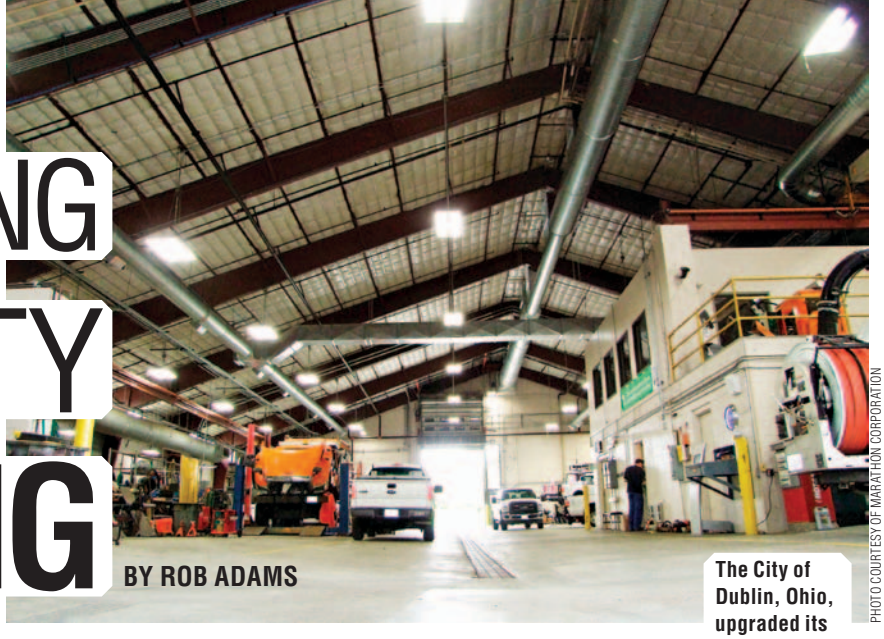
UPGRADING A FACILITY FOR CNG

BY ROB ADAMS



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The City of Dublin, Ohio, upgraded its maintenance facility to allow technicians to safely work on CNG vehicles.

An often overlooked or misunderstood aspect of a compressed natural gas (CNG) project is the garage upgrade. Upgrades are necessary to ensure safe operation with CNG vehicles in existing maintenance or vehicle storage facilities.

Compressed natural gas (CNG) has proven itself to be a very safe fuel in vehicle use around the world; however, like any fuel, there are risks that must be addressed. Existing maintenance facilities are generally constructed to safely house or facilitate maintenance of liquid-fueled vehicles, where the combustion risk is mostly at floor level. CNG is a lighter-than-air fuel, so the risk resides primarily near the ceiling, and to a lesser extent in the zone between the vehicle and the ceiling. It is this area that is addressed in garage upgrades, primarily through heating and ventilating equipment changes.

While CNG upgrades are required to safely domicile CNG vehicles, the buildings must also meet all requirements of other fuels that might be present in the garage.

Follow Codes and Best Practices

Several U.S. codes provide guidance on required upgrades, but there is also ambiguity and conflict. For example, one code requires four air changes per hour (ACH) where another requires five ACH. A list of potentially applicable codes follows for facilities where CNG is not dispensed inside:

- International (or State) Building Code
- International (or State) Fire Code
- International (or State) Mechanical Code
- National Fire Protection Association (NFPA) 30A Motor Fuel Dispensing Facilities and Repair Garages
- NFPA 88A Standard for Parking Structures
- NFPA 70 National Electrical Code

The NFPA 52 Vehicular Gaseous Fuel Systems Code will also apply to facilities where CNG is dispensed indoors.

Facility designers cannot pick and choose which code they wish to follow; they must meet the requirements of all applicable codes. Rather than providing a detailed review of each code, this article will instead consolidate and summarize the dominant code requirements. Because codes represent the minimum allowable requirements, gaps in codes must be filled using best industry practices, which are also summarized.

There are basically three types of buildings or rooms that require CNG upgrade. Codes require differing levels of upgrade depending on the use of the area.

1. **Major repair facilities:** Areas where vehicle body work, hot work, or heavy repairs such as engine overhauls may be performed or where fueling system work may take place (this definition varies by code)
2. **Minor repair facilities:** Areas where no hot work or fuel system work takes place, such as an area for tire, brake, and lubrication work
3. **Vehicle storage areas.**

Indoor fueling facilities will not be addressed in this article — they require much more upgrade and cost than other parts of the facility and are a relative rarity in the CNG market.

