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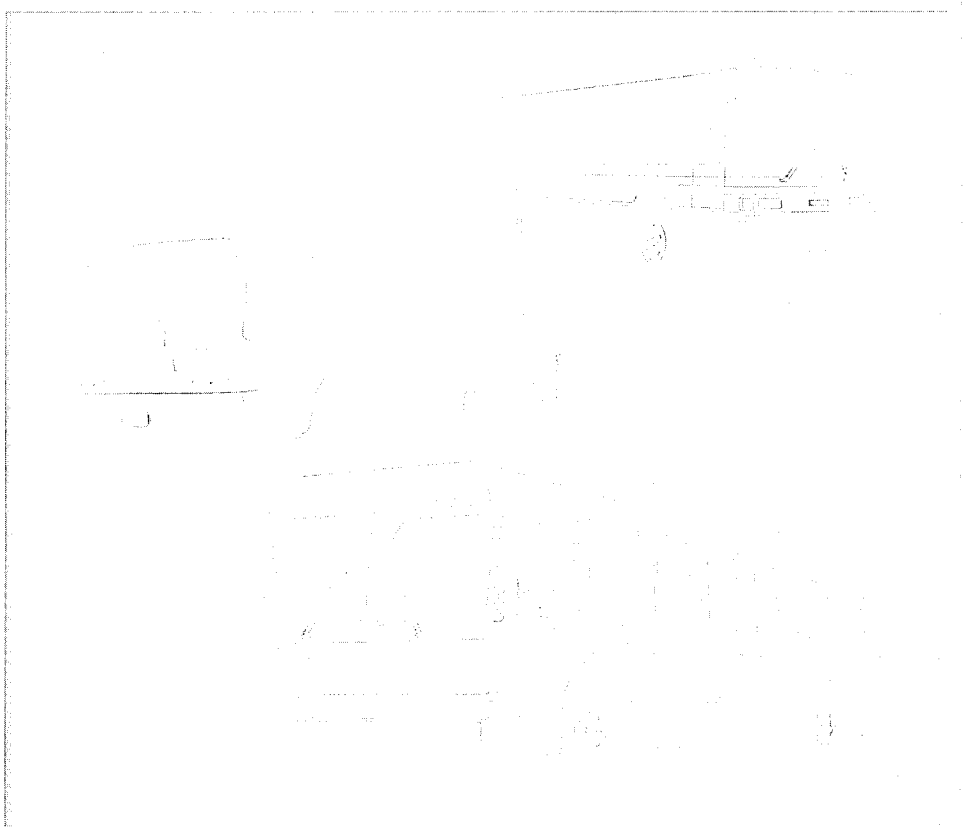
of Transportation
Federal Transit
Administration

Clean Air Program

Cylinder Issues Associated With Alternative Fuels

PB99-147613

Final Report
January 1999



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13. ABSTRACT (Maximum 200 words)

A number of incidents of compressed natural gas (CNG) cylinder leaks have occurred while transit buses were either in service or at a bus maintenance facility. This study was initiated to determine the degree to which cylinder problems still exist in the field and the status of their resolution. A letter requesting information was sent to 41 transit agencies, and 28 responded. The study identifies the types of compressed natural gas and liquefied natural gas (LNG) cylinders that are being used on transit buses, and the problems being experienced with them. The study assesses the magnitude of these problems, and remedial actions being taken by the transit industry.

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PREFACE

This study was undertaken for the U.S. Department of Transportation's (DOT) Volpe National Transportation Systems Center (Volpe Center) in support of its efforts for the Federal Transit Administration (FTA) to review safety incidents associated with transit buses that use alternative fuels. Specifically, this study is a review of safety incidents associated with compressed natural gas (CNG) and liquefied natural gas (LNG) cylinders.

Vincent R. DeMarco, PE, undertook this review under Contract No. DTRS57-98-P-80434, for the Volpe Center. Mr. William T. Hathaway was the Project Technical Officer.

The information presented in this document is based on 28 responses received to a letter that was sent to 41 transit agencies that had CNG and LNG transit buses in service. The cooperation of the staff of these transit agencies in both responding to this letter and in answering follow-up questions about their responses is sincerely appreciated.

The cooperation of Ms. Alissa Oppenheimer and Mr. William Liss of the Gas Research Institute (GRI), of Mr. Hank Seiff of the Natural Gas Vehicle Coalition (NGVC), and of Dr. Denny Stevens of Battelle was of great assistance in performing this review.

Special thanks are due to Mr. William T. Hathaway of the Volpe Center and Mr. Jeffrey Mora of the FTA for their support, review comments, and constructive suggestions.

METRIC/ENGLISH CONVERSION FACTORS

ENGLISH TO METRIC	METRIC TO ENGLISH
LENGTH (APPROXIMATE)	**LENGTH** (APPROXIMATE)
1 inch (in) = 2.5 centimeters (cm)	1 millimeter (mm) = 0.04 inch (in)
1 foot (ft) = 30 centimeters (cm)	1 centimeter (cm) = 0.4 inch (in)
1 yard (yd) = 0.9 meter (m)	1 meter (m) = 3.3 feet (ft)
1 mile (mi) = 1.6 kilometers (km)	1 meter (m) = 1.1 yards (yd)
	1 kilometer (km) = 0.6 mile (mi)
AREA (APPROXIMATE)	**AREA** (APPROXIMATE)
1 square inch (sq in, in^2) = 6.5 square centimeters (cm^2)	1 square centimeter (cm^2) = 0.16 square inch (sq in, in^2)
1 square foot (sq ft, ft^2) = 0.09 square meter (m^2)	1 square meter (m^2) = 1.2 square yards (sq yd, yd^2)
1 square yard (sq yd, yd^2) = 0.8 square meter (m^2)	1 square kilometer (km^2) = 0.4 square mile (sq mi, mi^2)
1 square mile (sq mi, mi^2) = 2.6 square kilometers (km^2)	10,000 square meters (m^2) = 1 hectare (ha) = 2.5 acres
1 acre = 0.4 hectare (he) = 4,000 square meters (m^2)	
MASS - WEIGHT (APPROXIMATE)	**MASS - WEIGHT** (APPROXIMATE)
1 ounce (oz) = 28 grams (gm)	1 gram (gm) = 0.036 ounce (oz)
1 pound (lb) = 0.45 kilogram (kg)	1 kilogram (kg) = 2.2 pounds (lb)
1 short ton = 2,000 pounds (lb) = 0.9 tonne (t)	1 tonne (t) = 1,000 kilograms (kg)
	= 1.1 short tons
VOLUME (APPROXIMATE)	**VOLUME** (APPROXIMATE)
1 teaspoon (tsp) = 5 milliliters (ml)	1 milliliter (ml) = 0.03 fluid ounce (fl oz)
1 tablespoon (tbsp) = 15 milliliters (ml)	1 liter (l) = 2.1 pints (pt)
1 fluid ounce (fl oz) = 30 milliliters (ml)	1 liter (l) = 1.06 quarts (qt)
1 cup (c) = 0.24 liter (l)	1 liter (l) = 0.26 gallon (gal)
1 pint (pt) = 0.47 liter (l)	
1 quart (qt) = 0.96 liter (l)	
1 gallon (gal) = 3.8 liters (l)	
1 cubic foot (cu ft, ft^3) = 0.03 cubic meter (m^3)	1 cubic meter (m^3) = 36 cubic feet (cu ft, ft^3)
1 cubic yard (cu yd, yd^3) = 0.76 cubic meter (m^3)	1 cubic meter (m^3) = 1.3 cubic yards (cu yd, yd^3)
TEMPERATURE (EXACT)	**TEMPERATURE** (EXACT)
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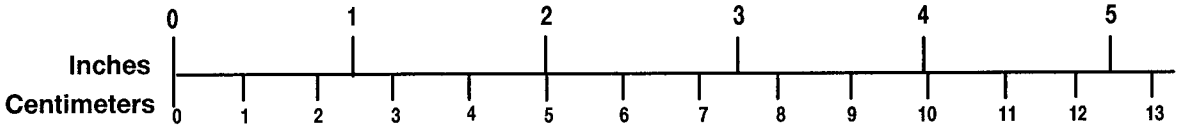

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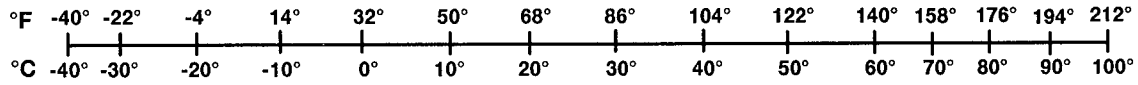

For more exact and or other conversion factors, see NIST Miscellaneous Publication 286, Units of Weights and Measures. Price $2.50 SD Catalog No. C13 10286

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1. INTRODUCTION

1.1 BACKGROUND

The Safety & Security Systems Division of the Volpe National Transportation Systems Center (Volpe Center) provides technical support to the Federal Transit Administration (FTA), of the U.S. Department of Transportation (DOT), in a wide range of activities. These activities range from conducting studies, analyzing and evaluating systems to working with industry or government agencies on the development or revision of standards or regulations to enhance safety and security in transit operations.

One such activity in which the Volpe Center has been involved recently is the assessment of safety in the use of alternative fuels in buses. This assessment included site visits to a number of bus facilities where buses powered by alternative fuels are maintained and fueled. Facility designs, operating practices, personnel training, and emergency responses were also evaluated. Major deficiencies were identified including the lack of data concerning safety incidents associated with transit buses that use alternative fuels, and the lack of information on the issues associated with compressed natural gas cylinders (CNG).

A number of incidents of cylinder leaks have occurred while the transit bus was either in service or at a bus maintenance facility. These leaks have been primarily due to premature release of a compressed natural gas (CNG) cylinder pressure relief device (PRD), glass composite stress corrosion cracking, or due to a plastic liner cracking in a CNG Type 4 cylinder. This study was commissioned to determine the degree to which storage cylinder problems still exist in the field and the status of their resolution.

1.2 OBJECTIVE

The objectives of this study effort were to:

- Identify the types of compressed natural gas (CNG) and liquefied natural gas (LNG) cylinders that are in use, and the problems being experienced with them.

- Assess the magnitude of these problems and remedial actions being taken by the transit industry to resolve them.

1.3 APPROACH

This section describes the approach taken to obtain data from various sources on the types of CNG and LNG cylinders that are used in transit vehicles, the problems with cylinder leaks that have been experienced in the field, and actions taken to resolve them.

1.3.1 Develop a Database on Alternative Fueled Transit Buses

Contacts were made at the FTA and at the American Public Transit Association (APTA) to obtain a database that contained information on which transit agencies were using CNG and LNG buses. The FTA data files were found to primarily contain information on the capital grants that have been made to the transit agencies for the purchase of buses, but not which buses were actually purchased and delivered to the transit agencies. APTA had more complete information in its 1997 APTA Transit Vehicle Database[1] that contained data needed on transit vehicle orders that were delivered, on order, or planned. This database consisted of a three-diskette set that contains Microsoft Word documents and Lotus 123 spreadsheets on transit vehicles (bus and rail), and on the transit agencies that had supplied the data. While the participating transit agencies in this collection may not contain all of the transit agencies using alternative fuels, the listing contains nearly all of them.

Using the 1997 APTA Transit Vehicle Database, the Lotus 123 spreadsheet files were converted into database files. These database files were subsequently combined into a Lotus Approach file, thus reducing the vast APTA data into a single combined database file and to a Microsoft Excel spreadsheet file that contains only the data on alternative fueled transit buses. Table 1-1 is a printout of this Excel file.

From Table 1-1, it can be seen that there are a total of 297 bus orders for alternative fueled buses that have been either delivered ("A"), on order ("O"), or planned ("P"). These orders are from 83 different transit agencies for a total of 6,925 alternative fueled buses. Of these 297 bus orders, 164 represent orders that have already been delivered, 40 are for bus orders that have not yet been delivered, and 93 are for planned bus orders. Further, of these 297 bus orders, there are 224 orders for CNG buses (for a total of 5,514 buses), and 47 orders for LNG buses (for a total of 807 buses). In addition, of the 6,925 alternative fueled buses, a total of 6,321 are for natural gas buses (or a total of 93 percent of all alternative fueled buses).

Table 1-2 shows the distribution of transit buses by fuel type and by bus order type. As can be seen of the 6,925 buses, 2,556 buses have already been delivered ("A"); 1,234 buses are on order ("O"); and 3,135 buses are planned ("P"). Since this data was assembled in 1997, most if not all of the buses that are on order have likely already been delivered.

1.3.2 Letter on Status of CNG and LNG Cylinder Use on Transit Buses

A letter was prepared and reviewed by knowledgeable persons in the field of alternative fuels, and by the sponsor (see Appendix A). It was sent to the 41 transit agencies from Table 1-1 that had 5 or more natural gas transit buses already in service or on order. Of these 41 transit agencies, 28 responses were received (or a response rate of 68 percent). These 28 responses contained 64 different groupings of bus orders that are presently in service at these transit agencies. The responses were entered into a Lotus Approach file, and a printout of this file (in a "Form" format) is contained in Appendix B. An analysis of these responses is provided in Section 2 of this report.

1.3.3 Visits to Obtain Data From Industry Sources

GRI Workshops

A Gas Research Institute (GRI) Workshop was held at APTA on March 18-19, 1998. Battelle described its efforts with regard to performing Failure Modes and Effects Analyses (FMEAs) on CNG cylinders and PRDs, and reviewed the crashworthiness of CNG tanks on trucks.

A GRI Transit Users Group (TUG) Workshop was held at MTA Long Island Bus on June 16-17, 1998. There were discussions on the status of GRI's effort to produce a recommended best practices guideline for the integration of natural gas (CNG and LNG) fuel systems for transit buses, lessons learned on CNG/LNG buses, and presentations on CNG and LNG fueling station technology.[2] In addition, a facility tour of Long Island Bus was taken. The tour leader noted the special safety equipment, including the use of Foxboro's open path gas detection system that was installed to sound an alarm whenever gas is detected above a selected threshold amount. The system uses a combination of open path and point infrared detectors. The open path detectors project infrared beams across spans of up to 300 feet in a checkerboard pattern to detect flammable gas leaks, while the point detectors are used in maintenance pits and other confined spaces.

A GRI Workshop was held at APTA on September 23-24, 1998 to review the first draft of a set of reference guides with regard to recommended practices for the integration of CNG and LNG fuel systems for transit vehicles, which were prepared by Battelle.[3] This set of documents, which are expected to be completed by May 1999, represent a comprehensive and thorough description of these fuel systems and should be considered a "must have" for transit agencies operating natural gas fueled buses, as well as equipment suppliers and consultants.

Battelle

A visit was made to Battelle Memorial Laboratories in Columbus, Ohio, on March 25, 1998 to meet with Dr. Denny Stevens of the Energy Systems Division. He provided valuable insights on the problems experienced in the field with CNG cylinders and PRDs, and provided a list of references and reports that proved to be very useful to this study effort.[4] [5] [6]

He also described the efforts Battelle had underway concerning CNG cylinders and PRDs. He indicated that PRDs were a severe bus industry problem two to five years ago, primarily because of problems with Mirada's Generation 3 PRD valves. A new natural gas industry standard today for PRDs (PRD-1 Standard)[7] has been adopted, which should produce a more robust PRD. Mirada, which supplied the majority of PRDs currently in use on transit buses, has moved to a Generation 2.5 PRD valve, which now appears to be working well. This valve only measures temperature, rather than both temperature and pressure that the older Mirada Generation 3 PRD model measured. It was the premature rupture of the pressure sensing rupture disk on this older model that caused many of the premature gas releases that were experienced by transit operators in the field. The rationale for monitoring only temperature was determined to be appropriate since excess pressure (without a corresponding large increase in temperature) could only occur during fueling fill time, where pressure was already being adequately monitored and controlled

by the filling station equipment. More information about this subject is contained in Appendix C of Volume 2 of the Battelle report. [3]

Dr. Stevens described the efforts that were underway to upgrade the NGV 2 Standard for CNG cylinders, which was issued in 1992. It may be instructive to note that under this revised standard, NGV2-1998,[8] CNG cylinders are divided into four types as follows:

- NGV2-1: Metal.
- NGV2-2: Resin impregnated continuous filament with metal liner with a minimum burst pressure of 125 percent of service pressure. The container may be either hoop-wrapped or full-wrapped.
- NGV2-3: Resin impregnated continuous filament with metal liner. The container may be either hoop-wrapped or full-wrapped.
- NGV2-4: Resin impregnated continuous filament with a non-metallic liner.

Note that the prior version of this standard, NGV2-1992, Type 2 cylinders included only hoop-wrapped. Dr. Stevens also described the efforts Battelle was undertaking for GRI concerning the development of a set of guideline documents on best practices for the integration and use of natural gas vehicle fuel systems,[3] and the efforts that he had underway to develop "smart" technologies that could be placed onto or made an integral part of a CNG cylinder to determine the integrity of the cylinder. These efforts included the use of special damage indicator coatings, and the use of an acoustic-based electronic monitoring system that measures changes in the acoustical characteristics of a cylinder which would provide a measure of the change in wall stiffness which correlates directly with a change in cylinder integrity.

Natural Gas Vehicle Coalition (NGVC)

Two visits were made to the (NGVC) offices in Arlington, Virginia, to see Mr. Hank Seiff, Director of Technology, to inform him about the study effort that was underway and to keep his office advised of its progress. A number of documents were obtained from the NGVC library.[9] [10] [11] [12]

Contacts with Cylinder and Transit Bus Manufacturers

A fax was sent to the eight cylinder and six transit bus original equipment manufacturers (OEMs) identified in the responses to provide them with:

- Notice about this study effort;
- Copy of the letter that was mailed to the 41 transit agencies;
- Preliminary summary of the responses received;
- Opportunity to offer any comments or advice;
- Request for pictures of cylinder installations on transit buses.

The pictures following the tables show typical cylinder installation on transit buses.

Table 1-1. Alternative Fueled Transit Buses

APTA ID Number	Short Agency Name	City	State	Year Built	Code	Mfr.	Model	Vehicle Type	Length (feet)	Fuel	Engine	Total
28400	Calgary Transit	Calgary	AB	1994	A	TBB	E37	Van/mini	22	CG	FO8	11
28400	Calgary Transit	Calgary	AB	1996	A	GCA	ELF 125	Van/mini	25	CN	FO8	1
6900	Birmingham-Jefferson Co TA	Birmingham	AL	1995	A	AVS	5128/B	Smallbus	28	EB	NE	3
700	City of Phoenix PTD	Phoenix	AZ	1994	A	SVM	5122/B	Van/mini	22	EB	NE	1
700	City of Phoenix PTD	Phoenix	AZ	1998	O	NAB	416-LF	Largebus	40	LN	CU4	156
700	City of Phoenix PTD	Phoenix	AZ	2000	P	UNK	UNKNOWN	Largebus	40	LN	UNK	55
700	City of Phoenix PTD	Phoenix	AZ	1999	P	UNK	UNKNOWN	Largebus	40	LN	UNK	20
115800	Regional Public Transp Auth	Phoenix	AZ	1995	A	EDN	AEROTECH	Smallbus	32	CG	DO6	4
115800	Regional Public Transp Auth	Phoenix	AZ	1998	O	NAB	416-LF	Largebus	40	LN	CU4	2
115800	Regional Public Transp Auth	Phoenix	AZ	1999	P	UNK	UNKNOWN	Largebus	40	LN	UNK	6
800	City of Tucson MTS	Tucson	AZ	1994	A	NEO	AN-440-A	Largebus	40	CD	DD6	29
800	City of Tucson MTS	Tucson	AZ	1993	A	NEO	AN-440-A	Largebus	40	CD	DD6	15
800	City of Tucson MTS	Tucson	AZ	1991	A	NEO	AN-440-A	Largebus	40	CN	DD6	3
800	City of Tucson MTS	Tucson	AZ	1996	A	NFI	C40	Largebus	40	CN	DD4	19
800	City of Tucson MTS	Tucson	AZ	1994	A	BIA	ORION 02.501	Van/mini	26	CN	TE8	6
800	City of Tucson MTS	Tucson	AZ	1997	O	NFI	C40	Largebus	40	CN	DD4	25
800	City of Tucson MTS	Tucson	AZ	2002	P	UNK	UNKNOWN	Largebus	40	CN	UNK	30
800	City of Tucson MTS	Tucson	AZ	2001	P	UNK	UNKNOWN	Largebus	40	CN	UNK	25
800	City of Tucson MTS	Tucson	AZ	1999	P	UNK	UNKNOWN	Largebus	40	CN	UNK	15
800	City of Tucson MTS	Tucson	AZ	1998	P	UNK	UNKNOWN	Largebus	40	CN	UNK	8
28800	BC Transit--Vancouver RTS	Vancouver	BC	1989	A	MCI	TC 40102N	Largebus	40	CN	DD6	1
28800	BC Transit--Vancouver RTS	Vancouver	BC	1995	A	NFI	D40	Largebus	40	CN	DD4	25
28800	BC Transit--Vancouver RTS	Vancouver	BC	1997	O	NFI	H40LF	Largebus	40	HY	NE	3
1400	Culver City Munic Bus Lines	Culver City	CA	1998	P	UNK	UNKNOWN	Largebus	40	CN	UNK	20
1800	Long Beach Transit	Long Beach	CA	1996	A	ORI	2.501	Van/mini	26	CN	GM8	5
136300	City of Los Angeles DOT	Los Angeles	CA	1992	A	EDN	ESCORT RE	Smallbus	29	CN	HE6	40
136300	City of Los Angeles DOT	Los Angeles	CA	1995	A	EDN	TRANSMARK RE	Smallbus	29	CN	CU6	5
136300	City of Los Angeles DOT	Los Angeles	CA	1991	A	NCC	ESCORT RE	Smallbus	29	CN	FO8	12
136300	City of Los Angeles DOT	Los Angeles	CA	1993	A	BBB	Q-BUS	Smallbus	30	LP	GM8	5
136300	City of Los Angeles DOT	Los Angeles	CA	1992	A	COL	WORLDTRANS	Smallbus	29	LP	FO8	3
136300	City of Los Angeles DOT	Los Angeles	CA	1999	P	UNK	UNKNOWN	Smallbus	29	LP	UNK	52
136300	City of Los Angeles DOT	Los Angeles	CA	1998	P	UNK	UNKNOWN	Smallbus	30	LP	UNK	18
136300	City of Los Angeles DOT	Los Angeles	CA	1997	P	UNK	UNKNOWN	Smallbus	30	LP	UNK	16
136300	City of Los Angeles DOT	Los Angeles	CA	1997	P	UNK	UNKNOWN	Smallbus	30	LP	UNK	18
4100	Los Angeles County MTA	Los Angeles	CA	1990	A	FLX	METRO 40102-6C-1	Largebus	40	CN	CU6	10
4100	Los Angeles County MTA	Los Angeles	CA	1995	A	NEO	AN-440-A	Largebus	40	CN	CU6	102
4100	Los Angeles County MTA	Los Angeles	CA	1996	A	NEO	AN-440-A A	Largebus	40	CN	CU6	94
4100	Los Angeles County MTA	Los Angeles	CA	1997	A	NEO	AN-440-A B	Largebus	40	CN	CU6	72
4100	Los Angeles County MTA	Los Angeles	CA	1996	A	NEO	AN-440-A B	Largebus	40	CN	CU6	26

Source: 1997 APTA Transit Vehicle Database
Code: A-Active, O-Ordered, P-Planned
Fuel: C-CNG, L-LNG, P-Propane, D-Diesel, G-Gasoline, ET-Ethanol, MT-Methanol, E-Electric, B-Battery

Table 1-1. Alternative Fueled Transit Buses (Continued)

APTA ID Number	Short Agency Name	City	State	Year Built	Code	Mfr.	Model	Vehicle Type	Length (feet)	Fuel	Engine	Total
4100	Los Angeles County MTA	Los Angeles	CA	1998	O	NEO	AN-440-A	Largebus	40	CN	CU6	178
4100	Los Angeles County MTA	Los Angeles	CA	1997	O	NEO	AN-440-A A	Largebus	40	CN	CU6	72
4100	Los Angeles County MTA	Los Angeles	CA	2002	P	UNK	UNKNOWN	Largebus	40	CN	UNK	166
4100	Los Angeles County MTA	Los Angeles	CA	2001	P	UNK	UNKNOWN	Largebus	40	CN	UNK	166
4100	Los Angeles County MTA	Los Angeles	CA	2000	P	UNK	UNKNOWN	Largebus	40	CN	UNK	166
4100	Los Angeles County MTA	Los Angeles	CA	1999	P	UNK	UNKNOWN	Largebus	40	CN	UNK	200
4100	Los Angeles County MTA	Los Angeles	CA	1993	A	TMC	RTS T80 206	Largebus	40	ET	DD6	303
4100	Los Angeles County MTA	Los Angeles	CA	1989	A	TMC	RTS T80 206	Largebus	40	ET	DD6	30
2100	Monterey-Salinas Transit	Monterey	CA	1995	A	FLX	METRO 35102-4D-0	Medbus	35	CN	DD4	8
2100	Monterey-Salinas Transit	Monterey	CA	1996	O	ORI	5.505	Smallbus	30	CN	CU6	9
2400	Orange County Transp Auth	Orange	CA	1989	A	GIL	PHANTOM (DD4)	Largebus	40	LP	DD4	2
3900	South Coast Area Transit	Oxnard	CA	1995	A	FLX	METRO 40102-4D-1	Largebus	40	CN	DD4	8
3900	South Coast Area Transit	Oxnard	CA	1995	A	FLX	METRO 35102-4D-1	Medbus	35	CN	DD4	18
3900	South Coast Area Transit	Oxnard	CA	1997	O	ORI	5.503	Smallbus	30	CN	DD4	9
2600	Riverside Transit Agency	Riverside	CA	1995	A	FLX	METRO 40102-6C-1	Largebus	40	CN	CU6	17
2600	Riverside Transit Agency	Riverside	CA	1994	A	CCI	AH-28	Trolleyr	29	CN	CU6	4
2600	Riverside Transit Agency	Riverside	CA	1994	A	SPC	SENATOR	Van/mini	23	CN	FO8	3
2600	Riverside Transit Agency	Riverside	CA	1997	P	UNK	UNKNOWN	Largebus	40	CN	UNK	3
2600	Riverside Transit Agency	Riverside	CA	1982	A	GMC	RTS T80 204	Largebus	40	MT	DD6	3
2700	Sacramento Regional Tr Dist	Sacramento	CA	1994	A	BIA	ORION 05.501	Largebus	40	CN	CU6	20
2700	Sacramento Regional Tr Dist	Sacramento	CA	1993	A	BIA	ORION 05.501	Largebus	40	CN	CU6	75
2700	Sacramento Regional Tr Dist	Sacramento	CA	1996	A	ORI	5.501	Largebus	40	CN	CU6	25
2700	Sacramento Regional Tr Dist	Sacramento	CA	1996	A	ORI	5.505	Smallbus	31	CN	CU6	15
2700	Sacramento Regional Tr Dist	Sacramento	CA	2002	P	UNK	UNKNOWN	Largebus	40	CN	UNK	50
2700	Sacramento Regional Tr Dist	Sacramento	CA	2000	P	UNK	UNKNOWN	Largebus	40	CN	UNK	20
2700	Sacramento Regional Tr Dist	Sacramento	CA	1996	O	AVS	5122/B	Van/mini	22	EB	NE	5
2300	OMNITRANS	San Bernardino	CA	1996	A	ORI	5.503	Largebus	40	CN	CU6	21
2300	OMNITRANS	San Bernardino	CA	1996	O	ORI	5.503	Largebus	40	CN	CU6	3
2300	OMNITRANS	San Bernardino	CA	1996	O	NEO	AN-440-A	Subbus	40	CN	CU6	7
2300	OMNITRANS	San Bernardino	CA	2002	P	UNK	UNKNOWN	Largebus	40	CN	UNK	8
2300	OMNITRANS	San Bernardino	CA	2001	P	UNK	UNKNOWN	Largebus	40	CN	UNK	9
2300	OMNITRANS	San Bernardino	CA	2000	P	UNK	UNKNOWN	Largebus	40	CN	UNK	9
2300	OMNITRANS	San Bernardino	CA	1999	P	UNK	UNKNOWN	Largebus	40	CN	UNK	13
2300	OMNITRANS	San Bernardino	CA	1998	P	UNK	UNKNOWN	Largebus	40	CN	UNK	8
2300	OMNITRANS	San Bernardino	CA	1997	P	UNK	UNKNOWN	Largebus	40	CN	UNK	16
2300	OMNITRANS	San Bernardino	CA	2000	P	UNK	UNKNOWN	Medbus	35	EB	NE	4
32900	San Diego Metro Tr Dev Bd	San Diego	CA	1995	A	NFI	C40	Largebus	40	CN	DD4	68
32900	San Diego Metro Tr Dev Bd	San Diego	CA	1995	A	EDN	RE29	Smallbus	29	CN	HE6	2
2800	San Diego Transit Corp	San Diego	CA	1995	A	NFI	C40	Largebus	40	CN	DD4	29

Source: 1997 APTA Transit Vehicle Database
Code: A-Active, O-Ordered, P-Planned
Fuel: C-CNG, L-LNG, P-Propane, D-Diesel, G-Gasoline, ET-Ethanol, MT-Methanol, E-Electric, B-Battery

Table 1-1. Alternative Fueled Transit Buses (Continued)

