

Vancouver Transit Natural Gas Bus System



Background

BC Transit - Vancouver, provides a fully integrated transit service in the Vancouver lower mainland area using diesel, CNG buses, trolley buses, Sea Bus, Sky Train and commuter rail in an 1,800 square kilometre area. The annual ridership in the Vancouver area is approximately 120 million and its revenue kilometres are approximately 86 million.

This system is noted for being one of the cleanest in North America with the majority of passengers travelling aboard non-polluting electrically powered vehicles. Vancouver continues its search for innovative sustainable transportation solutions through its natural gas and fuel cell bus research and development program.

BC Transit began to evaluate the use of natural gas buses in Vancouver in 1991 by operating three natural gas buses, powered by pilot diesel, port injected natural gas engines. BC transit was interested in evaluating natural gas transit buses because of the abundance of natural gas in BC and its low polluting characteristics. BC Gas had similar interests and participated in the evaluation by providing the fuelling facility for the first three buses.

In 1994 BC Transit undertook an extensive study of the economic and environmental benefits of using natural gas buses in its system. Based on the results of the study, Vancouver ordered 25 natural gas buses from New Flyer Industries in November 1994. These buses were partially financed by BC Gas through an agreement which only required BC Transit to use

natural gas and pay the standard tariff rate. The buses were commissioned and introduced into service in November 1995 and operate out of the Port Coquitlam Transit Facility. The performance of the buses has been monitored from April 1996 and will continue till April 2000.

An additional 25 low floor CNG buses, powered by Detroit Diesel Series 50G engines, were ordered from New Flyer Industries and entered service in September 1998 in Port Coquitlam. Vancouver Transit and West Coast Energy have entered into an operating lease for 15 of these CNG buses. BC Gas will upgrade the fuelling facility to handle the 51 buses.

To fuel the buses, BC Gas supplied a fuelling station capable of filling a bus in four minutes. This facility was designed and engineered by BC Gas with the equipment supplied by IMW Compressors. The original station was capable of fuelling the dual fuel buses in under 4 minutes. However, the addition of 25 dedicated natural gas buses resulted in an increased demand on the station and fuelling times increased. This was corrected by making some minor improvements plus adding three additional ASME vessels to the original three. The result was a station capable of an average fuelling time of 5 minutes per bus as long as there was sufficient time between fillings to partially refill the vessels. To accommodate the additional 25 buses which are just entering service the compressors will be upgraded and an additional dispenser added. The station has two compressors and a maximum working pressure of 3600 psi.

Bus Fleet

BC Transit operates a fleet 1006 transit buses in the Vancouver area. The fleet composition is as follows:

Number	Configuration	Manufacturer	Fuel	Engine
25	Conventional	New Flyer Industries	CNG	DDC Series 50G
25	Low Floor	New Flyer Industries	CNG	DDC Series 50G
1	Conventional	MCI	CNG	DDC 6V-92 Port Inject
457	Conventional	New Flyer Industries, MCI	Diesel	DD 6V-92, 6V-71
194	Low Floor	New Flyer Industries	Diesel	DD Series 50
21	Articulated	New Flyer Industries	Diesel	DD 6V-92
21	Articulated, low floor	New Flyer Industries	Diesel	DD Series 50
19	Community Bus	Orion Bus Industries	Diesel	Navistar 7.3L
244	Trolley Buses	New Flyer Industries	Electric	

Garage

Bus Storage

The natural gas buses are stationed at the Port Coquitlam Transit Centre and are stored outdoors because of the mild weather.

Maintenance Area

To accommodate the natural gas buses in the maintenance area, a full fire alarm and sprinkler system was installed. Also, twenty-one methane sensors were installed throughout the maintenance area and linked into the ventilation system. If gas is detected at a low level, a warning horn sounds and the ventilation fans are activated. Staff then attempts to determine the source of the gas. If gas concentration gets to the 50% LEL level, the fire alarm system is triggered and the evacuation procedures are initiated.



Photograph 1:
Manual shut-off valve on CNG bus

Most of the unit heaters in the maintenance area are supplied with external air and did not have to be modified. Two of the unit heaters, which had open flame pilot ignition will be replaced with indirect external heaters now that the number of buses has been increased to fifty. The lights in the maintenance area have been lowered and are classified as explosion proof.

The natural gas buses are not defuelled prior to being brought in for regular maintenance unless the bus

will be in the area for more than eight hours. If maintenance work is required on the fuel storage system, a defuelling facility supplied by BC Gas is available. When a bus is brought in for maintenance, the gas in the cylinders is isolated from the engine with a manual shut off valve.

