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Automated Guideway Transit Technology Overview

August 1978

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16. Abstract

Automated Guideway Transit (AGT) systems offer the promise of meeting many of our present and future urban transportation needs and providing convenient and dependable service. However, many technological problems must be resolved before an AGT system can become a major transit operation. To address these problems, the Federal government established the AGT Technology (AGTT) Program. The AGTT program includes many projects aimed at specific problem areas. These include: Systems Operation Studies, Systems Safety and Passenger Security Studies, Vehicle Longitudinal Control and Reliability Studies, Vehicle Lateral Control and Switching Studies, and Guideway and Station Technology Studies. This overview describes the AGTT projects and parallel programs.

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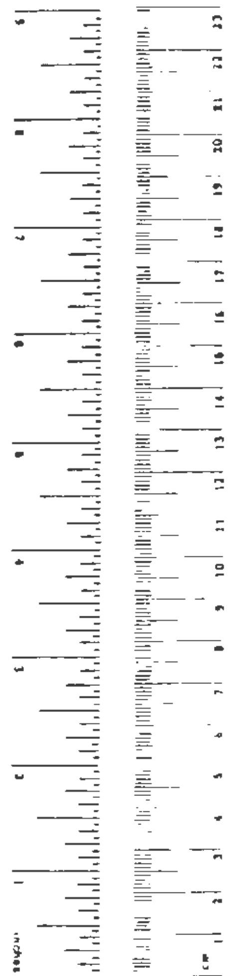
METRIC CONVERSION FACTORS

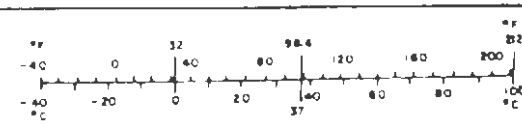
Approximate Conversions to Metric Measures

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



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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1.0 BACKGROUND AND DEFINITIONS

During the past few years there has been a renewed interest in the use of fully automated transit systems as a solution to many present and anticipated transportation problems in our urban areas. Automated systems offer the promise of convenient, dependable service and could replace or complement present urban transportation systems. Various types of Automated Guideway Transit (AGT) systems have been proposed to supplement services provided by present systems. However, many technological problems such as network operation, vehicle control, safety, reliability, and maintainability must be resolved before major operations can be started. To address these problems, the Federal government has established the Automated Guideway Transit Technology (AGTT) Program.

The AGTT program is designed to investigate critical problems related to the technology, cost, service, safety, and other operational aspects of various AGT system types. Service and performance characteristics, specifications, and guidelines will be developed during the course of this program for use by system planners, designers, and Federal and local government agencies.

With the development of computer and automation technology, new public transportation systems concepts have come into being. The AGTT program is directed toward the development of the operational technologies needed to provide the foundation for successful deployment of AGT systems in urban environments.

1.1 AGT System Definitions

Automated guideway transit systems are types of urban transportation systems and concepts that use automatically controlled, driverless vehicles on fixed, dedicated guideways. The capacity of a vehicle can be from one up to 100 passengers and the vehicles move at speeds of 25 to 100 kilometers per hour.

The technology, without reference to any particular system, is referred to as AGT Technology (AGTT). On the basis of studies of AGT, several categories of new automated transportation systems have become generally accepted.

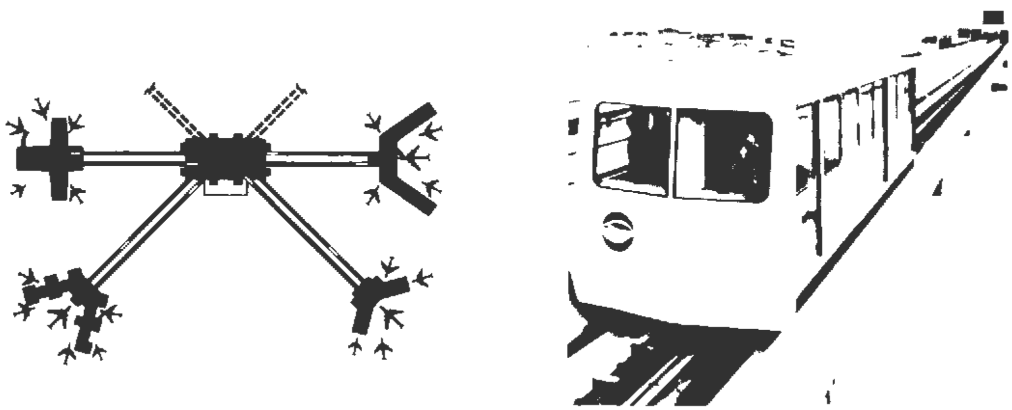
Three classes of service provide a structure for the study of AGTT:

- Shuttle-Loop Transit (SLT),
- Group Rapid Transit (GRT), and
- Personal Rapid Transit.

A brief description of the AGT classes is given below:

a. Shuttle-Loop Transit (SLT) - a class of AGTs that use larger vehicles (carrying mostly standees), which operate in scheduled service on relatively short lengths of dedicated guideway in activity centers, normally without switching. The shuttles accommodate a single vehicle within the dedicated lane. Headways are generally in excess of one minute in loops.

   The Tampa International Airport is an example of SLT (Figure 1). The terminal central building is connected to four satellites by 305 meter elevated guideways, each containing two passenger vehicles on separate tracks and a walkway for emergency use. The average trip time, counting waiting time and riding, is 1¼ minutes.



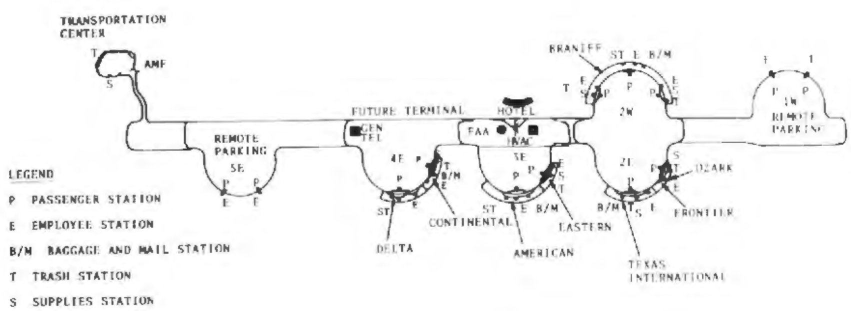
(a) AGT System Network

(b) AGT System Vehicle on Guideway

FIGURE 1
TAMPA AIRPORT SLT SYSTEM IN TAMPA, FLORIDA

b. <u>Group Rapid Transit (GRT)</u> - systems that use fleets of medium-size vehicles (normally 6 to 50 passengers per vehicle, including standees). These vehicles operate independently or are coupled into trains, which travel automatically on dedicated guideways with on-line and/or off-line stations, and provide either scheduled or limited-stop, origin-to-destination demand-responsive service. When operated on headways of 10 to 60 seconds, lane capacities ranging from 2500 to 25,000 seats per lane per hour are obtained (up to 360 vehicles per lane per hour for 10-car trains).

The Dallas/Ft. Worth Airport GRT (AIRTRANS) is shown in Figure 2. The AIRTRANS system links the numerous, widely separated elements of the airport. There are approximately 21 kilometers of one-way guideway carrying 68 vehicles between 55 station stops. Seventeen distinct service loops provide for passenger, airport employee, baggage, and mail transportation.



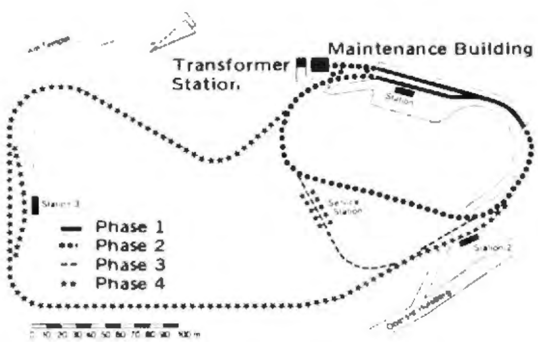
(a) AIRTRANS System Network

(b) AIRTRANS Vehicles on Guideway

FIGURE 2
AIRTRANS GRT SYSTEM IN DALLAS, TEXAS

c. Personal Rapid Transit (PRT) - systems that use fleets of small vehicle, transporting 2-6 seated passengers each, that travel automatically in dedicated guideways with off-line stations to provide nonstop origin-to-destination, demand-responsive service. High capacities of 30,000 or more seats per lane per hour are achieved by operating the vehicles at short headways (0.2 to 3 seconds); that is, up to 18,000 vheicles per hour per lane.

The Cabinentaxi test track at Hagen, West Germany, (Figure 3) is an example of PRT. The small, 3-seat vehicles (no standees) are designed to travel at speeds up to 35 kilometers per hour at headways of one second and less, between off-line stations.



(a) Cabinentaxi System Test Facility Network in Hagen

(b) Cabinentaxi Vehicles on Test Track

FIGURE 3
CABINENTAXI PRT SYSTEM IN HAGEN, WEST GERMANY

1.2 General Requirements of AGT Technology

To successfully introduce a new technology into the urban transportation environment, the general requirement is that the resulting service provide effective competition to any transportation system already available. Subject to this requirement, studies have been conducted on several aspects of new transportation technology. Parameters of the AGT technology studied include:

a. System Size - from small-scale local circulation systems in activity centers, up to metropolitan areawide systems.

b. System Characteristics - from scheduled service with shared vehicles to demand-responsive with exclusive use of vehicles.

c. Degree of Technological Innovation - from improved components and subsystems for existing transit systems to new guideway, station, and vehicle designs; new control concepts; and new system configurations.

Specific performance goals for vehicles and operational conditions for AGT systems are given in Tables I through III. The AGTT program is using these nominal parameters to develop technology that will be applicable to the three classes of AGT systems.

TABLE I
VEHICLE CATEGORIES

Category	Minimum Headway (secs)	Maximum Line Speed (KM/HR)	Energy Utilization $\left(\frac{KW\text{-}HR}{Veh.KM}\right)$	Number of Passengers	Empty Vehicle Weight (Newtons)	Size (Meters)		
						Length	Width	Height
SLT [Nominal]	>60 [90]	25 - 100 [50]	2.0	20 - 120 [30/80]*	45,000 - 135,000 [110,000]	7.5 - 12.0 [11.0]	2.5 - 3.0 [2.75]	3.0 - 3.75 [3.5]
GRT_L [Nominal]	15 - 60 [20]	25 - 100 [65]	1.4	20 - 50 [20/30]*	35,000 - 90,000 [55,000]	4.5 - 7.5 [6.0]	1.8 - 2.2 [2.0]	2.5 - 3.5 [3.0]
GRT_S [Nominal]	3 - 15 [5]	25 - 80 [65]	0.60	6 - 25 [10/15]*	3,000)- 65,000 [45,000]	3.5 - 5.0 [4.3]	1.8 - 2.2 [2.0]	2.4 - 2.8 [2.5]
PRT [Nominal]	<3 [0.5]	30 - 75 [50]	0.15	2 - 6 [4]**	[4,450 - 13,000 [6,500]	2.2 - 3.0 [2.5]	1.2 - 1.8 [1.5]	1.5 - 1.8 [1.8]

*Total Vehicle Capacity, Seated and Standing/Number of Seats

**All Seated

TABLE II
NOMINAL VEHICLE PERFORMANCE GOALS

Category	Maximum Acceleration (g)			Maximum Jerk (g/sec.)			Weight (Newtons/ Passenger)	Capital Cost (Dollars/ Vehicle)[1]
	Longitudinal			Longitudinal				
	Normal	Emergency	Lateral	Normal	Emergency	Lateral		
SLT	.15	.20	.10	.15	-	.05	1,300	125,000[2]
GRT LARGE VEHICLE	.15	.20	.10	.15	-	.05	1,750	100,000[3]
GRT SMALL VEHICLE	.15	.20	.10	.15	-	.05	2,225	80,000[3]
PRT	.15	.30	.10	.20	-	.05	1,550	15,000[4]

[1] 1975 Dollars

[2] Production Run of 20 Vehicles

[3] Production Run of 200 Vehicles

[4] Production Run of 2,000 Vehicles

TABLE III

NOMINAL VEHICLE OPERATIONAL ENVIRONMENT

The vehicle will be capable of satisfying all operational safety, and reliability requirements under the following conditions:

Climate Conditions

Wind:	65 km/h with gusts up to 100 km/h
Rainfall:	5 centimeters per hour
Sleet:	1.25 centimeters per hour
Glaze Accumulation:	0.75 centimeters per hour
Snowfall Accumulation:	25 to 60 centimeters
Temperature Range:	-34C to 48C

Guideway

Grades:	6% maximum
Superelevation:	10% maximum

Electromagnetic Environment

The system will be capable of operating in the electromagnetic environment (airports, radio and television stations, power transmission lines, and power plants) found in large cities.

2.0 STATUS OF AGT TECHNOLOGY

From the over 40 AGT system development projects, varying from conceptual description to full-scale prototype test and evaluation, it is possible to make some general assessments of the progression of AGT technology.

This section provides a brief survey of existing or planned AGT systems and their applications in the United States and abroad.

2.1 Domestic Developments

In the United States emphasis has been placed on the deployment of operating systems; whereas, foreign programs have focused on prototype development and testing. As a result, the domestic program has been characterized by more conservative technological development, particularly with respect to headways and vehicle size reduction aimed at producing hardware for near-term application (such as Transit Expressway, AIRTRANS, and Morgantown systems). AGT system technology has dominated the domestic scene, and several intermediate headway AGT systems have reached the engineering prototype stage.

At present, there are approximately 20 AGT systems in operational service. Ten AGT prototype systems are being used for technology development and testing.