APTA ID Number	Short Agency Name	City	State	Year Built	Code	Mfr.	Model	Vehicle Type	Length (feet)	Fuel	Engine	Total
2800	San Diego Transit Corp	San Diego	CA	1994	A	NFI	C40LF	Largebus	40	CN	DD4	4
2800	San Diego Transit Corp	San Diego	CA	1997	O	NFI	C40LF	Largebus	40	CN	DD4	27
2800	San Diego Transit Corp	San Diego	CA	2002	P	UNK	UNKNOWN	Largebus	40	CN	UNK	25
2800	San Diego Transit Corp	San Diego	CA	2001	P	UNK	UNKNOWN	Largebus	40	CN	UNK	25
2800	San Diego Transit Corp	San Diego	CA	2000	P	UNK	UNKNOWN	Largebus	40	CN	UNK	25
2800	San Diego Transit Corp	San Diego	CA	1999	P	UNK	UNKNOWN	Largebus	40	CN	UNK	25
2800	San Diego Transit Corp	San Diego	CA	1998	P	UNK	UNKNOWN	Largebus	40	CN	UNK	22
127700	San Luis Transit	San Luis Obispo	CA	1994	A	BIA	ORION 05.501	Largebus	40	CN	CU6	2
127700	San Luis Transit	San Luis Obispo	CA	1980	A	FLX	870 40102-6-1	Largebus	40	LP	DD6	3
3500	Santa Monica Munic Bus Lines	Santa Monica	CA	1996	A	APS	UNKNOWN	Van/mini	26	EB	NE	3
4300	SunLine Transit Agency	Thousand Palms	CA	1994	A	BIA	ORION 05.501	Largebus	40	CN	CU6	34
4300	SunLine Transit Agency	Thousand Palms	CA	1985	A	GIL	PHANTOM	Largebus	40	CN	DD6	1
4300	SunLine Transit Agency	Thousand Palms	CA	1994	A	EDN	ESCORT	Smallbus	29	CN	CU6	5
174400	Foothill Transit	West Covina	CA	1999	P	UNK	UNKNOWN	Largebus	40	CB	UNK	15
174400	Foothill Transit	West Covina	CA	1997	P	UNK	UNKNOWN	Largebus	40	CB	UNK	1
230700	Springs Transit	Colorado Springs	CO	1983	A	GIL	PHANTOM	Largebus	40	CD	DD6	1
4900	Regional Transportation Dist	Denver	CO	1997	P	UNK	UNKNOWN	Longbus	45	CB	UNK	26
4900	Regional Transportation Dist	Denver	CO	1986	A	NEO	AN-440-A	Largebus	40	CD	DD6	5
4900	Regional Transportation Dist	Denver	CO	1997	O	WTI	3000	Van/mini	27	CN	CU6	3
4900	Regional Transportation Dist	Denver	CO	1982	A	M/V	7000E	Largebus	40	EB	NE	6
83500	Transfort	Fort Collins	CO	1994	A	SPC	STARTRANS	Van/mini	24	LP	FO8	2
83500	Transfort	Fort Collins	CO	1991	A	SPC	STARTRANS	Van/mini	24	LP	FO8	1
83500	Transfort	Fort Collins	CO	1996	O	SPC	STARTRANS	Van/mini	24	LP	GM8	1
5500	Norwalk Transit Dist	Norwalk	CT	1993	A	TTT	CP30	Smallbus	29	CG	CH8	4
5500	Norwalk Transit Dist	Norwalk	CT	1998	P	UNK	UNKNOWN	Smallbus	29	CG	UNK	4
5700	Washington Metro Area Tr Auth	Washington	DC	1997	P	UNK	UNKNOWN	Smallbus	30	EB	NE	3
120200	Delaware Transit Corp	Dover	DE	1993	A	SPC	STARTRANS	Van/mini	25	CN	FO8	2
6000	Pinellas Suncoast Tran Auth	Clearwater	FL	1998	O	NFI	C40LF	Largebus	40	CN	DD4	4
6000	Pinellas Suncoast Tran Auth	Clearwater	FL	1995	A	AVS	5122/B	Van/mini	22	EB	NE	1
6300	Metro-Dade Transit Agency	Miami	FL	1992	A	FLX	METRO 40102-6C-1	Largebus	40	CN	CU6	5
6300	Metro-Dade Transit Agency	Miami	FL	1992	A	FLX	METRO 40102-6C-1	Largebus	40	MT	CU6	5
83100	Central Florida Reg Trp Auth	Orlando	FL	1994	A	BIA	ORION 05.505	Smallbus	30	CN	DD6	6
83100	Central Florida Reg Trp Auth	Orlando	FL	1997	O	NFI	C35	Medbus	35	CN	UNK	10
84500	Hillsborough Area Reg Tr Auth	Tampa	FL	1994	A	BBB	Q-BUS	Smallbus	29	CN	CU6	5
84500	Hillsborough Area Reg Tr Auth	Tampa	FL	1998	P	UNK	UNKNOWN	Trolleyr	30	CN	UNK	3
7000	Metro Atlanta Rapid Tr Auth	Atlanta	GA	1996	A	NFI	C40LF	Largebus	40	CN	DD4	118
7000	Metro Atlanta Rapid Tr Auth	Atlanta	GA	1998	P	UNK	UNKNOWN	Largebus	40	CN	UNK	132
129200	Chatham Area Transit Auth	Savannah	GA	1994	A	AVS	5122/B	Van/mini	21	EB	NE	4

Source: 1997 APTA Transit Vehicle Database
Code: A-Active, O-Ordered, P-Planned
Fuel: C-CNG, L-LNG, P-Propane, D-Diesel, G-Gasoline, ET-Ethanol, MT-Methanol, E-Electric, B-Battery

Table 1-1. Alternative Fueled Transit Buses (Continued)

APTA ID Number	Short Agency Name	City	State	Year Built	Code	Mfr.	Model	Vehicle Type	Length (feet)	Fuel	Engine	Total
7900	Boise Urban Stages	Boise City	ID	1993	A	BIA	ORION 01.507	Medbus	35	CN	CU6	2
7900	Boise Urban Stages	Boise City	ID	1994	A	NCC	TRANSMARK RE	Medbus	33	CN	HE6	20
7900	Boise Urban Stages	Boise City	ID	1996	A	THR	ELF 125	Van/mini	25	CN	FO8	3
7900	Boise Urban Stages	Boise City	ID	2000	P	UNK	UNKNOWN	Medbus	33	CN	UNK	2
7900	Boise Urban Stages	Boise City	ID	1998	P	UNK	UNKNOWN	Medbus	33	CN	UNK	2
7900	Boise Urban Stages	Boise City	ID	1997	P	UNK	UNKNOWN	Medbus	33	CN	UNK	3
8000	Chicago Transit Authority	Chicago	IL	1997	O	NFI	H40LF	Largebus	40	HY	NE	3
8400	Greater Peoria Mass Tr Dist	Peoria	IL	1992	A	TMC	RTS T70 606	Medbus	35	ET	DD6	14
93500	Springfield Mass Transit Dist	Springfield	IL	1996	A	NFI	C35	Medbus	35	CN	DD4	7
93500	Springfield Mass Transit Dist	Springfield	IL	1999	P	UNK	UNKNOWN	Medbus	35	CN	UNK	4
93500	Springfield Mass Transit Dist	Springfield	IL	1998	P	UNK	UNKNOWN	Medbus	35	CN	UNK	4
9200	Gary Public Transp Corp	Gary	IN	1995	A	FLX	METRO 35096-6C-1	Medbus	35	LN	CU6	3
9200	Gary Public Transp Corp	Gary	IN	1993	A	FLX	METRO 35096-6C-1	Medbus	35	LN	CU6	2
9200	Gary Public Transp Corp	Gary	IN	1997	P	UNK	UNKNOWN	Smallbus	30	LN	UNK	1
11500	Mass Transit Admin of MD	Baltimore	MD	1993	A	FLX	METRO 40102-6T-1	Largebus	40	LN	CU6	4
132600	Prince George's County DPW&T	Landover	MD	1996	A	GCC	CUTAWAY	Van/mini	25	CN	FO8	3
118400	Montgomery County Tr Svces	Rockville	MD	1994	A	BIA	ORION 05.504	Medbus	35	CN	CU6	3
13400	City of Detroit Dept of Transp	Detroit	MI	1998	P	CCI	AH-28	Trolleyr	28	CN	CU6	4
224400	Blue Water Area TC	Port Huron	MI	1996	P	UNK	UNKNOWN	Smallbus	30	CN	UNK	2
14900	Saint Cloud Metro Transit Comm	Saint Cloud	MN	1985	A	EBC	FALCON	Van/mini	21	CN	FO8	1
15200	Bi-State Development Agency	Saint Louis	MO	1991	A	FLX	METRO 40102-6C-1	Largebus	40	CN	CU6	2
15200	Bi-State Development Agency	Saint Louis	MO	1997	O	NEO	AN-440-A	Largebus	40	CN	CU6	38
15200	Bi-State Development Agency	Saint Louis	MO	1999	P	UNK	UNKNOWN	Largebus	40	CN	UNK	24
16400	New Jersey TC	Newark	NJ	1991	A	FLX	METRO 40102-6C-1	Largebus	40	CN	CU6	5
16400	New Jersey TC	Newark	NJ	1998	P	UNK	UNKNOWN	Interbus	40	CN	UNK	50
68400	Niagara Frontier Transp Auth	Buffalo	NY	1993	A	BIA	ORION 05.501	Largebus	40	CN	CU6	5
67700	MTA Long Island Bus	Garden City	NY	1992	A	BIA	ORION 05.501	Largebus	40	CN	CU6	10
67700	MTA Long Island Bus	Garden City	NY	1995	A	ORI	5.501	Largebus	40	CN	CU6	25
67700	MTA Long Island Bus	Garden City	NY	1996	A	ORI	2.501	Van/mini	26	CN	CU6	1
67700	MTA Long Island Bus	Garden City	NY	1995	A	ORI	2.501	Van/mini	26	CN	CU6	4
67700	MTA Long Island Bus	Garden City	NY	1997	O	ORI	5.501	Largebus	40	CN	CU6	75
67700	MTA Long Island Bus	Garden City	NY	1996	O	ORI	5.501	Largebus	40	CN	CU6	50
67700	MTA Long Island Bus	Garden City	NY	2001	P	UNK	UNKNOWN	Largebus	40	CN	UNK	21
67700	MTA Long Island Bus	Garden City	NY	2000	P	UNK	UNKNOWN	Largebus	40	CN	UNK	37
67700	MTA Long Island Bus	Garden City	NY	1999	P	UNK	UNKNOWN	Largebus	40	CN	UNK	30
67400	MTA New York City Transit	New York	NY	1990	A	TMC	RTS T80 206	Largebus	40	CD	DD6	1
67400	MTA New York City Transit	New York	NY	1993	A	BIA	ORION 05.501	Largebus	40	CN	CU6	1
67400	MTA New York City Transit	New York	NY	1995	A	ORI	5.501	Largebus	40	CN	CU6	30
67400	MTA New York City Transit	New York	NY	1993	A	TMC	RTS T80 206	Largebus	40	CN	CU6	1

Source: 1997 APTA Transit Vehicle Database
Code: A-Active, O-Ordered, P-Planned
Fuel: C-CNG, L-LNG, P-Propane, D-Diesel, G-Gasoline, ET-Ethanol, MT-Methanol, E-Electric, B-Battery

Table 1-1. Alternative Fueled Transit Buses (Continued)

APTA ID Number	Short Agency Name	City	State	Year Built	Code	Mfr.	Model	Vehicle Type	Length (feet)	Fuel	Engine	Total
67400	MTA New York City Transit	New York	NY	1990	A	TMC	RTS T80 206	Largebus	40	CN	CU6	1
67400	MTA New York City Transit	New York	NY	1998	P	UNK	UNKNOWN	Largebus	40	CN	UNK	190
67400	MTA New York City Transit	New York	NY	1990	A	TMC	RTS T80 206	Largebus	40	MT	DD6	1
32600	New York City Dept of Trp	New York	NY	1994	A	TMC	RTS T80 206	Largebus	40	CN	CU6	53
32600	New York City Dept of Trp	New York	NY	1997	O	ORI	5.501	Largebus	40	CN	DD4	174
32600	New York City Dept of Trp	New York	NY	1986	A	GMC	RTS T80 206	Largebus	40	MT	DD6	6
32600	New York City Dept of Trp	New York	NY	1994	A	TMC	RTS T80 206	Largebus	40	MT	DD6	12
18600	Rochester-Genessee RTA	Rochester	NY	1992	A	BIA	ORION 05.501	Largebus	40	CN	CU6	5
17300	CNY Centro	Syracuse	NY	1992	A	BIA	ORION 05.501	Largebus	40	CN	CU6	13
17300	CNY Centro	Syracuse	NY	1997	O	NOV	RTS T80 208	Largebus	40	CN	CU6	18
17300	CNY Centro	Syracuse	NY	1999	P	UNK	UNKNOWN	Largebus	40	CN	UNK	99
17300	CNY Centro	Syracuse	NY	1997	P	UNK	UNKNOWN	Largebus	40	CN	UNK	7
17300	CNY Centro	Syracuse	NY	2000	P	UNK	UNKNOWN	Medbus	35	CN	UNK	10
20800	Metro Regional Transit Auth	Akron	OH	1998	O	NFI	D35LF	Medbus	35	CN	DD4	6
20800	Metro Regional Transit Auth	Akron	OH	1998	O	ORI	5.502	Medbus	35	CN	DD4	27
20800	Metro Regional Transit Auth	Akron	OH	1999	P	UNK	UNKNOWN	Largebus	40	CN	UNK	6
20400	Greater Cleveland Reg Tr Auth	Cleveland	OH	1995	A	FLX	METRO 40102-4D-1	Largebus	40	CN	DD4	15
20400	Greater Cleveland Reg Tr Auth	Cleveland	OH	1994	A	FLX	METRO 40102-4D-1	Largebus	40	CN	DD4	65
20400	Greater Cleveland Reg Tr Auth	Cleveland	OH	1989	A	FLX	METRO 40102-6C-1	Largebus	40	CN	CU6	1
20400	Greater Cleveland Reg Tr Auth	Cleveland	OH	1992	A	FLX	METRO 35102-6C-1	Medbus	35	CN	CU6	5
20400	Greater Cleveland Reg Tr Auth	Cleveland	OH	1991	A	FLX	METRO 30102-6C-1	Smallbus	30	CN	CU6	15
20400	Greater Cleveland Reg Tr Auth	Cleveland	OH	1997	O	NOV	T-8200 WFD	Largebus	40	CN	DD4	65
20400	Greater Cleveland Reg Tr Auth	Cleveland	OH	1997	O	EDN	EZ RIDER	Smallbus	29	CN	CU6	5
20400	Greater Cleveland Reg Tr Auth	Cleveland	OH	2002	P	UNK	UNKNOWN	Largebus	40	CN	UNK	76
20400	Greater Cleveland Reg Tr Auth	Cleveland	OH	2001	P	UNK	UNKNOWN	Largebus	40	CN	UNK	74
20400	Greater Cleveland Reg Tr Auth	Cleveland	OH	2000	P	UNK	UNKNOWN	Largebus	40	CN	UNK	77
20400	Greater Cleveland Reg Tr Auth	Cleveland	OH	1999	P	UNK	UNKNOWN	Largebus	40	CN	UNK	39
20400	Greater Cleveland Reg Tr Auth	Cleveland	OH	1998	P	UNK	UNKNOWN	Largebus	40	CN	UNK	61
20600	LAKETRAN	Grand River	OH	1997	O	NFI	C35LF	Medbus	35	CN	DD4	12
21400	Central Oklahoma T&P Auth	Oklahoma City	OK	1989	A	NCC	ESCORT RE	Smallbus	28	CG	FO8	3
21400	Central Oklahoma T&P Auth	Oklahoma City	OK	1989	A	NCC	ESCORT RE	Smallbus	28	CN	HE6	1
21400	Central Oklahoma T&P Auth	Oklahoma City	OK	1997	O	NOV	RTS T70 608	Medbus	35	CN	DD4	3
21400	Central Oklahoma T&P Auth	Oklahoma City	OK	1999	P	UNK	UNKNOWN	Medbus	35	CN	UNK	5
21400	Central Oklahoma T&P Auth	Oklahoma City	OK	1998	P	UNK	UNKNOWN	Medbus	35	CN	UNK	5
21400	Central Oklahoma T&P Auth	Oklahoma City	OK	2000	P	UNK	UNKNOWN	Smallbus	30	CN	UNK	10
21400	Central Oklahoma T&P Auth	Oklahoma City	OK	1999	P	UNK	UNKNOWN	Smallbus	30	CN	UNK	4
137600	Hamilton Street Railway Co	Hamilton	ON	1977	A	GML	T6H 5307N	Largebus	40	CN	IV6	6
137600	Hamilton Street Railway Co	Hamilton	ON	1996	A	NFI	D40LF	Largebus	40	CN	DD4	25
137600	Hamilton Street Railway Co	Hamilton	ON	1992	A	OBI	ORION 05.501	Largebus	40	CN	CU6	15

Source: 1997 APTA Transit Vehicle Database
Code: A-Active, O-Ordered, P-Planned
Fuel: C-CNG, L-LNG, P-Propane, D-Diesel, G-Gasoline, ET-Ethanol, MT-Methanol, E-Electric, B-Battery

Table 1-1. Alternative Fueled Transit Buses (Continued)

APTA ID Number	Short Agency Name	City	State	Year Built	Code	Mfr.	Model	Vehicle Type	Length (feet)	Fuel	Engine	Total
137600	Hamilton Street Railway Co	Hamilton	ON	1991	A	OBI	ORION 05.501	Largebus	40	CN	CU6	15
137600	Hamilton Street Railway Co	Hamilton	ON	1997	O	ORI	6.501	Largebus	40	CN	CU6	25
137600	Hamilton Street Railway Co	Hamilton	ON	2001	P	UNK	UNKNOWN	Largebus	40	CN	UNK	10
137600	Hamilton Street Railway Co	Hamilton	ON	2000	P	UNK	UNKNOWN	Largebus	40	CN	UNK	10
137600	Hamilton Street Railway Co	Hamilton	ON	1999	P	UNK	UNKNOWN	Largebus	40	CN	UNK	10
137600	Hamilton Street Railway Co	Hamilton	ON	1998	P	UNK	UNKNOWN	Largebus	40	CN	UNK	10
137600	Hamilton Street Railway Co	Hamilton	ON	1997	P	UNK	UNKNOWN	Largebus	40	CN	UNK	10
28900	Mississauga Transit	Mississauga	ON	1989	A	OBI	ORION 01.508	Largebus	40	CN	CU6	1
28900	Mississauga Transit	Mississauga	ON	1992	A	OBI	ORION 05.501	Largebus	40	CN	CU6	10
28900	Mississauga Transit	Mississauga	ON	1997	O	ORI	5.501	Largebus	40	CN	CU6	12
29400	Toronto Transit Commission	Toronto	ON	1991	A	OBI	ORION 05.501	Largebus	40	CN	CU6	25
29400	Toronto Transit Commission	Toronto	ON	1996	A	ORI	5.501	Largebus	40	CN	CU6	41
29400	Toronto Transit Commission	Toronto	ON	1996	O	ORI	5.501	Largebus	40	CN	CU6	9
29400	Toronto Transit Commission	Toronto	ON	1997	O	ORI	6.501	Largebus	40	CN	CU6	50
21800	Tri-County Metro Trp Dist	Portland	OR	1992	A	CMC	CUTAWAY	Van/mini	20	CG	FO8	10
21800	Tri-County Metro Trp Dist	Portland	OR	1993	A	FLX	METRO 40102-6C-0	Largebus	40	LN	CU6	8
21800	Tri-County Metro Trp Dist	Portland	OR	1992	A	GIL	PHANTOM	Largebus	40	LN	CU6	2
21700	Salem Area Mass Transit Dist	Salem	OR	1999	P	UNK	UNKNOWN	Largebus	40	CN	UNK	10
21700	Salem Area Mass Transit Dist	Salem	OR	1998	P	UNK	UNKNOWN	Medbus	35	CN	UNK	10
21700	Salem Area Mass Transit Dist	Salem	OR	1997	P	UNK	UNKNOWN	Smallbus	30	CN	UNK	10
22600	Lehigh & Northampton Trp Auth	Allentown	PA	1996	A	AVS	5122/B	Van/mini	22	EB	NE	1
23000	Southeastern Pennsylvania TA	Philadelphia	PA	2000	P	UNK	UNKNOWN	Smallbus	30	CN	UNK	100
22800	Port Auth of Allegheny County	Pittsburgh	PA	1991	A	BIA	ORION 05.501	Largebus	40	CN	CU6	5
22800	Port Auth of Allegheny County	Pittsburgh	PA	1998	P	UNK	UNKNOWN	Largebus	40	CN	UNK	15
87600	Berks Area Reading Trp Auth	Reading	PA	1992	A	BIA	ORION 05.501	Largebus	40	CN	CU6	1
87600	Berks Area Reading Trp Auth	Reading	PA	1996	A	NFI	C40LF	Largebus	40	CN	DD4	5
87600	Berks Area Reading Trp Auth	Reading	PA	1996	A	ORI	5.501	Largebus	40	CN	DD4	1
87600	Berks Area Reading Trp Auth	Reading	PA	1995	A	ORI	5.501	Largebus	40	CN	DD4	1
87600	Berks Area Reading Trp Auth	Reading	PA	1998	P	UNK	UNKNOWN	Smallbus	25	CN	UNK	7
22100	Centre Area Transp Auth	State College	PA	1996	A	ORI	5.501	Largebus	40	CN	DD4	32
22100	Centre Area Transp Auth	State College	PA	1997	O	NFI	C35LF	Medbus	35	CN	DD4	8
22100	Centre Area Transp Auth	State College	PA	1998	P	NFI	C35LF	Medbus	35	CN	DD4	10
22100	Centre Area Transp Auth	State College	PA	1998	P	UNK	UNKNOWN	Smallbus	30	CN	UNK	2
23200	York County Transp Auth	York	PA	1996	A	NFI	C35LF	Medbus	35	CN	UNK	2
23200	York County Transp Auth	York	PA	1997	P	UNK	UNKNOWN	Smallbus	28	CN	UNK	3
23300	Metropolitan BA	Hato Rey	PR	1992	A	TMC	RTS T80 206	Largebus	40	MT	DD6	36
23400	Rhode Island Public Tr Auth	Providence	RI	1985	A	VOL	B10M	Largebus	40	CD	VO6	2
24200	Metropolitan Transit Auth	Nashville	TN	1997	O	AVS	5122/B	Trolleyr	22	EB	NE	2
24200	Metropolitan Transit Auth	Nashville	TN	1993	A	SPC	SENATOR	Van/mini	25	PG	FO8	14

Source: 1997 APTA Transit Vehicle Database
Code: A-Active, O-Ordered, P-Planned
Fuel: C-CNG, L-LNG, P-Propane, D-Diesel, G-Gasoline, ET-Ethanol, MT-Methanol, E-Electric, B-Battery

Table 1-1. Alternative Fueled Transit Buses (Continued)

APTA ID Number	Short Agency Name	City	State	Year Built	Code	Mfr.	Model	Vehicle Type	Length (feet)	Fuel	Engine	Total
24500	Capital Metropolitan Trp Auth	Austin	TX	1990	A	MTC	CLASSIC	Van/mini	26	CG	FO6	12
24500	Capital Metropolitan Trp Auth	Austin	TX	1993	A	TMC	RTS T80 208	Largebus	40	CN	CU6	30
24500	Capital Metropolitan Trp Auth	Austin	TX	1995	A	EDN	TRANSMARK RE	Smallbus	29	CN	HE8	4
24500	Capital Metropolitan Trp Auth	Austin	TX	1993	A	CCI	AH-28	Trolleyr	28	CN	CU6	1
24500	Capital Metropolitan Trp Auth	Austin	TX	1999	P	UNK	UNKNOWN	Largebus	40	CN	UNK	111
24500	Capital Metropolitan Trp Auth	Austin	TX	1997	P	UNK	UNKNOWN	Medbus	35	CN	UNK	70
24500	Capital Metropolitan Trp Auth	Austin	TX	1999	P	UNK	UNKNOWN	Smallbus	30	CN	UNK	77
24500	Capital Metropolitan Trp Auth	Austin	TX	1998	P	UNK	UNKNOWN	Smallbus	30	CN	UNK	57
24500	Capital Metropolitan Trp Auth	Austin	TX	1998	P	UNK	UNKNOWN	Trolleyr	27	CN	UNK	40
24900	Corpus Christi Reg Trp Auth	Corpus Christi	TX	1993	A	CCI	RT-52	Smallbus	30	LP	CU8	3
91500	Dallas Area Rapid Transit	Dallas	TX	1990	A	FLX	METRO 40102-6C-1	Largebus	40	CN	CU6	2
91500	Dallas Area Rapid Transit	Dallas	TX	2000	O	NOV	RTS T80 WFD	Largebus	40	LN	DD4	20
91500	Dallas Area Rapid Transit	Dallas	TX	1999	O	NOV	RTS T80 WFD	Largebus	40	LN	DD4	20
91500	Dallas Area Rapid Transit	Dallas	TX	1998	O	NOV	RTS T80 WFD (A)	Largebus	40	LN	DD4	50
91500	Dallas Area Rapid Transit	Dallas	TX	1998	O	NOV	RTS T80 WFD (B)	Largebus	40	LN	DD4	20
91500	Dallas Area Rapid Transit	Dallas	TX	1997	P	UNK	UNKNOWN	Smallbus	29	LN	UNK	100
25500	El Paso Mass Transit Dept	El Paso	TX	1994	A	BIA	ORION 05.501	Largebus	40	CN	CU6	18
25500	El Paso Mass Transit Dept	El Paso	TX	1993	A	TMC	RTS T80 206	Largebus	40	CN	CU6	2
25500	El Paso Mass Transit Dept	El Paso	TX	1996	A	CCI	AH-28	Trolleyr	28	CN	CU6	7
25500	El Paso Mass Transit Dept	El Paso	TX	1997	O	CCI	AH-28	Trolleyr	28	CN	CU6	18
25500	El Paso Mass Transit Dept	El Paso	TX	1994	A	NFI	D40	Largebus	40	LN	DD4	35
24800	Fort Worth Transp Auth	Fort Worth	TX	1993	A	CMC	CENTURION	Van/mini	25	CG	CV8	12
24800	Fort Worth Transp Auth	Fort Worth	TX	1995	A	FLX	METRO 40102-6C-1	Largebus	40	CN	CU6	13
24800	Fort Worth Transp Auth	Fort Worth	TX	1992	A	FLX	METRO 35102-6C-1	Medbus	35	CN	CU6	32
24800	Fort Worth Transp Auth	Fort Worth	TX	1991	A	FLX	METRO 35102-6C-1	Medbus	35	CN	CU6	9
24800	Fort Worth Transp Auth	Fort Worth	TX	1990	A	FLX	METRO 35102-6C-1	Medbus	35	CN	CU6	3
24800	Fort Worth Transp Auth	Fort Worth	TX	1997	P	UNK	UNKNOWN	Smallbus	29	CN	UNK	20
25200	Metro Tr Auth of Harris County	Houston	TX	1993	A	NEO	AN-460-A SUB PKG	Articbus	60	LD	DD8	40
25200	Metro Tr Auth of Harris County	Houston	TX	1992	A	NEO	AN-460-A SUB PKG	Articbus	60	LD	DD8	14
25200	Metro Tr Auth of Harris County	Houston	TX	1994	A	All	416.04	Largebus	40	LD	DD6	21
25200	Metro Tr Auth of Harris County	Houston	TX	1993	A	All	416.04	Largebus	40	LD	DD6	39
25200	Metro Tr Auth of Harris County	Houston	TX	1983	A	GMC	RTS T80 204	Largebus	40	LD	DD6	3
25200	Metro Tr Auth of Harris County	Houston	TX	1991	A	IKU	416.04	Largebus	40	LD	DD6	1
25200	Metro Tr Auth of Harris County	Houston	TX	1993	A	SSI	MERCEDES T-40 SUB PK	Largebus	40	LD	DD6	11
25200	Metro Tr Auth of Harris County	Houston	TX	1992	A	SSI	MERCEDES T-40 SUB PK	Largebus	40	LD	DD6	8
25200	Metro Tr Auth of Harris County	Houston	TX	1994	A	NEO	AN-345/3	Longbus	45	LD	DD8	37
25200	Metro Tr Auth of Harris County	Houston	TX	1993	A	NEO	AN-345/3	Longbus	45	LD	DD8	23
25200	Metro Tr Auth of Harris County	Houston	TX	1992	A	NEO	AN-345/3	Longbus	45	LD	DD8	1
25200	Metro Tr Auth of Harris County	Houston	TX	1993	A	SSI	FERRONI S-29 SUB PKG	Smallbus	29	LD	DD6	50

Source: 1997 APTA Transit Vehicle Database
Code: A-Active, O-Ordered, P-Planned
Fuel: C-CNG, L-LNG, P-Propane, D-Diesel, G-Gasoline, ET-Ethanol, MT-Methanol, E-Electric, B-Battery

Table 1-1. Alternative Fueled Transit Buses (Continued)

