the step problem as a hazard to other passengers.

*In an article in the St. Louis Post-Dispatch on June 24, 1979, a reporter accompanied a wheelchair user for several hours on a number of different routes. The pair attempted 10 boardings on that day, and ran into a variety of problems, including several denials, lengthy delays, and a missing securement arm. Interestingly, none of the successful trips, the denials, or the trouble occurrences were reported on the BSDA logs.

Table 12-5 shows the average rate of reported trouble incidents in relation to the number of scheduled accessible trips and runs. The rate has been halved in Phase III compared to Phase II which would indicate an increased reliability of service. This would still be true when comparing the number of trouble occurrences on the basis of ridership. Reported troubles dropped by a factor of six in Phase III while the ridership dropped by a factor of three. However, other service impacts such as the increased headways between accessible buses in Phase III must also be considered by the consumer in assessing service acceptability.

### 12.3.2 Missed Runs

Figure 12-2 shows that in theory there were always enough buses available during Phase III to meet the scheduled requirements. In practice, about 5% of the scheduled accessible runs were continually reported as fully missed. Missed runs tended to occur when one of the five garages did not have enough functioning accessible buses, and could not use the spare accessible buses at the other garages. Other causes of missed runs were congestion and blockage in the storage areas and errors in bus assignment. There were few partially missed runs (about 1-2% of scheduled runs), generally caused by on-road problems.

As mentioned in section 7-2, BSDA was reporting that at least 16-17% of all accessible runs were missed by the end of Phase II. Thus, the Phase III missed run figure of 5% represents an improvement in the ability of BSDA to insure that functioning accessible buses were used on scheduled accessible runs.

| REPORTED TROUBLE TYPE | PERCENT OF OCCURRENCES | |
|---|---|---|
| | PHASE II | PHASE III |
| A- Lift Stuck in Step Position - don't deploy | 15 | 13 |
| B- Lift Stuck in Other Position - won't stow | 67 | 63 |
| C- Lift Stuck on Curb | 4 | 1 |
| D- Steps Slipping | 14 | 24 |

TABLE 12-4 REASON FOR TROUBLE OCCURRENCES

| | PHASE II | PHASE III |
|---|---|---|
| Accessible Bus Runs Scheduled for Week | 2,119 | 706 |
| Accessible Bus Trips Scheduled per Week | 10,268 | 3,973 |
| Average No. Trouble Occurrences | 37.65 | 6.34 |
| Trouble Occurrences Per Bus Trip | .0037 | .0016 |

TABLE 12-5 RATE OF TROUBLE OCCURRENCES

## 12.4 TRAVEL BEHAVIOR

During Phase III the reported lift bus ridership dropped off substantially. The Phase III reported ridership has been factored up by the same number (i.e., 100%) as the Phase I and II reported ridership to yield the estimated total ridership. As explained in Chapter 8, this factor is based on limited information, and the actual number of trips could be either more or less than the estimated total number of trips. No further systematic evidence could be gained from the Phase III data to prove or disprove this assumption.*

Table 12-6 presents both the reported and estimated number of trips for each month of Phase III and also for the entire demonstration period, i.e., Phases I, II, and III. During Phase III only 578 estimated total trips were made, or an average of 57.8 estimated total trips per month. This compares with 164.2 estimated total trips per month during phases I and II. Thus, average monthly ridership in Phase III dropped to 35% of the level experienced in Phases I and II. In considering the entire project period, 2,630 estimated total trips were made, or a monthly average of 116.9.

The estimated total number of trips decreased rapidly during Phase III. Figure 12-4 illustrates this trend by showing the monthly estimated ridership for all three phases. Although a gradual ridership decline was noted during Phases I and II, this decline became precipitous in Phase III. The decline is attributed to the cutbacks in service during Phase III and also to the continued unreliability of the service. Figure 12-4 also shows the results of trend line analysis over all three phases.

*Footnote on page 12-13 illustrates the deficiencies in reported data.

| MONTH | REPORTED TRIPS | TOTAL ESTIMATED TRIPS | REPORTED DENIALS |
|---|---|---|---|
| September '78 | 81 | 162 | 4 |
| October | 52 | 104 | 0 |
| November | 36 | 72 | 3 |
| December | 17 | 34 | 5 |
| January '79 | 6 | 12 | 0 |
| February | 7 | 14 | 5 |
| March | 21 | 42 | 0 |
| April | 22 | 44 | 2 |
| May | 26 | 52 | 4 |
| June | 21 | 42 | 1 |
| Phase III Totals | 289 | 578 | 24 |
| Phase III Monthly Average | 28.9 | 57.8 | 2.4 |
| Phase I & II Totals | 1026 | 2052 | 116 |
| Phase I & II Monthly Average | 82.1 | 164.2 | 9.3 |
| Phase I, II, & III Totals | 1315 | 2630 | 140 |
| Phase I, II & III Monthly Average | 58.4 | 116.9 | 6.2 |

TABLE 12-6 PHASE III RIDERSHIP AND DENIAL TOTALS IN COMPARISON TO PHASES I & II

To show what effect service reductions have had on the ridership, Figure 12-5 shows the ratio of estimated monthly ridership to scheduled accessible buses since the project started. Although this ratio actually increased in September 1979, the first month of Phase III, the ratio declined fairly rapidly after that. Taken over the entire life of the project, the ridership per scheduled accessible bus has declined as shown by the trend line in Figure 12-5. Other factors besides the level of service changes must have contributed to the decrease in this ridership ratio. These factors are explored in the user follow-up survey described later in this chapter.

### 12.4.1 Effect of Weather

During Phase III, ridership dropped because of winter weather in a fashion similar to the ridership decline in Phase II. Figure 12-4 shows that estimated total ridership was less than 20 trips per month during January and February of 1979. During these two months a total of 23.2 inches of snow and ice precipitation fell on the St. Louis area and the average daily snow cover was 4.6 inches. Although the estimated total ridership was much lower in the winter of 78-79 than in the winter of 77-78, the weather was actually much better. During the 78-79 winter, St. Louis received a total of 26.6 inches of snow and ice precipitation, compared with the 77-78 winter snowfall of 66.0 inches. (The 77-78 winter snowfall was by far the heaviest since St. Louis began keeping snowfall records in 1937). The very low ridership levels of January and February 1979 are presumably a result, therefore, of both winter conditions and the reduced level of service available throughout phase III.