Descriptions of the significant AGT developments in the U.S. are provided in Tables IV and V. Table IV provides vehicle dimensions, weights, capacities, and a description of the major technical approaches that have been adopted in each development. Table V

TABLE IV

TECHNICAL FEATURES OF DOMESTIC AGT SYSTEMS

System	Manufacturer	Vehicle Dimensions Length (M)	Width (M)	Height (M)	Empty Weight (Newtons)	Number of Seats	Number of Standees	Total Vehicle Capacity	Crush Load	Suspension Type	Steering Type	Switching Type	Propulsion Type	Vehicle Control	Network Control
AIRTRANS	LTV	5.50	2.14	3.05	62,270	16	25	40	60	RTCC, SPDR	RGW, [illegible]	SA, [illegible]	DCIM	[illegible]	ASY
Aerial Transit System	Pullman Standard	3.66	1.68	1.59	21,350	6	0	6	6	STDR, SPDR	[illegible]	SA, [illegible]	ACTM	[illegible]	[illegible]
Bradley Field	Ford	7.53	2.04	2.65	63,600	10	14	24	40	RIDC, SPDR	RGW, [illegible]	[illegible]	[illegible]	[illegible]	SI
Busch Gardens	Westinghouse	11.06	2.99	3.35	117,880	8	92	100	150	RTK, SPDR	[illegible]	SA, [illegible]	[illegible]	[illegible]	ASY
California Expo	Universal Mobility	4.27	1.83	2.23	10,670	12	0	12	12	RIDS, SPRS	[illegible]	[illegible]	[illegible]	[illegible]	ASY
Carowinds	Universal Mobility	4.27	1.83	2.25	10,670	12	0	12	12	RIDS, SPPR	[illegible]	SA, [illegible]	DCLM	PF, FB	[illegible]
Dashaveyor	Bendix	7.01	2.04	3.29	80,000	12	20	32	50	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Duke University	OTIS-TTD	6.10	3.29	2.99	51,350	12	0	12	12	A	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Fairlane Shopping Center	Ford	7.53	2.04	2.65	64,600	10	14	24	40	RIDR, SPDR	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
HCPRT	Aerospace	3.05	1.52	1.52	8,000	6	0	6	6	RIDC, SPDR	[illegible]	SA, [illegible]	[illegible]	[illegible]	[illegible]
Hershey Park	Universal Mobility	4.27	1.83	2.25	10,670	12	0	12	12	[illegible]	[illegible]	SA, [illegible]	DCIM	PF, FB	ASY
Houston International Airport	Rohr	12.20	1.52	2.29	32,000	6	[illegible]	10	14	RIDC, SPDR	RGW, [illegible]	SA, [illegible]	[illegible]	[illegible]	ASY
PRT	Boeing	4.82	2.05	2.59	39,600	12	0	12	12	RIDC, SPDR	RGW, [illegible]	[illegible]	[illegible]	[illegible]	[illegible]
PRT	OTIS-TTD	5.79	3.05	[illegible]	48,000	12	0	12	12	AC, SPDR	[illegible]	[illegible]	SLIM	Hybrid	Hybrid
PRT	Rohr	5.94	2.23	2.44	43,700	12	0	12	12	MLev	[illegible]	[illegible]	[illegible]	VF	ASY
PRT	Stanray Pacific	3.66	2.21	2.23	19,630	6	[illegible]	10	14	RIDS, SPMR	[illegible]	SA, [illegible]	ACTM, [illegible]	[illegible]	ASY
King's Dominion	Universal Mobility	4.27	1.83	2.23	10,670	12	0	12	12	RIDS, SPMR	RGW, [illegible]	[illegible]	DCIM	[illegible]	ASY
King's Island	Universal Mobility	4.27	1.83	2.25	10,670	12	0	12	12	RIDS, SPMR	[illegible]	[illegible]	DCIM	PF, FB	ASY
Magic Mountain	Universal Mobility	4.27	1.83	2.25	10,670	12	0	12	12	RIDS, SPMR	[illegible]	[illegible]	DCIM	PF, FB	ASY
Miami Airport	Westinghouse	11.06	2.97	3.35	117,880	0	100	100	150	RIDC, SPDR	RGW, SGW	SA, [illegible]	DCIM	[illegible]	ASY
Monocab	Rohr	2.93	1.67	2.34	17,790	6	0	6	8	RIDS, SSMR	RGW, SGW	SA, [illegible]	DCTM	[illegible]	ASY
Morgantown	Boeing	4.72	2.04	2.68	38,250	8	7	15	21	RIDC, SPDR	RGW, [illegible]	[illegible]	DCTM	[illegible]	SI
Pearl Ridge	Rohr	12.19	1.83	2.24	32,000	8	8	16	24	RIDC, SPDR	RGW, [illegible]	SA, [illegible]	DCTM	PF, FB	ASY
PRT	OTIS-TTD	4.36	2.65	2.50	32,000	6	0	6	6	AC, SPDR	RGW, [illegible]	[illegible]	SLIM	Hybrid	Hybrid
Sea-Tac	Westinghouse	11.28	2.83	3.35	113,430	12	90	102	125	RIDC, SPDR	RGW, SGW	SA, [illegible]	[illegible]	PF, FB	ASY
StaRRcar	Alden	1.81	2.04	2.71	33,440	6	[illegible]	10	12	RIDC, SPDR	RGW, SGT	OB, [illegible]	ACIM, [illegible]	PF	SI
Tampa Airport	Westinghouse	11.06	2.81	3.35	95,640	0	100	100	125	RIDC, SPDR	RGW, SGW	SA, [illegible]	DCTM	PF, FB	ASY
Transette	Georgia Tech					4	0	4	15	RIDC, SPDR	RGW, SGW	SA, [illegible]	[illegible]	PF, FB	ASY
Uniflo	Ferguson	5.64	2.16	1.98	9,340	8	0	8	8	AC, SPDR	RGW, SGW	OB, [illegible]	LAN	VF	ASY
Walt Disney	Wedway	2.43	1.46	2.16	4,180	4	0	4	4	RIDS, SPDR	RGW, SGW	SA, [illegible]	SLIM	VF, FB	ASY

Note: See Glossary for meaning of abbreviations.

TABLE V

PERFORMANCE CHARACTERISTICS AND STATUS OF DOMESTIC AGT SYSTEMS

System	Manufacturer	Class	Line Speed (kmph)	Minimum Headway (sec.)	Seats Per Lane Per Hour	Passengers Per Lane Per Hour (crush load)	Status to Date	Station Code - Date
AIRTRANS	LTV	GRT	27	18	3,200	12,000	20.92 lane kilometers, 50 stations, 68 vehicles, 20% at-grade, 80% elevated, grid system with 17 interacting routes	CA-1974
Aerial Transit System	Pullman Standard	PRT	32	8	2,700	2,700	Two full-scale test vehicles on 0.55 kilometer test track	[illegible]P-1972
Bradley Field	Ford	SLT	48	20	1,800	5,400	1.29 lane kilometers, 3 stations, 2 vehicle single path shuttle with bypass	CA-Not yet in service
Busch Gardens	Westinghouse	GRT	48	100	576	10,800	2.25 lane kilometers, 2 stations, 2 vehicles in one train; 60% at-grade, 40% elevated, single Loop	CA-1975
California Expo	Universal Mobility	SLT	19	120	2,880	2,880	2.09 lane kilometers, 2 stations, 12 vehicles in 4 eight-car trains, single path loop	CA-1968
Carowinds	Universal Mobility	SLT	22	132	2,595	2,595	3.21 lane kilometers, 1 station, 12 vehicles in 4 eight-car trains, single path loop	CA-1973
Dashaveyor	Bendix	GRT	80	15	2,800	7,680	Two full-scale prototype vehicles on 0.[illegible] kilometer test track	PD-1972
Duke University	OTIS-TTD	PRT	64	2	21,600	21,600	0.80 lane kilometers, 3 stations, 3 vehicles; 50% at-grade, 50% elevated	CA-Not yet in service
Fairlane Shopping Center	Ford	SLT	48	20	1,800	5,400	0.80 lane kilometers, 2 stations, 2 vehicles	CA-1976
HCPRT	Aerospace	PRT	64	0.25	86,400	86,400	Extensive Technical and Planning Studies 1/10 scale Model demonstrated at 0.5 second headways	RP-1972
Hershey Park	Universal Mobility	SLT	16	75	3,465	3,465	1.29 lane kilometers, 2 stations, 24 vehicles in 4 six-car trains	CA-1969
Houston International Airport	Rohr	SLT	19	60	1,080	2,520	1.93 lane kilometers, 8 stations, 18 vehicles in 6 three-car trains, 100% underground	CA-1972
PRT	Boeing	PRT	64	3	14,000	14,000	System Design Study in progress	DS-1974
PRT	OTIS-TTD	PRT	64	3	14,000	14,000	System Design Study in progress	DS-1974
PRT	Rohr	PRT	64	3	14,000	14,000	System Design Study in progress	DS-1974
PRT	Stanray Pacific	GRT	24	20	1,800	2,520	2.57 lane kilometers, 3 stations, 10 vehicles	CA-1969 No longer in service
King's Dominion	Universal Mobility	SLT	10	210	1,850	1,850	3.38 lane kilometers, 1 station, 54 vehicles in 6 nine-car trains; 5% elevated, 95% at-grade, closed loop	CA-1974
King's Island	Universal Mobility	SLT	10	180	2,160	2,160	3.22 lane kilometers, 1 station, 63 vehicles in 7 nine-car trains	CA-1974
Magic Mountain	Universal Mobility	SLT	13	60	4,320	4,320	1.29 lane kilometers, 3 stations, 36 vehicles in 6 six-car train closed loop	CA-1971
Miami Airport	Westinghouse	GRT	45	85	0	12,600	0.80 lane kilometers, 2 stations, 4 vehicles in 2 two-car train; 100% elevated, shuttle	CA-1977
Monocab	Rohr	PRT	48	5	4,320	4,320	0.30 kilometer test track with 2 prototype vehicles	PD-1972
Morgantown	Boeing	GRT	48	15	1,920	5,040	8.53 lane kilometer, 3 stations, 45 vehicles, linear shuttle, 80% elevated, 20% at-grade	CA-1975
Pearl Ridge	Rohr	SLT	13	240	480	1,440	0.37 lane kilometers, 2 stations, 4 vehicles in 1 four-car train; 100% elevated, linear shuttle	CA-1976
PRT	OTIS-TTD	PRT	72	6	1,600	3,600	0.30 lane kilometers test track with 2 prototype vehicles	PD-1972
Sea-Tac	Westinghouse	GRT	48	100	432	4,500	2.74 lane kilometers, 8 stations, 12 vehicles, 100% underground, 2 loops and a shuttle	CA-1973
StaRRcar	Alden	PRT	45	5	4,320	7,200	Two prototype vehicles on 0.30 kilometer test track	TD-1965
Tampa Airport	Westinghouse	GRT	45	70	0	6,375	2.25 lane kilometer, 8 stations, 8 vehicles, 100% elevated	CA-1971
Transette	Georgia Tech	PRT	24	15	960	960	Full-scale test vehicle on 0.11 kilometer test track	TD-1972
Uniflo	Ferguson	GRT	32-80	3	9,600	9,600	1 lane kilometer, 3 stations, 2 vehicles, closed loop, 100% at-grade	TD-1976
Disney World	Wedway	GRT	22	14	5,140	5,140	1.40 lane kilometer, 1 station, 150 vehicles in 30 five-car trains	CA-1975

Note: See Glossary for meaning of abbreviations.

provides the major performance attributes (speed, headway, passenger carrying capacity) and a brief indication of current development status.

2.2 Foreign Developments

A significant amount of AGT system development activity has occurred outside of the U.S. Foreign activities have concentrated on the development of prototype technology rather than system deployment. Principal foreign developments are summarized in Tables VI and VII.

TABLE VI

TECHNICAL FEATURES OF FOREIGN AGT SYSTEMS

System	Vehicle Dimensions Length (m)	Width (m)	Height (m)	Empty Weight (Newtons)	Number of Seats	Number of Standees	Total Vehicle Capacity	Suspension Type	Steering Type	Switching Type	Propulsion Type	Propulsion Power (kw)	Vehicle Control	Network Control
TRRE CABTRACK UNITED KINGDOM	3.04	1.37	1.68	5,880	4	0	4	RTOC, SPDR	RGW, SGW	OB, CGW	DCTM	15	PF	QSC
TRRE MINITRAM UNITED KINGDOM	-	-	-	-	6	6	12	RTOC**, SWOR, SPDR	-	OB, CGW	DCTM	-	-	-
MBB CABINENTAXI WEST GERMANY	2.29	1.58	1.50	5,880	3	0	3	RTOS**, SSDR, SPDR	RGW, SGW	OB, CGW	DLIM	-	VF	ASY
SIEMENS H-BAHN WEST GERMANY	3.50	2.29	2.50	24,520	8	8	16	RTOS, SSMR	RGW, SGW	OB, CGW	SLIM	-	VF	ASY
KRAUSS-MAFEI TRANSURBAN WEST GERMANY	6.50	2.20	3.20	88,260	14	8	22	AMAC, SPDR	AMAC, SGW	OB, AMAC	SLIM		VF	ASY
ENGINS MATRA ARAMIS FRANCE	2.29	1.32	1.89	6,380	-	0	4	RTOC, SPDR	RGW, SGW	OB, CGW	RSM	16	VF	ASY
ENGINS MATRA VAL FRANCE	25.50	1.93	3.04	22,560	62	63	125	RTOC, SPDR	RGW, SGW	OB, CGW	DCTM	560	VF	ASY
ALSTHOM NEYRPIC TELERAIL FRANCE	2.10	1.40	2.29	8,140	4	4	8	RTOS, SSMR	RGW, CGW	WA, GB	CABLE	-	PF	SLC
CEL URBA FRANCE	9.10	2.00	2.00	35,300	30	0	30	NPAC, SSMR	NPAC	WA, GB	SLIM	-	PF	ASY
GOVERNMENT CVS JAPAN	3.35	1.66	1.85	10,790	4	0	4	RTOC, SPDR	RGW, CGW	OB, CGW	DCTM	12	PF	SLG
KAWASAKI-FUJI KCV JAPAN	6.34	2.40	3.14	44,130	24	26	50	RTOC, SPDR	RGW, SGW	WA, GB	DCTM	100	VF	ASY
MITSUBISHI MAT JAPAN	6.40	2.20	2.90	-	16	16	32	RTOS, SPDR	RGW, CGW	WA, GB	DCTM	-	-	-
TOSHIBA MINI-MONORAIL JAPAN	7.16* 4.50	2.00 -	2.40 -	60,510 33,830	4 8	12 23	16 31	RTOS SPMR	RGW, CGB	WA, GB	DCTM	360	VF	ASY
NIIGATA TEKKO NTS JAPAN	7.50	2.29	3.40	62,270	24	26	50	RTOC, SPDR	RGW, CGB	WA, GB	DCTM	50-70	VF	ASY
HITACHI PARATRAIN JAPAN	15.00	2.20	3.00	106,800	44	36	80	RTOC, SPDR	RGW, CGB	WA, GB	DCTM	55	VF	ASY
NIPPON SHARYO VONA JAPAN	5.30	2.07	3.04	40,010	11	14	25	RTOS, SPDR	RGW, CGB	WA, GB	DCTM	55	VF	ASY
KOBE KRT JAPAN	4.72	2.03	2.67	64,480	10	15	25	RTOC, SPDR	RGW, SWF	OB, GW	DCTM	-	PF	SLG