APTA ID Number	Short Agency Name	City	State	Year Built	Code	Mfr.	Model	Vehicle Type	Length (feet)	Fuel	Engine	Total
25200	Metro Tr Auth of Harris County	Houston	TX	1993	A	SSI	FERRONI T-29	Smallbus	29	LD	DD6	31
25200	Metro Tr Auth of Harris County	Houston	TX	1992	A	SSI	FERRONI T-29	Smallbus	29	LD	DD6	4
25200	Metro Tr Auth of Harris County	Houston	TX	1992	A	IKU	416.04 SUB PKG	Largebus	40	LN	CP6	1
25200	Metro Tr Auth of Harris County	Houston	TX	1990	A	SSI	MARCO POLO S-25	Van/mini	26	LN	FO8	9
25200	Metro Tr Auth of Harris County	Houston	TX	1997	O	NFI	L40LF	Largebus	40	LN	DD4	10
25900	Utah Transit Authority	Salt Lake City	UT	1992	A	BIA	ORION 05.501	Largebus	40	CN	CU6	5
26400	Tidewater Transp Dist Comm	Norfolk	VA	1983	A	BOY	TROLLEY	Trolleyr	23	CN	GM8	1
26200	Greater Richmond Transit Co	Richmond	VA	1996	A	BBB	Q-BUS	Smallbus	32	EB	NE	3
26200	Greater Richmond Transit Co	Richmond	VA	1997	P	UNK	UNKNOWN	Smallbus	32	EB	NE	7
26000	Chittenden County Trp Auth	Burlington	VT	1997	P	UNK	UNKNOWN	Van/mini	22	EB	NE	1
83900	Clallam Transit System	Port Angeles	WA	1980	A	CBW	CADET	Van/mini	25	LP	CV8	6
27100	Pierce County PTBA Auth Corp	Tacoma	WA	1973	A	GMC	T6H 4523N	Medbus	35	CD	DD6	1
27100	Pierce County PTBA Auth Corp	Tacoma	WA	1990	A	EBC	MST	Smallbus	29	CG	FO8	19
27100	Pierce County PTBA Auth Corp	Tacoma	WA	1992	A	BIA	ORION 01.508	Largebus	40	CN	CU6	15
27100	Pierce County PTBA Auth Corp	Tacoma	WA	1991	A	BIA	ORION 01.508	Largebus	40	CN	CU6	15
27100	Pierce County PTBA Auth Corp	Tacoma	WA	1994	A	BIA	ORION 05.501	Largebus	40	CN	CU6	27
27100	Pierce County PTBA Auth Corp	Tacoma	WA	1996	A	ORI	5.501	Subbus	40	CN	CU6	13
27100	Pierce County PTBA Auth Corp	Tacoma	WA	1996	A	ORI	05.501 LD	Subbus	40	CN	CU6	2
27100	Pierce County PTBA Auth Corp	Tacoma	WA	2003	P	UNK	UNKNOWN	Largebus	40	CN	UNK	34
27100	Pierce County PTBA Auth Corp	Tacoma	WA	2001	P	UNK	UNKNOWN	Largebus	40	CN	UNK	19
27100	Pierce County PTBA Auth Corp	Tacoma	WA	2000	P	UNK	UNKNOWN	Largebus	40	CN	UNK	18
27100	Pierce County PTBA Auth Corp	Tacoma	WA	1999	P	UNK	UNKNOWN	Largebus	40	CN	UNK	45
27100	Pierce County PTBA Auth Corp	Tacoma	WA	1998	P	UNK	UNKNOWN	Largebus	40	CN	UNK	45
199500	Kenosha Transit	Kenosha	WI	1996	A	NOV	RTS T80 208	Largebus	40	CN	CU6	3
199500	Kenosha Transit	Kenosha	WI	1994	A	TMC	RTS T80 208	Largebus	40	CN	CU6	9

Listings that are Active (A):	164
Listings that are on Order (O):	40
Listings that are on Order (P):	93
Total Listings:	297

Total Listings with CNG:	224	Total No.CNG Buses	5,514
Total Listings with LNG:	47	Total No.LNG Buses	807
Subtoal:	271	Subtotal:	6,321
Total Listings:	297	Total No. of Buses:	6,925

For the above listings :

	All Fuels	CNG Only	LNG Only
No. Buses -"A":	2,556	1,738	347
No. Buses -"O":	1,234	942	278
No. Buses -"P":	3,135	2,834	182

Source: 1997 APTA Transit Vehicle Database
Code: A-Active, O-Ordered, P-Planned
Fuel: C-CNG, L-LNG, P-Propane, D-Diesel, G-Gasoline, ET-Ethanol, MT-Methanol, E-Electric, B-Battery

Table 1-2: Alternative Fueled Bus Orders by Fuel Type

Bus Fuel	Active "A"	Ordered "O"	Planned "P"	Total
	No. of Buses	No. of Buses	No. of Buses	No. of Buses
CB			42	42
CD	54			54
CG	75		4	79
CN	1,609	942	2788	5,339
EB	22	7	15	44
ET	347			347
HY		6		6
LD	283			283
LN	64	278	182	524
LP	25	1	104	130
MT	63			63
PG	14			14
Total:	**2,556**	**1,234**	**3,135**	**6,925**

Note:

Columns: Bus Orders

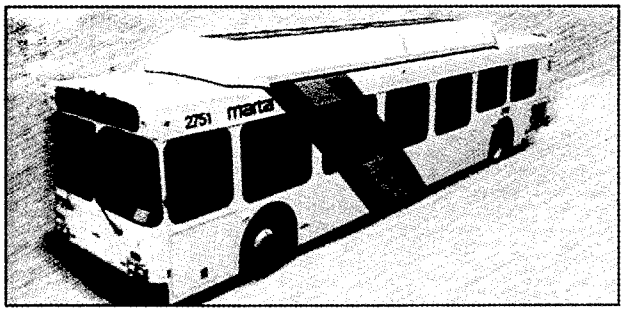
A Active (bus orders delivered)
O Ordered (bus orders placed)
P Planned (bus orders planned)

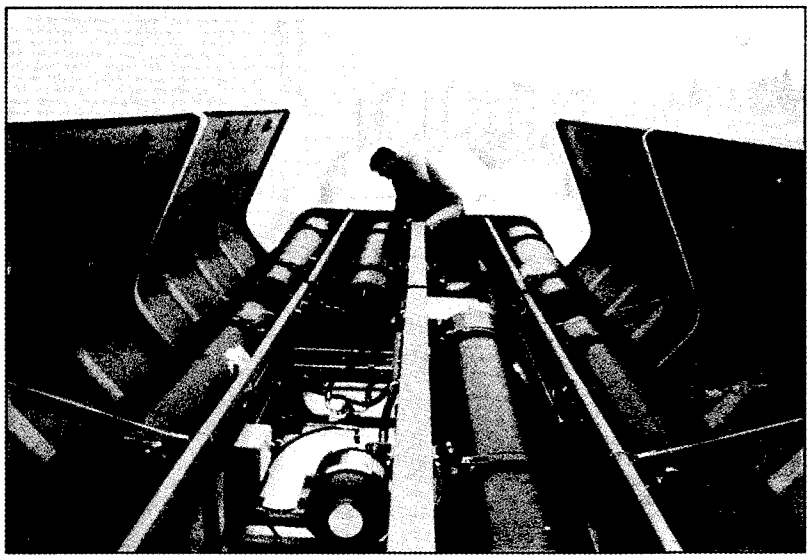
Rows: Vehicles Powered By

CB Compressed natural gas & electric battery
CD Compressed natural gas & diesel
CG Compressed natural gas & gasoline
CN Compressed natural gas
EB Electric battery
ET Ethanol
HY Hydrogen
LD Liquefied natural gas & diesel
LN Liquefied natural gas
LP Propane (liquefied petroleum gas)
MT Methanol
PG Propane & gasoline

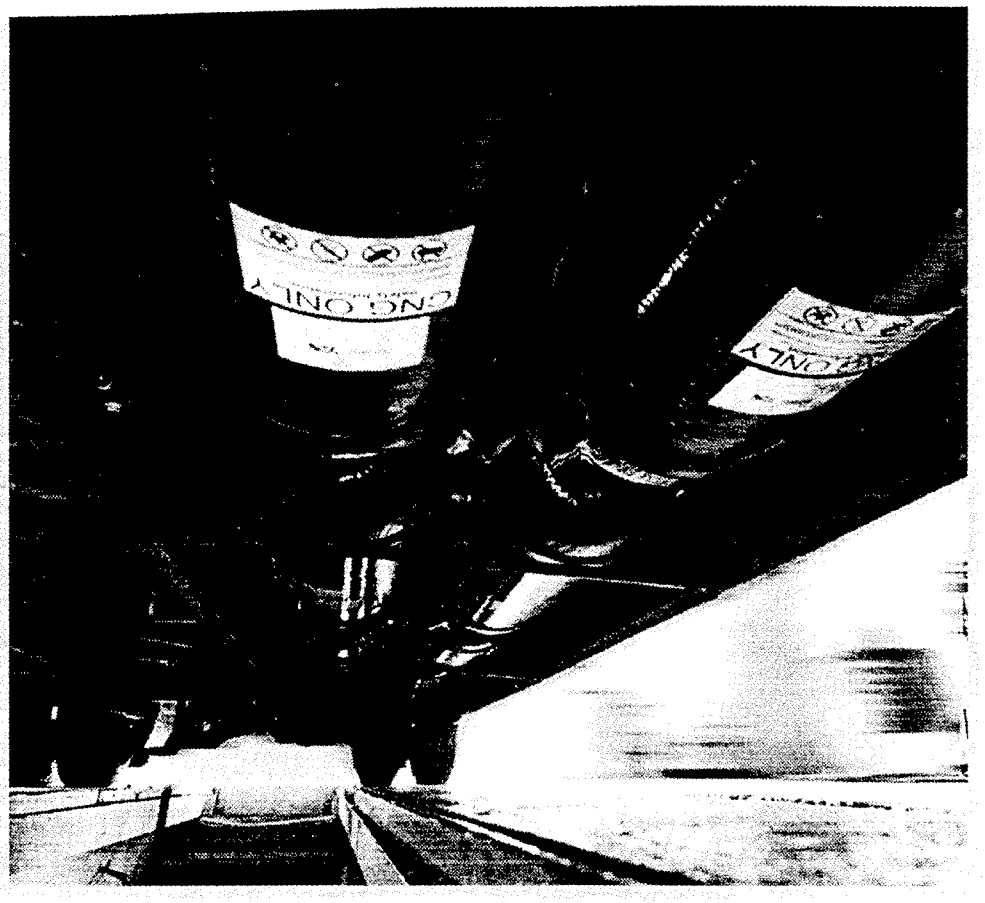
SOURCE: 1997 APTA Transit Vehicle Database

Lincoln Composites Makes The Olympic Team



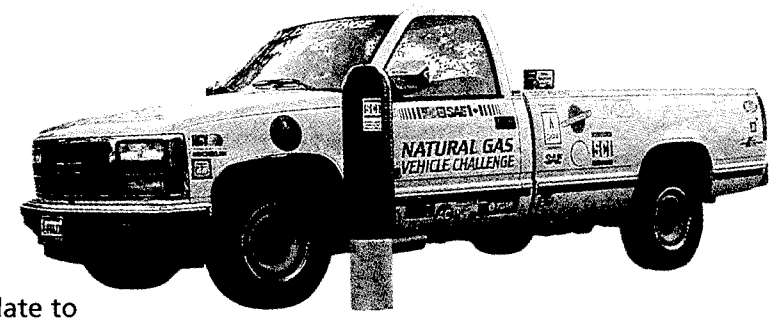


A fleet of buses used as part of the Olympic "CNG Team" includes tanks from Lincoln Composites. The buses, manufactured by New Flyer Industries for Metropolitan Atlanta Rapid Transit Agency (MARTA), include 6 roof-mounted 15.9" x 120" TUFFSHELL™ tanks on each vehicle. MARTA supplied 118 CNG buses for use during the Olympic Games.



Courtesy of Lincoln Composites

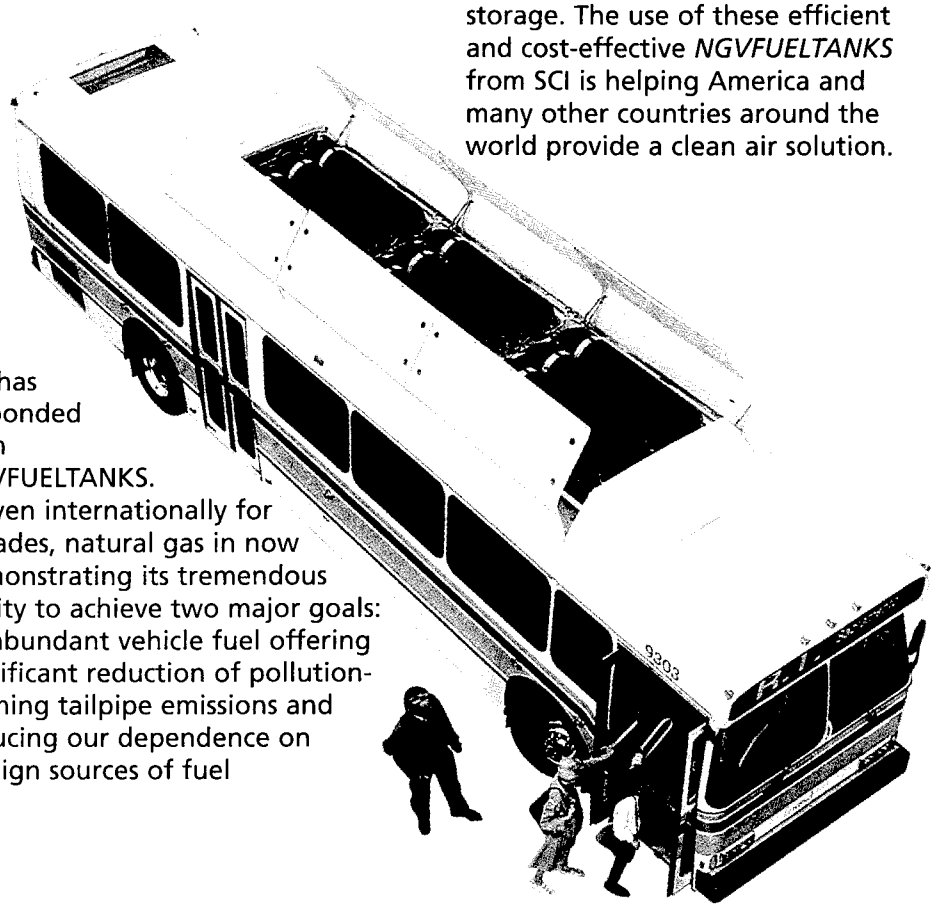
NGVFUELTANKS



The national mandate to reduce air pollution has been reflected in major legislative actions, including the Clean Air Act Amendments of 1990 and the Energy Policy Act of 1992. EPA requirements to provide healthy breathing air in the most polluted areas of the USA are in place, and California, Texas, New York and other states have adopted even tougher requirements to eliminate vehicular sources of air pollution.

SCI provides affordable use of advanced composite materials technology to solve the key problem facing this new market opportunity: lightweight, high pressure fuel storage. The use of these efficient and cost-effective *NGVFUELTANKS* from SCI is helping America and many other countries around the world provide a clean air solution.

SCI has responded with NGVFUELTANKS. Proven internationally for decades, natural gas in now demonstrating its tremendous ability to achieve two major goals: an abundant vehicle fuel offering significant reduction of pollution-forming tailpipe emissions and reducing our dependence on foreign sources of fuel



Courtesy of Structural Composites Industries (SCI)

Client:
Toronto Transit Commission

Tanks:
12 x V 174 NG – Neckmount

Total Capacity:
2,088 litres

Total Tank Weight:
696 kg

Service Pressure:
200 Bar

Max Fill Pressure:
260 Bar

DyneCell ADVANCED LIGHTWEIGHT FUEL SYSTEMS

Courtesy of Dynetek Industries Ltd.

2. ANALYSIS

This section provides a review of the data contained in the 28 responses received to the letter which was sent to 41 transit agencies that had 5 or more natural gas transit buses already in service or on order. These responses were entered into a database, using Lotus Approach. A printout of these responses is contained in Appendix B.

2.1 REVIEW OF RESPONSES - DATABASE STATISTICS

2.1.1 Summary Tables

A number of Lotus Approach worksheets were prepared to provide views of the database that highlight the following specific points:

- Table 2-1 highlights the transit agency's data (database is sorted by transit agencies, bus fuel, year of bus manufacture, and bus manufacturer).

  (Note: this sorting sequence was also used in preparing the printout of the responses shown in Appendix B).

- Table 2-2 highlights the bus manufacturer's data (database is sorted by bus fuel, bus manufacturer, year of bus manufacture, and transit agencies).

- Table 2-3 highlights the cylinder manufacturer's data (database is sorted by bus fuel, cylinder manufacturer, year of bus manufacture, and transit agencies).

- Table 2-4 highlights the PRD manufacturer's data (database is sorted by bus fuel, PRD manufacturer, year of bus manufacture, and transit agencies).

- Table 2-5 highlights the tank leakage data (database is sorted by bus fuel, leaks reported, leaks resolved, cylinder manufacturer, bus manufacturer, year of bus manufacture, and response page number). As can be seen from the table, for the 55 CNG bus groups, 37 groups had not experienced any leaks from their cylinders, 12 had leaks but these leak problems have been resolved, and 6 have leak problems that are still unresolved. It should be noted that the bus groups with unresolved leak problems have cylinders from manufacturers who have gone out of business (2 of these use Comdyne cylinders and 4 use EDO). For the 9 LNG bus groups, 5 groups had not experienced any leaks, while 4 had leaks but these leak problems have been resolved.

As these summary tables indicate, the 28 responses contained 64 separate bus orders that were manufactured by 16 different bus OEMs (original equipment manufacturers). A total of 2,416 buses are included in these responses, of which 1,781 are CNG and 635 are LNG. The cylinders for these buses were supplied by 13 different cylinder manufacturers, 9 of which were CNG and 4 of which were LNG. The 9 CNG cylinder manufacturers used 8 different PRD manufacturers.

2.1.2 Cross Tabulations

A number of Lotus Approach crosstabs were produced to provide views of the database to highlight the following specific points:

- Table 2-6 highlights the cylinder manufacturer's data (database is sorted by bus fuel, cylinder manufacturer, and by bus manufacturer), and provides a total for the number of cylinders produced by the cylinder manufacturer. For the 2,416 buses contained in the 28 responses there were 16,941 cylinders produced; 15,578 were CNG and 1,363 were LNG.

- Table 2-7 highlights the PRD manufacturer's data (database is sorted by bus fuel, PRD manufacturer, and by cylinder manufacturer), and provides a total for the number of cylinders produced by the cylinder manufacturer.

- Table 2-8 highlights the bus manufacturer's data (database is sorted by bus fuel, Bus manufacturer, and by cylinder manufacturer), and provides a total for the number of cylinders produced by the cylinder manufacturer.

- Table 2-9 highlights the transit agency's data (database is sorted by bus fuel and by bus manufacturer), and provides a total for the number of CNG and LNG buses delivered to the transit agency.

- Table 2-10 highlights the number of bus groups that have experienced cylinder leaks, and of these, the number of bus groups that have been able to resolve their leak problems and the number that have not.

  As can be seen from the table, for the 55 CNG bus groups:

  (a) 37 groups had not experienced any leaks from their cylinders.
  (b) 12 groups had leaks but these leak problems have been resolved.
  (c) 6 have leak problems that are still unresolved. It should be noted that the 6 bus groups whose leak problems could not be resolved have cylinders from manufacturers who have gone out of business (2 of these groups use Comdyne cylinders and 4 use EDO).

  For the 9 LNG bus groups:

  (a) 5 groups had not experienced any leaks.
  (b) The remaining 4 groups had leaks but these leak problems have been resolved.

- Table 2-11 highlights the number of buses in the bus groups that had cylinder leak problems, by cylinder manufacturer and bus fuel. Please note that in most cases only a few buses in such bus groups actually experienced a cylinder leak.

- Table 2-12 highlights the number of buses in the bus groups that had cylinder leak problems, by PRD manufacturer and by bus fuel. Please note that in most cases only a few buses in such bus groups actually experienced a cylinder leak.

2.1.3 Charts

A number of Lotus Approach charts were produced to provide views of the database to highlight the following specific points:

- Figure 2-1 highlights the substantial growth in the delivery of CNG and LNG powered transit buses during the last eight years: from about 40 buses in 1990 to over 400 in each of the past three years.

- Figure 2-2 highlights the number of cylinders produced by each cylinder manufacturer.

- Figure 2-3 highlights the number of PRDs produced by each PRD manufacturer.

2.2 FINDINGS

2.2.1 Cylinder Leaks or Rupture

First, there has been only a single incident of a cylinder rupture at a transit agency. A transit bus using an EDO all-composite cylinder ruptured during refueling on August 19, 1996 at the Los Angeles County MTA. The cylinder rupture was reported to be caused by an external impact loading, most likely due to road debris.[13 14]

While there has only been a single cylinder rupture on a transit bus, there is some concern about the remaining EDO all-composite and Comdyne cylinders still in use on transit buses. Several of the transit agencies, those that have experienced cylinder leak problems that have not been resolved, are changing out their cylinders to a new cylinder manufacturer. The cylinders they were using were manufactured by EDO or Comdyne, companies which are no longer in this business.

Second, the primary causes of cylinder leaks experienced in the field were due to the PRDs, i.e., premature rupture disk releases or "O" ring problems, or due to problems with a particular design of a cylinder (i.e., Comdyne and EDO). Most of the PRD premature rupture disk release problems that were experienced were caused by the use of the older Mirada PRD Generation 3 model, which has since been replaced with a more robust design (Mirada PRD Generation 2.5). Most of the older Mirada Generation 3's have been replaced with the newer Generation 2.5's. This has greatly reduced the leak problems being experienced on transit buses. The remaining PRD problems appear to be due to slow leaks around the "O" rings used to seal the valve, and due to leaks in certain composite cylinder designs (i.e., Comdyne and EDO).

As can be seen from Table 2-10, out of the 64 bus groups contained in the 28 responses:

- There were 42 bus groups (for a total of 1,021 buses of the 2,416 buses) that did not report any cylinder leak problem with their buses.

- The remaining 22 bus groups (with a total of 1,395 buses) reported that they had experienced a cylinder leak in one or more of their buses.

- Of these 22 bus groups, 16 bus groups have been able to fully resolve their cylinder leak problems.

- The remaining 6 bus groups have not been able to resolve their cylinder leak problems (these were all CNG bus groups that have a total of 364 buses). The reason stated by the transit agencies why these leak problems could not be resolved was that the manufacturer of their cylinders (i.e., Comdyne or EDO) had gone out of business. Several of these transit agencies are changing out their cylinders to a new cylinder manufacturer.

Third, the design of the cylinders and PRDs used for natural gas buses are rapidly maturing and the new designs appear to be performing properly. Transit agencies that are still using buses with the discontinued Comdyne and EDO cylinder designs seem to be carefully monitoring for any deterioration of these cylinders in service. This is also true for those transit agencies with buses that are using the older Mirada PRD Generation 3 designs.

Fourth, it should be noted that promising research efforts are being undertaken for the Gas Research Institute (GRI) by Battelle with regard to the development of "smart" technologies that could be placed onto or made an integral part of a CNG cylinder to determine the integrity of the cylinder. These efforts include the use of special damage indicator coatings, and the use of an acoustic-based electronic monitoring system that measures changes in the acoustical characteristics of a cylinder, providing a measure of the change in wall stiffness which correlates directly with a change in cylinder integrity.

A good deal of credit should be given to the gas industry for its efforts to respond to the needs of the transit industry to resolve the cylinder PRD leak problems and to review cylinder safety. GRI which has directed efforts to:

- Quickly investigate the causes of the PRD cylinder leaks, and provide technical and financial resources to assist cylinder and PRD manufacturers to diagnose the leak problems and come up with practical solutions.

- Lead the efforts to establish more rigorous standards for both PRD[7] and cylinder[8] designs.

- Develop a set of guideline documents on best practices for the integration and use of natural gas vehicle fuel systems.[3 4 5 6]

- Develop "smart" technologies that could be placed onto or made an integral part of a CNG cylinder to determine the integrity of the cylinder.

2.2.2 Inspection Procedures

The responses to the question about "How effective is the tank inspection process" that is being used by the transit agency were overwhelming favorable. Typical comments were:

- techniques very effective if mechanics/inspectors receive quality training
- very effective
- successful
- very good for preventing tank failures
- visual inspection has been effective in finding faults
- effective in finding leaks and obvious visual defects
- very good for preventing tank failures

However, one transit agency (Los Angeles County MTA) expressed a concern that while its inspection program is effective in finding leaks and obvious visual defects, the program is still not adequate since visual inspections may not predict long term cylinder structural integrity. This transit agency is looking into performing destructive cylinder testing at the 3-year interval to assure structural integrity. Another transit agency indicated that there is a need for a better, faster, and cheaper inspection process.

2.2.3 Other Comments

The responses to the question about "Other Data, Comments or Recommendations" include comments such as:

- Type 4 composite cylinders are not recommended for use on transit vehicles
- As tanks are roof mounted, unlikely tanks would suffer physical damage
- Recommend that CNG tanks not be placed under the bus floor since 75 percent of buses in accidents receive damage below the main frame.

Table 2-1. Responses Sorted by TAs, Bus Fuel, Yr Bus Built, & Bus Mfr

Transit Agency	CITY	ST	Fuel	Leak	Resol	Bus Mfr.	Year	Buses	Tank Mfr.	Tank Type	Tank	PRD Mfr.	Page
Phoenix Transit System	Phoenix	AZ	LNG	N		NABI	1998	180	Minnesota Valley En	stainless steel,double	2	N/A	1
City of Tucson Mass Transit Syst	Tucson	AZ	CNG	N		Neoplan	1993/4	47	Pressed Steel Tank,	Lincoln Composite ?	10	Unknown	2
City of Tucson Mass Transit Syst	Tucson	AZ	CNG	N		Orion	1994	6	Structural Composite	composite	4	Mirada	3
City of Tucson Mass Transit Syst	Tucson	AZ	CNG	N		NFI	1996/7	44	Lincoln Composites	Tuff Shell	4	Lincoln Comp	4
BC Transit - Vancover RTS	Surrey	BC	CNG	N		NFI	1995	25	Lincoln Composites	Type 4, composite	4	Mirada	5
Long Beach Transit	Long Beach	CA	CNG	N		Orion	1996	5	EDO	composite carbon fiber	6	Unknown	6
Los Angeles County Metropolitan	Los Angeles	CA	CNG	Y	N	Neoplan	1995/6	218	EDO	Type 4, carbon fiber	11	Mirada	7
Los Angeles County Metropolitan	Los Angeles	CA	CNG	Y	Y	Neoplan	1997/8	214	Lincoln Composites	Type 4, carbon fibre	11	Mirada	8
South Coast Area Transit	Oxnard	CA	CNG	N		Flxible	1995	26	Comdyne	aluminum with fiber co	4		9
South Coast Area Transit	Oxnard	CA	CNG	Y	Y	Orion	1997	9	EDO	aluminum with fiber co	4	Mirada	10
Sacramento Regional Transit Dis	Sacramento	CA	CNG	N		Orion	1993/4	96	Structural Composite	Type 3, aluminum/e-gl	12	Mirada	11
Sacramento Regional Transit Dis	Sacramento	CA	CNG	Y	N	Orion	1996	40	EDO	Type 4, carbon fiber wr	10	Mirada	12
Metropolitan Transit Developmen	San Diego	CA	CNG	N		El Dorado	1995	2	CNG Cylinder Corp.	Carbon fiber, thermopl	5	CNG Cylinder	13
Metropolitan Transit Developmen	San Diego	CA	CNG	N		NFI	1995	51	Lincoln Composites	Carbon fiber, thermopl	4	Mirada	14
San Diego Transit Corporation	San Diego	CA	CNG	Y	Y	NFI	1994	4	Lincoln Composites	fiberglass-thermo plast	10	Lucas - SVG	15
San Diego Transit Corporation	San Diego	CA	CNG	Y	Y	NFI	1995	46	Lincoln Composites	fiberglass-thermo plast	4	Mirada	16
San Diego Transit Corporation	San Diego	CA	CNG	N		NFI	1997	27	Lincoln Composites	fiberglass-thermo plast	6	Unknown	17
Regional Transportation District	Denver	CO	CNG	Y	N	Neoplan	1986	5	EDO	NGV2 Composite	12	Mirada	18
Regional Transportation District	Denver	CO	CNG	N		World Tra	1997	3	Lincoln Composites	Type 4, NGV2-4	5	Corona Circle	19
Metropolitan Atlanta Rapid Transi	Atlanta	GA	CNG	Y	Y	NFI	1996	118	Lincoln Composites	Type 4, composite	6	Mirada	20
Boise Urban Stages	Boise	ID	CNG	N		Orion	1993	2	NGV Systems	composite reinforced a	8	Mirada	21
Boise Urban Stages	Boise	ID	CNG	N		El Dorado	1994	20	CNG Cylinder Corp.	Type 2	6	Unknown	22
Boise Urban Stages	Boise	ID	CNG	Y	Y	ELF	1996	8	EDO	composite	3	Unknown	23
Bi-State Development Agency	St. Louis	MO	CNG	N		Flxible	1991	2	Comdyne	aluminum wrapped w.	6	Mirada	24
Bi-State Development Agency	St. Louis	MO	CNG	N		Neoplan	1997	36	Lincoln Composites	Type 4, all composite	10	Lincoln Comp	25
MTA New York City Transit	Brooklyn	NY	CNG	N		TMC	1990	2	Comdyne	Type 3, steel liner	6	Mirada	26
MTA New York City Transit	Brooklyn	NY	CNG	N		TMC	1993	1	CNG Cylinder Corp.	Type 2, aluminum liner	12	Superior	27
MTA New York City Transit	Brooklyn	NY	CNG	Y	N	Orion	1995	31	EDO	Type 4, composite pla	10	Mirada	28
Metropolitan Suburban Bus Auth	Garden City	NY	CNG	N		Orion	1995/6/	160	Structural Composite	Type 3, fibre wrap	12	Mirada	29
Metro Regional Transit Authority	Akron	OH	CNG	N		Dodge	1994	1	Unknown	aluminum wrapped	2		30
Greater Cleveland Regional Tran	Cleveland	OH	CNG	N		Flxible	1989	1	Comdyne	Type 3, aluminum	6	Mirada	31
Greater Cleveland Regional Tran	Cleveland	OH	CNG	N		Flxible	1991	15	Comdyne	Type 3, aluminum	4	Mirada	32
Greater Cleveland Regional Tran	Cleveland	OH	CNG	Y	N	Flxible	1992	5	Comdyne	Type 3, aluminum	4	Mirada	33
Greater Cleveland Regional Tran	Cleveland	OH	CNG	Y	N	Flxible	1994	65	Comdyne	Type 3, aluminum	6	Mirada	34
Greater Cleveland Regional Tran	Cleveland	OH	CNG	N		Flxible	1995	15	Comdyne	Type 3, aluminum	6	Mirada	35
Greater Cleveland Regional Tran	Cleveland	OH	CNG	Y	Y	Nova	1997	65	NGV Systems	Type 2, steel (Duraste	12	NGV Systems	36
LAKETRAN	Grand River	OH	CNG	N		NFI	1997	12	Lincoln Composites	Lincoln	5	Unknown	37
Hamilton Street Railway Compan	Hamilton	ON	CNG	N		GM	1977	2	CNG Cylinder Corp.	Type I, aluminum, fila	12	Unknown	38
Hamilton Street Railway Compan	Hamilton	ON	CNG	N		Orion	1991	15	Dynetek	Type 2, aluminum liner	8	Mirada	39