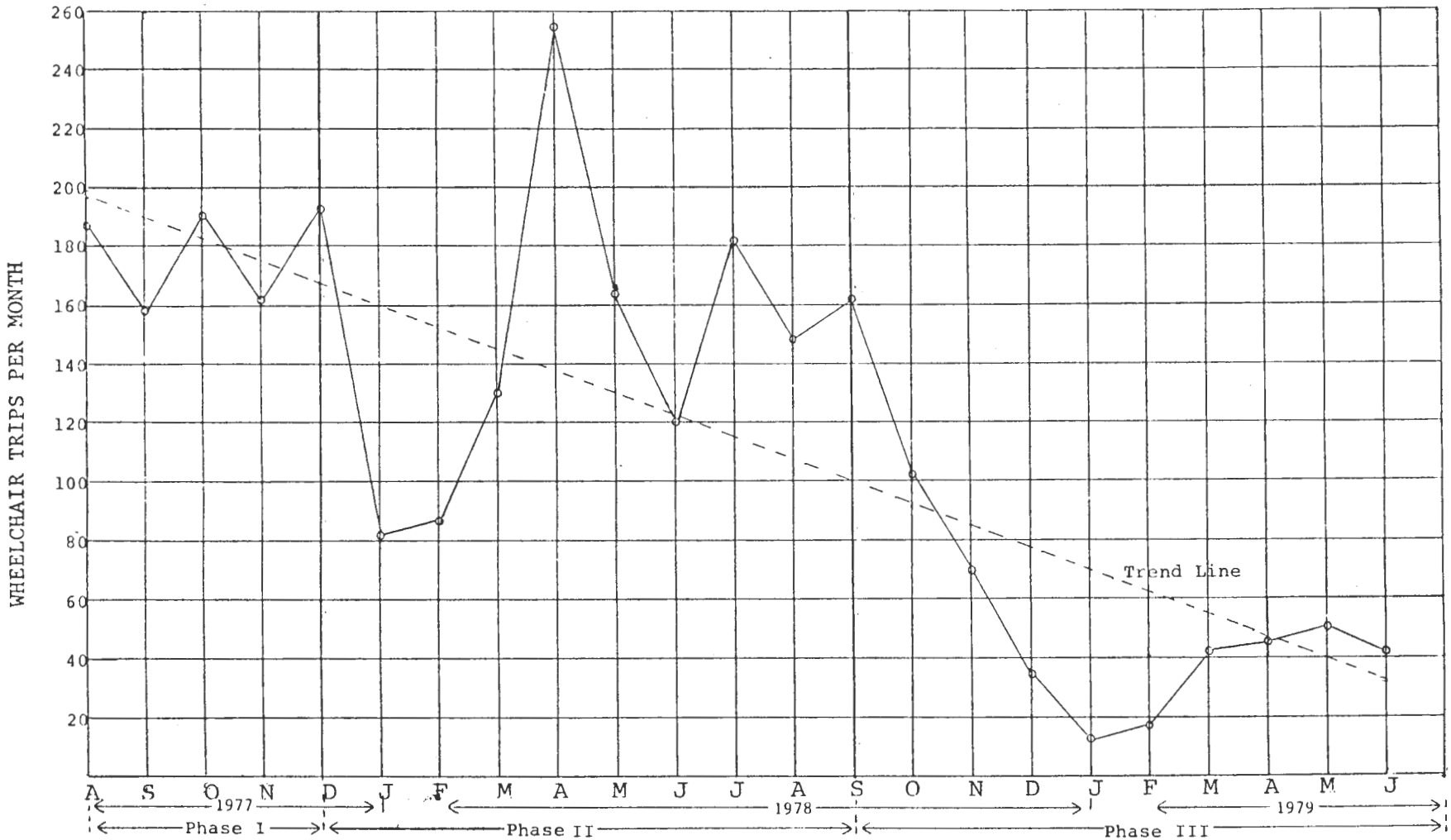


FIGURE 12-4 TOTAL ESTIMATED RIDERSHIP

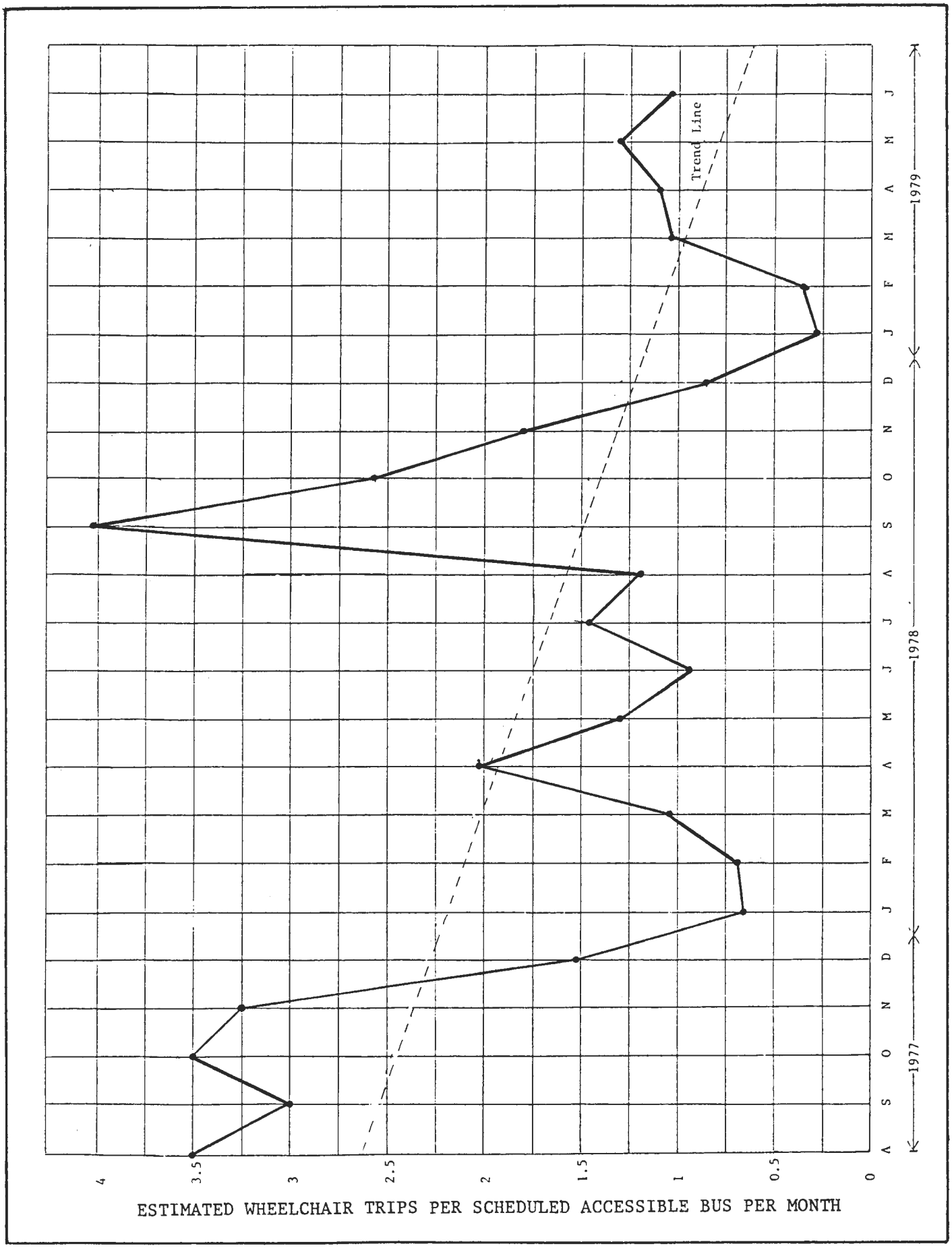


FIGURE 12-5 WHEELCHAIR RIDERSHIP VS. SCHEDULED BUSES

### 12.4.2 Individual Users

As described in Chapter 8.3.1, a total of 40 different individual users could be identified during Phases I and II. During Phase III, BSDA continued to assign all reported trips to a specific user. A total of 21 new individual users were identified, bringing the total number of different individual users identified over the entire course of the project to 61. However, none of the 21 new individual users identified in Phase III made very many trips. Most were residents of Koch Hospital or State Hospital and were only reported to have ridden a few times.

During Phase III, majority of the 61 different users who had been identified did not make any accessible bus trips. A large number of the Phase III trips were made by user No. 1, previously discussed under the pseudonym of Ted Brown. As Phase III progressed, Brown's reported trips consititued a larger and larger percentage of all reported trips. According to the data given in Figure 8-4, Brown made 211 reported trips (or 20% of all reported trips) in Phases I and II. By the end of Phase III, however, Brown was making a substantial majority of the reported trips. During the last four months of Phase III, Brown made 60 of the 90 reported trips (67%). This indicates that no individual users except Brown were trying to make regular use of the service by the end of Phase III.

### 12.4.3 Trip Denials

BSDA continued to monitor trip denials during Phase III, although relatively few were reported. Table 12-6 shows the reported denials for each month. As mentioned in Section 8.2, however, reported trip denials are not believed to reflect accurately the number of denials which actually

occured. This comment is equally applicable to Phase III. During Phase III, 24 trip denials were reported or a monthly average of 2.4. This is lower than the Phase I and II average of 9.3 reported denials per month. The reduced frequency of denials in Phase III is presumably due to the reduced level of service in Phase III and the reduced ridership, which would lead in turn to fewer opportunities for a denial to occur.

## 12.5 USER FOLLOW-UP SURVEY

In an effort to ascertain why the users did not ride more often, a follow-up attitudinal survey was administered by BSDA to 34 different users in May/June of 1979. The survey was open-ended, containing a series of opinion or other qualitative questions about several aspects of the service. These questions were structured to ascertain the following information:

- What were the respondents' beliefs about their use of accessible buses in the past?
- What were their attitudes about the quality and extent of current accessible service, i.e., in May/June 1979?
- What factors affected their own low use or non-use of the buses?
- Why did they think other handicapped didn't use the buses more often?
- What impact did the service really have on the respondent?
- What would happen if all BSDA buses were accessible and always worked right?

The respondents fell into two groups. There were 20 non-institutionalized users characterized as living independently and having the potential for regular ridership. (One of these 20 was a resident of State Hospital, but did ride very regularly.)

The other 14 respondents were all residents of Koch Hospital, a long-term residential care facility for people who cannot take care of themselves. Generally, the Koch residents travel infrequently and only under the care of an attendant from the hospital. The group of 20 non-institutionalized respondents made roughly 30 times as many trips on the accessible buses as did the group of 14 institutionalized respondents and consequently had much more experience with the service. The non-institutionalized respondents were generally much more critical of the service and articulate than were the institutionalized respondents. In some of the survey tabulations, the two groups are separated to reflect these differences.

### 12.5.1 Past and Current Use of Lift Buses

The users were asked about their past and current use of lift buses. Table 12-7 shows that most of the respondents had not used the lift buses often. Half had ridden no more than five times over the project life. This included all of the Koch Hospital residents. Only 4 respondents claimed to have ridden 100 times or more. Thus, the users generally didn't make extensive use of the lift buses. Also, the date at which they had taken their last lift bus trip ranged from February 1978 up to June 1979. Clearly, few of the users were still riding. Despite this fact, 65% stated that they still intended to use the buses, on at least an occasional basis. When asked if they had in the past tried to use the buses regularly (i.e., to rely on it for a recurring trip, such as a work trip), 38% said yes and 41% said no. Since the percentage who tried to ride regularly is much higher than the percent who did ride more than 15 times (only 17%), we can deduce that potential regular riders stopped trying to ride quite early in their experience with the lift buses. Finally, 82% of the respondents lived near an accessible bus, so this is not the reason why they were not riding.

1. Number of Times Ever Rode Lift Bus.

| # Trips | Number of Respondents | % |
|---|---|---|
| 1-5 | 18 | 51% |
| 6-10 | 8 | 23% |
| 11-15 | 2 | 6% |
| 16-20 | 0 | -- |
| 21-99 | 2 | 6% |
| 100 or more | 4 | 11% |
| No Response | 1 | 3% |

2. Date Last Rode a Lift Bus

| | Number of Respondents |
|---|---|
| February '78 | 1 |
| April '78 | 1 |
| May '78 | 1 |
| June '78 | 8 |
| July '78 | 2 |
| August '78 | 2 |
| September '78 | 7 |
| October '78 | 2 |
| December '78 | 2 |
| January '79 | 1 |
| April '79 | 1 |
| May '79 | 2 |
| No Response | 3 |

3. Is respondent still a lift bus rider intending to use them at least occasionally?

   Yes: 65% No: 15% NA: 20%

4. Did respondent ever try to use lift buses regularly?

   Yes: 38% No: 41% NA: 21%

5. Is respondent living close enough to an accessible bus route to use if he/she wanted to?

   Yes: 82% No: 9% NA: 9%

TABLE 12-7 PAST AND CURRENT LIFT BUS USE

### 12.5.2 Perceptions of Current Lift Bus Service

User's perceptions of the current lift bus service may have affected their propensity to use it, and have contributed to the decline in ridership. As shown in Table 12-8, the users perceptions of the service was not good. Ninety percent of the non-institutionalized users did not trust the lifts to work properly. Only 40% of the non-institutionalized users trust the drivers to work the lifts properly.* About 15% of the users reported having a mixed level of trust. Thus, the conclusion is that despite the reduced level of service of Phase III and the reported higher levels of bus reliability, the overall feeling that has remained in the users' eyes is poor. This is illustrated more graphically in the subsection which gives the users comments.

### 12.5.3 Reasons for Low Use

The respondents were asked why they themselves did not use the lift buses more and why they thought other handicapped did not use the lift buses more. As shown in Table 12-9 the most clearly perceived reason for the respondents' low use was the unreliability of the lifts/service and the fear of being stranded somewhere. Other reasons mentioned included living far from the bus route, lack of curb-cuts, impact of winter weather, and the availabilty of private transportation.

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*Most of the institutionalized users from Koch Hospital trusted the lifts and drivers. The hospital is located right at the end of a bus route and the wheelchair patients are able to board while the bus is laying over. This, and the presence of attendants, has meant that it was fairly easy for them to get on and off the bus.

1. "How reliable do you think the lifts or service are today?"

| | REGARDING | GOOD | NO GOOD | DON'T KNOW |
|---|---|---|---|---|
| All Respondents | Lift | 35% | 59% | 6% |
| | Service | 47% | 41% | 12% |
| Non-Institutionalized Respondents (N=20) | Lift | 5% | 90% | 5% |
| | Service | 20% | 65% | 15% |
| Institutionalized Respondents (N=14) | Lift | 78% | 14% | 8% |
| | Service | 86% | 7% | 7% |

2. "How much do you trust the driver to work the lifts properly?"

| | Non-Institutionalized (N=20) | Institutionalized (N=14) | All Respondents |
|---|---|---|---|
| Answer showing minimal level of trust | 35% | --- | 17% |
| Answer showing mixed level of trust | 20% | --- | 15% |
| Answer showing good amount of trust | 40% | 100% | 65% |
| No Response | 5% | --- | 3% |

TABLE 12-8 USER'S PERCEPTIONS OF SERVICE

1. "Why don't you use lift buses more often?"

| Response | # of Respondents |
|---|---|
| Lifts Don't Work | 11 |
| Unreliability of lifts/service | 11 |
| Getting stranded somewhere | 4 |
| Buses not available where resondents lives | 4 |
| Lack of curb-cuts | 3 |
| Winter weather | 2 |
| Respondent has own transportation | 1 |
| Dangerous to cross streets | 1 |
| Dislikes unfamiliar settings | 1 |

(Non-institutionalized resondents only)

2. "Why haven't other handicapped used these (lift) buses more often?"

| Type of Response | # of Responses |
|---|---|
| General inaccessibility of buildings, etc. | 10 |
| Lift buses not well routed/scheduled | 8 |
| Problems with lift bus drivers | 6 |
| Problems with lifts | 5 |
| Wheelchair people have little confidence to try buses | 5 |
| Wheelchair people not aware of service | 4 |
| Lack of assistance on the buses | 3 |
| Poor public attitude toward the handicapped | 3 |
| Physical condition prevents lift bus use | 3 |
| Wheelchair people have their own transportation | 2 |
| Poor identification on the lift buses | 1 |
| Too expensive to travel | 1 |
| Fear of crime | 1 |

TABLE 12-9 REASONS FOR NOT USING ACCESSIBLE BUSES

User's perceptions of why others did not use the lift buses were quite different from their perceptions of why they themselves did not use the buses. Reasons mentioned for others included the inaccessibility of buildings and destinations, lack of confidence on the part of wheelchair people, unawareness of the service, lack of personal assistance, negative public attitudes towards the handicapped, poor physical condition, availability of automobiles, and poor routing and scheduling of buses. Thus, a much greater variety of reasons for not using the lift buses was generated, many of them obviously beyond the control of BSDA.

Users were also asked specifically about winter weather, difficulty in reaching a bus stop, ease of using the lift (when working properly), and fear of being on the lift. Responses are given below.

- Answers varied on the effect of winter weather. About 35% said it would have no effect on their use of lift buses, but only 26% said it would stop their use entirely.