Note: See Glossary for meaning of abbreviations

*two vehicle types

**Two vehicle configuration

TABLE VII

PERFORMANCE CHARACTERISTICS AND STATUS OF FOREIGN ACT SYSTEMS

System	Classification	Line Speed (km/h)	Minimum Headway (sec.)	Seats Per Lane Per Hour	Passengers Per Lane Per Hour	Status to Date	Status Code and Date
TRRL CABTRACK UNITED KINGDOM	PRT	55	0.9	16,000	16,000	Extensive technical and planning studies performed; one-fifth scale model tested, estimated cost $7 million	RP, 197[illegible]
TRRL MINITRAM UNITED KINGDOM	GRT	48	10	2,160	4,320	Two design studies performed, planning studies for Sheffield and Glasgow completed; contract to be awarded for test and demonstration program; estimated cost $12-16 million	DS, 1974
MBB CABINENTAXI WEST GERMANY	PRT	35	0.5	21,600	21,600	Extensive technical and planning studies performed; five prototype vehicles operating on test track near Hagen; estimated cost $11 million	TD, 1973
SIEMENS H BAHN WEST GERMANY	GRT	35	5.0	4,800	9,600	Full-scale prototype vehicle on test track	TD, 1974
KRAUSS-MAFFEI TRANSURBAN WEST GERMANY	GRT	50	15.0	3,360	5,780	Two full-scale prototype vehicles on 1 KM test track; extensive planning studies for Heidelberg and Toronto; estimated cost $25 million	TD, 1974
ENGINS MATRA ARAMIS FRANCE	PRT	50	0.2	72,000 14,400**	72,000 14,400**	Three full scale prototype vehicles on 1 KM test track; planning studies for Paris and Nice; estimated cost $6 million	TD, 1972
ENGINS MATRA VAL FRANCE	GRT	96	60	3,720	7,500	Full-scale prototype vehicle on test track, ten-lane mile system with eight stations	CA, 1974
ALSTHOM NEYRPIC TELERAIL FRANCE	GRT	35	4.0	3,600	7,200	Full-scale prototype vehicle on test track	TD, 1973
CEL URBA FRANCE	GRT	50	60	1,800	1,800	Two prototype vehicles on test track	RP, 1973
GOVERNMENT CVS JAPAN	PRT	40-60	1.0	14,400	14,600	Sixty full-scale vehicles on 5.73 kilometer test track near Tokyo; estimated project cost $20 million	TD, 1974
KAWASAKI-FUJI KCV JAPAN	GRT	60	75	1,152	2,400	Two full-scale prototype vehicles on 0.5 kilometer test track	TD, 1974
MITSUBISHI MAT JAPAN	GRT	60	90	640	1,280	Full-scale prototype vehicle on test track	TD, 1974
TOSHIBA MINI-MONORAIL JAPAN	GRT	30	120	-	-	Full-scale prototype vehicle on test track	TD, 1974
NIIGATA TEKKO NTS JAPAN	GRT	50	70	3,600	9,000	Full-scale prototype vehicle on test track	TD, 1974
HITACHI PARATRAIN JAPAN	GRT	48	90	1,760	3,200	Full scale prototype vehicle on test track	TD, 1974
NIPPON SHARYO VONA JAPAN	GRT	60	90	440	1,000	Two full-scale prototype vehicles on 0.4 kilometer test track	TD, 1974
KOBE KRT JAPAN	GRT	48	90	2,400	3,200	Test track completed - 0.93 KM length; Operational guideway 3.? KM long; Installed for Ocean Expo of Okinawa in July 1975	TD, CA, 1975

Note: See Glossary for meaning of abbreviations.

3.0 AUTOMATED GUIDEWAY TRANSIT TECHNOLOGY PROGRAM

The Automated Guideway Transit Technology (AGTT) Program was established by the U.S. Department of Transportation to study the operational characteristics of AGT technologies in a variety of applications, and to solve critical technical and operational problems which impede the deployment of AGT systems. Participants in the program are studying system elements that may be used in various urban transportation systems rather than developing a complete AGT system design.

3.1 AGTT Program Objectives

The main purpose of the AGTT program is to provide information to system designers, developers, and planners that will assist in the development and deployment of new automated guideway transit technology systems in various application areas.

Objectives of the AGTT program are:

a. Develop a comprehensive AGT network simulation capability, suitable for a wide range of AGT system concepts and applications;

b. Explore the service and operating costs of AGT systems in various applications;

c. Identify, develop and test the technology required to minimize failures resulting in guideway blockage, and explore manual and automatic methods to expedite stalled vehicle removal while minimizing the number of operating personnel;

d. Study the technology requirements for short headway, small vehicle AGT systems and develop and test the essential subsystems;

e. Generate the technical and operating data required to make decisions concerning future AGT program activities;

f. Reduce the technical and financial risks involved in the development and deployment of automated systems; and

g. Develop a national data base for use by system designers, developers, local planners, and government officials to assist in selecting and evaluating automated systems and in preparing performance specifications.

Figure 4 summarizes the role of the AGTT program and its relationship to other parallel programs and industry activities.

3.2 AGTT Program Management

To accomplish the objectives of the AGTT program, the responsibility for policy, program management, technical direction, and project coordination was assigned to the Urban Mass Transportation Administration (UMTA). The system manager responsibilities for the small projects and the five major projects were divided between UMTA and the Transportation Systems Center (TSC) as shown in Figure 5.

The contractors selected for each project are:

a. Systems Operation Studies - General Motors (GM);

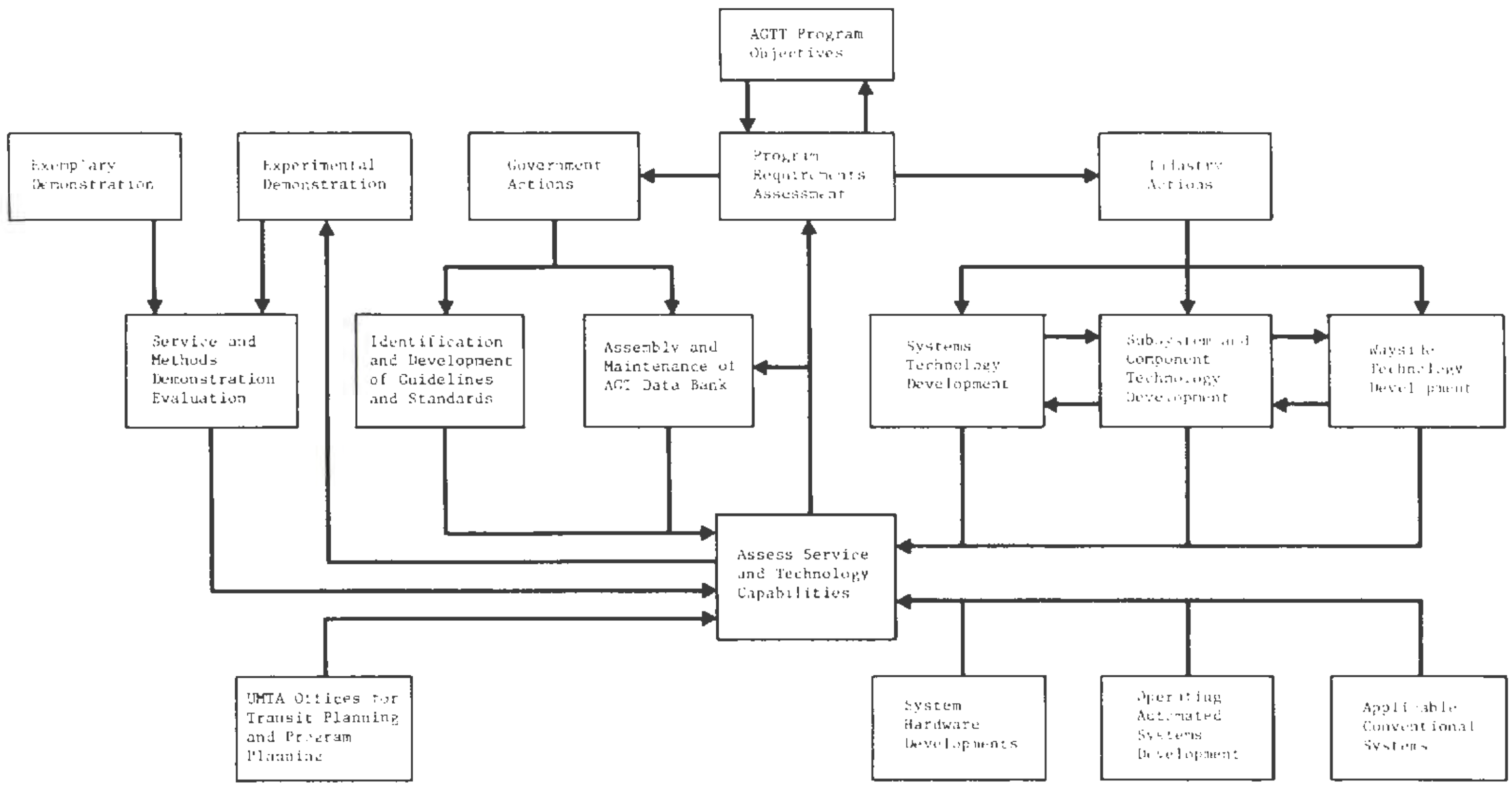
b. System Safety and Passenger Security Studies - Dunlap and Associates;

c. Vehicle Longitudinal Control and Reliability Studies - Otis Elevator Company;

d. Vehicle Lateral Control and Switching Studies - Otis Elevator Company; and

e. Guideway and Station Technology Studies - DeLeuw, Cather and Company.

The management approach will assure that there will be interaction between the project and contract managements, the different contractor managements, and AGTT program components as well as concurrent programs.



Source: "Program Plan, Automated Guideway Transit Technology," UMTA, May 1975.

FIGURE 4
AGTT PROGRAM RELATIONSHIPS TO GOVERNMENT AND INDUSTRY ACTIVITIES

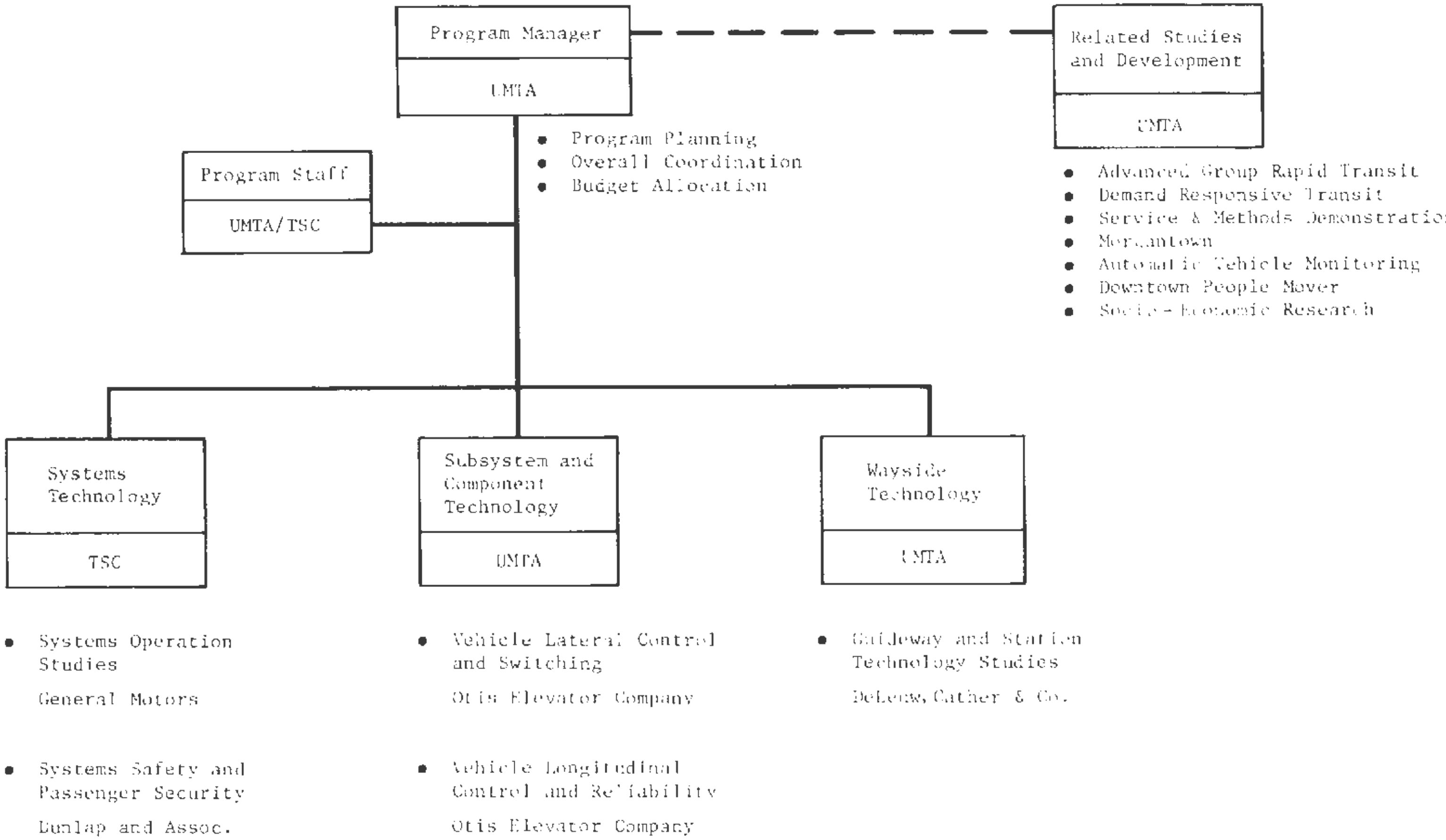


FIGURE 5
AGTT PROGRAM MANAGEMENT ORGANIZATION AND MAJOR PROGRAM ELEMENTS

3.3 Major AGTT Program Projects

The five major projects in the AGTT program are grouped into three subdivisions:

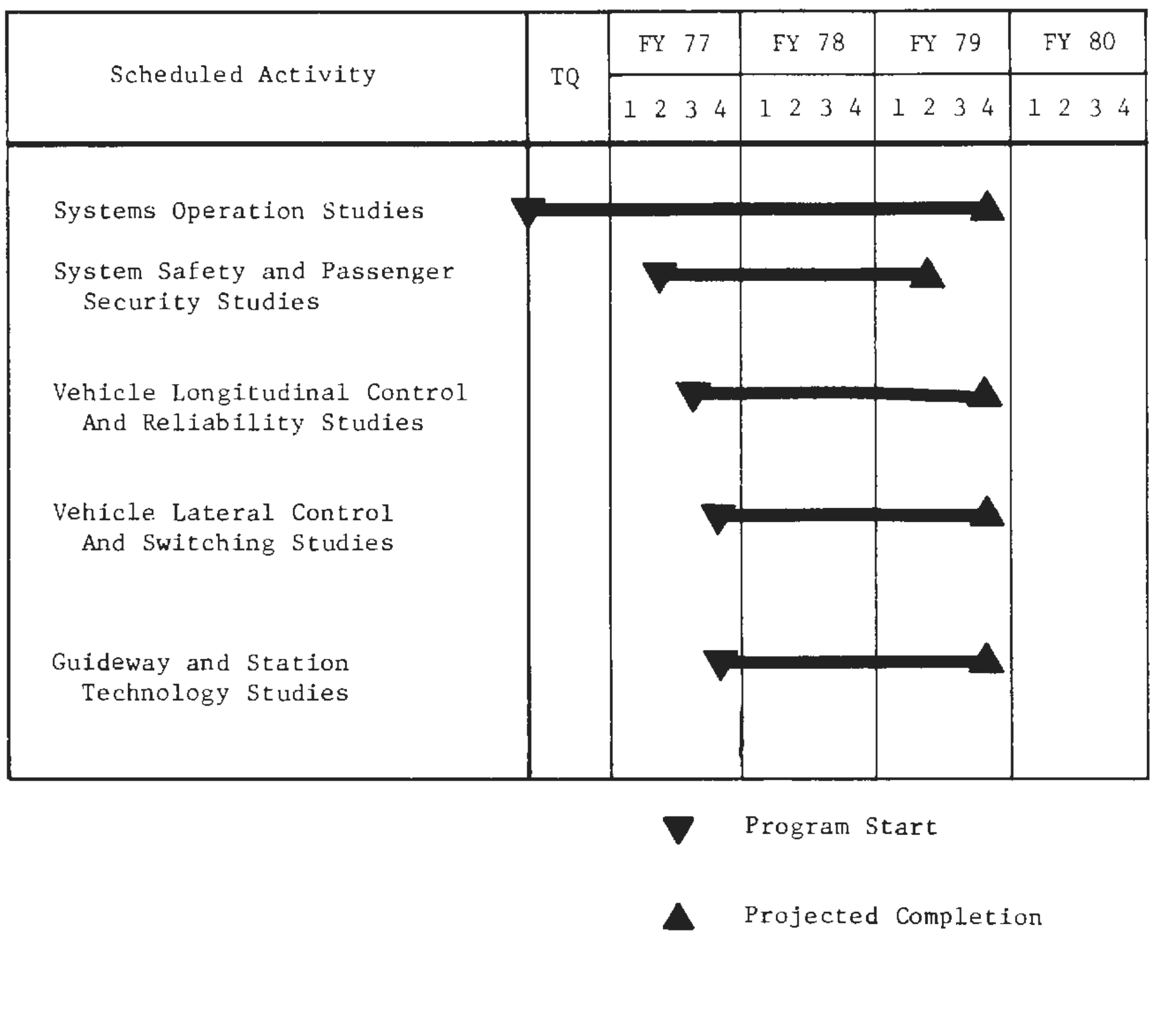
- Systems Technology:
  - Systems Operation Studies
  - Systems Safety and Passenger Security Studies
- Subsystem and Component Technology
  - Vehicle Longitudinal Control and Reliability Studies
  - Vehicle Lateral Control and Switching Studies
- Wayside Technology
  - Guideway and Station Technology Studies

The purpose of these projects is to investigate the technological and operational problems and to provide information to AGT system designers, developers, and planners. A summary schedule of the five major projects is shown in Table VIII.

3.3.1 System Technology

Projects within the Systems Technology subdivision analyze existing data, systems, requirements, and methods used in transit systems. From this effort, the project is to develop guidelines and standards for operation and design of AGT systems. This will permit local urban planners and government officials to evaluate the technical performance characteristics and expected cost elements of proposed AGT systems.

TABLE VIII
AGTT PROGRAM SCHEDULE



3.3.1.1 Systems Operation Studies. The Systems Operation Studies (SOS) project, being performed by GM, is the largest project in the AGTT program. Its broad objectives are (1) to conduct comparative AGT system analyses evaluating the system cost, performance and operating characteristics of a number of generic systems in representative urban network configurations; and (2) to develop and document a set of proven computer models allowing designers and planners to perform analyses of potential AGT systems.

More detailed objectives of the SOS project are:

a. Identify scenarios for differing application areas;

b. Evaluate the service capabilities of each generic class of AGT system in various application areas;

c. Identify costs (capital and operating) for each class of AGT system in various application areas;

d. Evaluate the technical performance of each class of AGT system in various application areas;

e. Identify AGT relevance for differing application areas;

f. Resolve the issues of vehicle control strategies and control management operating policies, and

g. Provide guidelines and trade-off data for use by industry planners, designers, and the U.S. Department of Transportation.

The project has twelve tasks:

a. Systems Definitions - define classes of AGT systems by service type, traveling unit capacity, and maximum vehicle operating speed based on data collected on representative AGT systems.

b. Application Area Definitions - define AGT application areas by using demand models based on actual travel demand information gathered in various surveys of cities located throughout the United States.

c. Analysis Requirements - develop requirements that define the analytical work required for the development and evaluation of the operation characteristics of various AGT systems.

d. Measures of System Effectiveness - develop descriptions of the operational goals, effectiveness measures, and procedures to be used in evaluating alternative AGT systems.

e. System Analysis - perform an analysis of SLT, GRT, and PRT systems in various applications and develop a set of guidelines for AGT system planners and designers.

f. Comparative System Analysis - perform a comparative evaluation of alternative AGT systems in various applications identifying the system types, the planning guidelines, and the evaluations of AGT alternative systems.

g. System Implementation Studies - develop a detailed technical and operational assessment of a staged implementation of a regionwide AGT system.

h. Analysis of Alternative Operational Control Strategies - analyze the alternative methods of operational control strategies including synchronous, quasi-synchronous, asynchronous, and hybrid control.

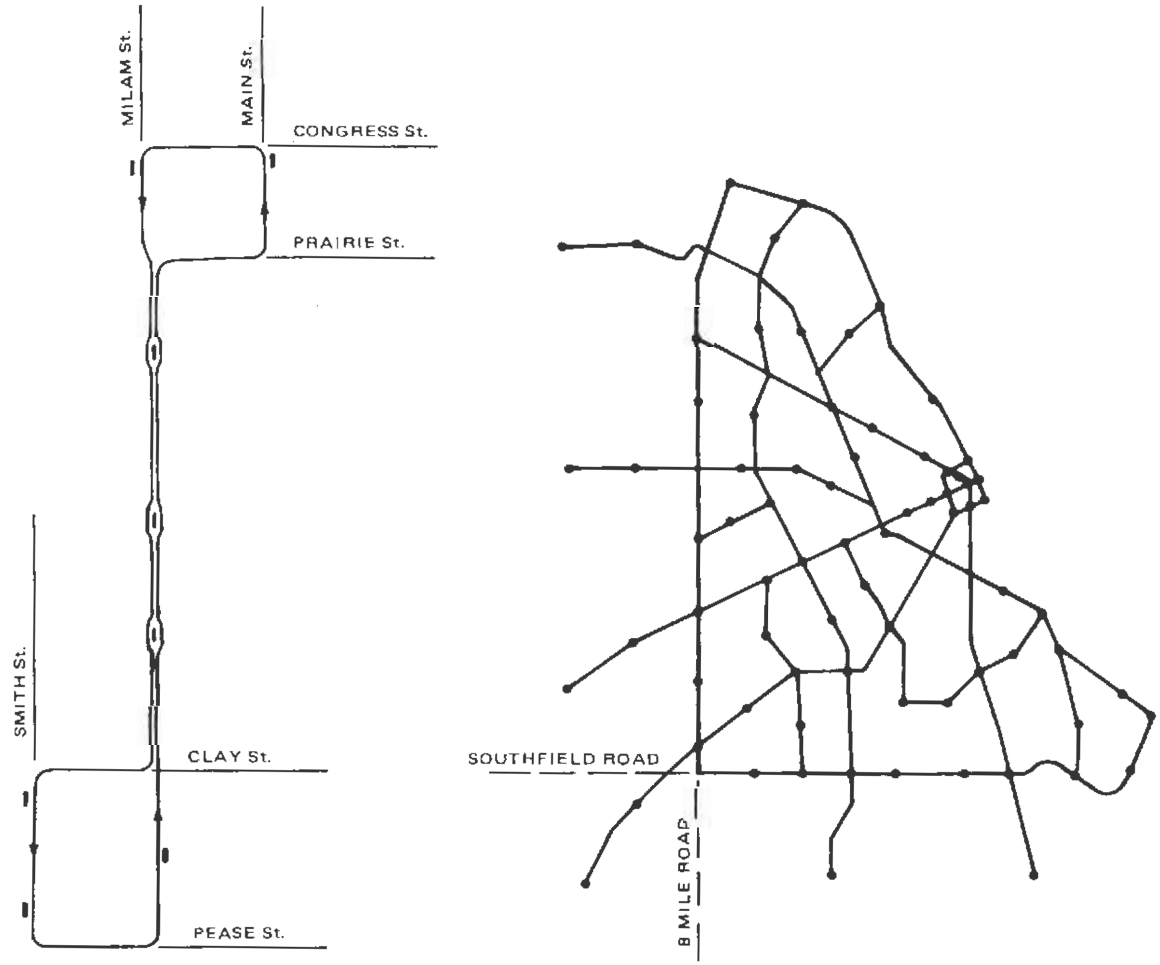
i. Model Requirements and Functional Specifications - develop technical and functional specifications for software models that will be used to evaluate AGT systems.

j. Model Development - develop coarse software models on system planning, feeder systems, availability, cost and detailed simulation models, encompassing stations, operational control, and discrete event network simulation.

k. Data Base Development - organize a computerized data base on AGT systems using data and results gathered and developed during the SOS project.

l. Implementation of Models and Data Base - install and implement the models and data base developed on a government computer facility.

Types of system networks to be studied in the SOS project range from the simple to the complex, as shown in Figure 6.



a) Simple AGT System

b) Complex AGT Systems

FIGURE 6
TYPES OF AGT SYSTEMS TO BE STUDIED IN SOS PROJECT

3.3.1.2 System Safety and Passenger Security Studies. The System Safety and Passenger Security Studies, being performed by Dunlop and Associates, will develop guidelines for the assurance of actual and perceived safety and security in various AGT systems.

The project has the following objectives:

a. Determine the perceived and actual security of AGT systems,

b. Develop methods for improving passenger security,

c. Develop methods for controlling vandalism,

d. Develop methods for evacuation and rescue,

e. Determine the maximum emergency deceleration and jerk levels, and

f. Express the results of these studies in terms of applicable requirements.

The project has six tasks:

a. Passenger Security - conduct a literature review of passenger security methods and produce a guidebook for use by AGT planners and designers which details effective methods and procedures for reducing crime and vandalism on AGT systems.

b. Evacuation and Rescue - conduct a literature review of evacuation and rescue methods and produce a guidebook for use by AGT planners and designers which describes in detail effective methods for evacuation and rescue of passengers from AGT systems.

c. Passenger Safety and Convenience Services - conduct a literature review of passenger safety and convenience service methods and produce a guidebook for use by AGT planners and designers which describes in detail the problems and effective methods for providing passenger safety and convenience services.

d. Passenger Value Structure Model - develop a mathematical model that depicts passenger needs and values with regard to perceived security and safety on AGT systems.

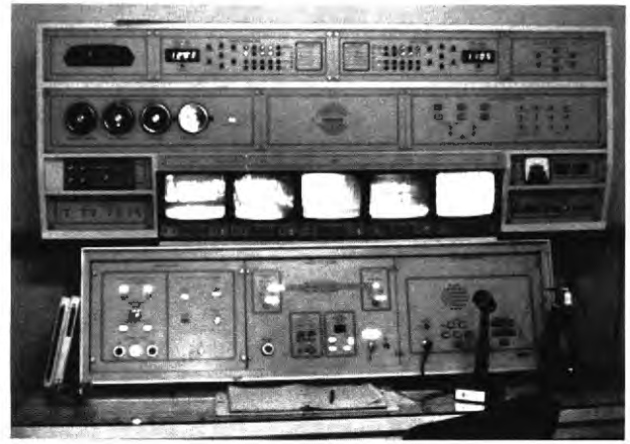
e. <u>Emergency Deceleration and Jerk</u> - design and execute a series of experimental studies that will determine the maximum emergency deceleration levels for AGT systems and the design specifications for high retention passenger seats.

f. <u>Security and Safety Workshop</u> - conduct three workshops to discuss the guidebooks developed and problems of AGT system security and passenger safety.

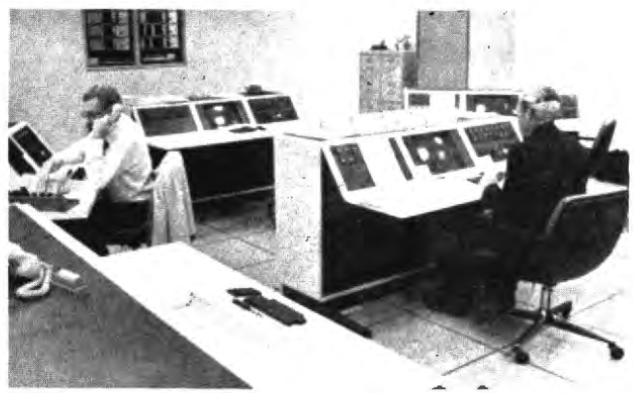
Some examples of existing systems and methods of passenger security and safety are shown in Figures 7 and 8.

FIGURE 7
CENTRAL CONTROL SYSTEM USED TO MAINTAIN SAFE VEHICLE OPERATING CONDITIONS FOR THE AIRTRANS AGT SYSTEM AT THE DALLAS-FT. WORTH AIRPORT IN TEXAS

(a) Security



(b) Safety and Control



(c) Communications

FIGURE 8
SYSTEM SAFETY AND SECURITY CONTROL EQUIPMENT

3.3.2 Subsystem and Component Technology

In the System Technology subdivision the main focus of the project is in the area of system simulation and operational analysis of future AGT systems. In contrast, the subsystem and component technology subdivision will concentrate on technical areas, performance goals, and design concepts of hardware for:

- Vehicle Longitudinal Control and Reliability, and
- Vehicle Lateral Control and Switching.

Both of these projects are being performed by the Transportation Technology Division of Otis Elevator Company and focus on analysis, evaluation, development, design, and demonstration of various control systems. Examples of vehicle control equipment are shown in Figure 9 and 10.