Table 2-1. Responses Sorted by TAs, Bus Fuel, Yr Bus Built, & Bus Mfr

Transit Agency	CITY	ST	Fuel	Leak	Resol	Bus Mfr.	Year	Buses	Tank Mfr.	Tank Type	Tank	PRD Mfr.	Page
Hamilton Street Railway Compan	Hamilton	ON	CNG	N		Orion	1992	15	Alusuisse	aluminum with Kevalar	4	Mirada	40
Hamilton Street Railway Compan	Hamilton	ON	CNG	Y	Y	NFI	1996	25	Lincoln Composites	Type 2, aluminum liner	7	Mirada	41
Toronto Transit Commission	Toronto	ON	CNG	N		Orion	1990	25	Alusuisse	Type 3, aluminum/Kevl	4	Superior	42
Toronto Transit Commission	Toronto	ON	CNG	Y	Y	Orion	1996	50	EDO	Type 4, polyethylene li	10	Mirada	43
Toronto Transit Commission	Toronto	ON	CNG	N		Orion	1997	50	Structural Composite	Type 3, aluminum/fiber	8	Superior	44
Tri-Met	Portland	OR	LNG	N		Gillig	1992	2	Gryogas		2	N/A	45
Tri-Met	Portland	OR	LNG	N		Flxible	1993	8	CVI Inc.		3	N/A	46
Port Authority of Allegheny Count	Pittsburgh	PA	CNG	N		Orion	1991	5	Pressed Steel Tank,	steel with fiberglass wr	10	Unknown	47
Centre Area Transportation Auth	State College	PA	CNG	N		Orion	1996	16	EDO	composite	8	Unknown	48
Centre Area Transportation Auth	State College	PA	CNG	N		NFI	1997	8	Lincoln Composites	composite	5	Unknown	49
Capital Metropolitan Transportati	Austin	TX	CNG	Y	Y	TMC	1993	30	CNG Cylinder Corp.	Type 2, aluminum hoo	12	Mirada	50
Capital Metropolitan Transportati	Austin	TX	CNG	N		El Dorado	1995	4	CNG Cylinder Corp.	Type 2, aluminum hoo	6	unknown	51
Dallas Area Rapid Transit Authori	Dallas	TX	CNG	N		Flxible	1990	2	Comdyne	rolled aluminum	6	Comdyne	52
Dallas Area Rapid Transit Authori	Dallas	TX	LNG	Y	Y	Nova	1997/8	210	Minnesota Valley En	stainless dewar	3	N/A	53
City of El Paso Mass Transit Dep	El Paso	TX	CNG	N		TMC	1993	2	CNG Cylinder Corp.	NGV 1 glass wrapped	12	Mirada	54
City of El Paso Mass Transit Dep	El Paso	TX	CNG	N		Orion	1994	18	Structural Composite	NGV 2 glass wrapped	10	Mirada	55
City of El Paso Mass Transit Dep	El Paso	TX	CNG	N		Chance In	1996/7	25	CNG Cylinder Corp.	Type 2, glass wrapped	12	Mirada	56
City of El Paso Mass Transit Dep	El Paso	TX	LNG	N		NFI	1994	35	Minnesota Valley En	stainless steel cryogen	2	N/A	57
Fort Worth Transportation Authori	Fort Worth	TX	CNG	Y	Y	Flxible	1990/1/	44	Comdyne	aluminum	4	Mirada	58
Fort Worth Transportation Authori	Fort Worth	TX	CNG	Y	Y	Flxible	1995	13	Comdyne	aluminum	6	Mirada	59
Metropolitan Transit Authority of	Houston	TX	CNG	N		NFI	1997	5	Lincoln Composites	tuffshell, all composite	6	Mirada	60
Metropolitan Transit Authority of	Houston	TX	LNG	Y	Y	Ikarus	1992	60	Taylor Wharton	custom stainless steel	2	N/A	61
Metropolitan Transit Authority of	Houston	TX	LNG	Y	Y	Mercedes	1992/3	20	Taylor Wharton	custom stainless steel	1	N/A	62
Metropolitan Transit Authority of	Houston	TX	LNG	Y	Y	Neoplan	1993/4	115	Taylor Wharton	custom built, single tan	1	N/A	63
Metropolitan Transit Authority of	Houston	TX	LNG	N		NFI	1997	5	Minnesota Valley En	HLNG 56, stainless ste	4	N/A	64

Table 2-2. Responses Sorted by Bus Fuel, Bus Mfr, Yr Bus Built, & TAs

Transit Agency	CITY	ST	Fuel	Leak	Resol	Bus Mfr.	Year	Buses	Tank Mfr.	Tank Type	Tank	PRD Mfr.	Page
City of El Paso Mass Transit Dep	El Paso	TX	CNG	N		Chance In	1996/7	25	CNG Cylinder Corp.	Type 2, glass wrapped	12	Mirada	56
Metro Regional Transit Authority	Akron	OH	CNG	N		Dodge	1994	1	Unknown	aluminum wrapped	2		30
Boise Urban Stages	Boise	ID	CNG	N		El Dorado	1994	20	CNG Cylinder Corp.	Type 2	6	Unknown	22
Metropolitan Transit Developmen	San Diego	CA	CNG	N		El Dorado	1995	2	CNG Cylinder Corp.	Carbon fiber, thermopl	5	CNG Cylinder	13
Capital Metropolitan Transportati	Austin	TX	CNG	N		El Dorado	1995	4	CNG Cylinder Corp.	Type 2, aluminum hoo	6	unknown	51
Boise Urban Stages	Boise	ID	CNG	Y	Y	ELF	1996	8	EDO	composite	3	Unknown	23
Greater Cleveland Regional Tran	Cleveland	OH	CNG	N		Flxible	1989	1	Comdyne	Type 3, aluminum	6	Mirada	31
Dallas Area Rapid Transit Authori	Dallas	TX	CNG	N		Flxible	1990	2	Comdyne	rolled aluminum	6	Comdyne	52
Fort Worth Transportation Authori	Fort Worth	TX	CNG	Y	Y	Flxible	1990/1/	44	Comdyne	aluminum	4	Mirada	58
Bi-State Development Agency	St. Louis	MO	CNG	N		Flxible	1991	2	Comdyne	aluminum wrapped w. f	6	Mirada	24
Greater Cleveland Regional Tran	Cleveland	OH	CNG	N		Flxible	1991	15	Comdyne	Type 3, aluminum	4	Mirada	32
Greater Cleveland Regional Tran	Cleveland	OH	CNG	Y	N	Flxible	1992	5	Comdyne	Type 3, aluminum	4	Mirada	33
Greater Cleveland Regional Tran	Cleveland	OH	CNG	Y	N	Flxible	1994	65	Comdyne	Type 3, aluminum	6	Mirada	34
South Coast Area Transit	Oxnard	CA	CNG	N		Flxible	1995	26	Comdyne	aluminum with fiber co	4		9
Greater Cleveland Regional Tran	Cleveland	OH	CNG	N		Flxible	1995	15	Comdyne	Type 3, aluminum	6	Mirada	35
Fort Worth Transportation Authori	Fort Worth	TX	CNG	Y	Y	Flxible	1995	13	Comdyne	aluminum	6	Mirada	59
Hamilton Street Railway Compan	Hamilton	ON	CNG	N		GM	1977	2	CNG Cylinder Corp.	Type I, aluminum, filam	12	Unknown	38
Regional Transportation District	Denver	CO	CNG	Y	N	Neoplan	1986	5	EDO	NGV2 Composite	12	Mirada	18
City of Tucson Mass Transit Syst	Tucson	AZ	CNG	N		Neoplan	1993/4	47	Pressed Steel Tank,	Lincoln Composite ?	10	Unknown	2
Los Angeles County Metropolitan	Los Angeles	CA	CNG	Y	N	Neoplan	1995/6	218	EDO	Type 4, carbon fiber	11	Mirada	7
Bi-State Development Agency	St. Louis	MO	CNG	N		Neoplan	1997	36	Lincoln Composites	Type 4, all composite	10	Lincoln Comp	25
Los Angeles County Metropolitan	Los Angeles	CA	CNG	Y	Y	Neoplan	1997/8	214	Lincoln Composites	Type 4, carbon fibre	11	Mirada	8
San Diego Transit Corporation	San Diego	CA	CNG	Y	Y	NFI	1994	4	Lincoln Composites	fiberglass-thermo plast	10	Lucas - SVG	15
BC Transit - Vancover RTS	Surrey	BC	CNG	N		NFI	1995	25	Lincoln Composites	Type 4, composite	4	Mirada	5
Metropolitan Transit Developmen	San Diego	CA	CNG	N		NFI	1995	51	Lincoln Composites	Carbon fiber, thermopl	4	Mirada	14
San Diego Transit Corporation	San Diego	CA	CNG	Y	Y	NFI	1995	46	Lincoln Composites	fiberglass-thermo plast	4	Mirada	16
Metropolitan Atlanta Rapid Transi	Atlanta	GA	CNG	Y	Y	NFI	1996	118	Lincoln Composites	Type 4, composite	6	Mirada	20
Hamilton Street Railway Compan	Hamilton	ON	CNG	Y	Y	NFI	1996	25	Lincoln Composites	Type 2, aluminum liner	7	Mirada	41
City of Tucson Mass Transit Syst	Tucson	AZ	CNG	N		NFI	1996/7	44	Lincoln Composites	Tuff Shell	4	Lincoln Comp	4
San Diego Transit Corporation	San Diego	CA	CNG	N		NFI	1997	27	Lincoln Composites	fiberglass-thermo plast	6	Unknown	17
LAKETRAN	Grand River	OH	CNG	N		NFI	1997	12	Lincoln Composites	Lincoln	5	Unknown	37
Centre Area Transportation Auth	State College	PA	CNG	N		NFI	1997	8	Lincoln Composites	composite	5	Unknown	49
Metropolitan Transit Authority of	Houston	TX	CNG	N		NFI	1997	5	Lincoln Composites	tuffshell, all composite	6	Mirada	60
Greater Cleveland Regional Tran	Cleveland	OH	CNG	Y	Y	Nova	1997	65	NGV Systems	Type 2, steel (Duraste	12	NGV Systems	36
Toronto Transit Commission	Toronto	ON	CNG	N		Orion	1990	25	Alusuisse	Type 3, aluminum/Kevl	4	Superior	42
Hamilton Street Railway Compan	Hamilton	ON	CNG	N		Orion	1991	15	Dynetek	Type 2, aluminum liner	8	Mirada	39
Port Authority of Allegheny Count	Pittsburgh	PA	CNG	N		Orion	1991	5	Pressed Steel Tank,	steel with fiberglass wr	10	Unknown	47
Hamilton Street Railway Compan	Hamilton	ON	CNG	N		Orion	1992	15	Alusuisse	aluminum with Kevalar	4	Mirada	40
Boise Urban Stages	Boise	ID	CNG	N		Orion	1993	2	NGV Systems	composite reinforced a	8	Mirada	21

Table 2-2. Responses Sorted by Bus Fuel, Bus Mfr, Yr Bus Built, & TAs

Transit Agency	CITY	ST	Fuel	Leak	Resol	Bus Mfr.	Year	Buses	Tank Mfr.	Tank Type	Tank	PRD Mfr.	Page
Sacramento Regional Transit Dis	Sacramento	CA	CNG	N		Orion	1993/4	96	Structural Composite	Type 3, aluminum/e-gl	12	Mirada	11
City of Tucson Mass Transit Syst	Tucson	AZ	CNG	N		Orion	1994	6	Structural Composite	composite	4	Mirada	3
City of El Paso Mass Transit Dep	El Paso	TX	CNG	N		Orion	1994	18	Structural Composite	NGV 2 glass wrapped	10	Mirada	55
MTA New York City Transit	Brooklyn	NY	CNG	Y	N	Orion	1995	31	EDO	Type 4, composite plas	10	Mirada	28
Metropolitan Suburban Bus Auth	Garden City	NY	CNG	N		Orion	1995/6/	160	Structural Composite	Type 3, fibre wrap	12	Mirada	29
Long Beach Transit	Long Beach	CA	CNG	N		Orion	1996	5	EDO	composite carbon fiber	6	Unknown	6
Sacramento Regional Transit Dis	Sacramento	CA	CNG	Y	N	Orion	1996	40	EDO	Type 4, carbon fiber wr	10	Mirada	12
Toronto Transit Commission	Toronto	ON	CNG	Y	Y	Orion	1996	50	EDO	Type 4, polyethylene li	10	Mirada	43
Centre Area Transportation Auth	State College	PA	CNG	N		Orion	1996	16	EDO	composite	8	Unknown	48
South Coast Area Transit	Oxnard	CA	CNG	Y	Y	Orion	1997	9	EDO	aluminum with fiber co	4	Mirada	10
Toronto Transit Commission	Toronto	ON	CNG	N		Orion	1997	50	Structural Composite	Type 3, aluminum/fiber	8	Superior	44
MTA New York City Transit	Brooklyn	NY	CNG	N		TMC	1990	2	Comdyne	Type 3, steel liner	6	Mirada	26
MTA New York City Transit	Brooklyn	NY	CNG	N		TMC	1993	1	CNG Cylinder Corp.	Type 2, aluminum liner	12	Superior	27
Capital Metropolitan Transportati	Austin	TX	CNG	Y	Y	TMC	1993	30	CNG Cylinder Corp.	Type 2, aluminum hoo	12	Mirada	50
City of El Paso Mass Transit Dep	El Paso	TX	CNG	N		TMC	1993	2	CNG Cylinder Corp.	NGV 1 glass wrapped	12	Mirada	54
Regional Transportation District	Denver	CO	CNG	N		World Tra	1997	3	Lincoln Composites	Type 4, NGV2-4	5	Corona Circle	19
Tri-Met	Portland	OR	LNG	N		Flxible	1993	8	CVI Inc.		3	N/A	46
Tri-Met	Portland	OR	LNG	N		Gillig	1992	2	Gryogas		2	N/A	45
Metropolitan Transit Authority of	Houston	TX	LNG	Y	Y	Ikarus	1992	60	Taylor Wharton	custom stainless steel	2	N/A	61
Metropolitan Transit Authority of	Houston	TX	LNG	Y	Y	Mercedes	1992/3	20	Taylor Wharton	custom stainless steel	1	N/A	62
Phoenix Transit System	Phoenix	AZ	LNG	N		NABI	1998	180	Minnesota Valley En	stainless steel,double	2	N/A	1
Metropolitan Transit Authority of	Houston	TX	LNG	Y	Y	Neoplan	1993/4	115	Taylor Wharton	custom built, single tan	1	N/A	63
City of El Paso Mass Transit Dep	El Paso	TX	LNG	N		NFI	1994	35	Minnesota Valley En	stainless steel cryogen	2	N/A	57
Metropolitan Transit Authority of	Houston	TX	LNG	N		NFI	1997	5	Minnesota Valley En	HLNG 56, stainless ste	4	N/A	64
Dallas Area Rapid Transit Authori	Dallas	TX	LNG	Y	Y	Nova	1997/8	210	Minnesota Valley En	stainless dewar	3	N/A	53

Table 2-3. Responses Sorted by Bus Fuel, Cyl Mfr, Yr Bus Built, & TAs

Transit Agency	CITY	ST	Fuel	Leak	Resol	Bus Mfr.	Year	Buses	Tank Mfr.	Tank Type	Tank	PRD Mfr.	Page
Toronto Transit Commission	Toronto	ON	CNG	N		Orion	1990	25	Alusuisse	Type 3, aluminum/Kevl	4	Superior	42
Hamilton Street Railway Compan	Hamilton	ON	CNG	N		Orion	1992	15	Alusuisse	aluminum with Kevalar	4	Mirada	40
Hamilton Street Railway Compan	Hamilton	ON	CNG	N		GM	1977	2	CNG Cylinder Corp.	Type I, aluminum, fila	12	Unknown	38
MTA New York City Transit	Brooklyn	NY	CNG	N		TMC	1993	1	CNG Cylinder Corp.	Type 2, aluminum liner	12	Superior	27
Capital Metropolitan Transportati	Austin	TX	CNG	Y	Y	TMC	1993	30	CNG Cylinder Corp.	Type 2, aluminum hoo	12	Mirada	50
City of El Paso Mass Transit Dep	El Paso	TX	CNG	N		TMC	1993	2	CNG Cylinder Corp.	NGV 1 glass wrapped	12	Mirada	54
Boise Urban Stages	Boise	ID	CNG	N		El Dorado	1994	20	CNG Cylinder Corp.	Type 2	6	Unknown	22
Metropolitan Transit Developmen	San Diego	CA	CNG	N		El Dorado	1995	2	CNG Cylinder Corp.	Carbon fiber, thermopl	5	CNG Cylinder	13
Capital Metropolitan Transportati	Austin	TX	CNG	N		El Dorado	1995	4	CNG Cylinder Corp.	Type 2, aluminum hoo	6	unknown	51
City of El Paso Mass Transit Dep	El Paso	TX	CNG	N		Chance In	1996/7	25	CNG Cylinder Corp.	Type 2, glass wrapped	12	Mirada	56
Greater Cleveland Regional Tran	Cleveland	OH	CNG	N		Flxible	1989	1	Comdyne	Type 3, aluminum	6	Mirada	31
MTA New York City Transit	Brooklyn	NY	CNG	N		TMC	1990	2	Comdyne	Type 3, steel liner	6	Mirada	26
Dallas Area Rapid Transit Authori	Dallas	TX	CNG	N		Flxible	1990	2	Comdyne	rolled aluminum	6	Comdyne	52
Fort Worth Transportation Authori	Fort Worth	TX	CNG	Y	Y	Flxible	1990/1/	44	Comdyne	aluminum	4	Mirada	58
Bi-State Development Agency	St. Louis	MO	CNG	N		Flxible	1991	2	Comdyne	aluminum wrapped w.	6	Mirada	24
Greater Cleveland Regional Tran	Cleveland	OH	CNG	N		Flxible	1991	15	Comdyne	Type 3, aluminum	4	Mirada	32
Greater Cleveland Regional Tran	Cleveland	OH	CNG	Y	N	Flxible	1992	5	Comdyne	Type 3, aluminum	4	Mirada	33
Greater Cleveland Regional Tran	Cleveland	OH	CNG	Y	N	Flxible	1994	65	Comdyne	Type 3, aluminum	6	Mirada	34
South Coast Area Transit	Oxnard	CA	CNG	N		Flxible	1995	26	Comdyne	aluminum with fiber co	4		9
Greater Cleveland Regional Tran	Cleveland	OH	CNG	N		Flxible	1995	15	Comdyne	Type 3, aluminum	6	Mirada	35
Fort Worth Transportation Authori	Fort Worth	TX	CNG	Y	Y	Flxible	1995	13	Comdyne	aluminum	6	Mirada	59
Hamilton Street Railway Compan	Hamilton	ON	CNG	N		Orion	1991	15	Dynetek	Type 2, aluminum liner	8	Mirada	39
Regional Transportation District	Denver	CO	CNG	Y	N	Neoplan	1986	5	EDO	NGV2 Composite	12	Mirada	18
MTA New York City Transit	Brooklyn	NY	CNG	Y	N	Orion	1995	31	EDO	Type 4, composite pla	10	Mirada	28
Los Angeles County Metropolitan	Los Angeles	CA	CNG	Y	N	Neoplan	1995/6	218	EDO	Type 4, carbon fiber	11	Mirada	7
Long Beach Transit	Long Beach	CA	CNG	N		Orion	1996	5	EDO	composite carbon fiber	6	Unknown	6
Sacramento Regional Transit Dis	Sacramento	CA	CNG	Y	N	Orion	1996	40	EDO	Type 4, carbon fiber wr	10	Mirada	12
Boise Urban Stages	Boise	ID	CNG	Y	Y	ELF	1996	8	EDO	composite	3	Unknown	23
Toronto Transit Commission	Toronto	ON	CNG	Y	Y	Orion	1996	50	EDO	Type 4, polyethylene li	10	Mirada	43
Centre Area Transportation Auth	State College	PA	CNG	N		Orion	1996	16	EDO	composite	8	Unknown	48
South Coast Area Transit	Oxnard	CA	CNG	Y	Y	Orion	1997	9	EDO	aluminum with fiber co	4	Mirada	10
San Diego Transit Corporation	San Diego	CA	CNG	Y	Y	NFI	1994	4	Lincoln Composites	fiberglass-thermo plast	10	Lucas - SVG	15
BC Transit - Vancover RTS	Surrey	BC	CNG	N		NFI	1995	25	Lincoln Composites	Type 4, composite	4	Mirada	5
Metropolitan Transit Developmen	San Diego	CA	CNG	N		NFI	1995	51	Lincoln Composites	Carbon fiber, thermopl	4	Mirada	14
San Diego Transit Corporation	San Diego	CA	CNG	Y	Y	NFI	1995	46	Lincoln Composites	fiberglass-thermo plast	4	Mirada	16
Metropolitan Atlanta Rapid Transi	Atlanta	GA	CNG	Y	Y	NFI	1996	118	Lincoln Composites	Type 4, composite	6	Mirada	20
Hamilton Street Railway Compan	Hamilton	ON	CNG	Y	Y	NFI	1996	25	Lincoln Composites	Type 2, aluminum liner	7	Mirada	41
City of Tucson Mass Transit Syst	Tucson	AZ	CNG	N		NFI	1996/7	44	Lincoln Composites	Tuff Shell	4	Lincoln Comp	4
San Diego Transit Corporation	San Diego	CA	CNG	N		NFI	1997	27	Lincoln Composites	fiberglass-thermo plast	6	Unknown	17

Table 2-3. Responses Sorted by Bus Fuel, Cyl Mfr, Yr Bus Built, & TAs

Transit Agency	CITY	ST	Fuel	Leak	Resol	Bus Mfr.	Year	Buses	Tank Mfr.	Tank Type	Tank	PRD Mfr.	Page
Regional Transportation District	Denver	CO	CNG	N		World Tra	1997	3	Lincoln Composites	Type 4, NGV2-4	5	Corona Circle	19
Bi-State Development Agency	St. Louis	MO	CNG	N		Neoplan	1997	36	Lincoln Composites	Type 4, all composite	10	Lincoln Comp	25
LAKETRAN	Grand River	OH	CNG	N		NFI	1997	12	Lincoln Composites	Lincoln	5	Unknown	37
Centre Area Transportation Auth	State College	PA	CNG	N		NFI	1997	8	Lincoln Composites	composite	5	Unknown	49
Metropolitan Transit Authority of	Houston	TX	CNG	N		NFI	1997	5	Lincoln Composites	tuffshell, all composite	6	Mirada	60
Los Angeles County Metropolitan	Los Angeles	CA	CNG	Y	Y	Neoplan	1997/8	214	Lincoln Composites	Type 4, carbon fibre	11	Mirada	8
Boise Urban Stages	Boise	ID	CNG	N		Orion	1993	2	NGV Systems	composite reinforced a	8	Mirada	21
Greater Cleveland Regional Tran	Cleveland	OH	CNG	Y	Y	Nova	1997	65	NGV Systems	Type 2, steel (Duraste	12	NGV Systems	36
Port Authority of Allegheny Count	Pittsburgh	PA	CNG	N		Orion	1991	5	Pressed Steel Tank,	steel with fiberglass wr	10	Unknown	47
City of Tucson Mass Transit Syst	Tucson	AZ	CNG	N		Neoplan	1993/4	47	Pressed Steel Tank,	Lincoln Composite ?	10	Unknown	2
Sacramento Regional Transit Dis	Sacramento	CA	CNG	N		Orion	1993/4	96	Structural Composite	Type 3, aluminum/e-gl	12	Mirada	11
City of Tucson Mass Transit Syst	Tucson	AZ	CNG	N		Orion	1994	6	Structural Composite	composite	4	Mirada	3
City of El Paso Mass Transit Dep	El Paso	TX	CNG	N		Orion	1994	18	Structural Composite	NGV 2 glass wrapped	10	Mirada	55
Metropolitan Suburban Bus Auth	Garden City	NY	CNG	N		Orion	1995/6/	160	Structural Composite	Type 3, fibre wrap	12	Mirada	29
Toronto Transit Commission	Toronto	ON	CNG	N		Orion	1997	50	Structural Composite	Type 3, aluminum/fiber	8	Superior	44
Metro Regional Transit Authority	Akron	OH	CNG	N		Dodge	1994	1	Unknown	aluminum wrapped	2		30
Tri-Met	Portland	OR	LNG	N		Flxible	1993	8	CVI Inc.		3	N/A	46
Tri-Met	Portland	OR	LNG	N		Gillig	1992	2	Gryogas		2	N/A	45
City of El Paso Mass Transit Dep	El Paso	TX	LNG	N		NFI	1994	35	Minnesota Valley En	stainless steel cryogen	2	N/A	57
Metropolitan Transit Authority of	Houston	TX	LNG	N		NFI	1997	5	Minnesota Valley En	HLNG 56, stainless ste	4	N/A	64
Dallas Area Rapid Transit Authori	Dallas	TX	LNG	Y	Y	Nova	1997/8	210	Minnesota Valley En	stainless dewar	3	N/A	53
Phoenix Transit System	Phoenix	AZ	LNG	N		NABI	1998	180	Minnesota Valley En	stainless steel,double	2	N/A	1
Metropolitan Transit Authority of	Houston	TX	LNG	Y	Y	Ikarus	1992	60	Taylor Wharton	custom stainless steel	2	N/A	61
Metropolitan Transit Authority of	Houston	TX	LNG	Y	Y	Mercedes	1992/3	20	Taylor Wharton	custom stainless steel	1	N/A	62
Metropolitan Transit Authority of	Houston	TX	LNG	Y	Y	Neoplan	1993/4	115	Taylor Wharton	custom built, single tan	1	N/A	63

Table 2-4. Responses Sorted by Bus Fuel, PRD Mfr, Yr Bus Built, & TAs

Transit Agency	CITY	ST	Fuel	Leak	Resol	Bus Mfr.	Year	Buses	Tank Mfr.	Tank Type	Tank	PRD Mfr.	Page
Metro Regional Transit Authority	Akron	OH	CNG	N		Dodge	1994	1	Unknown	aluminum wrapped	2		30
South Coast Area Transit	Oxnard	CA	CNG	N		Flxible	1995	26	Comdyne	aluminum with fiber co	4		9
Metropolitan Transit Developmen	San Diego	CA	CNG	N		El Dorado	1995	2	CNG Cylinder Corp.	Carbon fiber, thermopl	5	CNG Cylinder	13
Dallas Area Rapid Transit Authori	Dallas	TX	CNG	N		Flxible	1990	2	Comdyne	rolled aluminum	6	Comdyne	52
Regional Transportation District	Denver	CO	CNG	N		World Tra	1997	3	Lincoln Composites	Type 4, NGV2-4	5	Corona Circle	19
City of Tucson Mass Transit Syst	Tucson	AZ	CNG	N		NFI	1996/7	44	Lincoln Composites	Tuff Shell	4	Lincoln Comp	4
Bi-State Development Agency	St. Louis	MO	CNG	N		Neoplan	1997	36	Lincoln Composites	Type 4, all composite	10	Lincoln Comp	25
San Diego Transit Corporation	San Diego	CA	CNG	Y	Y	NFI	1994	4	Lincoln Composites	fiberglass-thermo plast	10	Lucas - SVG	15
Regional Transportation District	Denver	CO	CNG	Y	N	Neoplan	1986	5	EDO	NGV2 Composite	12	Mirada	18
Greater Cleveland Regional Tran	Cleveland	OH	CNG	N		Flxible	1989	1	Comdyne	Type 3, aluminum	6	Mirada	31
MTA New York City Transit	Brooklyn	NY	CNG	N		TMC	1990	2	Comdyne	Type 3, steel liner	6	Mirada	26
Fort Worth Transportation Authori	Fort Worth	TX	CNG	Y	Y	Flxible	1990/1/	44	Comdyne	aluminum	4	Mirada	58
Bi-State Development Agency	St. Louis	MO	CNG	N		Flxible	1991	2	Comdyne	aluminum wrapped w.	6	Mirada	24
Greater Cleveland Regional Tran	Cleveland	OH	CNG	N		Flxible	1991	15	Comdyne	Type 3, aluminum	4	Mirada	32
Hamilton Street Railway Compan	Hamilton	ON	CNG	N		Orion	1991	15	Dynetek	Type 2, aluminum liner	8	Mirada	39
Greater Cleveland Regional Tran	Cleveland	OH	CNG	Y	N	Flxible	1992	5	Comdyne	Type 3, aluminum	4	Mirada	33
Hamilton Street Railway Compan	Hamilton	ON	CNG	N		Orion	1992	15	Alusuisse	aluminum with Kevalar	4	Mirada	40
Boise Urban Stages	Boise	ID	CNG	N		Orion	1993	2	NGV Systems	composite reinforced a	8	Mirada	21
Capital Metropolitan Transportati	Austin	TX	CNG	Y	Y	TMC	1993	30	CNG Cylinder Corp.	Type 2, aluminum hoo	12	Mirada	50
City of El Paso Mass Transit Dep	El Paso	TX	CNG	N		TMC	1993	2	CNG Cylinder Corp.	NGV 1 glass wrapped	12	Mirada	54
Sacramento Regional Transit Dis	Sacramento	CA	CNG	N		Orion	1993/4	96	Structural Composite	Type 3, aluminum/e-gl	12	Mirada	11
City of Tucson Mass Transit Syst	Tucson	AZ	CNG	N		Orion	1994	6	Structural Composite	composite	4	Mirada	3
Greater Cleveland Regional Tran	Cleveland	OH	CNG	Y	N	Flxible	1994	65	Comdyne	Type 3, aluminum	6	Mirada	34
City of El Paso Mass Transit Dep	El Paso	TX	CNG	N		Orion	1994	18	Structural Composite	NGV 2 glass wrapped	10	Mirada	55
BC Transit - Vancover RTS	Surrey	BC	CNG	N		NFI	1995	25	Lincoln Composites	Type 4, composite	4	Mirada	5
Metropolitan Transit Developmen	San Diego	CA	CNG	N		NFI	1995	51	Lincoln Composites	Carbon fiber, thermopl	4	Mirada	14
San Diego Transit Corporation	San Diego	CA	CNG	Y	Y	NFI	1995	46	Lincoln Composites	fiberglass-thermo plast	4	Mirada	16
MTA New York City Transit	Brooklyn	NY	CNG	Y	N	Orion	1995	31	EDO	Type 4, composite pla	10	Mirada	28
Greater Cleveland Regional Tran	Cleveland	OH	CNG	N		Flxible	1995	15	Comdyne	Type 3, aluminum	6	Mirada	35
Fort Worth Transportation Authori	Fort Worth	TX	CNG	Y	Y	Flxible	1995	13	Comdyne	aluminum	6	Mirada	59
Los Angeles County Metropolitan	Los Angeles	CA	CNG	Y	N	Neoplan	1995/6	218	EDO	Type 4, carbon fiber	11	Mirada	7
Metropolitan Suburban Bus Auth	Garden City	NY	CNG	N		Orion	1995/6/	160	Structural Composite	Type 3, fibre wrap	12	Mirada	29
Sacramento Regional Transit Dis	Sacramento	CA	CNG	Y	N	Orion	1996	40	EDO	Type 4, carbon fiber wr	10	Mirada	12
Metropolitan Atlanta Rapid Transi	Atlanta	GA	CNG	Y	Y	NFI	1996	118	Lincoln Composites	Type 4, composite	6	Mirada	20
Hamilton Street Railway Compan	Hamilton	ON	CNG	Y	Y	NFI	1996	25	Lincoln Composites	Type 2, aluminum liner	7	Mirada	41
Toronto Transit Commission	Toronto	ON	CNG	Y	Y	Orion	1996	50	EDO	Type 4, polyethylene li	10	Mirada	43
City of El Paso Mass Transit Dep	El Paso	TX	CNG	N		Chance In	1996/7	25	CNG Cylinder Corp.	Type 2, glass wrapped	12	Mirada	56
South Coast Area Transit	Oxnard	CA	CNG	Y	Y	Orion	1997	9	EDO	aluminum with fiber co	4	Mirada	10
Metropolitan Transit Authority of	Houston	TX	CNG	N		NFI	1997	5	Lincoln Composites	tuffshell, all composite	6	Mirada	60