- About 65% said they had little or no trouble reaching an accessible bus stop. However, a large minority mentioned the lack of curb cuts, the difficulty in crossing streets, and long distances as factors which made it difficult for them to reach a stop.

- Most of the users (88%) did not have trouble using the lift when it worked properly.

- Sixty percent (60%) of the non-institutionalized users were not inconvenienced by the fact that not every bus on an accessible route has a lift. However, the other 40% did feel inconvenienced. This was probably a minor contributory cause of low ridership.

### 12.5.4 Impact on Users

Despite infrequent use, 65% of the users stated that the lift buses had had an impact on them. This was even true for users who had ridden only a few times. The user's comments showed that the major impact was often not so much better transportation, but the feeling of independence which the lift buses gave them. This feeling was that, finally, the first small step in a totally accessible world was being taken. Thus, even if they did not use the buses, they felt a psychological impact. Others, in fact, felt an impact because they believed accessible buses would lead to additional accessibility in buildings or other non-transportation facilities.

### 12.5.5 Availability of Other Transportation

Since the availability of other transportation has an obvious impact on users' need for lift buses, the respondents were asked how they usually do get around. For the non-institutionalized users, the answers were: (multiple answers allowed)

- 30% are driven by a friend
- 30% are driven by a family member
- 25% formerly took taxicabs (interestingly, none of the respondents now use taxicabs)
- 25% own their own car, presumably with hand controls
- 15% have their own specially equipped van

Only 1 of the 20 non-institutionalized users did not indicate any "usual" means of getting around. This high availability of other transportation means that users are not dependent on the lift buses and do have an alternative when they find the lift bus service to be unacceptable.

### 12.5.6 The Future

As a matter of interest, the useI rs were told to imagine that all BSDA buses were lift-equipped and that the lifts always worked. All (100%) of the non-institutionalized and most of the institutionalized stated they would use the lift buses. Although this "non-committment" demand is not necessarily indicative of true user behavioral patterns, it does indicate at least a conceptual desire on the users' parts for lift buses.

Interestingly, the users also displayed a difference between how they themselves would react to complete accessibility and how they thought others would react. Half of the respondents thought other handicapped would use lift buses only if certain conditions were fulfilled, such as better publicity and/or well-trained drivers. By and large, therefore, the users did feel that future use of the buses would be made if they were available and always worked.

## 12.6 USER COMMENTS

Because of the open-ended nature of the follow-up survey, many of the users had an opportunity to make generalized comments on the entire BSDA lift bus service. Since many of these comments give a realistic expression of the user's feeling and provide an interesting perspective of the service, they have been included in Appendix K.

## 12.7 COSTS

There were no purchases of capital equipment for the program during Phase III and, therefore, program costs consisted solely of operating costs. These included service hours, lift repairs, preventive maintenance, administrative staff and accident liability. These costs cannot always be clearly established or exactly quantified but the following represents the best data available. Labor costs are based on current BSDA rates and are 6-10% greater than in Phases I and II.

## 12.7.1. Service Hour Costs

At the beginning of Phase III, BSDA made adjustments in the schedule and platform hours for the accessible buses. It was difficult to ascertain the number, if any, of extra platform hours that could be attributed to accessibility. During Phase I and II (See Chapter 5) it was estimated that a 2.7 percent increase in paid platform hours was attributed to accessibility. Lacking any more specific data, all that can be concluded is that the number of extra platform hours in Phase III ranged between 0 to 2.7 percent of the total platform hours and were probably closer to the lower rather than higher figure. For Phase III, the upper bound of service hours resulted in:

Platform hours on accessible routes = 13,407 per week

Maximum increase (2.7%) that culd be attributed to accessibility = 362 hrs./week

Mean Operator hourly rate (including fringe) = $9.55/hr.

Maximum Service Hours Cost = $3457/week

The operator hourly rate reflects a number of cost of living increases and also the introduction of a new labor contract. This resulted in an average increase in the hourly cost rate of approximately 10%. Thus, the service hour cost for the 42 weeks of Phase III through June 1979 ranged from 0 up to a maximum of $145,194.

The maximum increase in service hours estimated above is far greater than was needed on the basis of wheelchair ridership. Assuming ridership levels similar to that observed in Phase III, extrapolation of the BSDA costs to other systems should not included any significant service hour costs.

### 12.7.2 Lift Repair Costs

As was shown in Section 12.2.3 and Table 12-3 the BSDA repair effort declined throughout most of Phase III. Table 12-10 shows the costs on a month by month basis using BSDA supplied labor hours and rates and repair materials costs from the central shop bus records. Overall these figures represent a 30-40% drop from the levels reported during Phase II. It is not possible to make exact comparisons between phases because a large proportion of the mileage on the accessible buses is accumulated in non-accessible service. It is evident that the wheelchair service no longer has a high priority at BSDA as reflected in the reduced repair effort. The estimated total cost of lift repairs in Phase III was $130,718.

### 12.7.3 Preventive Maintenance Costs

During Phase III the accessible buses averaged 532,490 miles per month, of which a large proportion was accumulated in non-accessible service. Preventive maintenance inspections are, however, set up on an accumulated mileage basis and thus include the non-accessible mileage. The preventive maintenance costs have been based on the following monthly schedule:

Number of 9,000 mile, 10 minute inspections = 59 or 590 minutes

Number of 1,500 mile, 5 minute inspection = 295 or 1,475 minutes

Total inspection and preventive maintenance time = 2,065 minutes or 34.42 hours

The BSDA labor rates have varied over this period due to cost of living adjustments and a new contract, and an average value for the period under consideration is $9.73 per hour including fringe benefits. The cost attributable to preventive maintenance is, therefore, $335 per month or $3,350 for all of Phase III.

| MONTH | PARTS COST | LABOR COST | TOTAL REPAIR COST |
|---|---|---|---|
| September '78 | $7,408 | $13,518 | $ 20,926 |
| October '78 | 2,601 | 12,487 | 15,088 |
| November '78 | 1,180 | 8,219 | 9,399 |
| December '78 | 3,360 | 7,841 | 11,201 |
| January '79 | 5,309 | 8,793 | 14,102 |
| February '79 | 9,145 | 6,412 | 15,557 |
| March '79 | 2,185 | 6,286 | 8,471 |
| April '79 | 7,372 | 5,250 | 12,622 |
| May '79 | 2,521 | 4,534 | 7,055 |
| June '79 | 1,432 | 14,865 | 16,297 |
| TOTAL $ | $42,513 | $ 88,205 | $130,718 |

Note: As in Phase II, some of these costs may later be claimed by BSDA under the manufacturers warranty. However, no breakdowns of warranty vs. non-warranty costs are yet available.

TABLE 12-10 PHASE III LIFT REPAIR COSTS

### 12.7.4 Administrative and Staff Costs

BSDA allocated the following administrative and staff costs to the lift buses during Phase III.

| | |
|---|---|
| Staff Time | $87,187 |
| Publicity, Revised Schedules, etc. | $11,700 |
| Total | $98,887 |

It should be noted that the above staff time costs were 28% higher than the total of $68,183 for Phase I and II.

### 12.7.5 Accident Liability Costs

There does not seem to have been any marked decrease in the number of accidents involving ambulatory passengers during Phase III but claims from wheelchair passengers were reduced from 4 to zero. Complete records for Phase II are not available, as was indicated earlier, but are sufficient to make a reasonable comparison possible. Table 12-11 summarizes the available data. The figures represent the sum of expenses and claims and are, therefore, the total costs to BSDA at this time. Since there are still a number of open claims those costs will probably increase in the final analysis. Many of the tripping accidents only involve nominal amounts such as $10 or $20. It is evident, however, that the average cost of the non-wheelchair claims has increased substantially with the passage of time. Inspection of the records does not indicate any change in the overall severity of individual cases. The increase, therefore, probably reflects a greater overall awareness of BSDA liability and the current consumer oriented environment.

| PERIOD | NO. MONTHS | NUMBER OF ACCIDENTS | | | COSTS ($) | | |
|---|---|---|---|---|---|---|---|
| | | Non-Wheelchair | Wheelchair | Total | Non-Wheelchair | Wheelchair | Total |
| Phase II (1/78-8/78) | 8 | 25 (11) | 4 | 29 | 2,600 | 4,478 | 7,078 |
| Phase III (9/78-5/79 only) | 9 | 22 (7) | 0 | 22 | 6,530 | 0 | 6,530 |

*Figures in parenthesis represent the number of accidents that did not result in any expense or claims costs.

TABLE 12-11 COMPARISON OF REPORTED ACCIDENTS IN PHASES II AND III

In terms of accident severity to ambulatory passengers those occurring while descending the steps are the more serious although they are far less frequent. Accidents going "down" represent only one third of all step accidents but they account for over 60% of the costs. Also in approximately 50% of the "up" accidents no claim was made indicating the minor nature of the incident. This would be expected since falling out of the bus to the ground is likely to produce a more serious injury than tripping while climbing the steps.

For the 9 months of Phase III for which data were available (9/78 - 5/79) there were 22 accidents, none of which involved wheelchair users, for a total cost of $6,530 or $297 per accident. Seven accidents did not involve any cost and five remain open. Exact comparisons with earlier phases are not possible but in the first 8 months of 1978 during Phase II operations there were 29 accidents, including 4 to wheelchair persons, for a total cost of $7,078 or $244 per accident. Eleven accidents did not involve any costs and six remained open including three involving wheelchair users.

### 12.7.6 Total Phase III Costs

Using the preceding items the total operating costs are shown in Table 12-12 for September 1978 through June 1979. Compared to the earlier phases the service and lift repair costs remain the major items although at a slightly reduced level. The preventive maintenance costs are reduced reflecting the trends initiated towards the end of Phase II. BSDA has, however, increased their estimate of the amount of administrative staff and support costs in the light of recent experience and this is clearly evident in Table 12-12. The caveats regarding service hour costs which were expressed earlier are as applicable here as in Phases I and II. As in Chapter 9, alternative calculations are shown in Table 12-12 of the estimated out-of-pocket costs and the estimated

| ITEM | Fully Allocated Costs | Percent of Total | Marginal (Out-of-Pocket) Costs | Marginal (Out-of-Pocket) Costs Excluding Service Hours |
|---|---|---|---|---|
| 1. Service Hours | $145,194 | 38% | $145,194 | - |
| 2. Lift Repair | $130,718 | 34% | $130,718 | $130,718 |
| 3. Lift Preventive Maintenance | $ 3,550 | 1% | - | - |
| 4. Administrative Support | $ 98,887 | 26% | - | - |
| 5. Accident Liability (prorated to 10 months from 9) | $ 7,256 | 2% | $ 7,256 | $ 7,256 |
| TOTAL | $385,605 | 100 | $283,168 | $137,974 |

TABLE 12-12 PHASE III OPERATING COSTS

out-of-pocket costs excluding the service hour costs. These alternative calculations, as in Chapter 9, do not show as accurately the value of the time and materials which BSDA expended, but may be more applicable to other systems.

The total costs for Phase III are shown in Table 12-13. The costs include the operating costs and the depreciated capital and start-up costs. The total costs, including fully allocated operating costs, are $462,611. The total costs when only marginal (out-of-pocket) operating costs are included were $360,174 for an average of $623 per trip. Thus, the ridership reductions experienced in Phase III resulted in a 206% increase in the cost/trip compared to the $204/trip of Phase I and II. Excluding service hour costs reduces the total marginal costs to $214,980 with a corresponding ratio of $372/trip; 372% higher than Phase I and II.