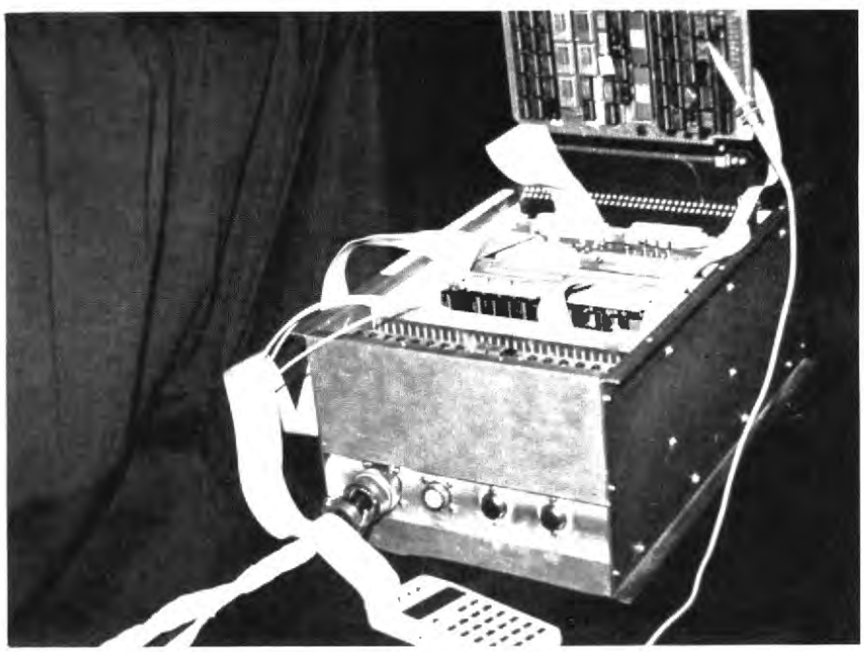


FIGURE 9
PROGRAMMABLE ON-BOARD VEHICLE CONTROLLER USED IN THE OTIS TEST VEHICLE IN THE VEHICLE LONGITUDINAL CONTROL AND RELIABILITY PROJECT

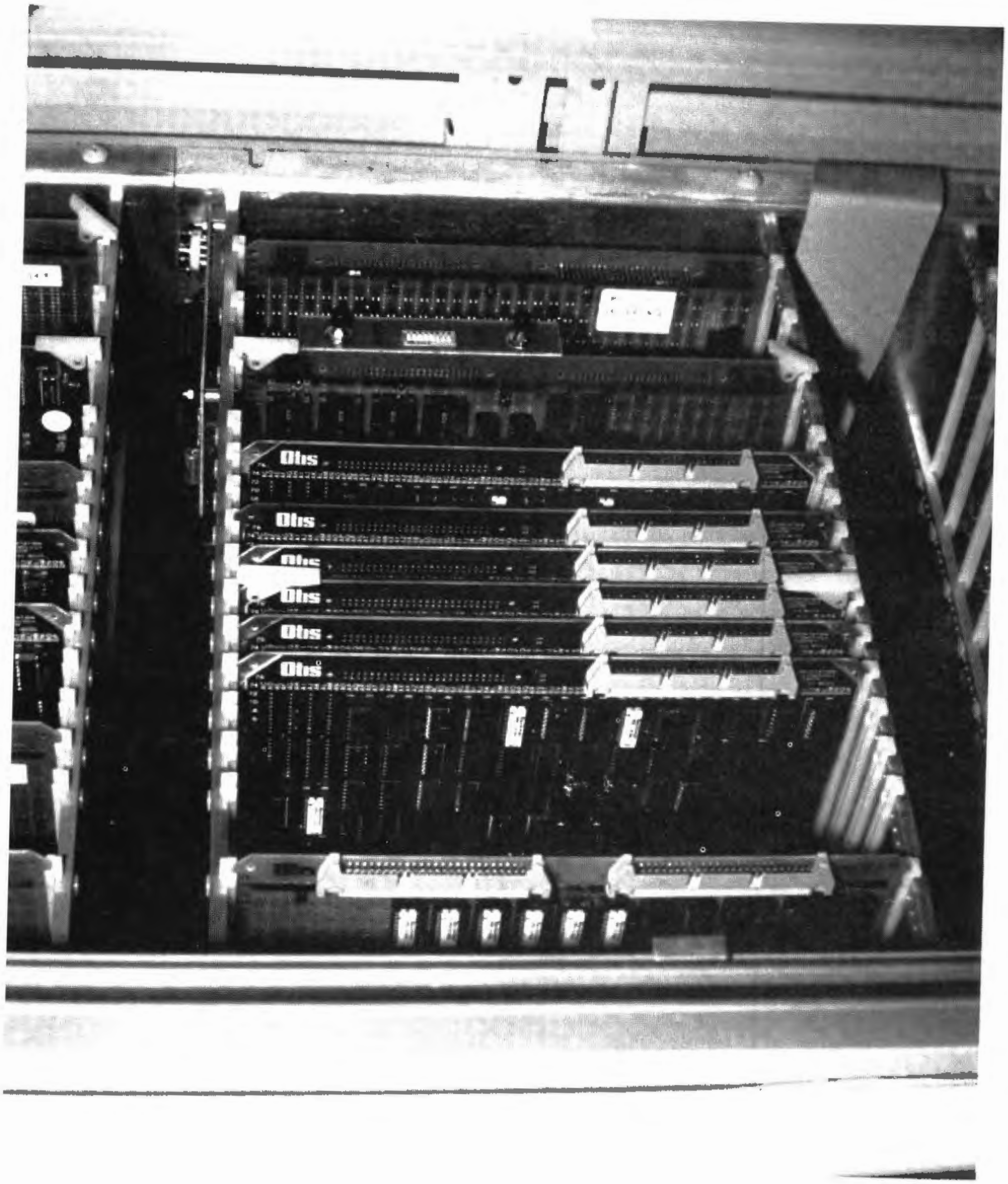


FIGURE 10
OTIS BREADBOARD SAFETY UNIT USED AT THE TEST FACILITY

3.3.2.1 <u>Vehicle Longitudinal Control and Reliability (VLCR) Studies</u>. The Vehicle Longitudinal Control and Reliability Studies project is studying areas that will advance the state-of-the-art of AGT longitudinal control systems and components, as well as provide reliability requirements. Three major areas that are being studied are (1) the development, design and demonstration of longitudinal control systems; (2) the development of techniques for reliability enhancement; and (3) the study of automatic vehicle entrainment and platooning concepts. Types of vehicle longitudinal control technology alternatives to be evaluated are shown in Table IX. Objectives of this project are:

a. Develop specific cost and performance requirements for longitudinal control systems for various headways;

b. Provide a comprehensive analytical and experimental evaluation of point-follower and vehicle-follower techniques;

c. Demonstrate longitudinal control at headways of less than 5 seconds;

d. Develop requirements for longitudinal control at separations less than the emergency stopping distance;

e. Reduce the cost and complexity of longitudinal control systems;

f. Demonstrate potential performance improvements;

g. Develop and demonstrate techniques for enhancing reliability;

h. Establish reasonable goals for longitudinal control system component reliability;

i. Develop performance specifications for longitudinal control systems for AGT systems using automatic vehicle entrainment and platooning techniques;

TABLE IX

LONGITUDINAL CONTROL SYSTEMS STUDIED IN THE VEHICLE LONGITUDINAL CONTROL AND RELIABILITY PROJECT

Classification	Minimum Headway (seconds)	Vehicle Protection	Vehicle Class	Operating Policies
Fixed Block Control	20-90	Fixed Block	Large GRT SLT	Not Applicable
Point-Follower	3-5	Moving Block	GRT	Constant Headway, Constant K-Factor, Constant Separation (Platooned)
Vehicle-Follower	3-5	Moving Block	GRT	
Point-Follower	0.5	Moving Block	PRT	Constant Headway, Constant K-Factor, Constant Maximum Collision Velocity, Constant Separation (Platooned)
Vehicle-Follower	0.5	Moving Block	PRT	

j. Perform an analytical and experimental evaluation of an automatic coupling and de-coupling system;

k. Establish design concepts and specifications for automatic coupling systems; and

l. Assess the platooning concept and establish the longitudinal control performance requirements for achieving platooned vehicle operation.

The VLCR project has six tasks:

a. Technology Evaluation Model Development - develop performance measures and goals, and vehicle cost, weight, and longitudinal control system reliability models to establish design goals and evaluate progress.

b. Vehicle Longitudinal Control Studies - develop concepts for reducing the cost and weight and for improving the reliability of AGT vehicle longitudinal control systems.

c. Reliability Enhancement Studies - develop techniques for the improvement of reliability of AGT vehicle longitudinal control systems by improving component design and applying redundancy.

d. Entrainment and Platooning Studies - identify and evaluate the various concepts for automatically entraining and platooning AGT vehicles in various system configurations.

e. Experimental Program - develop an experimental program to verify the performance and practicality of the longitudinal control techniques developed during the VLCR project.

f. Data Base Development and Guideline Specification Requirements - develop a data base on longitudinal control systems and techniques and reliability enhancement techniques; and develop a set of guideline specifications and requirements for control systems, reliability enhancement techniques, and entrainment and platooning techniques.

Test vehicles to be used in the longitudinal control experimental program are shown in Figure 11.

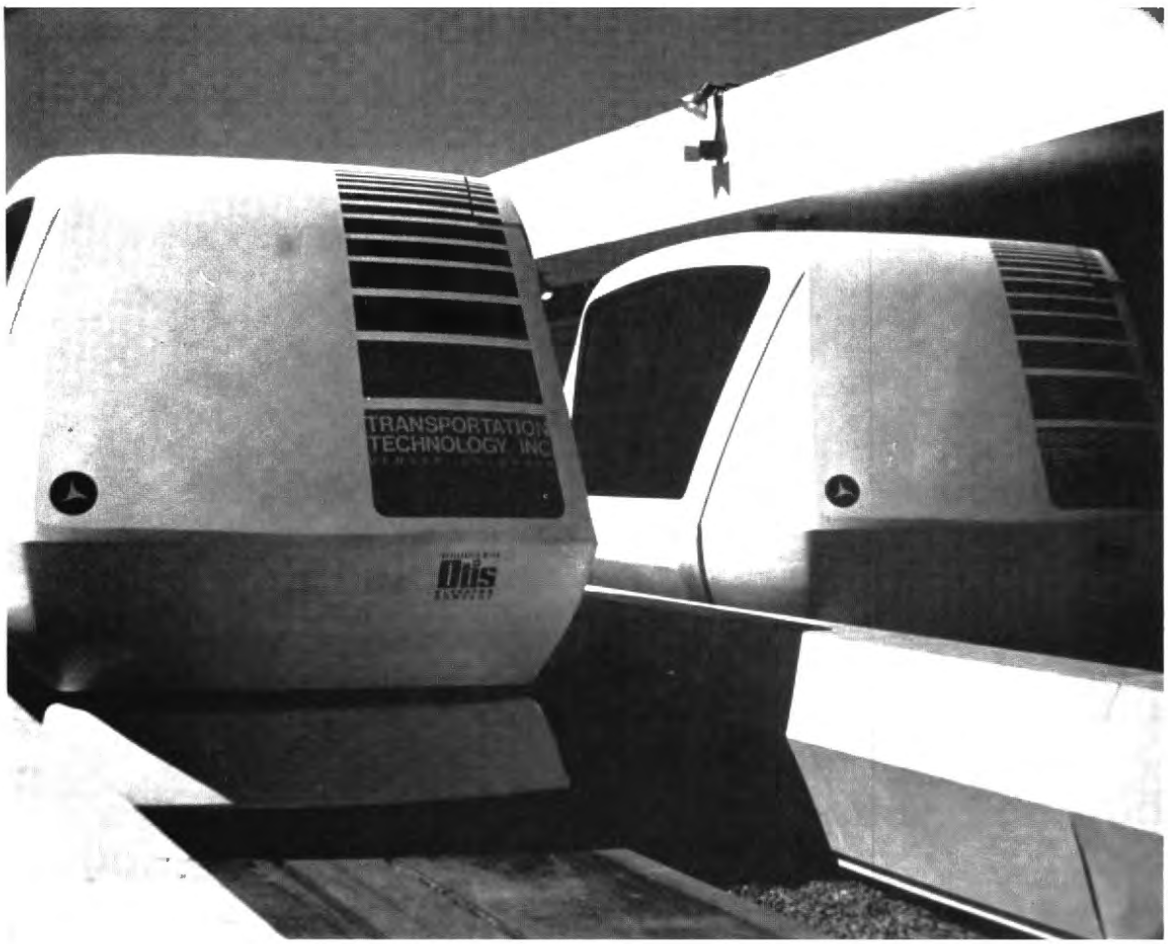


FIGURE 11
OTIS TEST VEHICLES

3.3.2.2 Vehicle Lateral Control and Switching (VLACS) Studies. The purpose of this project is to study areas that will improve the performance of AGT lateral control and switching systems for all classes of AGT vehicles. Areas that will be studied are (1) the development, design and demonstration of lateral control systems, and (2) the development, design and demonstration of vehicle switching systems. Types of vehicle lateral control technology alternatives to be evaluated are shown in Table X.

Objectives of this project are:

a. Reduce the cost, complexity, and weight while increasing the life, reliability, maintainability, ride quality, and switching capability of the VLACS system;

b. Develop performance requirements and guidelines for lateral control and switching systems at cruise speeds of 32 to 80 km/h for the various classes of AGT vehicles;

c. Develop and evaluate VLACS hardware designs reflecting objective a above;

d. Provide experimental data on the performance of VLACS systems and subsystems;

e. Provide a comprehensive evaluation of contact and noncontact lateral guidance techniques; and

f. Assess the positive retention capabilities of automatic switching systems.

The VLACS project has five tasks:

a. Technology Evaluation Model Development - develop performance measures and goals, and cost and weight models to be used to establish design goals for lateral control and switching systems.

b. Lateral Control and Switching Technology Review, Design, and Analysis - develop concepts for reducing cost and weight and for improving the performance and reliability of AGT lateral control and switching systems.