Table 2-4. Responses Sorted by Bus Fuel, PRD Mfr, Yr Bus Built, & TAs

Transit Agency	CITY	ST	Fuel	Leak	Resol	Bus Mfr.	Year	Buses	Tank Mfr.	Tank Type	Tank	PRD Mfr.	Page
Los Angeles County Metropolitan	Los Angeles	CA	CNG	Y	Y	Neoplan	1997/8	214	Lincoln Composites	Type 4, carbon fibre	11	Mirada	8
Greater Cleveland Regional Tran	Cleveland	OH	CNG	Y	Y	Nova	1997	65	NGV Systems	Type 2, steel (Duraste	12	NGV Systems	36
Toronto Transit Commission	Toronto	ON	CNG	N		Orion	1990	25	Alusuisse	Type 3, aluminum/Kevl	4	Superior	42
MTA New York City Transit	Brooklyn	NY	CNG	N		TMC	1993	1	CNG Cylinder Corp.	Type 2, aluminum liner	12	Superior	27
Toronto Transit Commission	Toronto	ON	CNG	N		Orion	1997	50	Structural Composite	Type 3, aluminum/fiber	8	Superior	44
Hamilton Street Railway Compan	Hamilton	ON	CNG	N		GM	1977	2	CNG Cylinder Corp.	Type I, aluminum, fila	12	Unknown	38
Port Authority of Allegheny Count	Pittsburgh	PA	CNG	N		Orion	1991	5	Pressed Steel Tank,	steel with fiberglass wr	10	Unknown	47
City of Tucson Mass Transit Syst	Tucson	AZ	CNG	N		Neoplan	1993/4	47	Pressed Steel Tank,	Lincoln Composite ?	10	Unknown	2
Boise Urban Stages	Boise	ID	CNG	N		El Dorado	1994	20	CNG Cylinder Corp.	Type 2	6	Unknown	22
Capital Metropolitan Transportati	Austin	TX	CNG	N		El Dorado	1995	4	CNG Cylinder Corp.	Type 2, aluminum hoo	6	unknown	51
Long Beach Transit	Long Beach	CA	CNG	N		Orion	1996	5	EDO	composite carbon fiber	6	Unknown	6
Boise Urban Stages	Boise	ID	CNG	Y	Y	ELF	1996	8	EDO	composite	3	Unknown	23
Centre Area Transportation Auth	State College	PA	CNG	N		Orion	1996	16	EDO	composite	8	Unknown	48
San Diego Transit Corporation	San Diego	CA	CNG	N		NFI	1997	27	Lincoln Composites	fiberglass-thermo plast	6	Unknown	17
LAKETRAN	Grand River	OH	CNG	N		NFI	1997	12	Lincoln Composites	Lincoln	5	Unknown	37
Centre Area Transportation Auth	State College	PA	CNG	N		NFI	1997	8	Lincoln Composites	composite	5	Unknown	49
Tri-Met	Portland	OR	LNG	N		Gillig	1992	2	Gryogas		2	N/A	45
Metropolitan Transit Authority of	Houston	TX	LNG	Y	Y	Ikarus	1992	60	Taylor Wharton	custom stainless steel	2	N/A	61
Metropolitan Transit Authority of	Houston	TX	LNG	Y	Y	Mercedes	1992/3	20	Taylor Wharton	custom stainless steel	1	N/A	62
Tri-Met	Portland	OR	LNG	N		Flxible	1993	8	CVI Inc.		3	N/A	46
Metropolitan Transit Authority of	Houston	TX	LNG	Y	Y	Neoplan	1993/4	115	Taylor Wharton	custom built, single tan	1	N/A	63
City of El Paso Mass Transit Dep	El Paso	TX	LNG	N		NFI	1994	35	Minnesota Valley En	stainless steel cryogen	2	N/A	57
Metropolitan Transit Authority of	Houston	TX	LNG	N		NFI	1997	5	Minnesota Valley En	HLNG 56, stainless ste	4	N/A	64
Dallas Area Rapid Transit Authori	Dallas	TX	LNG	Y	Y	Nova	1997/8	210	Minnesota Valley En	stainless dewar	3	N/A	53
Phoenix Transit System	Phoenix	AZ	LNG	N		NABI	1998	180	Minnesota Valley En	stainless steel,double	2	N/A	1

Table 2-5. Responses Sorted by Bus Fuel, Leak, Resolved, Tank & Bus Mfr

Transit Agency	CITY	ST	Fuel	Leak	Resol	Bus Mfr.	Year	Buses	Tank Mfr.	Tank Type	Tank	PRD Mfr.	Page
Toronto Transit Commission	Toronto	ON	CNG	N		Orion	1990	25	Alusuisse	Type 3, aluminum/Kevl	4	Superior	42
Hamilton Street Railway Compan	Hamilton	ON	CNG	N		Orion	1992	15	Alusuisse	aluminum with Kevalar	4	Mirada	40
City of El Paso Mass Transit Dep	El Paso	TX	CNG	N		Chance In	1996/7	25	CNG Cylinder Corp.	Type 2, glass wrapped	12	Mirada	56
Boise Urban Stages	Boise	ID	CNG	N		El Dorado	1994	20	CNG Cylinder Corp.	Type 2	6	Unknown	22
Metropolitan Transit Developmen	San Diego	CA	CNG	N		El Dorado	1995	2	CNG Cylinder Corp.	Carbon fiber, thermopl	5	CNG Cylinder	13
Capital Metropolitan Transportati	Austin	TX	CNG	N		El Dorado	1995	4	CNG Cylinder Corp.	Type 2, aluminum hoo	6	unknown	51
Hamilton Street Railway Compan	Hamilton	ON	CNG	N		GM	1977	2	CNG Cylinder Corp.	Type I, aluminum, fila	12	Unknown	38
MTA New York City Transit	Brooklyn	NY	CNG	N		TMC	1993	1	CNG Cylinder Corp.	Type 2, aluminum liner	12	Superior	27
City of El Paso Mass Transit Dep	El Paso	TX	CNG	N		TMC	1993	2	CNG Cylinder Corp.	NGV 1 glass wrapped	12	Mirada	54
Greater Cleveland Regional Tran	Cleveland	OH	CNG	N		Flxible	1989	1	Comdyne	Type 3, aluminum	6	Mirada	31
Dallas Area Rapid Transit Authori	Dallas	TX	CNG	N		Flxible	1990	2	Comdyne	rolled aluminum	6	Comdyne	52
Bi-State Development Agency	St. Louis	MO	CNG	N		Flxible	1991	2	Comdyne	aluminum wrapped w.	6	Mirada	24
Greater Cleveland Regional Tran	Cleveland	OH	CNG	N		Flxible	1991	15	Comdyne	Type 3, aluminum	4	Mirada	32
South Coast Area Transit	Oxnard	CA	CNG	N		Flxible	1995	26	Comdyne	aluminum with fiber co	4		9
Greater Cleveland Regional Tran	Cleveland	OH	CNG	N		Flxible	1995	15	Comdyne	Type 3, aluminum	6	Mirada	35
MTA New York City Transit	Brooklyn	NY	CNG	N		TMC	1990	2	Comdyne	Type 3, steel liner	6	Mirada	26
Hamilton Street Railway Compan	Hamilton	ON	CNG	N		Orion	1991	15	Dynetek	Type 2, aluminum liner	8	Mirada	39
Long Beach Transit	Long Beach	CA	CNG	N		Orion	1996	5	EDO	composite carbon fiber	6	Unknown	6
Centre Area Transportation Auth	State College	PA	CNG	N		Orion	1996	16	EDO	composite	8	Unknown	48
Bi-State Development Agency	St. Louis	MO	CNG	N		Neoplan	1997	36	Lincoln Composites	Type 4, all composite	10	Lincoln Comp	25
BC Transit - Vancover RTS	Surrey	BC	CNG	N		NFI	1995	25	Lincoln Composites	Type 4, composite	4	Mirada	5
Metropolitan Transit Developmen	San Diego	CA	CNG	N		NFI	1995	51	Lincoln Composites	Carbon fiber, thermopl	4	Mirada	14
City of Tucson Mass Transit Syst	Tucson	AZ	CNG	N		NFI	1996/7	44	Lincoln Composites	Tuff Shell	4	Lincoln Comp	4
San Diego Transit Corporation	San Diego	CA	CNG	N		NFI	1997	27	Lincoln Composites	fiberglass-thermo plast	6	Unknown	17
LAKETRAN	Grand River	OH	CNG	N		NFI	1997	12	Lincoln Composites	Lincoln	5	Unknown	37
Centre Area Transportation Auth	State College	PA	CNG	N		NFI	1997	8	Lincoln Composites	composite	5	Unknown	49
Metropolitan Transit Authority of	Houston	TX	CNG	N		NFI	1997	5	Lincoln Composites	tuffshell, all composite	6	Mirada	60
Regional Transportation District	Denver	CO	CNG	N		World Tra	1997	3	Lincoln Composites	Type 4, NGV2-4	5	Corona Circle	19
Boise Urban Stages	Boise	ID	CNG	N		Orion	1993	2	NGV Systems	composite reinforced a	8	Mirada	21
City of Tucson Mass Transit Syst	Tucson	AZ	CNG	N		Neoplan	1993/4	47	Pressed Steel Tank,	Lincoln Composite ?	10	Unknown	2
Port Authority of Allegheny Count	Pittsburgh	PA	CNG	N		Orion	1991	5	Pressed Steel Tank,	steel with fiberglass wr	10	Unknown	47
Sacramento Regional Transit Dis	Sacramento	CA	CNG	N		Orion	1993/4	96	Structural Composite	Type 3, aluminum/e-gl	12	Mirada	11
City of Tucson Mass Transit Syst	Tucson	AZ	CNG	N		Orion	1994	6	Structural Composite	composite	4	Mirada	3
City of El Paso Mass Transit Dep	El Paso	TX	CNG	N		Orion	1994	18	Structural Composite	NGV 2 glass wrapped	10	Mirada	55
Metropolitan Suburban Bus Auth	Garden City	NY	CNG	N		Orion	1995/6/	160	Structural Composite	Type 3, fibre wrap	12	Mirada	29
Toronto Transit Commission	Toronto	ON	CNG	N		Orion	1997	50	Structural Composite	Type 3, aluminum/fiber	8	Superior	44
Metro Regional Transit Authority	Akron	OH	CNG	N		Dodge	1994	1	Unknown	aluminum wrapped	2		30
Greater Cleveland Regional Tran	Cleveland	OH	CNG	Y	N	Flxible	1992	5	Comdyne	Type 3, aluminum	4	Mirada	33
Greater Cleveland Regional Tran	Cleveland	OH	CNG	Y	N	Flxible	1994	65	Comdyne	Type 3, aluminum	6	Mirada	34

Table 2-5. Responses Sorted by Bus Fuel, Leak, Resolved, Tank & Bus Mfr

Transit Agency	CITY	ST	Fuel	Leak	Resol	Bus Mfr.	Year	Buses	Tank Mfr.	Tank Type	Tank	PRD Mfr.	Page
Regional Transportation District	Denver	CO	CNG	Y	N	Neoplan	1986	5	EDO	NGV2 Composite	12	Mirada	18
Los Angeles County Metropolitan	Los Angeles	CA	CNG	Y	N	Neoplan	1995/6	218	EDO	Type 4, carbon fiber	11	Mirada	7
MTA New York City Transit	Brooklyn	NY	CNG	Y	N	Orion	1995	31	EDO	Type 4, composite pla	10	Mirada	28
Sacramento Regional Transit Dis	Sacramento	CA	CNG	Y	N	Orion	1996	40	EDO	Type 4, carbon fiber wr	10	Mirada	12
Capital Metropolitan Transportati	Austin	TX	CNG	Y	Y	TMC	1993	30	CNG Cylinder Corp.	Type 2, aluminum hoo	12	Mirada	50
Fort Worth Transportation Authori	Fort Worth	TX	CNG	Y	Y	Flxible	1990/1/	44	Comdyne	aluminum	4	Mirada	58
Fort Worth Transportation Authori	Fort Worth	TX	CNG	Y	Y	Flxible	1995	13	Comdyne	aluminum	6	Mirada	59
Boise Urban Stages	Boise	ID	CNG	Y	Y	ELF	1996	8	EDO	composite	3	Unknown	23
Toronto Transit Commission	Toronto	ON	CNG	Y	Y	Orion	1996	50	EDO	Type 4, polyethylene li	10	Mirada	43
South Coast Area Transit	Oxnard	CA	CNG	Y	Y	Orion	1997	9	EDO	aluminum with fiber co	4	Mirada	10
Los Angeles County Metropolitan	Los Angeles	CA	CNG	Y	Y	Neoplan	1997/8	214	Lincoln Composites	Type 4, carbon fibre	11	Mirada	8
San Diego Transit Corporation	San Diego	CA	CNG	Y	Y	NFI	1994	4	Lincoln Composites	fiberglass-thermo plast	10	Lucas - SVG	15
San Diego Transit Corporation	San Diego	CA	CNG	Y	Y	NFI	1995	46	Lincoln Composites	fiberglass-thermo plast	4	Mirada	16
Metropolitan Atlanta Rapid Transi	Atlanta	GA	CNG	Y	Y	NFI	1996	118	Lincoln Composites	Type 4, composite	6	Mirada	20
Hamilton Street Railway Compan	Hamilton	ON	CNG	Y	Y	NFI	1996	25	Lincoln Composites	Type 2, aluminum liner	7	Mirada	41
Greater Cleveland Regional Tran	Cleveland	OH	CNG	Y	Y	Nova	1997	65	NGV Systems	Type 2, steel (Duraste	12	NGV Systems	36
Tri-Met	Portland	OR	LNG	N		Flxible	1993	8	CVI Inc.		3	N/A	46
Tri-Met	Portland	OR	LNG	N		Gillig	1992	2	Gryogas		2	N/A	45
Phoenix Transit System	Phoenix	AZ	LNG	N		NABI	1998	180	Minnesota Valley En	stainless steel,double	2	N/A	1
City of El Paso Mass Transit Dep	El Paso	TX	LNG	N		NFI	1994	35	Minnesota Valley En	stainless steel cryogen	2	N/A	57
Metropolitan Transit Authority of	Houston	TX	LNG	N		NFI	1997	5	Minnesota Valley En	HLNG 56, stainless ste	4	N/A	64
Dallas Area Rapid Transit Authori	Dallas	TX	LNG	Y	Y	Nova	1997/8	210	Minnesota Valley En	stainless dewar	3	N/A	53
Metropolitan Transit Authority of	Houston	TX	LNG	Y	Y	Ikarus	1992	60	Taylor Wharton	custom stainless steel	2	N/A	61
Metropolitan Transit Authority of	Houston	TX	LNG	Y	Y	Mercedes	1992/3	20	Taylor Wharton	custom stainless steel	1	N/A	62
Metropolitan Transit Authority of	Houston	TX	LNG	Y	Y	Neoplan	1993/4	115	Taylor Wharton	custom built, single tan	1	N/A	63

Table 2-6. Cylinder Manufacturer and Number of Cylinders versus Bus Manufacturer

Bus Fuel	Cylinder Manufacturer	Bus Manufacturer	Total Number of Cylinders
CNG	Alusuisse	Orion	160
		Total	160
	CNG Cylinder Corp.	Chance Industries	300
		El Dorado National	130
		GM	24
		TMC	396
		Total	850
	Comdyne	Flxible	948
		TMC	12
		Total	960
	Dynetek	Orion	120
		Total	120
	EDO	ELF	24
		Neoplan	2,458
		Orion	1,404
		Total	3,886
	Lincoln Composites	Neoplan	2,714
		NFI	1,879
		World Trans	15
		Total	4,608
	NGV Systems	Nova	780
		Orion	16
		Total	796
	Pressed Steel Tank, Inc.	Neoplan	470
		Orion	50
		Total	520
	Structural Composites Inc.	Orion	3,676
		Total	3,676
	Unknown	Dodge	2
		Total	2
	Total:		**15,578**
LNG	CVI Inc.	Flxible	24
		Total	24
	Gryogas	Gillig	4
		Total	4
	Minnesota Valley Engr.	NABI	360
		NFI	90
		Nova	630
		Total	1,080
	Taylor Wharton	Ikarus	120
		Mercedes	20
		Neoplan	115
		Total	255
	Total:		**1,363**
Total:			**16,941**

Table 2-7. PRD Manufacturer and Number of Cylinders versus Cylinder Manufacturer

Bus Fuel	PRD Manufacturer	Cylinder Manufacturer	Total Number of Cylinders
CNG		Comdyne	104
		Unknown	2
		Total	106
	CNG Cylinders	CNG Cylinder Corp.	10
		Total	10
	Comdyne	Comdyne	12
		Total	12
	Corona Circle Seal	Lincoln Composites	15
		Total	15
	Lincoln Composites	Lincoln Composites	536
		Total	536
	Lucas - SVG	Lincoln Composites	40
	Lucas - SVG	Total	40
	Mirada	Alusuisse	60
		CNG Cylinder Corp.	684
		Comdyne	844
		Dynetek	120
		EDO	3,704
		Lincoln Composites	3,755
		NGV Systems	16
		Structural Composites Inc.	3,276
		Total	12,459
	NGV Systems	NGV Systems	780
		Total	780
	Superior	Alusuisse	100
		CNG Cylinder Corp.	12
		Structural Composites Inc.	400
		Total	512
	Unknown	CNG Cylinder Corp.	144
		EDO	182
		Lincoln Composites	262
		Pressed Steel Tank, Inc.	520
		Total	1,108
	Total:		**15,578**
LNG	N/A	CVI Inc.	24
		Gryogas	4
		Minnesota Valley Engr.	1,080
		Taylor Wharton	255
		Total	1,363
	Total:		**1,363**
Total:			**16,941**

Table 2-8. Bus Manufacturer and Number of Cylinders versus Cylinder Manufacturer

Bus Fuel	Bus Manufacturer	Cylinder Manufacturer	Total Number of Cylinders
CNG	Chance Industries	CNG Cylinder Corp.	300
		Total	300
	Dodge	Unknown	2
		Total	2
	El Dorado National	CNG Cylinder Corp.	130
		Total	130
	ELF	EDO	24
		Total	24
	Flxible	Comdyne	948
		Total	948
	GM	CNG Cylinder Corp.	24
		Total	24
	Neoplan	EDO	2,458
		Lincoln Composites	2,714
		Pressed Steel Tank, Inc.	470
		Total	5,642
	NFI	Lincoln Composites	1,879
		Total	1,879
	Nova	NGV Systems	780
		Total	780
	Orion	Alusuisse	160
		Dynetek	120
		EDO	1,404
		NGV Systems	16
		Pressed Steel Tank, Inc.	50
		Structural Composites Inc.	3,676
		Total	5,426
	TMC	CNG Cylinder Corp.	396
		Comdyne	12
		Total	408
	World Trans	Lincoln Composites	15
		Total	15
	Total:		**15,578**
LNG	Flxible	CVI Inc.	24
		Total	24
	Gillig	Gryogas	4
		Total	4
	Ikarus	Taylor Wharton	120
		Total	120
	Mercedes	Taylor Wharton	20
		Total	20
	NABI	Minnesota Valley Engr.	360
		Total	360
	Neoplan	Taylor Wharton	115
		Total	115
	NFI	Minnesota Valley Engr.	90
		Total	90
	Nova	Minnesota Valley Engr.	630
		Total	630
	Total:		**1,363**
Total:			**16,941**

Table 2-9. Bus Fuel, Transit Agency, Year Bus Built, and Bus Manufacturer versus Number of Buses

Bus Fuel	Transit Agency	Year Bus Built	Bus Manufacturer	No. of Buses
CNG	BC Transit - Vancouver RTS	1995	NFI	25
		Total		25
	Bi-State Development Agency	1991	Flxible	2
		1997	Neoplan	36
		Total		38
	Boise Urban Stages	1993	Orion	2
		1994	El Dorado National	20
		1996	ELF	8
		Total		30
	Capital Metropolitan Transportation Authority	1993	TMC	30
		1995	El Dorado National	4
		Total		34
	Centre Area Transportation Authority	1996	Orion	16
		1997	NFI	8
		Total		24
	City of El Paso Mass Transit Department (Sun Metro)	1993	TMC	2
		1994	Orion	18
		1996/7	Chance Industries	25
		Total		45
	City of Tucson Mass Transit System (Sun Tran)	1993/4	Neoplan	47
		1994	Orion	6
		1996/7	NFI	44
		Total		97
	Dallas Area Rapid Transit Authority	1990	Flxible	2
		Total		2
	Fort Worth Transportation Authority	1990/1/2	Flxible	44
		1995	Flxible	13
		Total		57
	Greater Cleveland Regional Transit Authority	1989	Flxible	1
		1991	Flxible	15
		1992	Flxible	5
		1994	Flxible	65
		1995	Flxible	15
		1997	Nova	65
		Total		166
	Hamilton Street Railway Company	1977	GM	2
		1991	Orion	15
		1992	Orion	15
		1996	NFI	25
		Total	GM	57
	LAKETRAN	1997	NFI	12
		Total	NFI	12
	Long Beach Transit	1996	Orion	5
		Total		5
	Los Angeles County Metropolitan Transportation Auth.	1995/6	Neoplan	218
		1997/8	Neoplan	214
		Total		432
	Metro Regional Transit Authority	1994	Dodge	1
		Total		1

Table 2-9. Bus Fuel, Transit Agency, Year Bus Built, and Bus Manufacturer versus Number of Buses (Continued)

Bus Fuel	Transit Agency	Year Bus Built	Bus Manufacturer	No. of Buses
CNG	Metropolitan Atlanta Rapid Transit Authority	1996	NFI	118
		Total		118
	Metropolitan Suburban Bus Authority	1995/6/7	Orion	160
		Total		160
	Metropolitan Transit Authority of Harris County	1997	NFI	5
		Total		5
	Metropolitan Transit Development Board	1995	El Dorado National	2
		1995	NFI	51
		Total		53
	MTA New York City Transit	1990	TMC	2
		1993	TMC	1
		1995	Orion	31
		Total		34
	Port Authority of Allegheny County	1991	Orion	5
		Total		5
	Regional Transportation District	1986	Neoplan	5
		1997	World Trans	3
		Total		8
	Sacramento Regional Transit District	1993/4	Orion	96
		1996	Orion	40
		Total		136
	San Diego Transit Corporation	1994	NFI	4
		1995	NFI	46
		1997	NFI	27
		Total		77
	South Coast Area Transit	1995	Flxible	26
		1997	Orion	9
		Total		35
	Toronto Transit Commission	1990	Orion	25
		1996	Orion	50
		1997	Orion	50
		Total		125
	Total:			**1,781**
LNG	City of El Paso Mass Transit Department (Sun Metro)	1994	NFI	35
		Total	NFI	35
	Dallas Area Rapid Transit Authority	1997/8	Nova	210
		Total	Nova	210
	Metropolitan Transit Authority of Harris County	1992	Ikarus	60
		1992/3	Mercedes	20
		1993/4	Neoplan	115
		1997	NFI	5
		Total		200
	Phoenix Transit System	1998	NABI	180
		Total		180
	Tri-Met	1992	Gillig	2
		1993	Flxible	8
		Total		10
	Total:			**635**
Total:				**2,416**

Table 2-10. Buses with Cylinder Leaks/Resolved Problem, by Bus Fuel and Number of Buses

a. Number of Bus Groups by Leaks/Resolved

Leaks	Resolved	CNG	LNG	Total
		No. of Bus Groups	No. of Bus Groups	No. of Bus Groups
None	N/A	37	5	42
Yes	No	6	0	6
	Yes	12	4	16
Total:		**55**	**9**	**64**

b. Number of Buses (in these Bus Groups) by Leaks/Resolved

Leaks	Resolved	CNG	LNG	Total
		Number of Buses	Number of Buses	Number of Buses
None	N/A	791	230	1,021
Yes	No	364	0	364
	Yes	626	405	1,031
Total:		**1,781**	**635**	**2,416**

Note: "Number of Buses" in the table above are those contained in the Bus Groups. For those Bus Groups that experienced leaks, only a few of the buses in the Bus Group had leaks.

Table 2-11. Buses with Cylinder Leaks/Resolved Problem, by Cylinder Manufacturer, Bus Fuel and Number of Buses

Bus Fuel:	CNG				LNG			All Buses
Leaks:	None	Yes		Total	None	Yes	Total	
Resolved:	N/A	No	Yes		N/A	Yes		
	No. of Buses	No. of Buses	No. of Buses	No. of Buses	No. of Buses	No. of Buses	No. of Buses	No. of Buses
Cylinder Manufacturer								
Alusuisse	40			40				40
CNG Cylinder Corp.	56		30	86				86
Comdyne	63	70	57	190				190
CVI Inc.					8		8	8
Dynetek	15			15				15
EDO	21	294	67	382				382
Gryogas					2		2	2
Lincoln Composites	211		407	618				618
Minnesota Valley					220	210	430	430
NGV Systems	2		65	67				67
Pressed Steel Tank	52			52				52
Structural Composites	330			330				330
Taylor Wharton						195	195	195
Unknown	1			1				1
Total:	**791**	**364**	**626**	**1,781**	**230**	**405**	**635**	**2,416**

Note: "Number of Buses" in the table above are those contained in the Bus Groups.
For those Bus Groups that experienced leaks, only a few of the buses in the Bus Group had leaks.

Table 2-12. CNG Buses with Cylinder Leaks/Resolved Problem, by PRD Manufacturer and Number of Buses

Leaks:	None	Yes		Total
Resolved:	N/A	No	Yes	
	No. of Buses	No. of Buses	No. of Buses	No. of Buses
PRD Manufacturer				
CNG Cylinders	2			2
Comdyne	2			2
Corona Circle Seal	3			3
Lincoln Composites	80			80
Lucas - SVG			4	4
Mirada	455	364	549	1,368
NGV Systems			65	65
Superior	76			76
Unknown	173		8	181
Total:	**791**	**364**	**626**	**1,781**

Note: "Number of Buses" in the table above are those contained in the Bus Groups. For those Bus Groups that experienced leaks, only a few of the buses in the Bus Group had leaks.

Figure 2-1. Natural Gas Buses by Year Bus Built

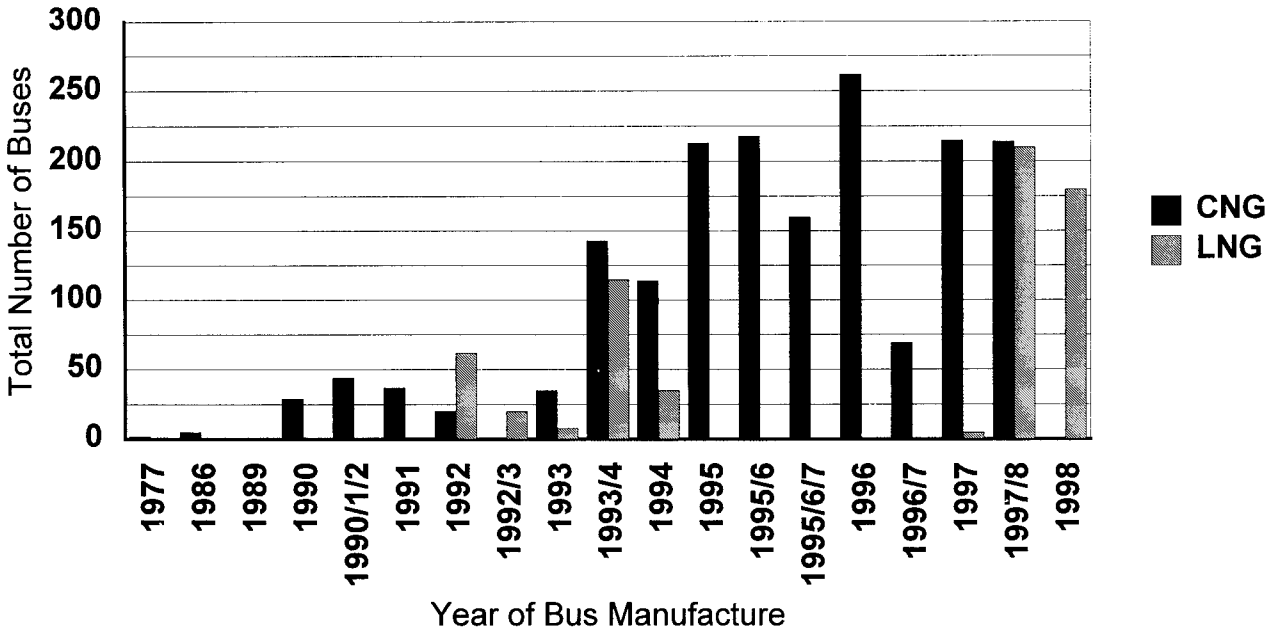


Figure 2-2. Number of Cylinders by Cylinder Mfr.