## 12.8 TOTAL PROGRAM COSTS

The total costs involved in the accessible bus program over all 22.5 months of Phases I, II and III may be summarized as:

| | |
|---|---|
| Capital | $917,805 |
| Start-up | 95,546 |
| Fully Allocated Operating (Phases I & II) | 622,170 |
| Fully Allocated Operating (Phase III) | 385,605 |
| TOTAL | $2,021,126 |

Table 12-14 shows the total program costs when capital and start-up are depreciated over the entire 22.5 month period. The total marginal costs were $778,916, resulting in a cost/trip of $296 and a cost/unduplicated user of $12,769. Excluding service hour costs results in a total marginal cost of $420,540 with a corresponding cost of $160/trip and a cost/unduplicated user of $6,894.

| | Fully Allocated Costs | Marginal (Out-of-Pocket) Costs | Marginal (Out-of-Pocket) Costs Excluding Service Hour Costs |
|---|---|---|---|
| 1. Operating Costs (Phase III - 10 months) | $385,605 | $283,168 | $137,974 |
| 2. Depreciated Capital Cost* | $ 63,736 | $ 63,736 | $ 63,736 |
| 3. Depreciated Start-up Costs** | $ 13,270 | $ 13,270 | $ 13,270 |
| 4. Total Phase III Cost | $ 462,611 | $360,174 | $214,980 |
| 5. Ridership, Phase III | 578 | 578 | 578 |
| 6. Cost/Trip | | $ 623 | $ 372 |

*Depreciation period of 10 months out of an estimated 12 year life.

**Depreciation period of 10 months out of an estimated 6 year life.

TABLE 12-13 PHASE III TOTAL COSTS

| | Fully Allocated Costs | Marginal (Out-of-Pocket) Costs | Marginal (Out-of-Pocket) Costs Excluding Service Hour Costs |
|---|---|---|---|
| 1. Phase I & II Operating Totals | $ 622,170 | $322,483 | $ 109,301 |
| 2. Phase III Operating Total | 385,605 | 283,168 | 137,974 |
| 3. Depreciated Capital | 143,407 | 143,407 | 143,407 |
| 4. Depreciated Start-up | 29,858 | 29,858 | 29,858 |
| TOTAL | $1,181,040 | $778,916 | $ 420,540 |
| 5. Cost/Trip[1] | | $ 296 | $ 160 |
| 6. Cost/Unduplicated User[2] | | 12,769 | $ 6,894 |

1. Based on an estimated total of 2,630 trips
2. Based on estimated 61 unduplicated users in all three phases

TABLE 12-14 TOTAL PROGRAM COSTS (ALL PHASES - 22.5 MONTHS)

## 12.9 PHASE III SUMMARY AND CONCLUSIONS

In summary, BSDA attempted to improve the reliability of the accessible bus service by reducing the scheduled service to a level requiring only 40 vehicles. It was hoped this would allow a reduced level of missed runs and enough time to repair all of the lifts. A total of 12 accessible routes were operated, with an average of about one third of the runs accessible.

During Phase III, about 50% of the accessible fleet was available for service. Although unsatisfactory from a mechanical point of view, this was more than enough to meet the Phase III schedule. About 95% of all accessible runs were operated in Phase III, indicating a more reliable service than in Phase II. In addition, reported trouble occurrences per scheduled bus were about half the rate of Phase II. Thus, the available data indicated that overall service performance did improve in Phase III, relative to the Phase II service.

Reported wheelchair ridership dropped off in Phase III because of the reduced level of service and the continued feelings of users that the lifts were unreliable. During Phase III, the average monthly number of reported trips was 35% of the Phase I/II level of tripmaking and by the end of Phase III, the estimated number of trips was only about 40-50 per month. Although an additional 21 different users rode on the service in Phase III, none of these people rode very often. During the last few months of Phase III, Ted Brown was making over 50% of the reported trips. Under-reporting of trips appeared to continue but no accurate data was available to scale up the reported ridership.

The ridership decline was primarily attributed by the users to their continuing perceptions that the lifts were very unreliable. Problems were also mentioned with drivers attitudes, and training, bad weather, curb cuts, and scheduling and routing of the buses.

Most users indicated a desire to continue using lift buses, if and when the reliability was improved.

Based upon the repair records there appears to be some evidence of improvement in lift reliability due to the installation of the Automatic Recovery Device (ARD) and the stow lock microswitch. More extensive experience with these, particularly the ARD, of which only 11 were used, is needed before definite conclusions can be drawn. Despite these improvements, repairs remained at a high level, controlled only by the level of effort that BSDA provided in the repair shop. Repair effort was progressively reduced during this phase of the program.

Costs attributed by BSDA to the program continued at a high level due mainly to lift repair and possible extra platform costs which together accounted for 72% of the fully allocated operating costs. The estimated total marginal cost per trip for Phase III through June, 1979 was $623. In comparison, the some cost ratio averaged over all three phases was $296 per trip. Exclusion of service hour costs reduces the total marginal cost to $372/trip in Phase III and $160/trip for all three phases of the program.

# REFERENCES

## References


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3. Annual Report For the Year Ended June 30, 1977, Bi-State Development Agency, June, 1977.

4. Transcript of Public Hearing on Grant Application Under Sections 3 & 5 of the National Mass Transportation Act of 1974, Bi-State Development Agency at St. Louis County, Government Center, August 17, 1976.

5. How to Assist Elderly & Handicapped Passengers - An Operators Handbook, Bi-State Development Agency, June, 1977.

6. Operating Procedure: Wheelchair Lift System: Flxible Transit Coach, Bi-State Development Agency, June, 1977.

7. Service Information Bulletin #181, Wheelchair Lift System Preventative Maintenance, Grumman Flxible Corporation, March 6, 1978.

# APPENDICES

## APPENDIX A

## DAILY WHEELCHAIR TRIP AND DENIAL RECORD

# DAILY WHEELCHAIR TRIP & DENIAL RECORD DATE _____

| RUN | LINE | TIME ON | DIR. | ORIGIN | DESTINATION | no. W/C | Denial Code |
|---|---|---|---|---|---|---|---|
| | | | | | | | |
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DENIAL CODE

A - Bus too crowded
B - W/C positions already
C - Lift malfunction
D - Other

DAILY TRIP TOTAL _____

DENIALS _____

APPENDIX B

BI-STATE LIFT BUS TRAVEL DIARY

## INSTRUCTION FOR USE OF TRAVEL DIARY

The travel diary is designed to help us evaluate the lift bus service so that it can be of better service to you. The diary is supposed to apply to all trips you take on the lift buses over a certain period of time. It does not require you to perform any specialized data collection other than remembering where you went, how you got there and approximately when you left and arrived.

Each trip you take is recorded on a separate line. A trip is any one-way passage from one point to another. Each column should be filled out as labeled.

Date - Enter the date.

Trip Origin - Enter the address where you began your trip and the approximate time of day.

Access to Bus - Enter the mode code (explained on the travel diary sheet) and the approximate number of blocks from the origin of your trip to where you boarded the bus.

Route # - Enter the number of the bus route.

Transfer - Check if you transferred to a second bus enroute to your destination.

Second Bus Route # - Enter the number of the second bus route.

Access to Destination - Enter the mode code for how you reached your destination after getting off the bus and the approximate distance in blocks.

Trip Destination - Enter the address of your destination and the approximate time of day you reached it.

Weather Code - Enter the weather code which best describes what it was like during your trip.

Trip Purpose Code - Enter the trip purpose code which best decribes why you were going to that destination. The trip purpose code is governed by the destination. A trip from home to work is a work trip. A trip from anywhere to home, for any reason, is a home trip.

Lift Bus Trouble Code - Enter here the code of any trouble you may have had on that particular trip.

Alternate Mode Code - Enter here how you think you would have gotten to each destination if lift buses were not available.

Comments - Fill in any additional comments.

# BI-STATE LIFT BUS TRAVEL DIARY NAME _____

| Trip No. | Date | Trip Origin | | Access to Bus | | Route no. | Transfer | 2nd Route no. | Access to Destination | | Trip Destination | | Weather Code | Trip Purpose Code | Lift Bus Trouble Code | Alternate Mode Code | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Address | Time of Day Left | Mode Code | Distance (blocks) | | | | Mode Code | Distance (blocks) | Address | Time of Day Arrived | | | | | |
| 1. | | | | | | | | | | | | | | | | | |
| 2. | | | | | | | | | | | | | | | | | |
| 3. | | | | | | | | | | | | | | | | | |
| 4. | | | | | | | | | | | | | | | | | |
| 5. | | | | | | | | | | | | | | | | | |
| 6. | | | | | | | | | | | | | | | | | |
| 7. | | | | | | | | | | | | | | | | | |
| 8. | | | | | | | | | | | | | | | | | |
| 9. | | | | | | | | | | | | | | | | | |
| 10. | | | | | | | | | | | | | | | | | |

**MODE CODE**

1. Walk/wheel unattended
2. Walk/wheel attended
3. Taxi
4. Auto passenger
5. Auto driver
6. Agency transportation

**WEATHER CODE**

1. Clear, warm
2. Clear, cold
3. Rain
4. Snow

**TRIP PURPOSE CODE**

1. Work
2. Sheltered occupation
3. Rehabilitation
4. School
5. Shopping
6. Personal business
7. Social-recreation
8. Home
9. Other

**LIFT BUS TROUBLE CODE**

1. Lift malfunction-denied entrance into vehicle
2. Lift malfunction-boarded vehicle with delay
3. Bus too crowded-denied entry
4. Both w/c positions occupied-entry denied
5. Lift bus late-trip delayed
6. Other (describe in Comments)
7. Snow or other environment
8. Securement device
9. No trouble

**ALTERNATE MODE CODE**

1. Auto passenger
2. Auto driver
3. Walk/wheel unattended
4. Walk/wheel with assistance
5. Taxi
6. Social agency transportation
7. Other (describe in Comments)
8. Would not make trip

APPENDIX C

WEEKLY TROUBLE SUMMARY

# WEEKLY TROUBLE SUMMARY

WEEK OF _____

| | Scheduled Lift Runs | Missed Runs | | Trouble Occurence | | | | | | | | | | | | | | Rectification Procedure | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Code A | | Code B | | Code C | | Code D | | Code E | | Code F | | Totals | | Code X | | Code Y | | Code Z | |
| | | Full | Partial | no. | min. | no. | min. | no. | min. | no. | min. | no. | min. | no. | min. | no. | min. | no. | min. | no. | min. | no. | min. |
| Monday | | | | | | | | | | | | | | | | | | | | | | | |
| Tuesday | | | | | | | | | | | | | | | | | | | | | | | |
| Wednesday | | | | | | | | | | | | | | | | | | | | | | | |
| Thursday | | | | | | | | | | | | | | | | | | | | | | | |
| Friday | | | | | | | | | | | | | | | | | | | | | | | |
| Saturday | | | | | | | | | | | | | | | | | | | | | | | |
| Sunday | | | | | | | | | | | | | | | | | | | | | | | |

**TROUBLE CODE**

- **A** Lift stuck in step position - won't deploy
- **B** Lift stuck in other position - won't stow
- **C** Lift stuck on curb
- **D** Steps slipping
- **E** Automatic barrier doesn't function properly
- **F** Accident involving person in wheelchair
- **G** Securement device

**RECTIFICATION CODE**

- **X** Bus replaced
- **Y** Emergency dispatcher sent
- **Z** Shop called

# APPENDIX D

## PRE-IMPLEMENTATION ABLE-BODIED RIDER SURVEY

# WHEELCHAIR LIFT SURVEY

1. FOR WHAT PURPOSE ARE YOU MAKING THIS TRIP?

   ☐ work ☐ medical visit ☐ recreational/social ☐ school ☐ other _____

2. HOW MUCH ADDITIONAL TIME CAN BE ADDED TO YOUR TRIP, FOR USE OF THE NEW WHEELCHAIR LIFT, BEFORE YOU WOULD DISCONTINUE RIDING OR CHANGE BUS ROUTES.