TABLE X

LATERAL CONTROL TECHNOLOGIES STUDIED IN THE VEHICLE LATERAL CONTROL AND SWITCHING PROJECT

CLASSIFICATION	LATERAL REFERENCE	LATERAL SENSOR	STEERING ACTUATOR	STEERING GEOMETRY	SWITCHING
Wall-Follower	Side Wall	Wheel	Direct Mechanical Coupling	Ackerman	Onboard/ Wayside
Power Assisted Wall-Follower	Side Wall	Wheel	Hydraulic Power Assisted	Ackerman	Onboard/ Wayside
Wire-Follower	Conductor	Array of Coils	Hydraulic Power Assisted	Ackerman	Onboard/ Wayside

c. Detailed Hardware Implementation Development - develop detailed component level designs of the lateral control and switching system to permit detailed cost, weight and reliability evaluations, and verify that the reliability and cost goals have been achieved.

d. Experimental Program - develop an experimental program that will verify the simulation models; resolve major uncertainties in component, subsystem, and system behavior; demonstrate the operability of the proposed lateral control and switching designs; and experiment with vehicle lateral control and switching systems.

e. Data Base Development and Guideline Specifications and Requirements - develop a data base on vehicle lateral control and switching systems based on information gathered in the VLACS project; and develop a set of guideline specifications and requirements to be used by system planners and designers.

The wire-follower and wall-follower lateral control systems mounted on the Otis test vehicle (Figure 12) will be tested on the Otis test track (Figure 13) located in Denver, Colorado. High speed wire-follower system tests will be performed at a vehicle test facility located on Lowry Air Force Base in Denver. Front and front/rear steering concepts will be tested and demonstrated.

3.3.3 Wayside Technology

The Wayside Technology subdivision encompasses the Guideway and Station Technology Studies project, awarded to DeLeuw, Cather and Company. This project is to investigate technologies for implementing guideway, station, and power distribution systems. Since wayside technology represents 50 to 70 percent of the cost of constructing an AGT system, the acceptability and effectiveness of an AGT system is highly dependent on the wayside technology. The

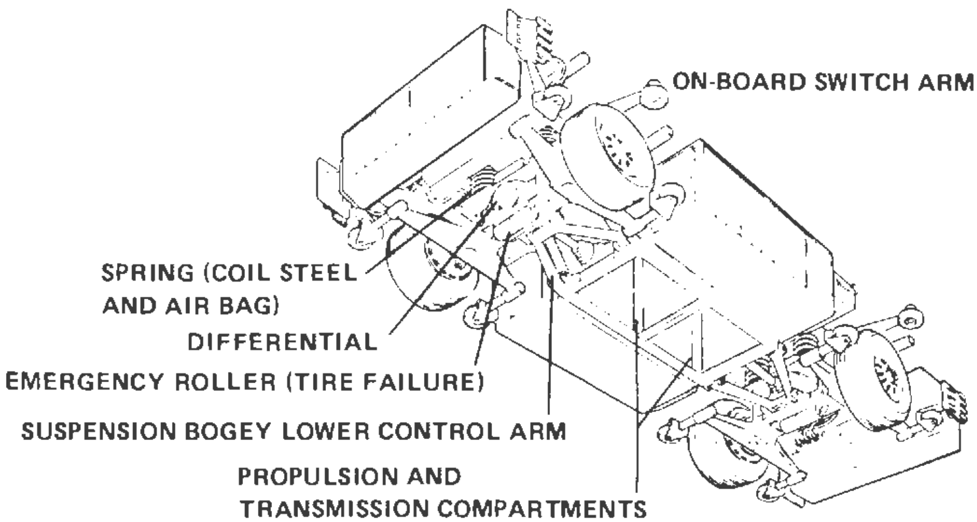


FIGURE 12
OTIS TEST TRACK VEHICLE UNDERCARRIAGE

a) Otis Test Facility, Denver, Colorado Straight Section, 513 Meters Long; Curved Sections, 257 Meters Long; Station Siding, 88 Meters Long

b) Duke University AGT Vehicles Being Tested at the Otis Test Facility

FIGURE 13
OTIS TEST FACILITY

project will place a major emphasis on innovative construction techniques such as prefabrication, improved contracting methods, and reduction of environmental impact. A major task area addresses the requirements for improved all-weather operation of AGT systems.

Objectives of the project are:

a. Reduce the cost and installation time of AGT guideways and stations;

b. Establish AGT guideway and station design guidelines and requirements;

c. Establish methodology for evaluating AGT guideway and station designs;

d. Develop and validate computer based cost and implementation time models for AGT guideway and station designs;

e. Improve guideway and station site integration and aesthetics; and,

f. Develop a data base for AGT guideway and station technology.

The Guideway and Station Technology Studies project has five tasks:

a. Technology Evaluation Model Development - develop performance measures and goals, cost models, and implementation time models that will be used to establish the performance of guideway and station design concepts.

b. Guideway Technology Studies - develop concepts for reducing costs and implementation times of AGT guideways; and evaluate guideway design and construction concepts for the different classes of AGT systems.

c. Station Technology Studies - develop concepts for reducing costs and implementation times of AGT stations; and evaluate station design and construction concepts for the different classes of AGT systems.

d. All-Weather Operation - develop and evaluate methods for improving and maintaining operation of AGT systems in all types of weather conditions.

e. Data Base Development and Guideline Specifications and Requirements - develop a data base from all data collected during the Wayside Technology project, and develop a guideline document for use by AGT planners and designers.

Some examples of different types of guideway and stations are shown in Figures 14 through 16.

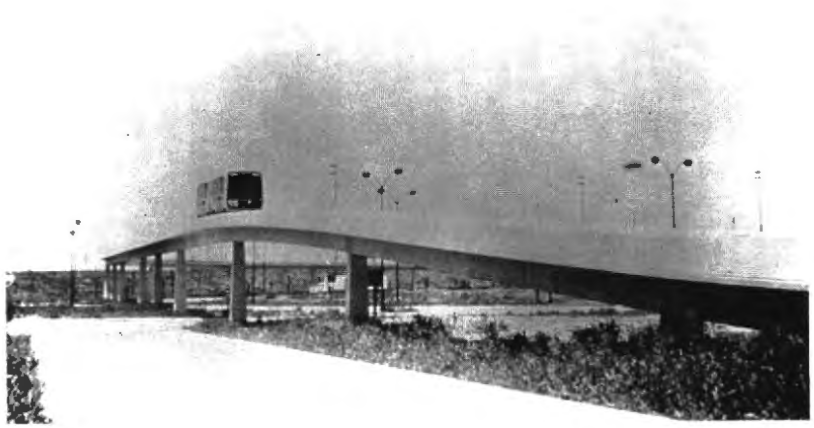
FIGURE 14
AGT STATION DESIGN SEATAC AGT STATION, SEATTLE, WASHINGTON

(a) Walnut Street Station, Morgantown AGT System
Morgantown, West Virginia

(b) AIRTRANS AGT Station, Dallas-Ft. Worth Airport
Dallas, Texas

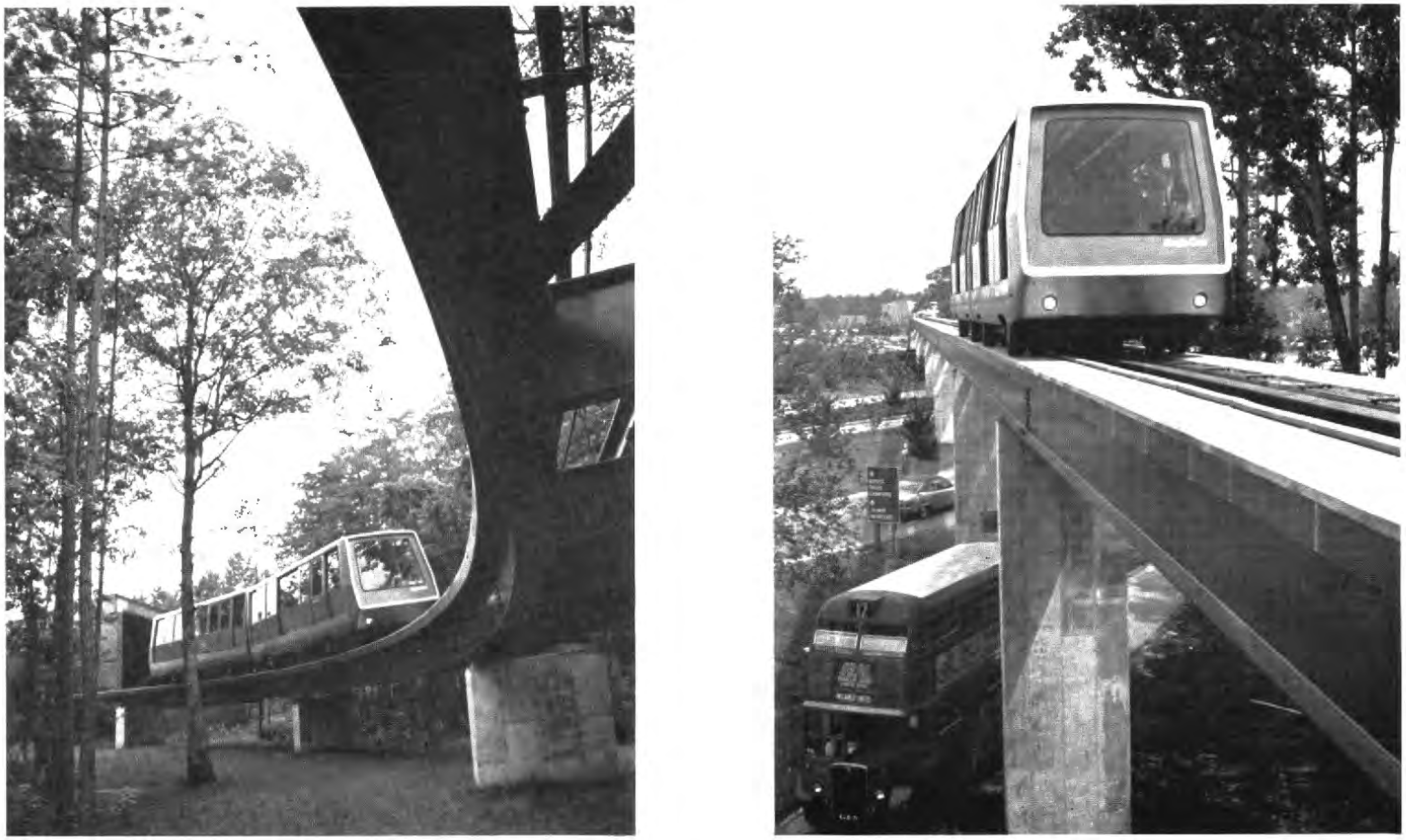
FIGURE 15
AGT STATION DESIGN

(a) Fairlane AGT System Guideway-Dearborn, Michigan



(b) AIRTRANS AGT System Guideway - Dallas-Ft. Worth Airport
Dallas, Texas

FIGURE 16
AGT GUIDEWAY DESIGN



(c) System Guideway at Busch Gardens, Williamsburg, Virginia

FIGURE 16 (CONCLUDED)
AGT GUIDEWAY DESIGN

3.4 Small AGTT Program Projects

Eight small projects are being conducted as part of the AGTT program:

a. Systems Hardware Reliability and Service Availability Studies--Battelle Columbus Laboratories;

b. Independent Vehicle Control Studies--Johns Hopkins Applied Physics Laboratory;

c. Hydrostatic Drive Studies--Mobility Systems and Equipment Corporation;

d. Independent Studies--The MITRE Corporation;

e. Independent PRT Studies--Aerospace Corporation;

f. Platooning and Entrainment Studies--Massachusetts Institute of Technology;

g. Vehicle Data Acquisition System--Port of Seattle; and

h. Automated Mixed Traffic Vehicle--Jet Propulsion Laboratory.

3.4.1 Systems Hardware Reliability and Service Availability Studies

The Systems Hardware Reliability and Service Availability Studies project, completed by Battelle Columbus Laboratories, analyzed existing AGT systems, reviewed definitions for service availability and hardware reliability, and developed a guidelines document of the most effective definitions.

Objectives of this project were:

a. Develop and examine various definitions and expressions for the service availability of AGT systems;

b. Develop a set of guidelines that will present the definitions and their applicability and use; and

c. Develop a methodology to translate the system level expressions into hardware requirements.

The project consisted of five tasks:

a. Literature Review - conduct a literature search and review to study and assess hardware reliability and service availability requirements of AGT systems.

b. Discussions with System Designers and Transit Operators - discuss with AGT system designers, transit planners, and transit operators the definitions of service availability and integrate the information gathered with the information gathered by the literature search.

c. Development of a Systems Level Expression for Service Availability - develop various system level expressions for service availability as a measure of system effectiveness from the data gathered in the literature search and the discussions.

d. Guidelines Document - develop a guidebook presenting the system level expressions defined and explain the methods and techniques for implementing them in an AGT system.

e. Service Availability Workshop - conduct a workshop to discuss the definitions selected and their applications to AGT system design. This workshop was held in October 1977.

3.4.2 Independent Control Studies

Johns Hopkins Applied Physical Laboratory is performing independent analyses and evaluation of critical problems associated with the vehicle longitudinal and lateral control systems. They are also providing test equipment to Otis for use in the VLCR test program.

Objectives of this project are:

a. Establish performance guidelines, develop evaluation tasks, analyze prime contractor designs, and study identified problem areas of the VLCR and the VLACS studies; and

b. Assist in achieving the overall goals of the AGT program in the areas of detection of emergencies, dynamic entrainment and platooning, controller sensitivity to hardware parameter variations and implementation approaches, and control concepts for the automated mixed traffic vehicle.

The project has four tasks:

a. Longitudinal Control Support Studies - perform independent analyses of the longitudinal control system designs proposed by the VLCR study.

b. Lateral Control Systems and Switching Support Studies - perform independent analyses of the lateral control and switching systems designs proposed by the VLACS study.

c. Independent Control Systems Analyses - conduct independent control system studies to assist in achieving the overall goals of the AGTT program.

d. Data Acquisition Equipment - provide to Transportation Technology Division-Otis Elevator Company data acquisition and test equipment for use on the VLCR project.

3.4.3 Hydrostatic Drive Studies

Hydrostatic drive units have the potential of delivering propulsion power to small AGT vehicles because the units have excellent torque and speed control, low electromagnetic noise, and high efficiency and reliability characteristics. Some test and evaluation work on the units has been completed. To provide more test and evaluation data, Mobility Systems and Equipment Corporation is performing additional studies.

The objective of this project is to test and evaluate the efficiency and reliability characteristics of hydrostatic drive units using representative AGT vehicle duty cycles.

The project has three tasks:

a. Duty Cycle and Test Plan Development - develop an AGT vehicle duty that includes periods of acceleration, constant velocity, deceleration, and dwell time; and prepare a detailed test plan for evaluating the hydrostatic drive unit under the vehicle duty cycle developed.

b. Test and Evaluation - test and evaluate the hydrostatic drive unit in accordance with the test plan.

c. Reevaluate and Update Previous Work - reevaluate and update previous work on the hydrostatic drive unit based on the test and evaluation results.