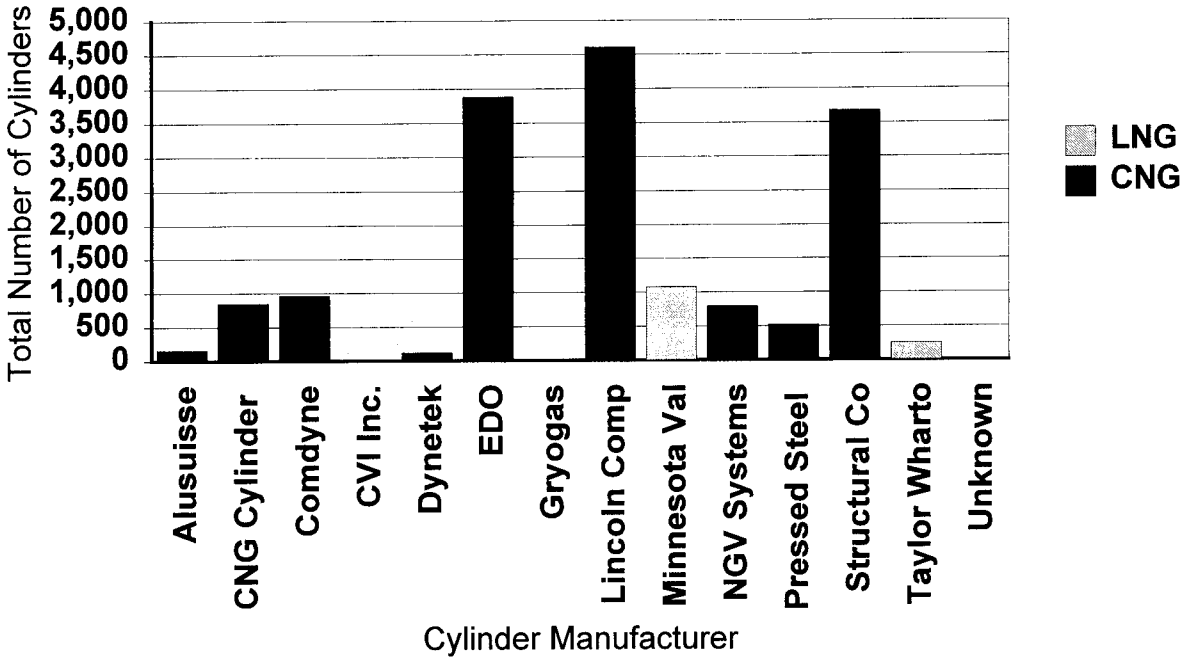
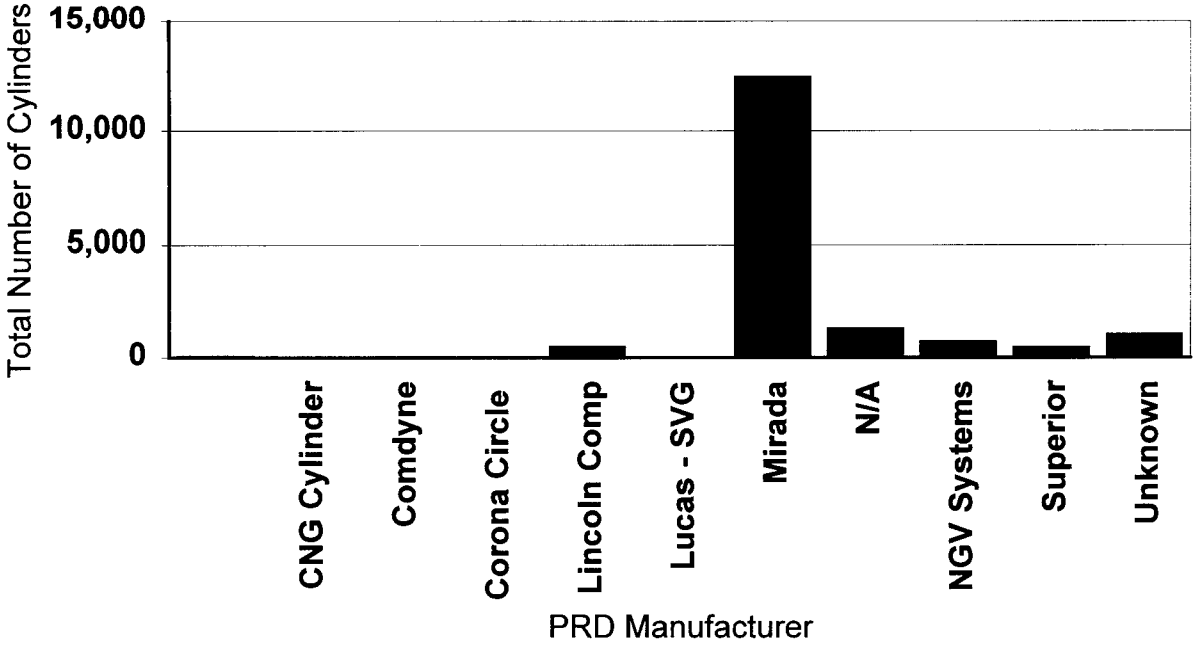


Figure 2-3. Number of Cylinders by PRD Mfr



Appendix – A

March 27, 1998 Letter to 41 Transit Agencies

Data Entry Form on Problems Regarding CNG and LNG Cylinder Tanks

1. Transit Agency: «COMPANYNAM»
   «STREET1»
   «CITY», «STATE» «ZIPCODE»

2. Total number of Natural Gas Buses in Service: CNG _____, LNG _____

3. Size and make of Cylinder Tanks in Service (enter data separately for each type of bus fuel and bus manufacturer):

   a. CNG Bus Mfr. & Model: _____, Number of buses: ____
   Tank Mfr.: _____, Tank fill press: _____
   Type of tank (type num., material, etc.): _____
   Tank Dimensions, Diameter: _____, Length: _____
   Num. of tanks on bus: ____, Fuel Capacity of bus (scf): _____
   Placement of tanks (top, bottom, or rear of bus): _____
   PRD Mfr. & Model (if known): _____
   Have you experienced any incidents of tank leaks or failures: ___
   If so, how often have they occurred: _____
   Please describe the incidents: _____

   Are the cause of these incidents being resolved: _____

   b. LNG Bus Mfr. & Model: _____, Number of buses: ____
   Tank Mfr.: _____, Tank fill press: _____
   Type of tank (type num., material, etc.): _____
   Tank Dimensions, Diameter: _____, Length: _____
   Num. of tanks on bus: ____, Fuel Capacity of bus (gal): _____
   Placement of tanks (top, bottom, or rear of bus): _____
   Have you experienced any incidents of tank leaks or failures: ___
   If so, how often have they occurred: _____
   Please describe the incidents: _____

   Are the cause of these incidents being resolved: _____

Data Entry Form on Problems Regarding CNG and LNG Cylinder Tanks

1. Transit Agency: «COMPANYNAM»
«STREET1»
«CITY», «STATE» «ZIPCODE»

2. Total number of Natural Gas Buses in Service: CNG _____, LNG _____

3. Size and make of Cylinder Tanks in Service (enter data separately for each type of bus fuel and bus manufacturer):

c. CNG Bus Mfr. & Model: _____, Number of buses: ____
Tank Mfr.: _____, Tank fill press: _____
Type of tank (type num., material, etc.): _____
Tank Dimensions, Diameter: _____, Length: _____
Num. of tanks on bus: ____, Fuel Capacity of bus (scf): _____
Placement of tanks (top, bottom, or rear of bus): _____
PRD Mfr. & Model (if known): _____
Have you experienced any incidents of tank leaks or failures: ___
If so, how often have they occurred: _____
Please describe the incidents: _____
_____
_____
_____
_____
_____
_____
_____
_____
_____
Are the cause of these incidents being resolved: _____
_____
_____
_____
_____
_____

d. LNG Bus Mfr. & Model: _____, Number of buses: ____
Tank Mfr.: _____, Tank fill press: _____
Type of tank (type num., material, etc.): _____
Tank Dimensions, Diameter: _____, Length: _____
Num. of tanks on bus: ____, Fuel Capacity of bus (gal): _____
Placement of tanks (top, bottom, or rear of bus): _____
Have you experienced any incidents of tank leaks or failures: ___
If so, how often have they occurred: _____
Please describe the incidents: _____
_____
_____
_____
_____
_____
_____
_____
_____
_____
Are the cause of these incidents being resolved: _____
_____
_____
_____
_____

Data Entry Form on Problems Regarding CNG and LNG Cylinder Tanks

1. Transit Agency: «COMPANYNAM»
«STREET1»
«CITY», «STATE» «ZIPCODE»

4. Tank Inspection Procedures (general or detailed, visual or acoustic, etc.) and Frequencies: _____

5. Have your inspections found any cylinders that should be removed from service: _____

6. How effective is the tank inspection process: _____

7. Other Data, Comments, or Recommendations: _____

8. Completed by: _____
Date: _____
Phone: _____
Fax: _____

9. If follow-up is needed, who should be contacted (if different from above):
Name: _____
Position: _____
Phone: _____

Thank your for filling out this data form, your assistance is appreciated.

Vincent R. DeMarco, PE

Appendix – B

Responses from 28 Transit Agencies to March 27, 1998 Letter

Responses to March 27, 1998 Letters on Status of CNG/LNG Cylinders

COMPANYNAM	CITY	STATE
Phoenix Transit System	Phoenix	AZ

Bus Fuel	No. of Buses	Bus Mfr.	Bus Model	Year Bus Built
LNG	180	NABI	416-LF	1998

Tank Mfr.	Tank Type
Minnesota Valley Engr.	stainless steel,double wall,insulated

Tank Diameter	Tank Length	Tank Placement	Tank Pressure
24"	65"	rear/above engine	50 psi (over tank)

No. of Tanks	Fuel Capacity	Tank PRD Mfr.	Tank PRD Model
2	172 gross, 154 (net)	N/A	

Tank Leak/Rupture	Leak Frequency
No	None

Incidents Descript.

Cause Resolved

Tank Inspection

Plan to use a general inspection of fuel system using portable gas detectors and liquid leak detectors fluid at preventative maintenance cycles of 4000 to 6000 miles

Cylinders Removed

Not Applicable

Inspection Effective

inspection procedures ok to date

Other

Buses to be delivered in mid-May 1998; would like recommendations on PM of LNG tanks

Reporter Name	Reporter Phone	Date Completed
Glenn A. Kelly	602-534-1761	4/10/98

Compiled by: Vincent R. DeMarco, PE File: afi-sum3.dbf 09/12/98

Responses to March 27, 1998 Letters on Status of CNG/LNG Cylinders

COMPANYNAM	CITY	STATE
City of Tucson Mass Transit System (Sun Tran)	Tucson	AZ

Bus Fuel	No. of Buses	Bus Mfr.	Bus Model	Year Bus Built
CNG	47	Neoplan	AN440-A	1993/4

Tank Mfr.	Tank Type
Pressed Steel Tank, Inc.	Lincoln Composite ?

Tank Diameter	Tank Length	Tank Placement	Tank Pressure
24"	56"	bottom	3000 psi

No. of Tanks	Fuel Capacity	Tank PRD Mfr.	Tank PRD Model
10	9,160 scf	Unknown	

Tank Leak/Rupture	Leak Frequency
No	None

Incidents Descript.

Cause Resolved

Tank Inspection

acoustic once every 5 years

Cylinders Removed

None

Inspection Effective

Excellent

Other

Reporter Name	Reporter Phone	Date Completed
Diacomo Pisciotta	520-623-4301 x220	4/2/98

Compiled by: Vincent R. DeMarco, PE File: afi-sum3.dbf 09/12/98

Responses to March 27, 1998 Letters on Status of CNG/LNG Cylinders

COMPANYNAM	CITY	STATE
City of Tucson Mass Transit System (Sun Tran)	Tucson	AZ

Bus Fuel	No. of Buses	Bus Mfr.	Bus Model	Year Bus Built
CNG	6	Orion	02.501	1994

Tank Mfr.	Tank Type
Structural Composites Inc.	composite

Tank Diameter	Tank Length	Tank Placement	Tank Pressure
15"	72"	bottom	3000 psi

No. of Tanks	Fuel Capacity	Tank PRD Mfr.	Tank PRD Model
4	5,296 scf	Mirada	B51618, B51609

Tank Leak/Rupture	Leak Frequency
No	None

Incidents Descript.

Cause Resolved

Tank Inspection

detailed once every 12 months

Cylinders Removed

None

Inspection Effective

Excellent

Other

This model bus also has another size and mfr of tanks, CNG Cylinders with 13" dia and 60" long and 7,074 scf

Reporter Name	Reporter Phone	Date Completed
Diacomo Pisciotta	520-623-4301 x220	4/2/98

Compiled by: Vincent R. DeMarco, PE File: afi-sum3.dbf 09/12/98

Responses to March 27, 1998 Letters on Status of CNG/LNG Cylinders

COMPANYNAM	CITY	STATE
City of Tucson Mass Transit System (Sun Tran)	Tucson	AZ

Bus Fuel	No. of Buses	Bus Mfr.	Bus Model	Year Bus Built
CNG	44	NFI	C-40 HF	1996/7

Tank Mfr.	Tank Type
Lincoln Composites	Tuff Shell

Tank Diameter	Tank Length	Tank Placement	Tank Pressure
18.4	120"	bottom	3000 psi

No. of Tanks	Fuel Capacity	Tank PRD Mfr.	Tank PRD Model
4	14,384 scf	Lincoln Composites	

Tank Leak/Rupture	Leak Frequency
No	None

Incidents Descript.

Cause Resolved

Tank Inspection

detailed once every 12 months

Cylinders Removed

None

Inspection Effective

Excellent

Other

Reporter Name	Reporter Phone	Date Completed
Diacomo Pisciotta	520-623-4301 x220	4/2/98

Compiled by: Vincent R. DeMarco, PE File: afi-sum3.dbf 09/12/98

Responses to March 27, 1998 Letters on Status of CNG/LNG Cylinders

COMPANYNAM	CITY	STATE
BC Transit - Vancover RTS	Surrey	BC

Bus Fuel	No. of Buses	Bus Mfr.	Bus Model	Year Bus Built
CNG	25	NFI	D40	1995

Tank Mfr.	Tank Type
Lincoln Composites	Type 4, composite

Tank Diameter	Tank Length	Tank Placement	Tank Pressure
18"	120"	bottom	3000 psi

No. of Tanks	Fuel Capacity	Tank PRD Mfr.	Tank PRD Model
4	14,384 scf	Mirada	MK 4

Tank Leak/Rupture	Leak Frequency
No	None

Incidents Descript.

Cause Resolved

Tank Inspection

Cylinders Removed

Inspection Effective

very effective

Other

Reporter Name	Reporter Phone	Date Completed
Eric Holmberg	604-293-4640	

Compiled by: Vincent R. DeMarco, PE File: afi-sum3.dbf 09/12/98

Responses to March 27, 1998 Letters on Status of CNG/LNG Cylinders

COMPANYNAM	CITY	STATE
Long Beach Transit	Long Beach	CA

Bus Fuel	No. of Buses	Bus Mfr.	Bus Model	Year Bus Built
CNG	5	Orion	02.501	1996

Tank Mfr.	Tank Type
EDO	composite carbon fiber

Tank Diameter	Tank Length	Tank Placement	Tank Pressure
15" and 13"	76.5" and 60"	top	3600 psi

No. of Tanks	Fuel Capacity	Tank PRD Mfr.	Tank PRD Model
6	1,800 scf	Unknown	

Tank Leak/Rupture	Leak Frequency
No	None

Incidents Descript.

None

Cause Resolved

Tank Inspection

general, visual and acoustic every 45 days or 6,000 miles

Cylinders Removed

None

Inspection Effective

very effective

Other

Our five Orion II CNG's are perfoming very good as far as fuel system is concerned. (tanks 4 are 15" and 2 are 13")

Reporter Name	Reporter Phone	Date Completed
Vic Villaflor	562-599-8508	4/6/98

Compiled by: Vincent R. DeMarco, PE File: afi-sum3.dbf 09/12/98

Responses to March 27, 1998 Letters on Status of CNG/LNG Cylinders

COMPANYNAM	CITY	STATE
Los Angeles County Metropolitan Transportation	Los Angeles	CA

Bus Fuel	No. of Buses	Bus Mfr.	Bus Model	Year Bus Built
CNG	218	Neoplan	AN-44O	1995/6

Tank Mfr.	Tank Type
EDO	Type 4, carbon fiber

Tank Diameter	Tank Length	Tank Placement	Tank Pressure
15.9" and 18.4	50"	bottom and rear	3600 psi

No. of Tanks	Fuel Capacity	Tank PRD Mfr.	Tank PRD Model
11	16,000 scf	Mirada	Gen III

Tank Leak/Rupture	Leak Frequency
Yes	various leaks, impact damage

Incidents Descript.

leaks occured at water seal (recall prg done 11/95), through liner due to cracks, at seal at metal boss & end plugs; MTA replaced ~ 250 EDO cylinders with Lincoln units; PRD actuations due to excessive heat & actual fires; one EDO tank rupture on 8/19/96

Cause Resolved

No, cylinder design flaw; EDO out of business

Tank Inspection

detailed visual at 6,000 miles; leak check at 1,000 miles; may increase visual to 18,000 miles

Cylinders Removed

several from impact, but mostly leaks

Inspection Effective

effective in finding leaks and obvious visual defects

Other

MTA has over 2,000 EDO cylinders and relacing them as they fail with Lincoln Composites; no PRD "events"; actual release was due to proper operation; looking into performing destructive cylinder testing at 3 year interval to assure structural integrity

Reporter Name	Reporter Phone	Date Completed
Dan Quigg	213-922-5895	4/8/98

Compiled by: Vincent R. DeMarco, PE File: afi-sum3.dbf 09/12/98

Responses to March 27, 1998 Letters on Status of CNG/LNG Cylinders

COMPANYNAM	CITY	STATE
Los Angeles County Metropolitan Transportation	Los Angeles	CA

Bus Fuel	No. of Buses	Bus Mfr.	Bus Model	Year Bus Built
CNG	214	Neoplan	AN-44O	1997/8

Tank Mfr.	Tank Type
Lincoln Composites	Type 4, carbon fibre

Tank Diameter	Tank Length	Tank Placement	Tank Pressure
15.9" and 18.4	50"	bottom and rear	3600 psi

No. of Tanks	Fuel Capacity	Tank PRD Mfr.	Tank PRD Model
11	13,400 scf	Mirada	

Tank Leak/Rupture	Leak Frequency
Yes	Not often

Incidents Descript.

Leak at dome (no evidence at factory); slight leak at "O" ring (rear plug); slight leak at PRD "O" ring

Cause Resolved

Yes

Tank Inspection

detailed visual at 6,000 miles; leak check at 1,000 miles; may increase viaual to 18,000 miles

Cylinders Removed

several from impact, but mostly leaks

Inspection Effective

effective in finding leaks and obvious visual defects

Other

no PRD "events"; actual release was due to proper operation; inspection program is still not adequate, visual versus long term structural; looking into performing destructive cylinder testing at 3 year interval to assure structural integrity

Reporter Name	Reporter Phone	Date Completed
Dan Quigg	213-922-5895	4/8/98

Compiled by: Vincent R. DeMarco, PE File: afi-sum3.dbf 09/12/98

Responses to March 27, 1998 Letters on Status of CNG/LNG Cylinders

COMPANYNAM	CITY	STATE
South Coast Area Transit	Oxnard	CA

Bus Fuel	No. of Buses	Bus Mfr.	Bus Model	Year Bus Built
CNG	26	Flxible	Metro 40102 & 35102	1995

Tank Mfr.	Tank Type
Comdyne	aluminum with fiber covering

Tank Diameter	Tank Length	Tank Placement	Tank Pressure
		bottom	3600 psi

No. of Tanks	Fuel Capacity	Tank PRD Mfr.	Tank PRD Model
4			

Tank Leak/Rupture	Leak Frequency
No	None

Incidents Descript.

Cause Resolved

Tank Inspection

visual; methane leak detection equipment

Cylinders Removed

None

Inspection Effective

excellent

Other

Reporter Name	Reporter Phone	Date Completed
George D. Jones	805-487-5336	5/15/98

Compiled by: Vincent R. DeMarco, PE File: afi-sum3.dbf 09/12/98

Responses to March 27, 1998 Letters on Status of CNG/LNG Cylinders

COMPANYNAM	CITY	STATE
South Coast Area Transit	Oxnard	CA

Bus Fuel	No. of Buses	Bus Mfr.	Bus Model	Year Bus Built
CNG	9	Orion	05.503	1997

Tank Mfr.	Tank Type
EDO	aluminum with fiber covering

Tank Diameter	Tank Length	Tank Placement	Tank Pressure
		top	3600 psi

No. of Tanks	Fuel Capacity	Tank PRD Mfr.	Tank PRD Model
4		Mirada	

Tank Leak/Rupture	Leak Frequency
Yes	one tank leak

Incidents Descript.

leak detected during PM inspection and tank replaced

Cause Resolved

yes, by Orion

Tank Inspection

visual; methane leak detection equipment

Cylinders Removed

Yes, one tank was leaking

Inspection Effective

excellent

Other

Reporter Name	Reporter Phone	Date Completed
George D. Jones	805-487-5336	5/15/98

Compiled by: Vincent R. DeMarco, PE File: afi-sum3.dbf 09/12/98

Responses to March 27, 1998 Letters on Status of CNG/LNG Cylinders

COMPANYNAM	CITY	STATE
Sacramento Regional Transit District	Sacramento	CA

Bus Fuel	No. of Buses	Bus Mfr.	Bus Model	Year Bus Built
CNG	96	Orion	05.501	1993/4

Tank Mfr.	Tank Type
Structural Composites Inc.	Type 3, aluminum/e-glass

Tank Diameter	Tank Length	Tank Placement	Tank Pressure
15 "	76.5"	top	3000 psi

No. of Tanks	Fuel Capacity	Tank PRD Mfr.	Tank PRD Model
12	16,000 scf	Mirada	

Tank Leak/Rupture	Leak Frequency
No	None

Incidents Descript.

Cause Resolved

Tank Inspection

visual inspections performed yearly

Cylinders Removed

None

Inspection Effective

very effective

Other

recommend that CNG tanks not be placed under the bus floor; 75% of buses in accidents receive damage below the main frame

Reporter Name	Reporter Phone	Date Completed
Michael Cooke	916-321-2839	4/4/98

Compiled by: Vincent R. DeMarco, PE File: afi-sum3.dbf 09/12/98

Responses to March 27, 1998 Letters on Status of CNG/LNG Cylinders

COMPANYNAM	CITY	STATE
Sacramento Regional Transit District	Sacramento	CA

Bus Fuel	No. of Buses	Bus Mfr.	Bus Model	Year Bus Built
CNG	40	Orion	05.501	1996

Tank Mfr.	Tank Type
EDO	Type 4, carbon fiber wrapped

Tank Diameter	Tank Length	Tank Placement	Tank Pressure
15.9"	71"	top	3600 psi

No. of Tanks	Fuel Capacity	Tank PRD Mfr.	Tank PRD Model
10	15,360 scf	Mirada	

Tank Leak/Rupture	Leak Frequency
Yes	several times

Incidents Descript.

Battelle Report: small amounts seeping through dome end area; possible one liner crack around boss area; small emissions due to permeation

Cause Resolved

No, EDO out of business

Tank Inspection

visual inspections performed yearly

Cylinders Removed

4 EDO tanks replaced with spares (from Battelle report)

Inspection Effective

very effective

Other

recommend that CNG tanks not be placed under the bus floor; 75% of buses in accidents recieve damage below the main frame; (Note: of the 40 buses, 25 are 40-foot with 10 tanks each and 15 are 30-foot with 8 tanks each)

Reporter Name	Reporter Phone	Date Completed
Michael Cooke	916-321-2839	4/4/98

Compiled by: Vincent R. DeMarco, PE File: afi-sum3.dbf 09/12/98

Responses to March 27, 1998 Letters on Status of CNG/LNG Cylinders

COMPANYNAM	CITY	STATE
Metropolitan Transit Development Board	San Diego	CA

Bus Fuel	No. of Buses	Bus Mfr.	Bus Model	Year Bus Built
CNG	2	El Dorado National	RE-32	1995

Tank Mfr.	Tank Type
CNG Cylinder Corp.	Carbon fiber, thermoplastic liner

Tank Diameter	Tank Length	Tank Placement	Tank Pressure
15"	84" and 60"	bottom (3) and rear (2)	3600 psi

No. of Tanks	Fuel Capacity	Tank PRD Mfr.	Tank PRD Model
5	7,626 scf	CNG Cylinders	CG9

Tank Leak/Rupture	Leak Frequency
No	None

Incidents Descript.

None

Cause Resolved

Tank Inspection

visual inspection every 3,000 miles

Cylinders Removed

None

Inspection Effective

very effective

Other

None

Reporter Name	Reporter Phone	Date Completed
Ralph Ayala	619-427-5660 x16	4/3/98

Compiled by: Vincent R. DeMarco, PE File: afi-sum3.dbf 09/12/98

Responses to March 27, 1998 Letters on Status of CNG/LNG Cylinders

COMPANYNAM	CITY	STATE
Metropolitan Transit Development Board	San Diego	CA

Bus Fuel	No. of Buses	Bus Mfr.	Bus Model	Year Bus Built
CNG	51	NFI	C-40 HF	1995

Tank Mfr.	Tank Type
Lincoln Composites	Carbon fiber, thermoplastic liner

Tank Diameter	Tank Length	Tank Placement	Tank Pressure
18.4"	120"	bottom	3600 psi

No. of Tanks	Fuel Capacity	Tank PRD Mfr.	Tank PRD Model
4	16,384 scf	Mirada	

Tank Leak/Rupture	Leak Frequency
No	None

Incidents Descript.

Cause Resolved

Tank Inspection

visual inspection every 3,000 miles

Cylinders Removed

None

Inspection Effective

very effective

Other

None

Reporter Name	Reporter Phone	Date Completed
Ralph Ayala	619-427-5660 x16	4/3/98

Compiled by: Vincent R. DeMarco, PE File: afi-sum3.dbf 09/12/98

Responses to March 27, 1998 Letters on Status of CNG/LNG Cylinders

COMPANYNAM	CITY	STATE
San Diego Transit Corporation	San Diego	CA

Bus Fuel	No. of Buses	Bus Mfr.	Bus Model	Year Bus Built
CNG	4	NFI	C-40 LF	1994

Tank Mfr.	Tank Type
Lincoln Composites	fiberglass-thermo plastic liner

Tank Diameter	Tank Length	Tank Placement	Tank Pressure
15.9"	71"	roof	3600 psi

No. of Tanks	Fuel Capacity	Tank PRD Mfr.	Tank PRD Model
10	17,210 scf	Lucas - SVG	

Tank Leak/Rupture	Leak Frequency
Yes	

Incidents Descript.

PRD valves leaking because of defective "O" rings not sealing well

Cause Resolved

Yes, upgraded "O" rings have been installed

Tank Inspection

follow Lincoln Composites procedure; visual inspect PRD valves, cuts, gouges, cylinder damage and decals

Cylinders Removed

Yes

Inspection Effective

very effective

Other

Reporter Name	Reporter Phone	Date Completed
Julio Ortiz	619-238-0100 x517	4/6/98

Compiled by: Vincent R. DeMarco, PE File: afi-sum3.dbf 09/12/98

Responses to March 27, 1998 Letters on Status of CNG/LNG Cylinders

COMPANYNAM	CITY	STATE
San Diego Transit Corporation	San Diego	CA

Bus Fuel	No. of Buses	Bus Mfr.	Bus Model	Year Bus Built
CNG	46	NFI	C-40 HF	1995

Tank Mfr.	Tank Type
Lincoln Composites	fiberglass-thermo plastic liner

Tank Diameter	Tank Length	Tank Placement	Tank Pressure
18.4"	120"	bottom	3600 psi

No. of Tanks	Fuel Capacity	Tank PRD Mfr.	Tank PRD Model
4	13,700 scf	Mirada	

Tank Leak/Rupture	Leak Frequency
Yes	

Incidents Descript.

PRD valves leaking because of defective "O" rings not sealing well

Cause Resolved

Yes, installed new "O" rings

Tank Inspection

follow Lincoln Compositesguidelines: visual inspect PRD valves, cuts, gouges, cylinder damage and decals

Cylinders Removed

Yes

Inspection Effective

very effective

Other

Reporter Name	Reporter Phone	Date Completed
Julio Ortiz	619-238-0100 x517	4/6/98

Compiled by: Vincent R. DeMarco, PE File: afi-sum3.dbf 09/12/98

Responses to March 27, 1998 Letters on Status of CNG/LNG Cylinders

COMPANYNAM	CITY	STATE
San Diego Transit Corporation	San Diego	CA

Bus Fuel	No. of Buses	Bus Mfr.	Bus Model	Year Bus Built
CNG	27	NFI	C-40 LF	1997

Tank Mfr.	Tank Type
Lincoln Composites	fiberglass-thermo plastic liner

Tank Diameter	Tank Length	Tank Placement	Tank Pressure
15.9"	120"	top	3600 psi

No. of Tanks	Fuel Capacity	Tank PRD Mfr.	Tank PRD Model
6	18,000 scf	Unknown	

Tank Leak/Rupture	Leak Frequency
No	None

Incidents Descript.