   ☐ 0 ☐ 1-3 ☐ 4-5 ☐ 6-10 ☐ 11-20 ☐ 21+

3. HOW DO YOU FEEL THIS NEW SERVICE WILL EFFECT THE NUMBER OF TIMES YOU RIDE THE BUS EACH WEEK?

   ☐ No effect ☐ Increased trips ☐ Decreased trips

4. WHAT EFFECT DO YOU FEEL THE WHEELCHAIR SERVICE WILL HAVE ON YOUR TOTAL TRANSPORTATION HABITS?

   ☐ I will probably be using my car more in the future for trips I now make by bus.

   ☐ I will probably be a passenger in a car more in the future for trips I now make by bus.

   ☐ The wheelchair service will make no difference. I will continue to make the same trips by bus.

5. IF A PASSENGER IN A WHEELCHAIR ASKED FOR HELP WOULD YOU GIVE ASSISTANCE?

   ☐ Yes ☐ No

6. AREAS FOR PASSENGERS IN WHEELCHAIRS ARE CONVERTIBLE SEATS LOCATED NEAR THE FRONT OF THE BUS, WOULD YOU BE WILLING TO GIVE UP YOUR SEAT IF NEEDED?

   ☐ Yes ☐ No

7. GIVEN A CHOICE, WOULD YOU RATHER RIDE ON A BUS THAT IS RESERVED STRICTLY FOR ABLE BODIED PERSONS?

   ☐ Yes ☐ No ☐ Don't care

8. WHAT IS YOUR SEX?

   ☐ Female ☐ Male

9. WHAT IS YOUR AGE?

   ☐ Under 16 ☐ 16 to 64 ☐ 65 and over

10. WHAT IS YOUR RACIAL AND OR ETHNIC HERITAGE?

    ☐ Black ☐ White ☐ Spanish-American ☐ Oriental-American ☐ Other

11. TO HELP US IMPROVE THE ROUTING OF OUR SERVICE, PLEASE GIVE US THE ZIP CODE OF YOUR RESIDENCE_____ AND THE NAMES OF THE TWO STREETS AT THE INTERSECTION CLOSEST TO YOUR HOME.

_____ 1

_____ 2

APPENDIX E

POST-IMPLEMENTATION ABLE-BODIED RIDER SURVEY

Bi-State is very interested in obtaining your input for the evaluation of our New Totally Accessible (Wheelchair) Bus Program. Please answer each question and return to the research person.
YOUR ASSISTANCE IS VERY MUCH APPRECIATED. THANK YOU!

1. Did you know you were on one of Bi-State's new accessible (wheelchair) trips?

☐ Yes ☐ No

2. Has the accessible (wheelchair) feature had any effect on which trips or routes you use?

☐ Yes ☐ No

3. Have you ever rode <u>this</u> route when a wheelchair passenger boarded?

☐ Yes ☐ No

4. For what purpose are you making this trip:

☐ Work ☐ School ☐ Social/recreational ☐ Medical ☐ Shopping ☐ Personal Business

5. Should wheelchair passengers be allowed to ride Bi-State buses?

☐ Yes ☐ No

6. Would you give up your seat to allow a wheelchair passenger to strap (her) himself in?

☐ Yes ☐ No

7. Have you ever given up your seat for a wheelchair passenger?

☐ Yes ☐ No

8. Has this new accessible (wheelchair) service caused you any unreasonable delays?

☐ Yes ☐ No

9. Which response best represents your actions, if long delays occurred due to wheelchair passengers:

A. Stop riding all Bi-State buses ☐
B. Change trip time on this route ☐
C. Change Bus routes ☐
D. Tolerate these delays ☐
E. Other - specify: _____

10. Do you have other means of transportation for making <u>this trip</u>?

☐ Yes ☐ No

Questions 11-14 are being asked to insure our sample is a true reflection of our riders. None of these responses can be traced to you and will remain in strict confidence.

11. What is your approximate age:

19 and under ☐ 20-24 ☐ 25-44 ☐ 45-55 ☐ 56-60 ☐ 61-64 ☐ 65+ ☐

12. What is your sex?

☐ Female ☐ Male

13. What is your approximate annual family income:

Less than 3,999 ☐ 4,000-5,999 ☐ 6,000-7,999 ☐ 8,000-9,999 ☐ 10,000-14,999 ☐
15,000-19,999 ☐ 20,000 + ☐

14. What is the zip code of your residence: _____

THANKS AGAIN!
Bi-State Development Agency

## APPENDIX F

## PRE-IMPLEMENTATION OPERATOR SURVEY

PLEASE FILL IN OR CIRCLE THE APPROPRIATE ANSWER.

1. HAVE YOU OPERATED THE KNEELING FEATURE? _____

   1 - Yes
   2 - No

2. ARE YOU RELUCTANT TO USE THIS FEATURE FOR ANY OF THE FOLLOWING REASONS? _____

   1 - Potential equipment failure
   2 - Time consuming
   3 - Other (specify) _____
   4 - No

3. BI-STATE WILL BE IMPLEMENTING ACCESSIBLE ROUTE SERVICE IN THE NEAR FUTURE. DO YOU FEEL COMFORTABLE USING THE EQUIPMENT? _____

   1 - Yes
   2 - No. Why not? _____
   _____

4. DO YOU FEEL ADEQUATELY TRAINED TO DEAL WITH WHEELCHAIR PASSENGERS? _____

   1 - Yes
   2 - No. Why not? _____
   _____

5. DO YOU THINK OPERATING A LIFT VEHICLE WILL BE (you may choose more than one response): _____

   1 - More work
   2 - Greater responsibility
   3 - More troublesome
   4 - No problem

6. IF YOU FORESEE PROBLEMS, WHAT WOULD THEY BE? _____

   _____
   _____

7. DO YOU ANTICIPATE ANY SPECIFIC PROBLEMS WITH OPERATING THIS NEW SERVICE? _____

   1 - Yes (specify) _____
   2 - No

8. WOULD YOU CHOOSE TO DRIVE AN ACCESSIBLE ROUTE? _____

   1 - Yes
   2 - No. Why not? _____
   3 - Makes no difference

9. DO YOU HAVE ANY COMMENTS OR OPINIONS ABOUT THE NEW ACCESSIBLE LIFT SERVICE? _____

   _____
   _____

10. DO YOU HAVE ANY COMMENTS OR OPINIONS ABOUT YOUR ROLE IN PROVIDING ACCESSIBLE LIFT-EQUIPPED SERVICE? _____

    _____
    _____

PLEASE CIRCLE OR FILL IN THE APPROPRIATE ANSWER.

DO YOU EXPECT THE NEW ACCESSIBLE BUS SERVICE TO SIGNIFICANTLY INCREASE YOUR WORKLOAD? _____

1 - Yes. How? _____

2 - No _____

DO YOU FEEL YOU HAVE BEEN ADEQUATELY TRAINED TO DEAL WITH EQUIPMENT FAILURE WITH REGARD TO THE NEW FEATURES? _____

1 - Yes

2 - No (specify) _____

_____

DO YOU HAVE ANY COMMENTS OR OPINIONS ABOUT THE IMPLEMENTATION OF THE NEW ACCESSIBLE SERVICE? _____

_____

_____

_____

## APPENDIX G

## POST-IMPLEMENTATION OPERATOR AND SUPERVISOR SURVEYS

## OPERATOR SURVEY

This survey is designed to determine your opinion of our new totally accessible services. These responses will only be used for that purpose - so respond as you truely feel. Please return the completed responses to the Station Dispatcher.

THANK YOU!

1. What is your seniority date: _____ Month _____ Year

2. Could you have picked a run other than totally accessible?

☐ Yes ☐ No

3. For what two main reasons did you choose your accessible run?

☐ Straight Day Light ☐ Location ☐ Other

☐ Driving Hours (Platform) ☐ Days Off

☐ Like Challenge ☐ Pay

☐ Run Design ☐ Start Time

4. Did you receive any sensitivity training to prepare you to assist elderly or handicapped patrons?

☐ Yes ☐ No

5. Did the sensitivity training, if received, prove helpful in assisting wheelchair or elderly patrons?

☐ Yes ☐ No

6. How many lift passengers usually board your run daily?

☐ One per Day ☐ Less/Specify _____

☐ Two per Day ☐ More/Specify _____

7. Has the lift ever mal-functioned on any vehicle you operated?

☐ Yes ☐ No

8. Do you feel you know enough about the lift to allow you to feel comfortable operating the vehicle?

☐ Yes ☐ No

9. What is your approximate age?

☐ 23-30 ☐ 31-40 ☐ 41-50 ☐ 51-60 ☐ 61+

10. Would you select a totally accessible run again?

☐ Yes ☐ No

POST-IMPLEMENTATION SURVEY
ACCESSIBLE BUS PROGRAM
ROAD SUPERVISORS

Please complete this survey. No names are needed. Your answers are a key component of the evaluation of this program.

1. Has the new accessible bus service significantly increased your workload?

☐ Yes ☐ No

1a. Approximately how many hours have you spent on calls concerning accessible buses?

2. Have you at anytime been called upon to actually assist a person in a wheelchair in any of the following ways:

a. Boarding the lift from curb level or street level: ☐ Yes ☐ No

b. Depositing fare in the farebox: ☐ Yes ☐ No

c. Adjusting or positioning restraining arm: ☐ Yes ☐ No

d. Fastening or unfastening seat belt: ☐ Yes ☐ No

e. Alighting from lift: ☐ Yes ☐ No

f. Other, please specify: _____

3. Have you at anytime been called upon to assist the operator in any of the following ways:

a. Activating the lift: ☐ Yes ☐ No

b. Stowing the lift: ☐ Yes ☐ No

c. Replacing lift panel buttons: ☐ Yes ☐ No

d. Removal of jammed lift from curb: ☐ Yes ☐ No

e. Other, please specify: _____

4. How many calls have you had to take on a wheelchair lift bus that was outside your district:

☐ None ☐ 1 ☐ 2 to 5 ☐ More than 5

4a. How many calls have you had to take on a wheelchair lift bus that was inside your district:

☐ None ☐ 1 ☐ 2 to 5 ☐ More than 5

5. Have you ever had to request additional help, i.e., another supervisor to assist with a problem with a wheelchair lift bus: ☐ Yes ☐ No

6. Do you feel that the training you received concerning accessible buses has helped you in dealing with the accessible buses: ☐ Yes ☐ No

7. Do you feel that the training you received concerning persons in wheelchairs has helped you in dealing with wheelchair passengers:

☐ Yes - Please Explain: _____

☐ No - Please Explain: _____

8. Do you have any comments on the accessible bus program and your role in it:

# APPENDIX H

## USER SURVEY

LIFT-USERS OF BSDA BUSES

INTERVIEW FORM

INTERVIEWER'S NAME_____

RESPONDENT'S NAME_____

RESPONDENT'S ADDRESS_____

_____

*The following information should not be asked of the respondent: Use your discretion to supply the needed information.*

Time of Interview_____ Date _____

Sex_____ Race _____

Is the respondent apparently mentally retarded? 1) Yes 2) No

*You should ask the remaining questions directly of the respondent. If the respondent is mentally retarded, the interviewer should attempt as many questions as is feasible. Those which are too difficult for the respondent can be skipped and left blank.*

1. What is your age? _____Years.

2. (a) About how many times have you used a lift-bus since the service began?

   *(Help respondent to estimate)* _____ Trips.

   (b) About how many times have you ridden in the last three months?

   _____ Trips.

   (c) Do you intend to keep using lift-buses in the future?

   _____ Yes _____No _____Not sure

3. How many years have you used a wheelchair?

   1) Under a year

   2) Between one year and three years

   3) Between three and five years

   4) Over five years

4. Which of the following characteristics describe the type of wheelchair you use most often when traveling out of doors?