3.4.4. Independent Studies

Due to the broad nature of the AGTT program and its many projects and elements, many technical and operational problems occur that require independent analyses. The Independent Studies program, being performed by The MITRE Corporation, is to address new technology areas, perform technical reviews, and evaluate system assessments as related to technological and operational issues.

Objectives of this project are:

a. Provide to UMTA support activities in the technical and operational areas of the AGTT program;

b. Identify new technical problem areas and their relationship to the AGTT program;

c. Identify new areas of technology development for automated feeder systems; and

d. Provide an evaluation analysis of the findings of AGT system assessments as related to technological and operational aspects.

The project has five tasks:

a. Concept Definition - Undertake the concept definition and technology requirements feasibility analysis for automated feeder systems.

b. Technology Evaluation - Identify and evaluate new technology areas related to AGT and automated feeder systems.

c. Life Cycle Costs Analyses - Develop life cycle costs analyses on hardware components development for automated feeder systems.

d. Technical Assistance - Provide analysis, technical assistance, and consultation services to UMTA in the technical and operational areas of the AGTT program.

e. AGT System Assessments - Evaluate and analyze the finding of AGT system assessments as related to the technological and operational issues.

3.4.5 Independent Small Vehicle AGT Studies

The Aerospace Corporation completed an independent analysis of small vehicle AGT systems. Principal goals of the project were:

a. Document the results of previous in-hours funded research on PRT at Aerospace;

b. Review the potential cost, service, and reliability characteristics of small vehicle AGT systems;

c. Identify the environmental and energy impacts of small vehicle AGT deployments;

d. Describe the system-level performance specifications that small vehicle AGT systems must achieve;

e. Analyze the major technological problems that must be resolved to meet performance specifications; and

f. Recommend Research and Development activities for developing small vehicle AGT technology.

The project consisted of six tasks:

a. Review of Previous PRT Development Work - review and document all previous work on PRT systems funded by Aerospace Corporation.

b. Cost, Service, and Reliability Characteristics of Small Vehicle AGT Deployments - develop system level estimates of the cost, service, and reliability characteristics of small vehicle AGT deployments in various network configurations specifying the network geometries and assumed characteristics.

c. Environmental and Energy Impacts of Small Vehicle AGT - estimate the potential environmental and energy impacts of small vehicle AGT compared with other modes of urban transportation.

d. Implementation Concepts for Short Headway Small Vehicle AGT - describe techniques which can be used to implement the principal subsystems of short headway small vehicle AGT systems.

e. Small Vehicle AGT Technology Requirements - identify performance goals for subsystems that could improve the overall system performance; and quantify the engineering obstacles that impede the development of short headway small vehicle AGT systems.

f. Recommended R&D Activities - develop a list of Research and Development activities, based on the results of previous tasks, that could be used to develop the required technology for small vehicle AGT systems.

Several reports are available from this project.

3.4.6 Platooning and Entrainment Studies

This study, being conducted by MIT, addresses the potential service and capacity advantages which may be derived from the use of trains or platoons of small vehicles in addition to the individual small vehicles.

Objectives of this program are:

a. Investigate the capacity and delay tradeoffs at merge junctions of AGT systems; and

b. Determine what fraction of the theoretical capacity of the AGT system is usable.

The Project has four tasks:

a. Baseline Model Development - Select a set of realistic parameters to describe an entrained AGT system configuration and perform an kinematic analysis of the flow capacity based on various vehicle performance characteristics, train lengths, and safety requirements.

b. Y-Configuration Merge Simulation - Develop a Monte Carlo simulation model of a singly Y-configuration merge and perform a detailed study of the capacity and level of service tradeoffs.

c. X-Configuration Merge Simulation - Choose the best algorithm(s) from the Y-configuration simulation and study the case of a complete X-configuration intersection in a one-way network.

d. Conclusions - Use the merging simulation results to develop conclusions about the performance of larger networks.

3.4.7 Vehicle Data Acquisition System (VDAS)

The Port of Seattle is developing a failure monitoring system known as the Vehicle Date Acquisition System, which will consist of three main elements: (1) an on-board scanner and data storage device, (2) a portable tape recorder, and (3) a time sharing computer terminal system. The on-board equipment gathers data while the AGT system is in operation; the portable tape recorder is used to transport data from the vehicle to the wayside equipment; and the terminal is used to sort, format, and organize the data for analysis.

The two objectives of the project are:

a. Establish that maintenance costs on AGT systems can be reduced by the installation of monitoring devices into an operational AGT system; and

b. Determine if the long-term maintenance cost improvements justify the capital expense of installing failure monitoring equipment throughout a complete AGT system.

The project has seven tasks:

a. VDAS Hardware Development - Design and develop one breadboard scanner and data storage device, sensors and an interface between existing vehicle equipment and the data storage device;

b. VDAS Hardware Installation - Install, on one vehicle, sensors and an interface between the existing vehicle equipment and data storage device;

c. Data Transfer Equipment Development - Design a portable tape recorder which will transfer the data from the vehicle equipment to the computer terminal;

d. Data Input Device Development - Modify a Teletype Corporation punched paper tape reader to allow direct data input from the tape recorder;

e. VDAS Software Development - Develop a computer program to sort and plot the data from the data storage device;

f. Failure Analysis - Analyze failures using the VDAS data during six months of revenue service operation; and

g. VDAS Assessment - Prepare a final report on the performance of the device over the six month period of revenue service operation.

3.4.8 Extended Research on Automated Mixed Traffic Vehicle (AMTV) System

The high cost of operating conventional vehicles such as buses is primarily attributable to the labor costs associated with the driver. Such costs limit the ability of conventional public transit to serve many areas characterized by low trip volumes and short trip distances. While AGT systems such as those in Morgantown, West Virginia and at the Tampa and Dallas-Ft. Worth airports can eliminate most of the labor costs associated with operations, the expensive, elevated or protected at-grade exclusive guideways required by AGT systems has limited their application to major activity centers. A need was perceived for a less capital intensive automated vehicle mode which could utilize existing rights-of-way with relatively minor changes. The system would also have the ability to pickup or discharge passengers like a conventional transit bus thus eliminating the need for elaborate, expensive station facilities. In addition the system would be able to move safely at low speed over surfaces shared by pedestrians or move at higher speeds on a pedestrian free path protected by suitable side barriers. The vehicle would also be able to easily move from high-speed protected areas to a low-speed shared running surface to improve average travel speeds. The above system concept has been called an Automated Mixed Traffic Vehicle (AMTV) transit system.

A sensor and control system feasibility demonstration of an AMTV, using an experimental breadboard vehicle, was conducted at the Jet Propulsion Laboratory (JPL) during early 1976 over the route shown in Figure 17. The integration of an AMTV system into a pedestrian environment might take the form shown in Figure 18. As a follow-up to the development project, JPL is continuing the investigation on expanded AMTV concept using vehicles traveling at speeds of 2 km/h, 10 km/h, and 30 km/h.

Objectives of this project are:

a. Assess the technology of the present AMTV system; and

b. Determine where additional development work is needed to develop the three classes of vehicles.

The project has four tasks:

a. Required Technology Developments--identify technology developments needed to implement an AMTV system in an urban environment;

b. Vehicle Specifications and Model--develop specifications for AMTV subsystems and control system; and develop an analytical model of an AMTV vehicle;

c. Safety Investigation--examine the AMTV concept from the standpoint of safety; and recommend improvements to the AMTV designs to improve the system safety; and

d. Failure Mode Analysis--perform a failure mode analysis of the AMTV concept using data and the design of the present AMTV vehicle.

ROUTE MAP OF PRESENT JPL LOOP

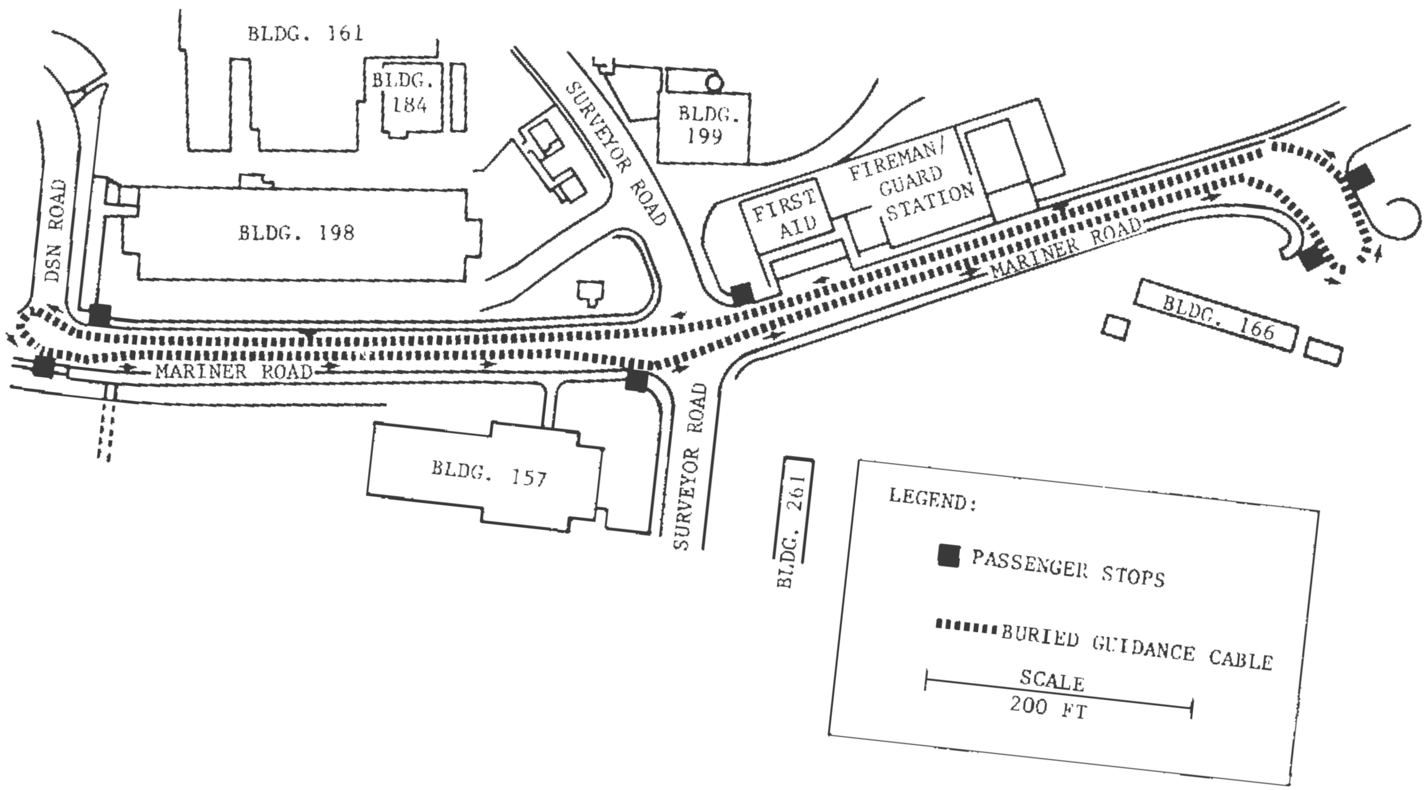


FIGURE 17
AMTV TEST ROUTE AT JPL

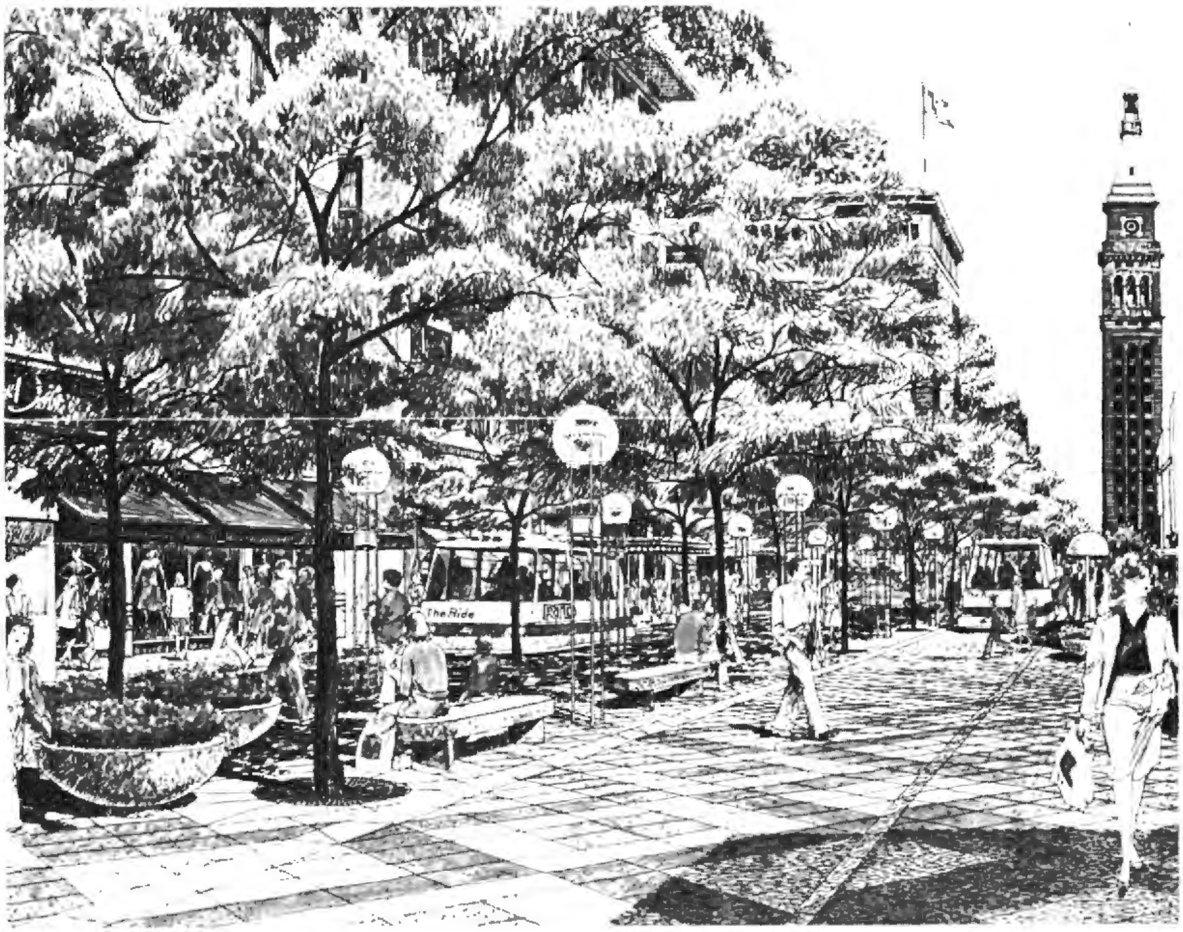


FIGURE 18
AMTV DEMONSTRATION SYSTEM — SHOPPING MALL

4.0 CURRENT PARALLEL PROGRAMS

Many new transit systems have been supported by or are related to Federal programs that have been conducted during the past decade. The results of the previous programs are the basis of several current UMTA programs in the transportation systems area.