Cause Resolved

Tank Inspection

follow Lincoln Composites guidelines: visual inspect PRD valves, cuts, gouges, cylinder damage and decals

Cylinders Removed

Yes

Inspection Effective

very effective

Other

Reporter Name	Reporter Phone	Date Completed
Julio Ortiz	619-238-0100 x517	4/6/98

Compiled by: Vincent R. DeMarco, PE File: afi-sum3.dbf 09/12/98

Responses to March 27, 1998 Letters on Status of CNG/LNG Cylinders

COMPANYNAM	CITY	STATE
Regional Transportation District	Denver	CO

Bus Fuel	No. of Buses	Bus Mfr.	Bus Model	Year Bus Built
CNG	5	Neoplan	AN-440	1986

Tank Mfr.	Tank Type
EDO	NGV2 Composite

Tank Diameter	Tank Length	Tank Placement	Tank Pressure
16" and 12.2"	49.9" and 37.5"	bottom	3600 psi

No. of Tanks	Fuel Capacity	Tank PRD Mfr.	Tank PRD Model
12	12,328 scf	Mirada	

Tank Leak/Rupture	Leak Frequency
Yes	Once

Incidents Descript.

EDO tank leak on end where the valve assembly attaches to the tank; leak located on tank side of valve threaded fitting; tank replaced and a Lincoln Composite tank installed because EDO has gone out of business

Cause Resolved

No, EDO went out of business

Tank Inspection

daily inspections of "Skid Pans" under bus; every 2,000 miles tanks are checked with a gas detector; every 6,000 miles "Skid Pans" are removed and tanks visually inspected

Cylinders Removed

Inspection Effective

inspection procedures are satisfactory

Other

Reporter Name	Reporter Phone	Date Completed
Robert G. Reposa	303-299-6930	4/14/98

Compiled by: Vincent R. DeMarco, PE File: afi-sum3.dbf 09/12/98

Responses to March 27, 1998 Letters on Status of CNG/LNG Cylinders

COMPANYNAM	CITY	STATE
Regional Transportation District	Denver	CO

Bus Fuel	No. of Buses	Bus Mfr.	Bus Model	Year Bus Built
CNG	3	World Trans	RE-185	1997

Tank Mfr.	Tank Type
Lincoln Composites	Type 4, NGV2-4

Tank Diameter	Tank Length	Tank Placement	Tank Pressure
15.9"	62"	top	3600 psi

No. of Tanks	Fuel Capacity	Tank PRD Mfr.	Tank PRD Model
5	7,395 scf	Corona Circle Seal	91816RV99

Tank Leak/Rupture	Leak Frequency
No	None

Incidents Descript.

Cause Resolved

Tank Inspection

every 2,000 miles tanks are checked with a gas detector

Cylinders Removed

Inspection Effective

inspection procedures are satisfactory

Other

Reporter Name	Reporter Phone	Date Completed
Robert G. Reposa	303-299-6930	4/14/98

Compiled by: Vincent R. DeMarco, PE File: afi-sum3.dbf 09/12/98

Responses to March 27, 1998 Letters on Status of CNG/LNG Cylinders

COMPANYNAM	CITY	STATE
Metropolitan Atlanta Rapid Transit Authority	Atlanta	GA

Bus Fuel	No. of Buses	Bus Mfr.	Bus Model	Year Bus Built
CNG	118	NFI	AN-440 40' LF	1996

Tank Mfr.	Tank Type
Lincoln Composites	Type 4, composite

Tank Diameter	Tank Length	Tank Placement	Tank Pressure
15.8"	120"	top	3600 psi

No. of Tanks	Fuel Capacity	Tank PRD Mfr.	Tank PRD Model
6	18,138 scf	Mirada	2.58

Tank Leak/Rupture	Leak Frequency
Yes	6 tanks leaking at crown

Incidents Descript.

6 tanks leaked at the crown where the composite body and the stainless crown are joined; the leaks have been detected by the Amerex Gas Detection System and the tanks replaced; at no time has there been a serious rupture or life threatening leak

Cause Resolved

sent damaged tanks back to mfr.; they are testing to determine cause of failure; these tanks may have been defective when shipped; no more problems since then

Tank Inspection

visual inspection every 6,000 miles; every 2 years a more detailed inspection is mandated consisting of acoustic leak detectors and a general cleaning

Cylinders Removed

Yes, 2 of the 6 leaks were found during the inspection process

Inspection Effective

very effective; visual checks and if a problem is detected, acoustic and liquid leak finders are used to determine the extent of the leak

Other

Reporter Name	Reporter Phone	Date Completed
Sidney McWaters	404-848-4367	4/7/98

Compiled by: Vincent R. DeMarco, PE File: afi-sum3.dbf 09/12/98

Responses to March 27, 1998 Letters on Status of CNG/LNG Cylinders

COMPANYNAM	CITY	STATE
Boise Urban Stages	Boise	ID

Bus Fuel	No. of Buses	Bus Mfr.	Bus Model	Year Bus Built
CNG	2	Orion	V 01.507	1993

Tank Mfr.	Tank Type
NGV Systems	composite reinforced aluminum

Tank Diameter	Tank Length	Tank Placement	Tank Pressure
15"	72"	top	3000 psi

No. of Tanks	Fuel Capacity	Tank PRD Mfr.	Tank PRD Model
8	11,576 scf	Mirada	

Tank Leak/Rupture	Leak Frequency
No	None

Incidents Descript.

Cause Resolved

Tank Inspection

visual every 3,000 to 4,000 miles on regular PM inspections

Cylinders Removed

None

Inspection Effective

good

Other

Reporter Name	Reporter Phone	Date Completed
Roger Zabel	208-336-4303	4/8/98

Compiled by: Vincent R. DeMarco, PE File: afi-sum3.dbf 09/12/98

Responses to March 27, 1998 Letters on Status of CNG/LNG Cylinders

COMPANYNAM	CITY	STATE
Boise Urban Stages	Boise	ID

Bus Fuel	No. of Buses	Bus Mfr.	Bus Model	Year Bus Built
CNG	20	El Dorado National	Transmark RE	1994

Tank Mfr.	Tank Type
CNG Cylinder Corp.	Type 2

Tank Diameter	Tank Length	Tank Placement	Tank Pressure
15"	84"	bottom and rear	3600 psi

No. of Tanks	Fuel Capacity	Tank PRD Mfr.	Tank PRD Model
6		Unknown	

Tank Leak/Rupture	Leak Frequency
No	None

Incidents Descript.

Cause Resolved

Tank Inspection

visual, every 3,000 to 4,000 miles on regular PM inspections

Cylinders Removed

None

Inspection Effective

good

Other

Reporter Name	Reporter Phone	Date Completed
Roger Zabel	208-336-4303	4/8/98

Compiled by: Vincent R. DeMarco, PE File: afi-sum3.dbf 09/12/98

Responses to March 27, 1998 Letters on Status of CNG/LNG Cylinders

COMPANYNAM	CITY	STATE
Boise Urban Stages	Boise	ID

Bus Fuel	No. of Buses	Bus Mfr.	Bus Model	Year Bus Built
CNG	8	ELF	vans	1996

Tank Mfr.	Tank Type
EDO	composite

Tank Diameter	Tank Length	Tank Placement	Tank Pressure
			3600 psi

No. of Tanks	Fuel Capacity	Tank PRD Mfr.	Tank PRD Model
3	250 litres	Unknown	

Tank Leak/Rupture	Leak Frequency
Yes	in Jan/Feb '97

Incidents Descript.

9 of these tanks developed leaks which EDO replaced

Cause Resolved

9 EDO tanks replaced by EDO; no further problems at this time

Tank Inspection

visual every 3,000 to 4,000 miles on regular PM inspections

Cylinders Removed

9 leaking tanks removed

Inspection Effective

good

Other

Reporter Name	Reporter Phone	Date Completed
Roger Zabel	208-336-4303	4/8/98

Compiled by: Vincent R. DeMarco, PE File: afi-sum3.dbf 09/12/98

Responses to March 27, 1998 Letters on Status of CNG/LNG Cylinders

COMPANYNAM: Bi-State Development Agency
CITY: St. Louis
STATE: MO

Bus Fuel	No. of Buses	Bus Mfr.	Bus Model	Year Bus Built
CNG	2	Flxible	Metro 40102-6C-1	1991

Tank Mfr.	Tank Type
Comdyne	aluminum wrapped w. fibrglass

Tank Diameter	Tank Length	Tank Placement	Tank Pressure
19"	80"	bottom	3600 psi

No. of Tanks	Fuel Capacity	Tank PRD Mfr.	Tank PRD Model
6	16,100 scf	Mirada	

Tank Leak/Rupture	Leak Frequency
No	None

Incidents Descript.

Cause Resolved

Tank Inspection

daily visual inspect tanks; no shields installed; every 3,000 miles detailed leak tests w. leak detector; leakage of PRDs checked at vent tube; tank restaints and bracket pads checked; bracket mount. bolts torqued; shut-off valves/PRDs "O" rings checked

Cylinders Removed

None

Inspection Effective

very effective

Other

Reporter Name	Reporter Phone	Date Completed
Charles Priscu	314-982-1400 x202	4/3/98

Compiled by: Vincent R. DeMarco, PE File: afi-sum3.dbf 09/12/98

Responses to March 27, 1998 Letters on Status of CNG/LNG Cylinders

COMPANYNAM	CITY	STATE
Bi-State Development Agency	St. Louis	MO

Bus Fuel	No. of Buses	Bus Mfr.	Bus Model	Year Bus Built
CNG	36	Neoplan	AN-440-A	1997

Tank Mfr.	Tank Type
Lincoln Composites	Type 4, all composite

Tank Diameter	Tank Length	Tank Placement	Tank Pressure
15.9"	49.9"	bottom	3600 psi

No. of Tanks	Fuel Capacity	Tank PRD Mfr.	Tank PRD Model
10	11,540 scf	Lincoln Composites	

Tank Leak/Rupture	Leak Frequency
No	None

Incidents Descript.

Cause Resolved

Tank Inspection

daily check metal tank shields for road impacts; every 3,000 miles detailed leak tests w. leak detector; leakage of PRDs checked at vent tube; tank restaints and bracket pads checked; bracket mount. bolts torqued; shut-off valves/PRDs "O" rings checked

Cylinders Removed

None

Inspection Effective

successful

Other

Reporter Name	Reporter Phone	Date Completed
Charles Priscu	314-982-1400 x202	4/3/98

Compiled by: Vincent R. DeMarco, PE File: afi-sum3.dbf 09/12/98

Responses to March 27, 1998 Letters on Status of CNG/LNG Cylinders

COMPANYNAM	CITY	STATE
MTA New York City Transit	Brooklyn	NY

Bus Fuel	No. of Buses	Bus Mfr.	Bus Model	Year Bus Built
CNG	2	TMC	RTS-06 T80-206	1990

Tank Mfr.	Tank Type
Comdyne	Type 3, steel liner

Tank Diameter	Tank Length	Tank Placement	Tank Pressure
19"	78"	top	3000 psi

No. of Tanks	Fuel Capacity	Tank PRD Mfr.	Tank PRD Model
6	13,400 scf	Mirada	Gen 2.5

Tank Leak/Rupture	Leak Frequency
No	None

Incidents Descript.

Cause Resolved

Tank Inspection

every three years perform a hydrostatic test

Cylinders Removed

None

Inspection Effective

have two buses that require hydrostatic testing, looking into an exemption; use soap bubble testing; visual inspection has been effective in finding faults

Other

need a better, faster, and cheaper inpection process

Reporter Name	Reporter Phone	Date Completed
Andrew Janusas	718-927-8075	4/13/98

Compiled by: Vincent R. DeMarco, PE File: afi-sum3.dbf 09/12/98

Responses to March 27, 1998 Letters on Status of CNG/LNG Cylinders

COMPANYNAM	CITY	STATE
MTA New York City Transit	Brooklyn	NY

Bus Fuel	No. of Buses	Bus Mfr.	Bus Model	Year Bus Built
CNG	1	TMC	RTS-06 T80-206	1993

Tank Mfr.	Tank Type
CNG Cylinder Corp.	Type 2, aluminum liner

Tank Diameter	Tank Length	Tank Placement	Tank Pressure
13"	72"	top	3600 psi

No. of Tanks	Fuel Capacity	Tank PRD Mfr.	Tank PRD Model
12	13,200 scf	Superior	

Tank Leak/Rupture	Leak Frequency
No	None

Incidents Descript.

Cause Resolved

Tank Inspection

annual visual

Cylinders Removed

None

Inspection Effective

visual inspection has been effective in finding faults

Other

need a better, faster, and cheaper inspection process

Reporter Name	Reporter Phone	Date Completed
Andrew Janusas	718-927-8075	4/13/98

Compiled by: Vincent R. DeMarco, PE File: afi-sum3.dbf 09/12/98

Responses to March 27, 1998 Letters on Status of CNG/LNG Cylinders

COMPANYNAM	CITY	STATE
MTA New York City Transit	Brooklyn	NY

Bus Fuel	No. of Buses	Bus Mfr.	Bus Model	Year Bus Built
CNG	31	Orion	05.501	1995

Tank Mfr.	Tank Type
EDO	Type 4, composite plastic

Tank Diameter	Tank Length	Tank Placement	Tank Pressure
15.4"	74.1"	top	3600 psi

No. of Tanks	Fuel Capacity	Tank PRD Mfr.	Tank PRD Model
10	16,000 scf	Mirada	Gen 2.5

Tank Leak/Rupture	Leak Frequency
Yes	---

Incidents Descript.

all 310 cylinders tested on site by Cyltek on 8/97; report indicates 3 w. large leak (100% of LEL) and 16 w. medium leak (0.2 to 7.1% of LEL)

Cause Resolved

No, EDO is out of business; hired a consultant to see if EDO cylinders will last 12 yrs; Mirada PRDs get water in vent tubes (from 1 to 2" at times)

Tank Inspection

annual visual

Cylinders Removed

None

Inspection Effective

visual inspection has been effective in finding faults

Other

need a better, faster, and cheaper inpection process

Reporter Name	Reporter Phone	Date Completed
Andrew Janusas	718-927-8075	4/13/98

Compiled by: Vincent R. DeMarco, PE File: afi-sum3.dbf 09/12/98

Responses to March 27, 1998 Letters on Status of CNG/LNG Cylinders

COMPANYNAM	CITY	STATE
Metropolitan Suburban Bus Authority	Garden City	NY

Bus Fuel	No. of Buses	Bus Mfr.	Bus Model	Year Bus Built
CNG	160	Orion	V 02.501 and 05.501	1995/6/7

Tank Mfr.	Tank Type
Structural Composites Inc.	Type 3, fibre wrap

Tank Diameter	Tank Length	Tank Placement	Tank Pressure
14.9"	76.5"	top	3000 psi

No. of Tanks	Fuel Capacity	Tank PRD Mfr.	Tank PRD Model
12	21,600 scf	Mirada	B-51618

Tank Leak/Rupture	Leak Frequency
No	None

Incidents Descript.

Cause Resolved

Tank Inspection

every 24,000 miles

Cylinders Removed

None

Inspection Effective

highly effective

Other

Reporter Name	Reporter Phone	Date Completed
Susane Perez	516-542-0100 x452	5/11/98

Compiled by: Vincent R. DeMarco, PE File: afi-sum3.dbf 09/12/98

Responses to March 27, 1998 Letters on Status of CNG/LNG Cylinders

COMPANYNAM	CITY	STATE
Metro Regional Transit Authority	Akron	OH

Bus Fuel	No. of Buses	Bus Mfr.	Bus Model	Year Bus Built
CNG	1	Dodge	Van- 350	1994

Tank Mfr.	Tank Type
Unknown	aluminum wrapped

Tank Diameter	Tank Length	Tank Placement	Tank Pressure
16"	36"	bottom	3600 psi

No. of Tanks	Fuel Capacity	Tank PRD Mfr.	Tank PRD Model
2	2,500 scf		

Tank Leak/Rupture	Leak Frequency
No	None

Incidents Descript.

Cause Resolved

Tank Inspection

visual every 3,000 miles; rotational visual inspection every 3 years

Cylinders Removed

None

Inspection Effective

good

Other

Reporter Name	Reporter Phone	Date Completed
R. J. Fitzgerald	330-762-7267 x312	4/1/98

Compiled by: Vincent R. DeMarco, PE File: afi-sum3.dbf 09/12/98

Responses to March 27, 1998 Letters on Status of CNG/LNG Cylinders

COMPANYNAM	CITY	STATE
Greater Cleveland Regional Transit Authority	Cleveland	OH

Bus Fuel	No. of Buses	Bus Mfr.	Bus Model	Year Bus Built
CNG	1	Flxible	40102-6C 40'	1989

Tank Mfr.	Tank Type
Comdyne	Type 3, aluminum

Tank Diameter	Tank Length	Tank Placement	Tank Pressure
19.3"	78"	bottom	3600 psi

No. of Tanks	Fuel Capacity	Tank PRD Mfr.	Tank PRD Model
6	15,996 scf	Mirada	B51061S, B51062S

Tank Leak/Rupture	Leak Frequency
No	None

Incidents Descript.

Cause Resolved

Tank Inspection

visual done during refueling; general visual every 6,000 miles; detailed visual every 3 years

Cylinders Removed

Inspection Effective

very effective if mechanics/inspectors receive quality training

Other

Bus taken out of service to be retrofitted for a hybrid bus project

Reporter Name	Reporter Phone	Date Completed
David A. Romeo	216-421-2806	4/15/98

Compiled by: Vincent R. DeMarco, PE File: afi-sum3.dbf 09/12/98

Responses to March 27, 1998 Letters on Status of CNG/LNG Cylinders

COMPANYNAM	CITY	STATE
Greater Cleveland Regional Transit Authority	Cleveland	OH

Bus Fuel	No. of Buses	Bus Mfr.	Bus Model	Year Bus Built
CNG	15	Flxible	30102-6C 30'	1991

Tank Mfr.	Tank Type
Comdyne	Type 3, aluminum

Tank Diameter	Tank Length	Tank Placement	Tank Pressure
16" and 19.3"	54" and 78"	bottom	3600 psi

No. of Tanks	Fuel Capacity	Tank PRD Mfr.	Tank PRD Model
4	6,814 scf	Mirada	B51618, B51061S, B5106

Tank Leak/Rupture	Leak Frequency
No	None

Incidents Descript.

cylinders ports are beginning to exhibit signs of corrosion at the "O" ring sealing areas; these have seen buses see limited service

Cause Resolved

Tank Inspection

visual done during refueling; general visual every 6,000 miles; detailed visual every 3 years

Cylinders Removed

Yes;inspections revealed cylinders with level II and III damage, these cylinders were either drained and isolated, or immediately removed

Inspection Effective

very effective if mechanics/inspectors receive quality training

Other

Other methods besides hydrostatic testing is needed for Types II & III cylinders; cylinder mfrs should develop go/no-go gauges on level of damage to cylinders; system of tracking cylinders and their status must be in place

Reporter Name	Reporter Phone	Date Completed
David A. Romeo	216-421-2806	4/15/98

Compiled by: Vincent R. DeMarco, PE File: afi-sum3.dbf 09/12/98

Responses to March 27, 1998 Letters on Status of CNG/LNG Cylinders

COMPANYNAM	CITY	STATE
Greater Cleveland Regional Transit Authority	Cleveland	OH

Bus Fuel	No. of Buses	Bus Mfr.	Bus Model	Year Bus Built
CNG	5	Flxible	35102-6C 35'	1992

Tank Mfr.	Tank Type
Comdyne	Type 3, aluminum

Tank Diameter	Tank Length	Tank Placement	Tank Pressure
19.3"	78"	bottom	3600 psi

No. of Tanks	Fuel Capacity	Tank PRD Mfr.	Tank PRD Model
4	10,664 scf	Mirada	B51061S, B51062S

Tank Leak/Rupture	Leak Frequency
Yes	

Incidents Descript.

cylinders ports are beginning to exhibit signs of corrosion at the "O" ring sealing areas; one cylinder port leaking due to corrosion

Cause Resolved

cylinder mfr no longer produces units, is not responsive; leaking cylinders are drained and isolated; investigating alternative cylinders

Tank Inspection

visual done during refueling; general visual every 6,000 miles; detailed visual every 3 years

Cylinders Removed

Yes;inspections revealed cylinders with level II and III damage, these cylinders were either drained and isolated, or immediately removed

Inspection Effective

very effective if mechanics/inspectors receive quality training

Other

Other methods besides hydrostatic testing is needed for types II & III; cylinder mfrs should develop go/no-go gaues on level of damage to cylinders; system of tracking cylinders and their status must be in place

Reporter Name	Reporter Phone	Date Completed
David A. Romeo	216-421-2806	4/15/98

Compiled by: Vincent R. DeMarco, PE File: afi-sum3.dbf 09/12/98

Responses to March 27, 1998 Letters on Status of CNG/LNG Cylinders

COMPANYNAM	CITY	STATE
Greater Cleveland Regional Transit Authority	Cleveland	OH

Bus Fuel	No. of Buses	Bus Mfr.	Bus Model	Year Bus Built
CNG	65	Flxible	40102-6C 40'	1994

Tank Mfr.	Tank Type
Comdyne	Type 3, aluminum

Tank Diameter	Tank Length	Tank Placement	Tank Pressure
19.5"	78"	bottom	3600 psi

No. of Tanks	Fuel Capacity	Tank PRD Mfr.	Tank PRD Model
6	15,996 scf	Mirada	B51638, B51624

Tank Leak/Rupture	Leak Frequency
Yes	

Incidents Descript.

began experiencing leaks at the cylinder ports mid Jan '98; some cylinders show signs of corrosion at port "O" ring sealing areas in varying degrees; corrosions leads to leakage; corrosion apperars to be due to dissimilar metals condition

Cause Resolved

cylinder mfr no longer produces units, and is not responsive; retrofitting all buses with Type IIIs with Type II - steel cylinders from NGV Systems

Tank Inspection

visual done during refueling; general visual every 6,000 miles; detailed visual every 3 years

Cylinders Removed

Yes;inspections revealed cylinders with level II and III damage, these cylinders were either drained and isolated, or immediately removed

Inspection Effective

very effective if mechanics/inspectors receive quality training

Other

Other methods besides hydrostatic testing is needed for types II & III; cylinder mfrs should develop go/no-go gaues on level of damage to cylinders; system of tracking cylinders and their status must be in place

Reporter Name	Reporter Phone	Date Completed
David A. Romeo	216-421-2806	4/15/98

Compiled by: Vincent R. DeMarco, PE File: afi-sum3.dbf 09/12/98

Responses to March 27, 1998 Letters on Status of CNG/LNG Cylinders

COMPANYNAM	CITY	STATE
Greater Cleveland Regional Transit Authority	Cleveland	OH

Bus Fuel	No. of Buses	Bus Mfr.	Bus Model	Year Bus Built
CNG	15	Flxible	40102-6C 40'	1995

Tank Mfr.	Tank Type
Comdyne	Type 3, aluminum

Tank Diameter	Tank Length	Tank Placement	Tank Pressure
19.5"	78"	bottom	3600 psi

No. of Tanks	Fuel Capacity	Tank PRD Mfr.	Tank PRD Model
6	15,996 scf	Mirada	B51638, B51624

Tank Leak/Rupture	Leak Frequency
No	None

Incidents Descript.

cylinders ports are beginning to exhibit signs of corrosion at the "O" ring sealing areas

Cause Resolved

cylinder mfr no longer produces units, and is not responsive; retrofitting all buses with Type IIIs with Type II - steel cylinders from NGV Systems

Tank Inspection

visual done during refueling; general visual every 6,000 miles; detailed visual every 3 years

Cylinders Removed

Yes;inspections revealed cylinders with level II and III damage, these cylinders were either drained and isolated, or immediately removed

Inspection Effective

very effective if mechanics/inspectors receive quality training

Other

Other methods besides hydrostatic testing is needed for types II & III; cylinder mfrs should develop go/no-go gaues on level of damage to cylinders; system of tracking cylinders and their status must be in place

Reporter Name	Reporter Phone	Date Completed
David A. Romeo	216-421-2806	4/15/98

Compiled by: Vincent R. DeMarco, PE File: afi-sum3.dbf 09/12/98

Responses to March 27, 1998 Letters on Status of CNG/LNG Cylinders

COMPANYNAM: Greater Cleveland Regional Transit Authority
CITY: Cleveland
STATE: OH

Bus Fuel	No. of Buses	Bus Mfr.	Bus Model	Year Bus Built
CNG	65	Nova	RTWFD82	1997

Tank Mfr.	Tank Type
NGV Systems	Type 2, steel (Durasteel)

Tank Diameter	Tank Length	Tank Placement	Tank Pressure
12.5"	72"	bottom	3600 psi

No. of Tanks	Fuel Capacity	Tank PRD Mfr.	Tank PRD Model
12	14,076 scf	NGV Systems	GP01-012

Tank Leak/Rupture	Leak Frequency
Yes	

Incidents Descript.
buses delivered 10/97 to 2/98; cylinder ports were not finished properly and 20% of them had small leaks when system was filled

Cause Resolved
Yes; cylinder mfr rectifying condition; problems resolved

Tank Inspection
visual done during refueling; general visual every 6,000 miles; detailed visual every 3 years

Cylinders Removed

Inspection Effective
very effective if mechanics/inspectors receive quality training

Other
Other methods besides hydrostatic testing is needed for types II & III; cylinder mfrs should develop go/no-go gauges on level of damage to cylinders; system of tracking cylinders and their status must be in place

Reporter Name	Reporter Phone	Date Completed
David A. Romeo	216-421-2806	4/15/98

Compiled by: Vincent R. DeMarco, PE File: afi-sum3.dbf 09/12/98

Responses to March 27, 1998 Letters on Status of CNG/LNG Cylinders

COMPANYNAM	CITY	STATE
LAKETRAN	Grand River	OH

Bus Fuel	No. of Buses	Bus Mfr.	Bus Model	Year Bus Built
CNG	12	NFI	Low Floor C35LF	1997

Tank Mfr.	Tank Type
Lincoln Composites	Lincoln

Tank Diameter	Tank Length	Tank Placement	Tank Pressure
15.9"	120"	top	3600 psi

No. of Tanks	Fuel Capacity	Tank PRD Mfr.	Tank PRD Model
5	15,115 scf	Unknown	

Tank Leak/Rupture	Leak Frequency
No	None

Incidents Descript.

Cause Resolved

Tank Inspection

every 3,000 miles visual and soap test

Cylinders Removed

None

Inspection Effective

Other

Reporter Name	Reporter Phone	Date Completed
Gary May	440-350-1036	4/2/98

Compiled by: Vincent R. DeMarco, PE File: afi-sum3.dbf 09/12/98

Responses to March 27, 1998 Letters on Status of CNG/LNG Cylinders

COMPANYNAM	CITY	STATE
Hamilton Street Railway Company	Hamilton	ON

Bus Fuel	No. of Buses	Bus Mfr.	Bus Model	Year Bus Built
CNG	2	GM	New Look T6H 5307N	1977

Tank Mfr.	Tank Type
CNG Cylinder Corp.	Type I, aluminum, filament wound

Tank Diameter	Tank Length	Tank Placement	Tank Pressure
13"	72"	bottom	3000 psi

No. of Tanks	Fuel Capacity	Tank PRD Mfr.	Tank PRD Model
12	7,500 scf	Unknown	

Tank Leak/Rupture	Leak Frequency
No	None

Incidents Descript.

Cause Resolved

Tank Inspection

visual every 6 months; full external inspection every three years

Cylinders Removed

None

Inspection Effective

inspection procedures are fine, no problems

Other

these buses were converted from diesel to CNG in 1985 by replacing the 6V71 engine with an IVECO engine

Reporter Name	Reporter Phone	Date Completed
Larry Howarth	905-528-4200 x290	4/21/98

Compiled by: Vincent R. DeMarco, PE File: afi-sum3.dbf 09/12/98

Responses to March 27, 1998 Letters on Status of CNG/LNG Cylinders

COMPANYNAM	CITY	STATE
Hamilton Street Railway Company	Hamilton	ON

Bus Fuel	No. of Buses	Bus Mfr.	Bus Model	Year Bus Built
CNG	15	Orion	V 05.501	1991

Tank Mfr.	Tank Type
Dynetek	Type 2, aluminum liner

Tank Diameter	Tank Length	Tank Placement	Tank Pressure
12.9"	114.1" and 129"	top	3000 psi

No. of Tanks	Fuel Capacity	Tank PRD Mfr.	Tank PRD Model
8	15,500 scf	Mirada	B51609

Tank Leak/Rupture	Leak Frequency
No	None

Incidents Descript.

Cause Resolved

Tank Inspection

visual every 6 months; full external inspection every three years

Cylinders Removed

None

Inspection Effective

inspection procedures are fine, no problems

Other

as tanks are roof mounted, unlikely tanks would suffer physical damage

Reporter Name	Reporter Phone	Date Completed
Larry Howarth	905-528-4200 x290	4/21/98

Compiled by: Vincent R. DeMarco, PE File: afi-sum3.dbf 09/12/98

Responses to March 27, 1998 Letters on Status of CNG/LNG Cylinders

COMPANYNAM	CITY	STATE
Hamilton Street Railway Company	Hamilton	ON

Bus Fuel	No. of Buses	Bus Mfr.	Bus Model	Year Bus Built
CNG	15	Orion	V 05.501	1992

Tank Mfr.	Tank Type
Alusuisse	aluminum with Kevalar

Tank Diameter	Tank Length	Tank Placement	Tank Pressure
13"	240"	top	3000 psi

No. of Tanks	Fuel Capacity	Tank PRD Mfr.	Tank PRD Model
4	14,500 scf	Mirada	B51609

Tank Leak/Rupture	Leak Frequency
No	None

Incidents Descript.