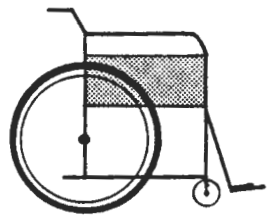
   Are the tires...

   1) pneumatic (*air filled*), or

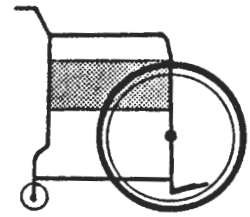
   2) hard rubber

- Is the smaller set of wheels...
  1) 5 inches in diameter
  2) 8 inches in diameter
  3) Other

- Which picture best describes the wheel placement of your chair? *(Show the respondent the pictures below and circle his choice.)*



A



B

- Is the chair powered...
  1) manually
  2) electrically

- Do you have a footrest extension on the chair?
  1) Yes  2) No

- Do you have a head rest extension or reclining back on the chair?
  1) Yes  2) No

5) How many blocks can you wheel alone

A. In good weather?
   0) 0 blocks  1) 1 block  2) 2 blocks  3) 3 blocks
   4) 4 or more blocks

B. In rainy or cold weather?
   0) 0 blocks  1) 1 block  2) 2 blocks  3) 3 blocks
   4) 4 or more blocks

C. The day after a 3 inch snow?
   0) 0 blocks  1) 1 block  2) 2 blocks  3) 3 blocks
   4) 4 or more blocks

6. (a) Why are you confined to a wheelchair? (*Note: Get medical reason, i.e. paralysis, spinal cord injury, MS, polio, etc.*)_____

_____

_____

_____

(b) Do you always use a wheelchair when you go out? ____ Yes _____No

(*Note: if "No", describe conditions which affect when person does and does not need a wheelchair when going out.*)_____

_____

_____

_____

(c) Do you have any use of your legs at all?

_____No _____Limited Use

7. Are you in good general health?

1) Yes 2) No

8. How much use of your arms do you have?

1) Full use and strong enough to independently wheel about;

2) Full use, but not strong enough to wheel yourself about;

3) Limited use;

4) No use

9. What type of housing do you live in?

1) Private residence

2) Special housing for the handicapped

3) Nursing home or other type of institution (*Specify if other*)_____

_____

10. Which employment category best describes you?

    1) Full-time worker

    2) Unemployed, looking for full-time work

    3) Full-time rehabilitation

    4) Sheltered employment

    5) Student

    6) Homemaker

    7) Retired

    8) Unemployed, unable to work

    9) None of the above

11. If employed, what kind of work do you do?

    1) Professional

    2) Service

    3) Clerical

    4) Manual

    5) Other *(Specify)*_____

    _____

12. Do you have a driver's license? 1) Yes 2) No

13. Do you own a car? 1) Yes 2) No

14. How many autos are owned by your household? *(i.e. that you live with)*_____

15. Do you use transportation services sponsored by social or human service agencies such as Care-Cabs, OATS, or the service offered by the Mayor's Office for Senior Citizens? 1) Yes 2) No 3) Don't know

16. Can you afford taxis when you need them? 1) Yes 2) No

17. How often did you ride in a taxi over the last month?

    0) Never

    1) Once

    2) Twice

    3) Three or four times

    4) More than four times

18. How easy is it for you to use taxis? (*Note: This means the ease with which respondent can physically get in and out of the taxi vehicle.*)

    1) Very easy

    2) Moderately easy

    3) Difficult

    4) Impossible

19. How helpful and courteous do you find taxi drivers to be?

    1) Very helpful

    2) Moderately helpful and courteous

    3) Not very helpful or courteous

20. Has a Bi-State representative ever trained you in the proper use of the Bi-State buses' wheelchair lift feature? 1) Yes 2) No

    *If respondent answered no to question 20, skip to question 22.*

21. How useful was the training in helping you to use the lifts? (*Prompt the respondent for his comments, if necessary*)_____

22. (a) Have you ever tried to ride on the lift buses, but been unable to do so? (*Note: This means that the respondent wanted to ride a lift-bus, but was prevented from doing so by a lift malfunction, driver wouldn't stop, cars parked in bus stop, or other reason.*)

_____Yes _____No

(b) About how many times has this happened to you? _____Times

(c) Generally, about how many times have you been denied entry for each of the following reasons?

_____ 1) Scheduled lift bus trip did not have a lift on the vehicle.

_____ 2) Lift was inoperative.

_____ 3) Driver refused to stop or allow me to board for unknown reason.

_____ 4) Cars parked in bus stop or other barriers prevented me from reaching bus.

_____5) Bus was too crowded.

(d) What generally happens after you are denied entry? (*Note: This question asks what the respondent did then, i.e. waited for another bus, gave up the trip, driven in supervisor car, etc.*)_____

_____

_____

23. How far is the nearest bus stop from your house? (*i.e. which is served by an accessible bus route.*)

0) Less than 1 block

1) 1 block

2) 2 blocks

3) 3 blocks

4) 4 blocks

5) 5 or more blocks

6) Do not know

24. How often do you travel alone on the lift buses? (*i.e. without bringing along a friend or assistant for help.*)

_____ always _____sometimes _____never

25. (a) Has the introduction of the lift-buses had a substantial impact on your life? (*Note: This question asks the respondent to state whether they really benefit from lift buses in some tangible way?*)

_____ Yes _____ No

(b) Have lift-buses enabled you to achieve any of the following, <u>which you could not have done without lift buses?</u> (*Note: Make sure that respondent <u>could not do activity</u> without lift buses.*)

| | YES | NO |
|---|---|---|
| Get a job or change jobs | _____ | _____ |
| Apply for different jobs | _____ | _____ |
| Be more independent of others | _____ | _____ |
| Attend school or training | _____ | _____ |
| Attend church | _____ | _____ |
| Attend social events | _____ | _____ |
| Attend entertainment facilities | _____ | _____ |
| See more of family/friends | _____ | _____ |
| Attend medical/health functions | _____ | _____ |
| Utilize social services, such as day care, nutrition, etc. | _____ | _____ |

26. This part of the survey is to determine the kinds of problems you have had with the lift buses. It works like this: As I read each of the following items, I would like you to tell me whether you view it as: a serious problem; a moderate problem or; little or no problem. Is that clear to you, or shall I repeat the categories? (*If yes, re-explain the directive.*)

| | | A Serious Problem | A Moderate Problem | Little or No Problem |
|---|---|---|---|---|
| (a) | Feeling safe on the lift | _____ | _____ | _____ |
| (b) | Getting over the lip and on to the lift platform. | _____ | _____ | _____ |
| (c) | Maneuvering to the wheelchair station | _____ | _____ | _____ |
| (d) | Adjusting the restraint arm | _____ | _____ | _____ |
| (e) | Crowds in the aisle | _____ | _____ | _____ |
| (f) | People seated on the fold down seats in the wheelchair station | _____ | _____ | _____ |
| (g) | Being denied entry because the lift was not working | _____ | _____ | _____ |
| (h) | Both wheelchair stations already occupied by a handicapped person | _____ | _____ | _____ |
| (i) | Driver assistance and courtesy | _____ | _____ | _____ |
| (j) | Buses not stopping at the curb | _____ | _____ | _____ |
| (k) | Bad weather | _____ | _____ | _____ |
| (l) | Buses not arriving on time | _____ | _____ | _____ |
| (m) | Attitude of other passengers | _____ | _____ | _____ |
| (n) | The wheelchair restraint arm does not secure the chair from moving | _____ | _____ | _____ |
| (o) | Lack of curb cuts | _____ | _____ | _____ |
| (p) | Lack of bus shelters | _____ | _____ | _____ |
| (q) | Difficulty getting schedules | _____ | _____ | _____ |
| (r) | The length of time needed to get on or off a bus using a lift | _____ | _____ | _____ |
| (s) | Other passengers being delayed while I use the lift | _____ | _____ | _____ |

27. In the same way, how important would you rate the following types of improvements: very important; moderately important; not very important?

| | Very Important | Moderately Important | Not Very Important |
|---|---|---|---|
| (a) A better designed lift | _____ | _____ | _____ |
| (b) All buses on accessible routes should have lifts | _____ | _____ | _____ |
| (c) All Bi-State routes should be accessible | _____ | _____ | _____ |
| (d) Drivers should help more | _____ | _____ | _____ |
| (e) Door-to-door service instead of accessible buses | _____ | _____ | _____ |
| (f) Door-to-door service in addition to accessible buses | _____ | _____ | _____ |
| (g) A better designed interior on the lift buses | _____ | _____ | _____ |
| (h) There should be more curb-cuts and adequate snow removal from sidewalks and roads | _____ | _____ | _____ |
| (i) Better wheelchair positions in the lift buses | _____ | _____ | _____ |
| (j) An escort service when you want to go on the lift buses | _____ | _____ | _____ |
| (k) Less crowding on the lift buses during rush hour | _____ | _____ | _____ |

28. How did you first learn about the lift buses?

1) Radio

2) TV

3) Newspaper/Magazine

4) Bus Demonstration

5) Social agency

6) Word of mouth

7) Saw bus on street

8) Other

29. What do you think could be done to make your riding of the Bi-State buses easier, more convenient, or more pleasent? *(Note: This is an open-ended question about all other problems respondent has with the lift buses or suggestions for better service.)*

*(Here copy down as precisely as possible the respondent's reply.)*

_____

_____

_____

_____

_____

30. What is your: *(Interviewer, ask for <u>both</u> personal and household income)*

*(Note: If respondent lives alone, do not ask household income.)*

| Personal Income | Family's Income |
|---|---|
| 1) Less than $3,999 | 1) Less than $3,999 |
| 2) $4,000 - $5,999 | 2) $4,000 - $5,999 |
| 3) $6,000 - $7,999 | 3) $6,000 - $7,999 |
| 4) $8,000 - $9,999 | 4) $8,000 - $9,999 |
| 5) $10,000 - $14,999 | 5) $10,000 - $14,999 |
| 6) $15,000 - $19,999 | 6) $15,000 - $19,999 |
| 7) Less than $20,000 | 7) Less than $20,000 |
| 8) No response | 8) No response |

31. What's the source of your personal income?_____

_____

_____

That almost completes my survey. The final part of my survey is to ask you to record your trip-making. This would be something you would do yourself over the course of the next three weeks. It will only take a few minutes of your time each day and will be extremely valuable to our planning efforts. Let me show you how easy it is to do. (*Here pull out the travel diary and show it to the respondent. Explain, in your own words, that the diary has only four sections and that normally only two would have to be filled out. Give the respondent a set of instructions "for his reference" and explain each column to him slowly and carefully, a section at a time. After you have explained it to him, tell him you will come by and pick the completed diary up in three weeks. Ask the respondent if he has any questions, thank him and end the survey.*)

*This space is for your comments on the interview. How well did it go? How reliable do you think the respondent's answers are? If not reliable, why not? Was there any special circumstances surrounding this interview (i.e. was a translator needed, was the respondent particularly annoyed during the interview, etc.?)*_____

# APPENDIX I

## NON-USER SURVEY

BI STATE

Dear Friend,

Are you aware that the Bi-State Development Agency now operates wheelchair accessible buses on 17 of our lines? Most vehicles on these 17 lines are equipped with hydraulic lifts which allow someone in a wheelchair to board and exit easily. We are hoping that this first-in-the-nation service will help people who use wheelchairs to get about easily, quickly, and safely.

To evaluate this service, Bi-State is trying to get in touch with handicapped people. If you use a wheelchair and have ridden on the lift buses at least once, we would like to interview you about your reactions to this service. Would you please call Deborah K. Phillips of my staff at 771-1414, extension 300 to set up an appointment or write her at the address which appears below.

If you use a wheelchair, but have never ridden on the lift buses, we would like to ask you to fill out the attached confidential survey and return it in the enclosed return envelope. If you do not use a wheelchair at all, you need not bother to complete the attached survey.