While there are a number of risk scenarios to consider, a small or slow leak of gas into a large well-ventilated room poses a relatively low risk. The primary concern is the potential for a fast release and complete depressurization of one or all CNG tanks on the vehicle (in many vehicles, venting from one tank will empty all tanks). In the late 1990s, the CNG industry had a number of unprovoked releases from CNG vehicles in buildings through the failure of the vehicle's pressure relief device (PRD), a device intended to release gas pressure in the event of a fire. These unprovoked PRD releases have effectively disappeared through design improvements, but the industry continues to design building upgrades to protect against such an event.

Table 1 on page 28 shows upgrade requirements for a garage. The most common

At a glance

When retrofitting a maintenance facility for CNG vehicles, consider:

- Electrical codes
- Heating without using open flames
- Continuous and emergency ventilation
- Gas detection
- Architectural requirements.

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Facility changes at the City of Dublin, Ohio, include: 1. Ducts running near the eave of the shop have registers blowing air toward the floor. 2. A new direct-fired heating unit outside the building replaced a furnace inside the building. 3. Registers are projected up from the exhaust duct along the full length of the peak. 4. A stand-by generator backs up the gas detection system, ventilation, and overhead doors.

and costly upgrades are the heating and ventilation systems. There are a number of heating options including hydronic floor or unit heaters; warm air (direct or indirect fired) with unit outside of garage and 100% outside air; low temperature (<750°F) radiant tube heaters with ducted combustion air and sealed combustion; and rated catalytic task heaters.

The code requirements for storage areas are very low (see Table 2 on page 30), but there have been releases in those spaces, so I recommend a more robust upgrade approach in those areas.

Defueling is Not a Viable Alternative

Defueling is the act of safely removing gas from cylinders and venting directly to the atmosphere or with recapture — the requirements of these systems are addressed in International Fire Code 2208.8 Discharge of CNG from Motor Vehicle Fuel Storage Containers.

It is not unusual for newcomers to the CNG industry to propose defueling any vehicle requiring indoor maintenance to reduce or eliminate garage upgrades. While this sounds appealing initially, defueling is time-consuming and wasteful, and creates other safety risks. Wide-scale defueling is not a practical alternative to building upgrades, and in fact, it should only be used when work involves repair or removal of a vehicle tank. Most well-managed fleets defuel very infrequently.

Case Study: City of Dublin's Maintenance Garage

The City of Dublin, Ohio, operates a municipal fleet that includes 57 CNG trucks and cars, with a goal to grow to 185 CNG

Table 1: CNG Building Upgrade Requirements for a Major Repair Garage

	Minimum Code Requirements	Typical Recommended Practice	High-End Upgrade Approach
Electrical	Class 1, Division 2 within 18 inches of ceiling or upgrade continuous ventilation to 4 ACH	Remove all arcing/sparking sources above 10 feet from floor (not a full upgrade to Class 1, Division 2) and provide 4 ACH as noted in the Continuous Ventilation recommendation. Contactor or relay to remove power to welders, grinders, cranes, other sparking equipment on gas detection.	
Heating	No open flames; all heating equipment surfaces must be <750°F	No open flames; all heating equipment surfaces must be <750°F	No open flames; all heating equipment surfaces must be <750°F Heat recovery heating units
Ventilation: Continuous	1 cfm/ft^2, same as diesel (2.5 ACH for a 24-foot ceiling or 3 ACH for a 20-foot ceiling) and no recirculation	4 ACH Fresh air in at building exterior near floor/exhaust at highest point(s) and no recirculation Not shared with other spaces	
Ventilation: Emergency	5 ACH Fresh air in at building exterior near floor/exhaust at highest point(s). No recirculation	4 ACH continuous plus at least 1 ACH direct exhaust at roof, activated by gas detection. Open overhead doors for makeup air	4 ACH continuous plus additional 6 to 8 ACH direct exhaust at roof, activated by gas detection. Open overhead doors for makeup air
Gas Detection	Not required for odorized CNG	Infrared-based system on ~30-foot grid with a fail-safe design	
Generator	Not required	Back-up gas detection, ventilation, overhead doors	
Architectural	Interior walls are to be 2-hour fire rated and extend full height from floor to ceiling. Fire-rated doors between major repair and other areas. Minimum one outside wall.		