Cause Resolved

Tank Inspection

visual every 6 months; full external inspection every three years

Cylinders Removed

None

Inspection Effective

inspection procedures are fine, no problems; replaced Alusuisse tanks with Dynetek because of tank certification problems with Ministry, no tank problems

Other

as tanks are roof mounted, unlikely tanks would suffer physical damage

Reporter Name	Reporter Phone	Date Completed
Larry Howarth	905-528-4200 x290	4/21/98

Compiled by: Vincent R. DeMarco, PE File: afi-sum3.dbf 09/12/98

Responses to March 27, 1998 Letters on Status of CNG/LNG Cylinders

COMPANYNAM: Hamilton Street Railway Company
CITY: Hamilton
STATE: ON

Bus Fuel	No. of Buses	Bus Mfr.	Bus Model	Year Bus Built
CNG	25	NFI	LFS D40LF	1996

Tank Mfr.	Tank Type
Lincoln Composites	Type 2, aluminum liner

Tank Diameter	Tank Length	Tank Placement	Tank Pressure
15.9"	120"	top	3000 psi

No. of Tanks	Fuel Capacity	Tank PRD Mfr.	Tank PRD Model
7	18,500 scf	Mirada	D48919

Tank Leak/Rupture	Leak Frequency
Yes	once

Incidents Descript.
PRDs released on one tank bank due to ice in drain tubes

Cause Resolved
problerm resolved by gluing on a cap plus drilling a small hole (1/16") to allow water drainage near elbow bend

Tank Inspection
visual every 6 months; full external inspection every three years

Cylinders Removed
None

Inspection Effective
inspection procedures are fine, no problems

Other
as tanks are roof mounted, unlikely tanks would suffer physical damage

Reporter Name	Reporter Phone	Date Completed
Larry Howarth	905-528-4200 x290	4/21/98

Compiled by: Vincent R. DeMarco, PE File: afi-sum3.dbf 09/12/98

Responses to March 27, 1998 Letters on Status of CNG/LNG Cylinders

COMPANYNAM	CITY	STATE
Toronto Transit Commission	Toronto	ON

Bus Fuel	No. of Buses	Bus Mfr.	Bus Model	Year Bus Built
CNG	25	Orion	V 40' 05.0501	1990

Tank Mfr.	Tank Type
Alusuisse	Type 3, aluminum/Kevlar wrap

Tank Diameter	Tank Length	Tank Placement	Tank Pressure
13"	240"	top	3000 psi

No. of Tanks	Fuel Capacity	Tank PRD Mfr.	Tank PRD Model
4	15,000 scf	Superior	

Tank Leak/Rupture	Leak Frequency
No	None

Incidents Descript.

Cause Resolved

Tank Inspection

every 6000 miles use fuel detection device to scan fuel storage area; every 3 years visual inspection of cylinder external condition

Cylinders Removed

Yes, some cylinders found to be leaking during fuel detector scans

Inspection Effective

process is effective as scanners are very sensitive

Other

Type 4 composite cylinders are not recommended for use on transit vehicles

Reporter Name	Reporter Phone	Date Completed
W. D. Brown	416-393-3162	4/7/98

Compiled by: Vincent R. DeMarco, PE File: afi-sum3.dbf 09/12/98

Responses to March 27, 1998 Letters on Status of CNG/LNG Cylinders

COMPANYNAM	CITY	STATE
Toronto Transit Commission	Toronto	ON

Bus Fuel	No. of Buses	Bus Mfr.	Bus Model	Year Bus Built
CNG	50	Orion	V 40' HF 05.501	1996

Tank Mfr.	Tank Type
EDO	Type 4, polyethylene liner/carbon fiber wra

Tank Diameter	Tank Length	Tank Placement	Tank Pressure
14"	72"	top	3000 psi

No. of Tanks	Fuel Capacity	Tank PRD Mfr.	Tank PRD Model
10	16,500 scf	Mirada	

Tank Leak/Rupture	Leak Frequency
Yes	

Incidents Descript.

random venting of 2 PRDs due to freezing; 3 cracked inner liners; many excessive permeation leakage through inner/outer liners, particularly immediately after fueling; most had liner inward bulging at low press.; most possible faulty seal at end boss

Cause Resolved

Mirada PRDs changed to Superior; all cylinders changed to Dynetek Type 3-aluminum liner with carbon fiber wrap and auto frettage process applied to inner liner

Tank Inspection

every 6000 miles use fuel detection device to scan fuel storage area; every 3 years visual inspection of cylinder external condition

Cylinders Removed

Yes, some cylinders found to be leaking during fuel detector scans

Inspection Effective

process is effective as scanners are very sensitive

Other

Type 4 composite cylinders are not recommended for use on transit vehicles; bus OEM and Cylinder mfr have not supported in any way the change out program for these buses

Reporter Name	Reporter Phone	Date Completed
W. D. Brown	416-393-3162	4/7/98

Compiled by: Vincent R. DeMarco, PE File: afi-sum3.dbf 09/12/98

Responses to March 27, 1998 Letters on Status of CNG/LNG Cylinders

COMPANYNAM	CITY	STATE
Toronto Transit Commission	Toronto	ON

Bus Fuel	No. of Buses	Bus Mfr.	Bus Model	Year Bus Built
CNG	50	Orion	VI 40' LF 06.501	1997

Tank Mfr.	Tank Type
Structural Composites Inc.	Type 3, aluminum/fiberglass wrap

Tank Diameter	Tank Length	Tank Placement	Tank Pressure
15"	100"	top	3000 psi

No. of Tanks	Fuel Capacity	Tank PRD Mfr.	Tank PRD Model
8	15,300 scf	Superior	

Tank Leak/Rupture	Leak Frequency
No	None

Incidents Descript.

Cause Resolved

Tank Inspection

every 6000 miles use fuel detection device to scan fuel storage area; every 3 years visual inspection of cylinder external condition

Cylinders Removed

some cylinders found to be leaking during fuel detector scans

Inspection Effective

process is effective as scanners are very sensitive

Other

Type 4 composite cylinders are not recommended for use on transit vehicles; ; note that the increased weight and reduced volume for fuel storage system (as compared to Dynetek cylinders) results in reduced mileage range

Reporter Name	Reporter Phone	Date Completed
W. D. Brown	416-393-3162	4/7/98

Compiled by: Vincent R. DeMarco, PE File: afi-sum3.dbf 09/12/98

Responses to March 27, 1998 Letters on Status of CNG/LNG Cylinders

COMPANYNAM: Tri-Met

CITY: Portland

STATE: OR

Bus Fuel: LNG

No. of Buses: 2

Bus Mfr.: Gillig

Bus Model: Phantom

Year Bus Built: 1992

Tank Mfr.: Gryogas

Tank Type:

Tank Diameter:

Tank Length:

Tank Placement: bottom

Tank Pressure:

No. of Tanks: 2

Fuel Capacity: 125 gallons

Tank PRD Mfr.: N/A

Tank PRD Model:

Tank Leak/Rupture: No

Leak Frequency: None

Incidents Descript.:

Cause Resolved:

Tank Inspection: every 6000 miles visual inspection;

Cylinders Removed: None

Inspection Effective:

Other: we have had no troubles

Reporter Name: Jim Strong

Reporter Phone: 503-238-4873

Date Completed: 4/20/98

Compiled by: Vincent R. DeMarco, PE File: afi-sum3.dbf 09/12/98

Responses to March 27, 1998 Letters on Status of CNG/LNG Cylinders

COMPANYNAM	CITY	STATE
Tri-Met	Portland	OR

Bus Fuel	No. of Buses	Bus Mfr.	Bus Model	Year Bus Built
LNG	8	Flxible	Metro 40102-6C-0	1993

Tank Mfr.	Tank Type
CVI Inc.	

Tank Diameter	Tank Length	Tank Placement	Tank Pressure
		bottom	

No. of Tanks	Fuel Capacity	Tank PRD Mfr.	Tank PRD Model
3	220 gallons	N/A	

Tank Leak/Rupture	Leak Frequency
No	None

Incidents Descript.

Cause Resolved

Tank Inspection

every 6000 miles visual inspection;

Cylinders Removed

None

Inspection Effective

we have had no troubles

Other

Reporter Name	Reporter Phone	Date Completed
Jim Strong	503-238-4873	4/20/98

Compiled by: Vincent R. DeMarco, PE File: afi-sum3.dbf 09/12/98

Responses to March 27, 1998 Letters on Status of CNG/LNG Cylinders

COMPANYNAM	CITY	STATE
Port Authority of Allegheny County	Pittsburgh	PA

Bus Fuel	No. of Buses	Bus Mfr.	Bus Model	Year Bus Built
CNG	5	Orion	40' 05.0501	1991

Tank Mfr.	Tank Type
Pressed Steel Tank, Inc.	steel with fiberglass wrap

Tank Diameter	Tank Length	Tank Placement	Tank Pressure
14"	65"	top	3000 psi

No. of Tanks	Fuel Capacity	Tank PRD Mfr.	Tank PRD Model
10	11,760 scf	Unknown	

Tank Leak/Rupture	Leak Frequency
No	None

Incidents Descript.

Cause Resolved

Tank Inspection

every six weeks visual inspections of tanks' fittings and fuel lines; every 3 years detailed inspection and tests using acoustic and visual means

Cylinders Removed

None

Inspection Effective

no problems with any tanks

Other

procuring 15 additional CNG buses

Reporter Name	Reporter Phone	Date Completed
James D. Dwyer	412-488-3072	4/16/98

Compiled by: Vincent R. DeMarco, PE File: afi-sum3.dbf 09/12/98

Responses to March 27, 1998 Letters on Status of CNG/LNG Cylinders

COMPANYNAM	CITY	STATE
Centre Area Transportation Authority	State College	PA

Bus Fuel	No. of Buses	Bus Mfr.	Bus Model	Year Bus Built
CNG	16	Orion	V 05.0501	1996

Tank Mfr.	Tank Type
EDO	composite

Tank Diameter	Tank Length	Tank Placement	Tank Pressure
		top	3600 psi

No. of Tanks	Fuel Capacity	Tank PRD Mfr.	Tank PRD Model
8		Unknown	

Tank Leak/Rupture	Leak Frequency
No	None

Incidents Descript.

Cause Resolved

Tank Inspection

every 3000 miles we sniff; once a year we do a visual

Cylinders Removed

None

Inspection Effective

good

Other

Reporter Name	Reporter Phone	Date Completed
Robert Colton	814-238-0625	4/1/98

Compiled by: Vincent R. DeMarco, PE File: afi-sum3.dbf 09/12/98

Responses to March 27, 1998 Letters on Status of CNG/LNG Cylinders

COMPANYNAM	CITY	STATE
Centre Area Transportation Authority	State College	PA

Bus Fuel	No. of Buses	Bus Mfr.	Bus Model	Year Bus Built
CNG	8	NFI	C35LF	1997

Tank Mfr.	Tank Type
Lincoln Composites	composite

Tank Diameter	Tank Length	Tank Placement	Tank Pressure
16"	120"	top	

No. of Tanks	Fuel Capacity	Tank PRD Mfr.	Tank PRD Model
5	15,115 scf	Unknown	

Tank Leak/Rupture	Leak Frequency
No	None

Incidents Descript.

Cause Resolved

Tank Inspection

every 3000 miles we sniff; once a year we do a visual

Cylinders Removed

None

Inspection Effective

good

Other

Reporter Name	Reporter Phone	Date Completed
Robert Colton	814-238-0625	4/1/98

Compiled by: Vincent R. DeMarco, PE File: afi-sum3.dbf 09/12/98

Responses to March 27, 1998 Letters on Status of CNG/LNG Cylinders

COMPANYNAM: Capital Metropolitan Transportation Authority
CITY: Austin
STATE: TX

Bus Fuel	No. of Buses	Bus Mfr.	Bus Model	Year Bus Built
CNG	30	TMC	40' model 08	1993

Tank Mfr.	Tank Type
CNG Cylinder Corp.	Type 2, aluminum hoop wrap

Tank Diameter	Tank Length	Tank Placement	Tank Pressure
13"	72"	bottom	3600

No. of Tanks	Fuel Capacity	Tank PRD Mfr.	Tank PRD Model
12		Mirada	

Tank Leak/Rupture	Leak Frequency
Yes	early on with PRD failures

Incidents Descript.: had creep on vent and fill PRDs with a few leaks; OEM T.B.I. did retro. on fleet; no problems since

Cause Resolved: Yes, completely

Tank Inspection: detailed visual every 12,000 miles; and acoustic once in last 3 years

Cylinders Removed: none

Inspection Effective: very effective

Other:

Reporter Name	Reporter Phone	Date Completed
Steven Herrera	512-389-0501	6/19/98

Compiled by: Vincent R. DeMarco, PE File: afi-sum3.dbf 09/12/98

Responses to March 27, 1998 Letters on Status of CNG/LNG Cylinders

COMPANYNAM	CITY	STATE
Capital Metropolitan Transportation Authority	Austin	TX

Bus Fuel	No. of Buses	Bus Mfr.	Bus Model	Year Bus Built
CNG	4	El Dorado National	30' bus	1995

Tank Mfr.	Tank Type
CNG Cylinder Corp.	Type 2, aluminum hoop wrap

Tank Diameter	Tank Length	Tank Placement	Tank Pressure
		rear and bottom	3600

No. of Tanks	Fuel Capacity	Tank PRD Mfr.	Tank PRD Model
6		unknown	

Tank Leak/Rupture	Leak Frequency
No	None

Incidents Descript.

Cause Resolved

Tank Inspection

detailed visual every 12,000 miles; and acoustic once in last 3 years

Cylinders Removed

none

Inspection Effective

very effective

Other

Reporter Name	Reporter Phone	Date Completed
Steven Herrera	512-389-0501	6/19/98

Compiled by: Vincent R. DeMarco, PE File: afi-sum3.dbf 09/12/98

Responses to March 27, 1998 Letters on Status of CNG/LNG Cylinders

COMPANYNAM	CITY	STATE
Dallas Area Rapid Transit Authority	Dallas	TX

Bus Fuel	No. of Buses	Bus Mfr.	Bus Model	Year Bus Built
CNG	2	Flxible	Metro 40102-6C-1	1990

Tank Mfr.	Tank Type
Comdyne	rolled aluminum

Tank Diameter	Tank Length	Tank Placement	Tank Pressure
19"	78"	bottom	3200 psi

No. of Tanks	Fuel Capacity	Tank PRD Mfr.	Tank PRD Model
6	14,400 scf	Comdyne	155 0010

Tank Leak/Rupture	Leak Frequency
No	None

Incidents Descript.

Cause Resolved

Tank Inspection

check torque of mounting straps and visual condition of tank; check plumbing for leakage

Cylinders Removed

None

Inspection Effective

no problems have been noted

Other

Reporter Name	Reporter Phone	Date Completed
Rocky Rogers	214-828-6721	4/13/98

Compiled by: Vincent R. DeMarco, PE File: afi-sum3.dbf 09/12/98

Responses to March 27, 1998 Letters on Status of CNG/LNG Cylinders

COMPANYNAM	CITY	STATE
Dallas Area Rapid Transit Authority	Dallas	TX

Bus Fuel	No. of Buses	Bus Mfr.	Bus Model	Year Bus Built
LNG	210	Nova	WFD RTS T80	1997/8

Tank Mfr.	Tank Type
Minnesota Valley Engr.	stainless dewar

Tank Diameter	Tank Length	Tank Placement	Tank Pressure
22"	56"	bottom	80 psi

No. of Tanks	Fuel Capacity	Tank PRD Mfr.	Tank PRD Model
3	152 gallons	N/A	

Tank Leak/Rupture	Leak Frequency
Yes	

Incidents Descript.

tank and fitting

Cause Resolved

Yes, problems are being resolved by the bus OEM before they will be accepted and placed into service

Tank Inspection

check torque of mounting straps and visual condition of tank; check plumbing for leakage

Cylinders Removed

None

Inspection Effective

no problems have been noted

Other

None of these buses have been accepted

Reporter Name	Reporter Phone	Date Completed
Rocky Rogers	214-828-6721	4/13/98

Compiled by: Vincent R. DeMarco, PE File: afi-sum3.dbf 09/12/98

Responses to March 27, 1998 Letters on Status of CNG/LNG Cylinders

COMPANYNAM	CITY	STATE
City of El Paso Mass Transit Department (Sun Metr	El Paso	TX

Bus Fuel	No. of Buses	Bus Mfr.	Bus Model	Year Bus Built
CNG	2	TMC	RTS T80208	1993

Tank Mfr.	Tank Type
CNG Cylinder Corp.	NGV 1 glass wrapped aluminum

Tank Diameter	Tank Length	Tank Placement	Tank Pressure
13"	72"	bottom	3600 psi

No. of Tanks	Fuel Capacity	Tank PRD Mfr.	Tank PRD Model
12	12,000 scf	Mirada	

Tank Leak/Rupture	Leak Frequency
No	None

Incidents Descript.

Cause Resolved

Tank Inspection

every 6000 miles visual inspection; NGV 1 tanks are hydrostatic tested every three years

Cylinders Removed

None

Inspection Effective

satisfactory

Other

Reporter Name	Reporter Phone	Date Completed
Wesley C. Swenson	915-534-5874	4/17/98

Compiled by: Vincent R. DeMarco, PE File: afi-sum3.dbf 09/12/98

Responses to March 27, 1998 Letters on Status of CNG/LNG Cylinders

COMPANYNAM	CITY	STATE
City of El Paso Mass Transit Department (Sun Metr	El Paso	TX

Bus Fuel	No. of Buses	Bus Mfr.	Bus Model	Year Bus Built
CNG	18	Orion	V 05.501	1994

Tank Mfr.	Tank Type
Structural Composites Inc.	NGV 2 glass wrapped aluminum

Tank Diameter	Tank Length	Tank Placement	Tank Pressure
15"	72"	top	3600 psi

No. of Tanks	Fuel Capacity	Tank PRD Mfr.	Tank PRD Model
10	13,240 scf	Mirada	

Tank Leak/Rupture	Leak Frequency
No	None

Incidents Descript.

Cause Resolved

Tank Inspection

every 6000 miles visual inspection

Cylinders Removed

None

Inspection Effective

satisfactory

Other

Reporter Name	Reporter Phone	Date Completed
Wesley C. Swenson	915-534-5874	4/17/98

Compiled by: Vincent R. DeMarco, PE File: afi-sum3.dbf 09/12/98

Responses to March 27, 1998 Letters on Status of CNG/LNG Cylinders

COMPANYNAM	CITY	STATE
City of El Paso Mass Transit Department (Sun Metr	El Paso	TX

Bus Fuel	No. of Buses	Bus Mfr.	Bus Model	Year Bus Built
CNG	25	Chance Industries	AH-28 Trolleybus	1996/7

Tank Mfr.	Tank Type
CNG Cylinder Corp.	Type 2, glass wrapped aluminum

Tank Diameter	Tank Length	Tank Placement	Tank Pressure
10"	72"	top	3600 psi

No. of Tanks	Fuel Capacity	Tank PRD Mfr.	Tank PRD Model
12	13,868 scf	Mirada	

Tank Leak/Rupture	Leak Frequency
No	None

Incidents Descript.

Cause Resolved

Tank Inspection

every 6000 miles visual inspection

Cylinders Removed

None

Inspection Effective

satisfactory

Other

Reporter Name	Reporter Phone	Date Completed
Wesley C. Swenson	915-534-5874	4/17/98

Compiled by: Vincent R. DeMarco, PE File: afi-sum3.dbf 09/12/98

Responses to March 27, 1998 Letters on Status of CNG/LNG Cylinders

COMPANYNAM	CITY	STATE
City of El Paso Mass Transit Department (Sun Metr	El Paso	TX

Bus Fuel	No. of Buses	Bus Mfr.	Bus Model	Year Bus Built
LNG	35	NFI	G40HF	1994

Tank Mfr.	Tank Type
Minnesota Valley Engr.	stainless steel cryogenic vessel

Tank Diameter	Tank Length	Tank Placement	Tank Pressure
19"	114"	bottom	135 psi

No. of Tanks	Fuel Capacity	Tank PRD Mfr.	Tank PRD Model
2	190 gallons	N/A	

Tank Leak/Rupture	Leak Frequency
No	None

Incidents Descript.

Cause Resolved

Tank Inspection

every 6000 miles visual inspection

Cylinders Removed

None

Inspection Effective

satisfactory

Other

Reporter Name	Reporter Phone	Date Completed
Wesley C. Swenson	915-534-5874	4/17/98

Compiled by: Vincent R. DeMarco, PE File: afi-sum3.dbf 09/12/98

Responses to March 27, 1998 Letters on Status of CNG/LNG Cylinders

COMPANYNAM	CITY	STATE
Fort Worth Transportation Authority	Fort Worth	TX

Bus Fuel	No. of Buses	Bus Mfr.	Bus Model	Year Bus Built
CNG	44	Flxible	Metro 35102-6C-1	1990/1/2

Tank Mfr.	Tank Type
Comdyne	aluminum

Tank Diameter	Tank Length	Tank Placement	Tank Pressure
19"	84"	bottom	3600 psi

No. of Tanks	Fuel Capacity	Tank PRD Mfr.	Tank PRD Model
4	10,500 scf	Mirada	

Tank Leak/Rupture	Leak Frequency
Yes	

Incidents Descript.

we have only experienced PRD failures

Cause Resolved

replace PRDs every three years; Mirada has no maintenance PM procedures and states that PRDs should last 4 to 5 yrs, three weeks ago a TRD (Temp Release Device) released after it had replaced another one a year ago

Tank Inspection

general inspections at scheduled Preventive Maintenance cycles

Cylinders Removed

Yes, some as a result of failing hydrostatic testing

Inspection Effective

Very effective, we have not had any tank problems

Other

replace PRDs every three years

Reporter Name	Reporter Phone	Date Completed
Ron Anderson	817-215-8951	5/13/98

Compiled by: Vincent R. DeMarco, PE File: afi-sum3.dbf 09/12/98

Responses to March 27, 1998 Letters on Status of CNG/LNG Cylinders

COMPANYNAM: Fort Worth Transportation Authority

CITY: Fort Worth

STATE: TX

Bus Fuel	No. of Buses	Bus Mfr.	Bus Model	Year Bus Built
CNG	13	Flxible	Metro 40102-6C-1	1995

Tank Mfr.	Tank Type
Comdyne	aluminum

Tank Diameter	Tank Length	Tank Placement	Tank Pressure
19"	84"	bottom	3600 psi

No. of Tanks	Fuel Capacity	Tank PRD Mfr.	Tank PRD Model
6	16,000 scf	Mirada	

Tank Leak/Rupture: Yes

Leak Frequency:

Incidents Descript.: we have only experienced PRD failures

Cause Resolved: replace PRDs every three years; Mirada has no maintenance PM procedures and states that PRDs should last 4 to 5 yrs, three weeks ago a TRD (Temp Release Device) released after it had replaced another one a year ago

Tank Inspection: general inspections at scheduled Preventive Maintenance cycles

Cylinders Removed: Yes, some as a result of failing hydrostatic testing

Inspection Effective: Very effective, we have not had any tank problems

Other: replace PRDs every three years

Reporter Name	Reporter Phone	Date Completed
Ron Anderson	817-215-8951	5/13/98

Compiled by: Vincent R. DeMarco, PE File: afi-sum3.dbf 09/12/98

Responses to March 27, 1998 Letters on Status of CNG/LNG Cylinders

COMPANYNAM	CITY	STATE
Metropolitan Transit Authority of Harris County	Houston	TX

Bus Fuel	No. of Buses	Bus Mfr.	Bus Model	Year Bus Built
CNG	5	NFI	40' LF	1997

Tank Mfr.	Tank Type
Lincoln Composites	tuffshell, all composite

Tank Diameter	Tank Length	Tank Placement	Tank Pressure
15.9"	120"	top	3600 psi

No. of Tanks	Fuel Capacity	Tank PRD Mfr.	Tank PRD Model
6	18,138 scf	Mirada	2.5

Tank Leak/Rupture	Leak Frequency
No	None

Incidents Descript.

Cause Resolved

Tank Inspection

every 6000 miles tanks visual inspection, incl. mounting straps, welds, bolts and nuts, and connections to and from tanks; tank shells are inspected for dents, cracks or wear marks

Cylinders Removed

None

Inspection Effective

very good for preventing tank failures

Other

minimal experience with CNG; operate 40 non-revenue support vehicles and 5 revenue buses with CNG

Reporter Name	Reporter Phone	Date Completed
Richard Rotenberry	713-615-7262	4/14/98

Compiled by: Vincent R. DeMarco, PE File: afi-sum3.dbf 09/12/98

Responses to March 27, 1998 Letters on Status of CNG/LNG Cylinders

COMPANYNAM: Metropolitan Transit Authority of Harris County
CITY: Houston
STATE: TX

Bus Fuel	No. of Buses	Bus Mfr.	Bus Model	Year Bus Built
LNG	60	Ikarus	40' 416.04	1992

Tank Mfr.	Tank Type
Taylor Wharton	custom stainless steel

Tank Diameter	Tank Length	Tank Placement	Tank Pressure
		bottom	80 psi

No. of Tanks	Fuel Capacity	Tank PRD Mfr.	Tank PRD Model
2	160 gallons	N/A	

Tank Leak/Rupture	Leak Frequency
Yes	25 in 5 years

Incidents Descript.
vent line appurtenance not properly supported; normal road vibrations and stress cause outer vessel to crack resulting in loss of tank vacuum

Cause Resolved
local cyrogenic repair shop fabricated hardware to correct subsequent failures on repaired tanks

Tank Inspection
every 6000 miles tanks visual inspection, incl. mounting straps, welds, bolts and nuts, and connections to and from tanks; tank shells are inspected for dents, cracks or wear marks; tanks checked for skin temperature (icing or cold indicate weak vacuum

Cylinders Removed
None

Inspection Effective
very good for preventing tank failures

Other

Reporter Name	Reporter Phone	Date Completed
Richard Rotenberry	713-615-7262	4/14/98

Compiled by: Vincent R. DeMarco, PE File: afi-sum3.dbf 09/12/98

Responses to March 27, 1998 Letters on Status of CNG/LNG Cylinders

COMPANYNAM	CITY	STATE
Metropolitan Transit Authority of Harris County	Houston	TX

Bus Fuel	No. of Buses	Bus Mfr.	Bus Model	Year Bus Built
LNG	20	Mercedes	40' T-40 (SSI)	1992/3

Tank Mfr.	Tank Type
Taylor Wharton	custom stainless steel

Tank Diameter	Tank Length	Tank Placement	Tank Pressure
		bottom	80 psi

No. of Tanks	Fuel Capacity	Tank PRD Mfr.	Tank PRD Model
1	105 galons	N/A	

Tank Leak/Rupture	Leak Frequency
Yes	4 in 5 years

Incidents Descript.

failures are related to vacuum loss from fatigue/stress cracks

Cause Resolved

failures are handled individually, no set pattern has emerged

Tank Inspection

every 6000 miles tanks visual inspection, incl. mounting straps, welds, bolts and nuts, and connections to and from tanks; tank shells are inspected for dents, cracks or wear marks; tanks checked for skin temperature (icing or cold indicate weak vacuum

Cylinders Removed

None

Inspection Effective

very good for preventing tank failures

Other

Reporter Name	Reporter Phone	Date Completed
Richard Rotenberry	713-615-7262	4/14/98

Compiled by: Vincent R. DeMarco, PE File: afi-sum3.dbf 09/12/98

Responses to March 27, 1998 Letters on Status of CNG/LNG Cylinders

COMPANYNAM: Metropolitan Transit Authority of Harris County

CITY: Houston

STATE: TX

Bus Fuel	No. of Buses	Bus Mfr.	Bus Model	Year Bus Built
LNG	115	Neoplan	45' & 60' AN-345/3	1993/4

Tank Mfr.	Tank Type
Taylor Wharton	custom built, single tank

Tank Diameter	Tank Length	Tank Placement	Tank Pressure
		bottom	80 psi

No. of Tanks	Fuel Capacity	Tank PRD Mfr.	Tank PRD Model
1	158 gallons	N/A	

Tank Leak/Rupture	Leak Frequency
Yes	12 in 5 years

Incidents Descript.

normally a failure is due to a fatigue crack in the outer vessel lining which permits loss of vacuum

Cause Resolved

failures are handled individually, no set pattern has emerged

Tank Inspection

every 6000 miles tanks visual inspection, incl. mounting straps, welds, bolts and nuts, and connections to and from tanks; tank shells are inspected for dents, cracks or wear marks; tanks checked for skin temperature (icing or cold indicate weak vacuum

Cylinders Removed

None

Inspection Effective

very good for preventing tank failures

Other

Reporter Name	Reporter Phone	Date Completed
Richard Rotenberry	713-615-7262	4/14/98

Compiled by: Vincent R. DeMarco, PE File: afi-sum3.dbf 09/12/98

Responses to March 27, 1998 Letters on Status of CNG/LNG Cylinders

COMPANYNAM	CITY	STATE
Metropolitan Transit Authority of Harris County	Houston	TX

Bus Fuel	No. of Buses	Bus Mfr.	Bus Model	Year Bus Built
LNG	5	NFI	40' LF L40LF	1997

Tank Mfr.	Tank Type
Minnesota Valley Engr.	HLNG 56, stainless steel

Tank Diameter	Tank Length	Tank Placement	Tank Pressure
16"	84"	top	100 psi

No. of Tanks	Fuel Capacity	Tank PRD Mfr.	Tank PRD Model
4	56 gallons x 4?	N/A	

Tank Leak/Rupture	Leak Frequency
No	None

Incidents Descript.

only leaks have been vapor from joining lines and fittings, very minor

Cause Resolved

Tank Inspection

every 6000 miles tanks visual inspection, incl. mounting straps, welds, bolts and nuts, and connections to and from tanks; tank shells are inspected for dents, cracks or wear marks; tanks checked for skin temperature (icing or cold indicate weak vacuum

Cylinders Removed

None

Inspection Effective

very good for preventing tank failures

Other

Reporter Name	Reporter Phone	Date Completed
Richard Rotenberry	713-615-7262	4/14/98

Compiled by: Vincent R. DeMarco, PE File: afi-sum3.dbf 09/12/98

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