Thank you for your help and cooperation.

Sincerely,

Janis S. Grossman
Research Administrator

JSG:js
Attachment

Bi-State Development Agency
3869 Park Avenue/St. Louis, Missouri 63110/314-771-1414

BI-STATE DEVELOPMENT AGENCY

SURVEY OF WHEELCHAIR USERS

*Instructions: Please circle your response to each of the questions below or, where appropriate, write out your answer in the space provided.*

1) How long have you required the use of a wheelchair?

1) Less than one year

2) Between one year and three years

3) Between three and five years

4) Over five years

NOTE: THIS SURVEY IS ONLY FOR PEOPLE WHO USE A WHEELCHAIR AT LEAST SOME OF THE TIME. IF YOU NEVER USE A WHEELCHAIR WHEN YOU GO OUT OF YOUR HOME, PLEASE DO NOT COMPLETE THE REST OF THIS SURVEY.

2) How much use of your arms do you have?

1) Full use and strong enough to independently wheel about;

2) Full use, but not strong enough to wheel myself about;

3) Limited use;

4) No use

3) Are you in good general health?

1) Yes 2) No

4) Circle the characteristics which best describe the type of wheelchair you use most often when outdoors.

A. Are the tires...

1) pneumatic (air filled), or 2) hard rubber

B. Is the smaller set of wheels...

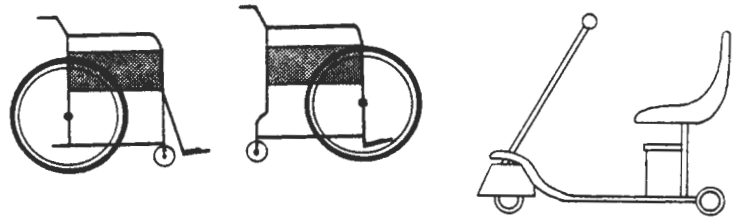
1) 5 inches in diameter

2) 8 inches in diameter

3) Other

C. Which picture best describes the wheel placement and construction of your chair?

1) A 2) B 3) C



D. Is the chair powered...

1) manually, or 2) electrically

E. Do you have a footrest extension on the chair?

1) Yes 2) No

F. Do you have a head rest extension or reclining back on your chair?

1) Yes 2) No

5) How often do you go outside your home without taking someone along to assist you, i.e. how often do you travel independently?

1) Always 2) Sometimes 3) Never

6) When you go out, independently, how far can you wheel by yourself?

A. In good weather?

1) No distance
2) Less than one block
3) One block
4) Two blocks
5) Three or four blocks
6) Five blocks or more

B. In rainy or cold weather?

1) No distance
2) Less than one block
3) One block
4) Two blocks
5) Three or four blocks
6) Five blocks or more

C. With three inches of snow on the ground?

1) No distance
2) Less than one block
3) One block
4) Two blocks
5) Three or four blocks
6) Five blocks or more

7) What type of housing do you live in?

1) Private residence (house or apartment)
2) Special housing for the handicapped
3) Nursing home or other type of institution *(Specify if other)*_____

_____

8) Which category best describes you?

1) Full-time worker
2) Unemployed, looking for full-time work
3) Part-time worker
4) Full-time rehabilitation
5) Sheltered employment
6) Student
7) Homemaker
8) Retired
9) Unable to work

9) Are you licensed and able to drive a car?

1) Yes 2) No

10) Do you own a car?

1) Yes 2) No

11) If you do not own a car, how often is an auto available for you to be driven in? (Skip this question if you answered "yes" to question 10.)

1) Always
2) Usually
3) Sometimes
4) Never

12) How often do you get a ride somewhere by calling a social service agency such as the Red Cross, OATS, or the Mayor's Office for Senior Citizens?

1) Very often 2) Occasionally 3) Never

13) If you answered "Very often" or occasionally to the previous question, which agency service(s) do you usually call?_____

_____

_____

14) Can you afford taxis when you need them?

1) Yes 2) No

15) How many times did you take a taxi in the last month?

1) Never
2) Once
3) Two or three times
4) Four to ten times
5) Over ten times

16) How easy is it for you to transfer out of your chair and to get into a taxi vehicle?

1) Very easy
2) Moderately easy
3) Difficult
4) Impossible

17) How helpful and courteous do you generally find taxi drivers to be?

1) Very helpful and courteous
2) Moderately helpful and courteous
3) Not very helpful or courteous

18) Which accessible Bi-State bus route(s) run near your home? _____

_____

_____

19) How far is it from your home to the nearest bus stop on an accessible route?

1) Right in front of my home
2) Less than a block
3) One block
4) Two blocks
5) Three blocks
6) Four or five blocks
7) Six or more blocks
8) Not sure - don't know

20) Do you ever use a private transportation service, such as Care-Cab, to get around?

1) Yes 2) No

21) *Please rate the following reasons for NOT using the accessible buses according to their importance to you. Circle from 1 to 5 based on how important the reason is:*

| REASONS FOR NOT USING ACCESSIBLE BUSES | NOT IMPORTANT 1 | 2 | 3 | 4 | VERY IMPORTANT 5 |
|---|---|---|---|---|---|
| a) Accessible routes don't go near my home | 1 | 2 | 3 | 4 | 5 |
| b) Accessible routes go near my home but don't go near my destination. | 1 | 2 | 3 | 4 | 5 |
| c) It is too difficult for me to travel on sidewalks or roads to reach the bus stop. | 1 | 2 | 3 | 4 | 5 |
| d) I cannot go out at all without help. | 1 | 2 | 3 | 4 | 5 |
| e) I can't get on the bus lifts very easily. | 1 | 2 | 3 | 4 | 5 |
| f) I don't feel safe on the lifts or on the buses. | 1 | 2 | 3 | 4 | 5 |
| g) Buses are too crowded when I want to use them. | 1 | 2 | 3 | 4 | 5 |
| h) I don't like going out in public. | 1 | 2 | 3 | 4 | 5 |
| i) The lifts are unreliable and sometimes don't work. | 1 | 2 | 3 | 4 | 5 |
| j) The buses are unreliable and don't keep to the published schedule. | 1 | 2 | 3 | 4 | 5 |
| k) I have trouble obtaining the schedule of accessible buses. | 1 | 2 | 3 | 4 | 5 |
| l) Lack of curb-cuts near my home or destination. | 1 | 2 | 3 | 4 | 5 |
| m) Bad weather such as rain, snow or cold. | 1 | 2 | 3 | 4 | 5 |
| n) Cars parked in the bus stop prevent me from reaching the bus. | 1 | 2 | 3 | 4 | 5 |
| o) I am afraid to try the buses because I have heard bad things about them. | 1 | 2 | 3 | 4 | 5 |
| p) Bus transportation takes too long or is too inconvenient compared to a car. | 1 | 2 | 3 | 4 | 5 |
| q) I don't need accessible buses. I have other transportation available. | 1 | 2 | 3 | 4 | 5 |

22) How did you first learn about the lift buses?

1) Radio
2) TV
3) Newspaper/Magazine
4) Bus Demonstration
5) Social Agency
6) Word of mouth
7) Saw bus on street
8) Other *(Specify)*_____

23) Are there any specific Bi-State bus routes which are not now accessible but which you would ride if they were accessible? If so, please list here.

1._____

2._____

3._____

24) *Please rate the following suggested improvements to the Bi-State service according to their importance to you. Circle from 1 to 5 based on how important you feel the improvement would be.*

| SUGGESTED IMPROVEMENTS | LEAST IMPORTANT 1 | 2 | 3 | 4 | MOST IMPORTANT 5 |
|---|---|---|---|---|---|
| a) The lift on the buses should be better designed. | 1 | 2 | 3 | 4 | 5 |
| b) Every vehicle on the 17 accessible bus lines should have a lift. | 1 | 2 | 3 | 4 | 5 |
| c) Every vehicle in the Bi-State fleet should have a lift and all routes should be accessible. | 1 | 2 | 3 | 4 | 5 |
| d) There should be more bus shelters. | 1 | 2 | 3 | 4 | 5 |
| e) Bus drivers should help more. | 1 | 2 | 3 | 4 | 5 |
| f) Dial-A-Ride (door-to-door service) should be available instead of lift-equipped buses. | 1 | 2 | 3 | 4 | 5 |
| g) Dial-A-Ride should be available in addition to lift-equipped buses. | 1 | 2 | 3 | 4 | 5 |
| h) The interior of the lift buses should be designed better. | 1 | 2 | 3 | 4 | 5 |
| i) All sidewalks should have adequate curb-cuts. | 1 | 2 | 3 | 4 | 5 |
| j) There should be adequate snow removal during winter so that I can reach the bus stops. | 1 | 2 | 3 | 4 | 5 |
| k) There should be an escort service for when I want to use the lift buses. | 1 | 2 | 3 | 4 | 5 |
| l) There should be less crowding on the lift buses. | 1 | 2 | 3 | 4 | 5 |

DEMOGRAPHIC DATA: THE FOLLOWING QUESTIONS WILL ONLY BE USED TO ESTABLISH AVERAGE DATA ABOUT THE RESPONDENTS - NO INDIVIDUAL ANSWERS WILL BE TABULATED.

25) What is your age?

1) Less than 16
2) 16-19 years
3) 20-29 years
4) 30-39 years
5) 40-49 years
6) 50-59 years
7) 60-64 years
8) 65-74 years
9) 75 or older

26) What sex are you?

1) Male
2) Female

27) What is your personal income and your total household income if you live with other members of your family?

Personal Income (Per Year)

1) Less than $3,999
2) $4,000 - $5,999
3) $6,000 - $7,999
4) $8,000 - $9,999
5) $10,000 - $14,999
6) $15,000 - $19,999
7) More than $20,000
8) No response

Household Income (Per Year)

1) Less than $3,999
2) $4,000 - $5,999
3) $6,000 - $7,999
4) $8,000 - $9,999
5) $10,000 - $14,999
6) $15,000 - $19,999
7) More than $20,000
8) No response

28) What is the source of your personal income?_____

_____

*Thank you for your cooperation! Please return this survey to us in the enclosed envelope or, if the envelope has been lost, mail it to:*

JANIS GROSSMAN
BI-STATE DEVELOPMENT AGENCY
3869 Park Avenue
St. Louis, MO 63110

APPENDIX J

WHEELCHAIR USERS

FOLLOW-UP SURVEY

APPENDIX J

BSDA WHEELCHAIR USERS

FOLLOW-UP SURVEY

INTERVIEWER'S NAME: _____

DATE: _____ I.D. NUMBER _____

RESPONDENT'S NAME: _____

ADDRESS: _____

TELEPHONE NUMBER: _____

INSTITUTIONALIZED? _____Yes _____No SEX _____

1. The first question asks the respondent several factual questions about their use of lift buses since the project began in August of 1977.

   (a.) "HOW MANY DIFFERENT TIMES HAVE YOU RIDDEN A LIFT BUS?" (help respondent estimate.) _____

   (b.) "WHEN WAS THE LAST TIME THAT YOU RODE ON A LIFT BUS?" (If unsure, try to get the latest month in which respondent used a lift bus.) _____

   (c.) "DO YOU STILL CONSIDER YOURSELF A RIDER OF THE LIFT BUSES IN SOME SENSE, INTENDING TO USE THEM AT LEAST OCCASIONALLY?" (How often does respondent intend to ride in the future?) _____

(d.) "DID YOU EVER TRY TO USE THE LIFT BUSES ON A REGULAR BASIS IN THE PAST?"_____

_____

_____

_____

(e.) "DO YOU NOW LIVE CLOSE ENOUGH TO AN ACCESSIBLE BUS ROUTE THAT YOU COULD USE IT IF YOU WANTED TO?"