SOURCE: MARATHON CORPORATION

Table 2: CNG Building Upgrade Requirements for a Minor Repair or Storage Garage

	Minimum Code Requirements	Typical Recommended Practice	High-End Upgrade Approach
Electrical	No requirements	Remove all arcing/sparking sources above 10 feet from floor (not a full upgrade to Class 1, Division 2)	
Heating	No requirements	No open flames; all heating equipment surfaces must be <750°F	No open flames; all heating equipment surfaces must be <750°F Heat recovery heating units
Ventilation: Continuous (also required for diesel)	1 cfm/ft^2, same as diesel (2.5 ACH for a 24-foot ceiling or 3 ACH for a 20-foot ceiling) and no recirculation	1 cfm/ft^2 Fresh air in at building exterior near floor/exhaust at highest point(s) and no recirculation Not shared with other spaces	
Ventilation: Emergency	No requirements	1 cfm/ft^2 plus additional 5 ACH direct exhaust at roof, activated by gas detection. Open overhead doors for makeup air.	
Gas Detection	Not required	Infrared-based system on ~30-foot grid with a fail-safe design	
Generator	Not Required	Back-up gas detection, ventilation, overhead doors	
Architectural	Interior walls are to be 2-hour fire rated and extend full height from floor to ceiling. Fire-rated doors between major repair and other areas. Minimum one outside wall.		

SOURCE: MARATHON CORPORATION

vehicles. Maintenance is consolidated to a single shop that is a steel structure with a high, steeply pitched roof. Multiple bays run down each side of the building.

When the city decided to go to CNG, officials realized garage upgrades would be required. After a consultant without direct CNG garage upgrade experience recommended a costly and limiting upgrade plan, the city hired Marathon Technical Services and a local general engineering firm to provide a more cost-effective and functional upgrade approach.

While flat-roofed buildings can be readily upgraded, Dublin's steeply pitched roof made it ideally suited to CNG since it naturally channels any leak to a central exhaust duct.

The garage had recently had a lighting upgrade so no further electrical upgrade was required other than an interrupt contactor on the welders and bridge crane.

An old furnace was removed from within the structure, along with older radiant tube heaters. A new direct-fired unit was installed outside the building. Heated makeup air is provided by two ducts that run near the eave on each side of the shop with registers blowing the air toward the floor.

An exhaust duct mounted near the peak of the roof was installed with redundant fans — one at each end of the building. Registers were projected up from the exhaust duct to the peak. Fans run continuously to provide 4 ACH.

An infrared gas detection system was also provided with three rows of detectors running the length of the building including one row at the peak. All outside doors, exhaust fans, and alarms are activated by the gas detection system and backed up with a standby generator.

"Much of the equipment that was replaced was nearing the end of its life, so the real cost of this CNG upgrade was modest," said Darryl Syler, fleet manager, City of Dublin. "We have operated for over two years and found that the indoor air quality is improved and the effectiveness of the heating system, even in last year's extreme cold, is much better than the old equipment. Our technicians are very happy with the indoor climate in our shop."

Use Common Sense & Safe Operating Procedures

Building upgrades are intended to allow the fleet to safely perform all required maintenance, repair, and storage of vehicles; however common sense and safe operating procedures must also be utilized. A partial list of recommendations follows:

1. Develop standard operating procedures (SOPs) and train and drill staff on their use
2. If maintenance is required, try to avoid fueling the vehicle before bringing it into the shop. If a vehicle is inadvertently fueled, defueling is only recommended if high pressure fuel system work is required where pressure isolation is not possible
3. Do not bring a leaking vehicle into a building
4. Use a handheld gas detector to check the vehicle for leaks prior to maintenance
5. Isolate the tank valves on any vehicle in a maintenance shop overnight
6. Maintain and test all building upgrade equipment including fans, gas detection, generators, etc.

Most facilities can be readily and cost-effectively upgraded for safe use with CNG vehicles. This article is intended to provide an overview of the issues involved in upgrading garages, but many design details have been omitted for brevity or may apply to unique site conditions. Given the gaps and ambiguities of current codes, fleets should consult with a design professional experienced with CNG upgrades to discuss code-compliant and cost-effective upgrades.

About the Author:
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