Service Lane

Servicing and fuelling of CNG and diesel buses is performed in three outdoor lanes in an open-air protected area. The three service lanes are located beside each other and only one lane can service both natural gas and diesel buses. Bus fluids are checked and light servicing may be carried out in this area. The bus is then taken through the bus wash and is parked.

The natural gas compressor and storage bottles have been placed beside the service lane. The gas dispenser is located close to the compressor station and slightly outside of the open-air protected area. When the bus is parked for fuelling, the fuelling receptacle on the bus is located in the open air. Three emergency shut-off switches are located at the fuelling island to shut-off the compressors in the event of a fuel problem.



Photograph 2: Service lanes and compressor

Refuelling Station

fuelling lane by two IMW electrically driven compressors. Their current total capacity is 680 However, to accommodate the additional 25 buses, the compressor station is being upgraded to supply scfm @ 3600 psi. It is being designed to fill buses in an average of five minutes with the storage seldom exceeds 200 kg.



Photograph 3:
Fuelling

Compressors

heavy duty IMW compressors with a non-lubricated The IMW compressor is a reciprocating type compressor configured in a W-style and is balanced resulting in low noise, low vibration and long service life. The cylinders are liquid cooled and the final ambient during summer conditions. The gas is not passed through a drier prior to entering the the gas.

Upgraded Compressor Description

	IMW Compressors, Canada
Model	IMW50/150s3
Quantity	2
Flow Capacity (scfm)	585 each
Horsepower	150 each
Compressor Speed (RPM)	735
Drive	Explosion-proof electric motor
Stages (double acting)	3
Minimum suction pressure (psig)	230
Fill time	Average 5 minutes



Photograph 4: Compressors and storage cascade

Storage Cascade

The storage cascade has three banks consisting of six ASME cylinders with a total capacity of 60,000 cu ft. The first bank comprises three cylinders, the second two and the third one.

The cascade provides a significant supplement to compressor delivery when fully charged to 3600 psig. The result is a major reduction in fuelling time. Secondary benefits of the cascade are smoothing of pressure pulsations in the delivery line, gas cooling and a minimizing of the loading and unloading of the compressors during disconnection and reconnection of fuelling nozzles. Once the storage cascade is full, the compressor shuts down.

Control System

The refuelling facility control system is PLC based, providing monitoring of all operating conditions and shutdowns on various alarm conditions. Once the bus is hooked up, the system controller measures the ambient air temperature and the initial fuel pressure in the bus fuel cylinder. The system then sends in a small charge of gas and the pressure is rechecked. Knowing the pressure rise and the tank volume, the controller estimates the weight of fuel required to fill the bus. At the mid point, the system performs another pressure check. It then computes the final fill and terminates at the "full condition". The "full condition" is the temperature compensated equivalent of 3000 psi at 70 degrees Fahrenheit.



: Defuelling facility

Defuelling Facility

The defuelling facility is located outside the garage facility. Each of the 50 buses is equipped with a defuelling interface. The interface is connected directly to the fuel manifold in the bus. In order to defuel the bus, the cylinder-mounted solenoids must be energized. Fuel is then released from the bus

cylinders. The gas is released to the distribution pipeline which supplies the transit facilities but not the fuelling station. Pressure regulation ensures that the gas does not over-pressurize the transit facility distribution line which typically operates in the 60 psig range.

Natural Gas Bus Fleet

In Vancouver, BC Transit operates 51 natural gas transit buses. Fifty (50) are supplied by New Flyer Industries and powered by Detroit Diesel Series 50G engines. Twenty-five are low floor and 25 are conventional. Each bus is equipped with four methane detectors in the engine and fuel storage compartments. Also, a fire suppression system has been installed in each engine compartment. The 51st bus is from the 1991 port injection project. BC Transit is currently considering upgrading this bus to the latest Westport Technologies direct injection CNG system.

	New Flyer Conventional Accessible, 1995	New Flyer Low Floor 1998
Number	25	25
Length (ft)	40	40
Width (in)	102	102
Engine	Detroit Diesel 50G	Detroit Diesel 50G
Power (bhp)	275	275
Cylinder Manufacturer	Lincoln Composites	Lincoln Composites
Number of cylinders	4	7
Cylinder capacity (scf)	3625 @ 3000 psi	2654 @ 3000 psi
Total fuel capacity (scf)	14000 (1568 litres water capacity)	18578 (2003.3 litres water capacity)
PRD	Miranda Type 2.5	Miranda Type 2.5
Range	Approximately 325 miles	Approximately 400 miles
Weight	30000 bs	30500 lbs