_____Yes _____No _____Don't Know

If Yes,_____route/line

_____nearest stop
(give street intersections)

(f.) WHAT TYPE OF TRIPS DID YOU MAKE ON THE LIFT BUSES? (i.e., work, shop, etc.)_____

_____

_____

_____

2. This question asks the respondent about their perceptions of the lift bus service as it is today, i.e., currently.

(a.) "HOW MANY ROUTES/LINES ARE NOW ACCESSIBLE"? _____

_____

_____

_____

_____

(b.) "HOW MANY LIFT BUSES DO YOU THINK BSDA IS NOW OPERATING EVERY DAY?" (Get respondent to give an actual number.)

_____

_____

_____

(c.) "HOW RELIABLE DO YOU THINK THE SERVICE & LIFTS ARE TODAY?"

_____

_____

_____

(d.) "HOW MUCH DO YOU TRUST THE DRIVERS TO WORK THE LIFTS PROPERLY?"_____

_____

_____

_____

(e.) "ARE THERE ANY PLACES YOU GO TO REGULARLY WHICH YOU COULD GET TO ON AN ACCESSIBLE ROUTE(S), IF YOU WANTED TO?" (If yes, list places)_____

_____

_____

_____

3. The third question asks the respondent to discuss why they didn't use the lift buses at all, or why they didn't use them more often. Get the respondent to discuss each of the following questions.

(a.) "WHY DON'T YOU USE THE LIFT BUSES MORE OFTEN?" (In respondent's own words.)_____

_____

_____

_____

(b.) "HAS WINTER WEATHER EFFECTED YOUR USE OF LIFT BUSES?" (Probe reasons why or why not.)_____

_____

_____

_____

(c.) "IS IT DIFFICULT FOR YOU TO REACH A BUS STOP ON AN ACCESSIBLE ROUTE?" (Probe reasons why or why not.)_____

_____

_____

_____

(d.) "WAS IT EASY TO USE THE LIFT WHEN IT WORKED PROPERLY?"

_____

_____

_____

(e.) "WERE YOU AFRAID THAT ONE OF THE LIFTS WOULDN'T WORK IF YOU TRIED TO USE IT? (Get respondent's feelings about this. Is this why respondent doesn't use lift buses?)

(f.) "ARE YOU INCONVENIENCED OR OTHERWISE AFFECTED BY THE FACT THAT NOT EVERY BUS ON AN "ACCESSIBLE ROUTE" IS SCHEDULED TO HAVE A LIFT?"

4. "THE BSDA LIFT EQUIPPED BUSES HAVE BEEN USED BY VERY FEW HANDICAPPED PERSONS. WHAT IS YOUR OPINION ON WHY THE HANDICAPPED HAVEN'T USED THESE BUSES MORE OFTEN?" (Make sure respondent says why other handicapped don't use the buses.)

5. "WHAT IMPACT HAVE LIFT BUSES HAD ON YOUR LIFE?" (Get respondent to be specific. Discuss job, school, residence, family, car, health, etc.)

6. "HOW DO YOU USUALLY GET AROUND?" (Exclude lift buses. Be specific on how respondent gets around.)

7. "NOW, I WANT YOU TO IMAGINE THAT ALL BSDA BUSES WERE LIFT-EQUIPPED: AND THEY ALL WORKED PROPERLY."

   (a.) "WHAT DIFFERENCE WOULD THIS MAKE TO YOU? WOULD YOU USE THE BUSES VERY MUCH?"_____

   _____

   _____

   (b.) "HOW DO YOU THINK OTHER HANDICAPPED PERSONS (EXCLUDING YOURSELF) WOULD REACT? WOULD THEY USE THE BUSES?" (Probe reasons why or why not. Does respondent have ideas on how many would use them?)_____

   _____

   _____

   _____

   (c.) "IF YOU ANSWERED THAT YOU WOULDN'T USE BSDA BUSES EVEN ALL OF THEM WERE LIFT-EQUIPPED, WHAT ELSE WOULD IT TAKE TO GET YOU TO USE TRANSIT?"_____

   _____

   _____

   _____

8. USE THIS SPACE TO GET ANY OTHER COMMENTS FROM THE RESPONDENT ON WHY THEY DON'T USE THE BUSES MORE._____

_____

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# APPENDIX K

# USER COMMENTS PHASE III

USER COMMENTS - PHASE III

Because of the open-ended nature of the follow-up survey in Phase III, many of the users had an opportunity to make generalized comments on the entire BSDA lift bus service. Because many of these comments give a realistic expression of the user's feelings, a selection of them are quoted verbatim as they appeared in the survey. The comments may not always be accurate, but they do reflect how the user's perceived the service.*

1) Lift/Service Reliability: Many of the comments reflected the lift unreliability and subsequent problems.

> "I am not sure about the service but the lifts are definitely not working or reliable."
>
> "I was disappointed so many times and left stranded, I just lost faith."
>
> "Service is pretty good but you can't trust yourself on lifts."
>
> "Became so frustrated after being stuck without a means to get home, just gave up."
>
> "It was pure aggravation when on many times that I tried to ride, and just couldn't get on."
>
> "On another occasion, the lift started to drift or go back to steps and if a lady hadn't caught (me), I would have flopped over backwards."
>
> "Too many bad rumors of getting left."
>
> "Having been denied so many entries, I have given up for awhile."
>
> "I would rate service very poor. This does not mean concept is poor, but just technology of lift is poor."
>
> "A lot of bad stories (about lifts) which is circulated very fast through the handicapped community."

---

*Misspellings or bad grammar are from the user's comments.

"Very lousy."

"Absolutely unworkable and undependable because of the poor quality of the lift and the drivers' attitudes."

"I think they are pretty poor."

2) Drivers: No aspect of the service created such passions or such divergent attitudes as the drivers. As the comments below show, many of the users had very negative opinions of the drivers, whereas some had very positive opinions.

"Attitude of drivers lately has been very bad. They make you feel as if they are doing you a big favor."

"You don't (trust the driver); depends on his own knowledge about the lift and the wheelchair."

"(Trust drivers) Not at all! Drivers tended to want to let lift down on the street, instead of on curb. Individuals operating lifts are not knowledgeable about wheelchair persons nor the lifts they are trying to operate."

"I felt the drivers were courteous, helpful, well trained; I had complete faith (in them)."

"Drivers have gone out of their way to be nice."

"Trusted drivers more than I trusted lifts."

"Our experiences (with drivers) have been very good, when able to entry."

"(Trusts the drivers) About as much as I trust Idi Amin - Not at all!"

"Drivers attitudes were humiliating."

"I trust them (the drivers) pretty much; only a few of them just honestly stated that they didn't know how."

"Drivers even told me to get on, on my own risk, as if he would rather I wouldn't even attempt to try and get on."

"Operators were very grumpy at times and made it appear that I was making them late on their schedule or just that they didn't want to be bothered. It appeared that these operators should have received more training because this is an important facet of this program, to make handicapped persons feel wanted."

3) Winter Weather: Several users made varying comments about how winter weather affected them.

> "It is impossible for me to wheel myself whenever there is ice or snow on the ground. Rain is also dangerous for me."
>
> "In snow, its very difficult to maneuver a wheelchair even when someone is pushing."
>
> "I have the ability to move in any weather."
>
> "I am very susceptible to colds, and just couldn't take the chance of being stuck out (in bad weather)."

4) Vehicle Design: Several users made comments about the lift design and about the interior design of the vehicle and how it was to use the vehicle.

> "Should have deeper (lift) depth for motorized chair."
>
> "The overall concept was genuinely a great idea."
>
> "Yes, (it was easy to use the lift), except for the lip of the lift."
>
> "Concerned that it would be too crowded that I would be taking someone's seat."
>
> "Hate idea of asking other people to move, even though it is a wheelchair station."
>
> "(Dislikes) rolling over people's feet and getting through crowds."
>
> "(Feels) embarassment in rolling over people's feet."
>
> "Unit design to hold chairs are very insecure."
>
> "Retaining arms were filthy."

5) Long Waits/Travels: Several users commented on the problem of long waits or travel times.

> "Sitting or waiting for an hour or so is certainly a discouraging factor."
>
> "I missed the meeting because bus took 2 hours to go 3 1/2 blocks."

6) Pros/Cons of Accessible Fixed Route Service: Several users commented on the general philosophy of accessible fixed route service.

> "Felt that if the (accessible) route were not directly to the point of exit, its really of no service. Having the ability to transfer is just no good for wheelchair persons."
>
> "Very rare occasions when I find bus where I want it to be and going where I want it to go."
>
> "A totally accessible system made need to be supplemented by a door-to-door system which can connect with the fixed route system for those who cannot travel to and from bus routes independently."
>
> "UMTA's own studies show that an accessible fixed route system is the only way to go."

7) Attitudes: Many comments were made about the attitudes of handicapped people in using the buses, particularly in being afraid of the lifts:

> "Most handicapped people are also just afraid to try unsure; untried or anything new."
>
> "I'm scared of all lifts."
>
> "...it's not something all handicapped would be willing to try at first."

"They are just afraid of lifts period especially if they are heavy people."

"(Other handicapped) feel that other passengers don't like them, or consider them (wheelchairs) a delay."

"Fear of being looked on as some sort of freak."

"I've come very close to being injured."

8) Impacts: Many users commented about the impact or lack thereof which the lift buses had on them.

"My first impression was one of delight, because I felt I could truly become independent."

"And then it became distressingly apparent that all my hopes to become totally independent were gone again; because I messed up rides, medical appointments, missed social appointments, etc."

(An institutionalized person's foster grandparent, speaking about their lift bus experience.)
"It was just like a new world. He likes meeting new people. It was (a) wonderful feeling for me also, that I could show him new things and new places...I just can't express the effect of his not being able to go (they stopped traveling because of the unreliability)."

"(Lift bus had) quite a bit (of impact)...In opening the eyes (of) the general public-attitudes have been changed. The buses certainly had a lot to do with getting curb cuts."

"New concept for disabled community--wil be slow in being used..."

"Gave me an extra feeling of security. Wasn't totally dependent on my car or friends."

"I appreciated equipment when it was functioning properly, but having fell off I was in hospital for three weeks (ruptured spine).

"This is a violation of my civil rights as this program receives federal monies, the services and benefits of which are neither equally accessible to me, nor do they function equally effectively for me, as they do for persons without disabilities."

"A better rumor will have to come out to make handicapped persons...feel that they won't get stranded..."

"So, it really was a disappointment."

"I went (on the buses) because of the cost it took to get this kind of equipment."

"Taught more patience--fast pace but wheelchair persons are having to move into fast pace."

"Expensive to become independent."

"Not enough nerve--hesitant to ask for help."

"Most (wheelchair) persons are in nursing homes and (have) little or no confidence."

9) Call-ins: One user commented on the informal system which sprang up of calling BSDA before riding to make sure an accessible bus would show up.

"Having to call (BSDA) to see if bus is working is not "regular" service."

10) Percent Accessibility: Comments varied on how inconvenient it was for not every bus on an accessible route to be a lift bus. One user made this comment:

"Yes, definitely (inconvenienced). If he were to miss one bus, he would not be able to wait 2-3 hours for next bus. In scheduling lifts--it would be better to have service following each other rather than spaced out; primarily (because) if one doesn't work, you wouldn't have to wait 2-3 hours."

# APPENDIX L

# REPORT OF INVENTORIES

## REPORT OF INVENTIONS

The work performed by Applied Resource Integration Ltd. (ARI) in conducting the evaluation reported herein under contract DOT-TSC-1248 will not result in any new patentable invention by ARI subject to the terms, conditions and limitation of the aforementioned contract. No such claim is implied or made by ARI with respect to the Bi-State Development Agency and manufacturers of equipment discussed in this report.

The findings in this document will be useful in providing valuable insights for other transit properties interested in performing an evaluation of or in operating accessible transit buses in fixed route operations.

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