4.1 The Morgantown Project

Originally, this project was initiated by West Virginia University in 1967 and, in 1969, funds were acquired from UMTA for a study. There were two main objectives for the system:

a. Establish a national demonstration facility for the study of AGT systems in an urban environment; and

b. Transport students, faculty, and staff members; better utilize facilities and staff; and transport the people of Morgantown.

In 1970, UMTA took charge of the management and funding of the project and decided to proceed with the Morgantown AGT demonstration project in order to install the world's first automated personalized transportation system in an urban area. A significant decision at that time was to contract directly with a systems development contractor (first the Jet Propulsion Laboratory of Caltech and later Boeing) instead of relying on the local sponsor, West Virginia University, to subcontract for and manage this major project.

The system, which started revenue service in the fall of 1975, connects the Morgantown, West Virginia, central business district with two campuses of West Virginia University by means of 8.7 kilometers of one-way concrete guideway. On this guideway, which can be heated to prevent icing conditions during cold weather, run 8-seat, 21 passenger, electrically powered automated vehicles at 15-second headways. The system is capable of moving up to 3000 passengers per hour. Service is personalized to the extent that vehicles can be summoned and directed by the passengers to desired destinations by pushing a button at the station where the passenger boards. Figure 19 shows a Morgantown vehicle in the Walnut Street Station in Morgantown, West Virginia.

A second phase of construction was started in May 1977 and the expected completion date is April 1980. Two stations, 4.7 kilometers of single-lane guideway, and a small maintenance facility will be constructed. Also, 23 new vehicles will be purchased and the existing fleet of 45 vehicles will be modified. When Phase II is completed, the system will be 13.4 kilometers long, have 5 stations and 73 vehicles.

4.2 The AIRTRANS Urban Technology Program (AUTP)

A successful application of AGT in an airport environment has been the Dallas-Ft. Worth (DFW) Airport AIRTRANS system. The system has the potential to be utilized to help solve a number of urban transportation problems. However, there are a number of improvements to the existing system which are necessary to make it suitable for urban deployment. To develop improvements and to apply them to the AIRTRANS system, a three year program was established in January 1977.

The objectives of the AIRTRANS Urban Technology Program are:

FIGURE 19
AGT VEHICLE IN STATION IN MORGANTOWN, WEST VIRGINIA

a. Develop better subsystem performance and reliability characteristics;

b. Improve system operational characteristics; and

c. Reduce capital, operation, and maintenance costs.

To accomplish the objectives of the program, the program was divided into two phases.

Phase I was a 12-months project used to develop improved propulsion, steering, power and signal collection, and control methods. During Phase I the subsystems underwent extensive laboratory testing and then the improved methods were installed on a test vehicle for evaluation and demonstration on the AIRTRANS system. The main projects of Phase I were:

a. Develop dual motor drive systems to power both vehicle drive axles in order to provide a 48 to 72 kilometers per hour operating speed;

b. Develop power and signal collectors which would operate at 72 kilometers per hour;

c. Develop a steering system that could operate at 72 kilometers per hour while reducing guideway and switch loading, steering component wear rates, and improving steering stability and response; and

d. Modify existing control equipment to allow operation of the test vehicle at speeds between 27 and 48 kilometers per hour and to evaluate second generation vehicle control electronics equipment.

The phase II program is a 24-months program that is to build on the results of the Phase I program. The major tasks of Phase II are:

a. Complete improvements to the control system equipment;

b. Develop better communication with passengers in stations and in vehicles;

c. Conduct demonstrations of the demand mode operation;

d. Improve operational reliability in subfreezing and snowy weather;

e. Evaluate operation and maintenance cost reductions from use of better methods and materials;

f. Continue testing of the instrumented test vehicle to verify the accomplishment of design objectives; and

g. Demonstrate on the AIRTRANS system guideway an improved prototype vehicle.

4.3 Advanced Group Rapid Transit (AGRT) System

The Advanced Group Rapid Transit System Development Program (formerly the High Performance PRT Program initiated in 1974) intends to develop a more advanced AGT system capable of carrying a maximum of 14,400 seated passengers (no standees) per lane per hour in 12-passenger vehicles at 3-second headways. Goals of the AGRT program are:

a. The design and installation of an AGRT system in a test track configuration and the verification through extensive testing of the ability of the system to satisfy the performance goals in the areas of guideway capacity, speed, safety and reliability; and

b. The design and verification of a command and control system capable of handling vehicles operating on various urban networks under normal conditions and in the event of failures.

The system development work is divided into two phases: Phase I - Design Concepts and Definitions, and Phase II - System Development and Test.

In August 1975, three contractors--Boeing, Otis, and Rohr--successfully completed a seven month design study for Phase I. System designs were developed to the point of producing preliminary drawings and specifications at the major subsystem level, specifications for the urban deployability studies simulation models, and the preliminary design of the test trace system.

Phase II, the implementation phase, is divided into two parts: Phase IIA - the Detailed Design and Phase IIB - the Test Track Installation. In June 1976, continued development of the preliminary designs was again started by the three contractors. Continued development of detailed designs and the development coarse and detailed simulation models were concluded at the end of Phase IIA in December 1977. Other tasks in Phase IIA included:

a. Development of breadboard models of critical systems identified in Phase I;

b. Testing of the breadboard models:

c. Analysis of the overall system design;

d. Development of the urban deployability simulation models; and

e. Comparison of the performance of the urban deployability simulation results with the goals defined in Phase I.

Phase IIB includes the design, manufacture, test and integration of all system hardware and software. It also includes the continuation of studies and simulations to verify the system operation in various network geometries and at various passenger demand levels.

Objectives of Phase IIB are:

a. Complete the detailed design of the test track;

b. Build all required hardware;

c. Construct the test track at Pueblo, Colorado;

d. Integrate hardware and test track into operational system;

e. Perform the engineering test and correct any design deficiencies;

f. Gather data on performance, reliability, energy usage, and cost;

g. Verify analytical models used in simulations; and

h. Determine the system performance for various urban networks through use of the urban deployability studies simulation models.

4.4 Downtown People Mover (DPM) Program

The Downtown People Mover Program is to provide a demonstration of a fully automated AGT system in several urban areas. Objectives of the DPM program are:

a. Test the operating and maintenance cost saving of AGT systems;

b. Assess the economic impact on the CBD of improved circulation;

c. Test the feasibility of AGT systems as feeders to or substitutes for more expensive fixed guideway systems;

d. Establish that simple, automated AGT systems are reliable and maintainable and provide adequate service availability at reasonable cost;

e. Establish the social acceptability and the environmental impact of small AGT systems in the CBD; and

f. Thoroughly document the entire project and develop a set of guidelines and procedures that could be used by system planners and designers in other urban areas.

Cities that were selected as potential sites for the DPM program had to meet a set of site selection criteria before selection. Selection was on the basis of need and likelihood of success. The minimum site selection criteria are:

a. The candidate city must select one of the existing people mover technologies;

b. The city must continue to operate the system after the initial public operation;

c. The city's proposed plan must be of a general nature to test the feasibility of urban uses of DPM systems;

d. The total cost of the system must be commensurate with the anticipated benefits; and

e. The city must demonstrate (1) adequate planning, (2) community support, (3) adequate financial resources; (4) adequate technical resources and (5) compliance with the UMTA Act of 1964.

In December 1976, UMTA announced the selection of four cities--Cleveland, Houston, Los Angeles, and St. Paul--as DPM demonstration sites. In addition, Baltimore, Miami, and Detroit were informed that they could divert funds from existing transit funding commitments for their proposed DPM systems. In June 1977, UMTA recevied direction from Congress to consider four additional cities--Indianapolis, Norfolk, Jacksonville, and St. Louis--as part of the DPM program.

In response to this directive, UMTA established a two tier DPM program in which the first tier cities of Cleveland, Houston, Los Angeles, St. Paul, Detroit, and Miami would be provided with capital funds to perform the first phase of preliminary engineering efforts and environmental impact studies. Upon the successful completion of these design efforts and environmental reviews, these cities would be provided with capital funds for the construction of their DPM systems. The second tier cities of Baltimore, Indianapolis, Jacksonville, Norfolk, and St. Louis would be provided with technical study funds to perform feasibility analyses of their proposed projects. These cities may be provided with capital funds for their first phase preliminary engineering efforts.

To date, preliminary engineering grants have been awarded to Houston, Los Angeles, Miami, and St. Paul and one is about to be awarded to Detroit. In November 1977, the mayor of Cleveland requested that the DPM grant application for that city be withdrawn. Technical study grants have been awarded to Indianapolis and Jacksonville and are about to be awarded to Baltimore, Norfolk, and St. Louis.

4.5 AGT Socio-Economic Research Program

The AGT Socio-Economic Research Program is to study the comparative advantages of AGT systems over other forms of mass transportation. Major objectives of the program are:

a. Determine the particular types of urban applications of AGT systems;

b. Identify and examine the various social and economic considerations associated with the implementation of AGT systems;

c. Evaluate the acceptability of AGT characteristics;

d. Determine the nature and magnitude of the market for AGT systems;

e. Determine capability of AGT systems to meet the needs of the urban environment;

f. Identify and examine the policy and financing options needed to implement AGT systems;

g. Determine the future requirements for research, development, and demonstration of AGT systems; and

h. Establish a data base of current information on AGT system social, economic, and performance characteristics.

To achieve the goals, the program was divided into five major activities:

a. Generic Alternatives Analysis - Identify the present and future transportation needs and perform and comparative analysis of the ability of various transportation systems types to fulfill these needs.

b. Assessments - Collect, combine, and present the social, economic, and performance characteristics of all operational AGT systems.

c. Costs - Improve the present understanding of the capital, operating and maintenance, and life cycle costs of AGT systems.

d. Markets - Estimate the potential market for the several classes of AGT systems based on the generic and site specific market research activities.

e. Communications - Assemble and synthesize results of the program research activities and ensure dissemination of the program data and findings.

4.6 Accelerating Walkway Systems Program

Accelerating Walkway Systems (AWS) are a new transportation means for transporting large volumes of patrons over short distances. At present, no operational systems have been installed but several prototype systems exist. These systems have been designed to carry up to 10,000 patrons per hour at speeds as high as 12 kmh, over distances from 100 meters to 1000 meters. Accelerating walkways hold great promise for reducing congestion at transportation terminals, quickly moving travelers between transportation terminals, permitting more optimum land use development around transportation terminals, and improving the practicality of auto-free zones.

There exists a potential for improved transportation with accelerating walkways but there also exists questions concerning the safety, cost, reliability and performance characteristics of these systems. This program has been established to answer these questions.

Objectives of the AWS program are:

a. Evaluate existing AWS state-of-the-art technology;

b. Identify potential applications and potential benefits;

c. Identify and evaluate potential sites for a demonstration;

d. Identify the safety, pedestrian traffic, and human factor characteristics related to deployment;

e. Establish installation requirements, estimate costs, and reliability and maintainability characteristics;

f. Deploy and demonstrate publicly an AWS; and,

g. Establish a data base on AWS reliability, costs, and maintainability in an operational environment.

The Accelerating Walkway program has been divided into five phases:

a. AWS Feasibility Study - This study provided an overview of accelerating walkway systems technology, identified six potential applications and associated cost benefits, and conducted a safety analysis and assessment.

b. AWS Design Development - This phase provides for the design development and demonstration implementation studies.

c. AWS Hardware Design Development and Laboratory Testing - AWS detailed hardware design development, fabrication, and laboratory subsystem system testing will be completed during Phase III.

d. AWS Public Demonstration - one of the AWS designs will be selected and publicly demonstrated and evaluated during this phase.

e. AWS Product Qualification - This phase will address the delivery system issues including product implementation, improvement, and development of standards such as technological eligibility and operational certification standards. It also provides for the tasks required to fully qualify a AWS technology for deployment.

4.7 Supporting Technology Studies

Independent studies and analyses by many organizations, ranging from private nonprofit organizations to government research laboratories and profit-making coporations, have brought to light critical problems as well as conflicting viewpoints on approaches or solutions. Examples of discussions range from philosophical issues of control strategy and headway to hardware subsystem tradeoffs, such as the approtionment of command, control, and communications functions.

4.8 University Research and Training

This is an ongoing program that provides funds for university research concerned with selected issues of AGT technology. Examples of such studies are guideway/vehicle dynamics studies at MIT and longitudinal control and crashworthiness studies at the University of Minnesota.

GLOSSARY

AC	-	air cushion
ACIM	-	air-colled induction motor
AMAG	-	attractive magnetic force
ASY	-	asynchronous control
CA	-	commercial application
CGB	-	center guide beam
CBW	-	captured guide wheel
DCTM	-	direct current traction motor
DLIM	-	double-sided linear induction motor
DS	-	design study
ECC	-	eddy current clutch
FB	-	fixed block
GB	-	guide beam
GW	-	guide wheel
HST	-	hydrostatic transmission
LAM	-	linear air motor
LSM	-	linear synchronous motor
MBS	-	moving belt system
NPAC	-	negative pressure air cushion
OB	-	on-board
PD	-	public demonstration
PF	-	point follower control
QSY	-	quasi-synchronous longitudinal guidance

GLOSSARY (Concluded)

RGW	-	rubber guide wheel
RP	-	reduced scale prototype
RSM	-	rotary synchronous motor
RTOC	-	rubber tire on concrete
RTOS	-	rubber tire on steel
SGW	-	side guidance surface
SLG	-	synchronous longitudinal guidance
SLIM	-	single-sided linear induction motor
SPDR	-	supported dual-rail
SPMR	-	supported monorail
SSDR	-	suspended dual-rail
SSMR	-	suspended monorail
SWF	-	side wall follower
SWOR	-	steel wheel on rail
TD	-	test track demonstration
VF	-	vehicle-follower control
WA	-	wayside actuated

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Project AGT TECHNOLOGY

File No. AGTT

Purpose of Meeting

APTA/AGTT MEETING

Meeting Attendance Record

FINAL VERSION

Date 8/17/78

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Project AGT TECHNOLOGY

File No. AGTF

Purpose of Meeting

APTA/AGTT MEETING

Meeting Attendance Record

Date 8/17/78

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