

Determining Modifications Required for Adding CNG or LNG Vehicles to Existing Maintenance Facilities



Wisconsin Clean Cities Webinar
March 25, 2013

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Today's Agenda

- Define the Problem/Opportunity
- Review Applicable Codes & Standards
- Intent /Rationale/Assumptions Behind Codes' Development
- Assess Current Activities in Facility, Potential Practices and Approaches to Reduce Modification Requirements
- Discuss Applicable Code Requirements for CNG and LNG in “Major Repair” Facilities
- Maintenance Facility “Best Practices” When Incorporating CNG/LNG Vehicle into Your Fleet
- Kwik Trip Experience and Lessons Learned

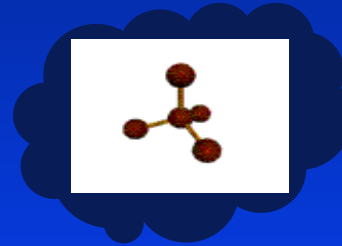
Defining the Problem/Opportunity

- NGV deployment is accelerating quickly, especially in fleet sector.
 - Economies of scale favor RTB and P2P fleets' adoption; most have centralized service facilities
 - Regional/long haul trucking and fueling operations will necessitate more ubiquitous CNG-/LNG-capable service garages
- Lack of familiarity with NGV technology and applicable codes among fleets, design consultants and AHJs
 - Codes are “performance” docs, relying on hazard assessment, mitigation
 - Diversity of facility designs/construction leads to variable interpretations
 - Conflicting codes, outdated government guidance and vendor misinformation exacerbate confusion and over-cautiousness, leading to overly expensive retrofits
- Opportunity: Knowledge/light on subject can avoid costly errors and facilitate wider adoption of NGVs more quickly

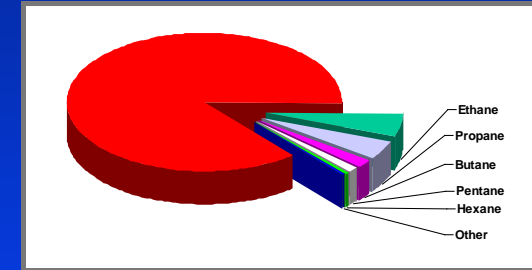


Properties of CNG and LNG

- Natural gas: 88-99% methane (nat'l avg: 93%)
- Methane is CH₄ (low carbon, energy-dense fuel)
- Lighter than air (specific gravity: .55-.65)
- Limited combustion ratio (5-15%)
- High ignition temperature: 1000+F
- Colorless, odorless, non-toxic substance



Methane Molecule



- Compressed Natural Gas (CNG)

- Onboard fuel storage: 3600psi
- Mercaptan is added to L/CNG

- Liquefied Natural Gas (LNG)

- Cryogenic liquid @ -260F;
- Methane content: ~95+%
- 1 cu ft of LNG = 600 cu ft of natural gas @ atmospheric pressure; 3.5 lbs/gallon
- Liquid LNG is not ignitable; vaporizes @ approx ~ -155F (lighter than air).



Applicable Codes to Vehicle Maintenance Facilities

- International Code Council's Intl Fire Code (IFC 2012)
- International Mechanical Code (IMC 2012)
- International Building Code (IBC 2012)
- National Fire Protection Assoc. (NFPA) 30A (2012) Code for Motor Fuel Dispensing Facilities and Repair Garages
- NFPA 52 (2010) Vehicular Gaseous Fuel Systems Code
- NFPA 88 (2007) Standards for Parking Structures
- These national codes are voluntarily adopted by states and local jurisdictions. Local codes often are not the most recent versions of national model codes (adoption often lags behind). Local AHJ is final decision-making authority and may enforce additional requirements.

Code Intent/Rationale/Assumptions

- Most CNG-/LNG-related codes developed in mid-late 1990s based on perceived hazards based on experience of code committees
 - Primary CNG concern: Unintended release in enclosed space.
 - Early PRD's designs were flawed and/or they were improperly selected and the result was unintended venting of CNG cylinders (most were transit applications).
 - Codes developed based on 150% of largest CNG cylinder (50% safety factor).
 - US FTA issued facility "guidance" tied to funding (1996-97) that went far beyond current codes. PRD standards were revised but FTA guidance still in place
 - **Not a single premature PRD failure/release in 10+ years.**

Code Intent/Rationale/Assumptions

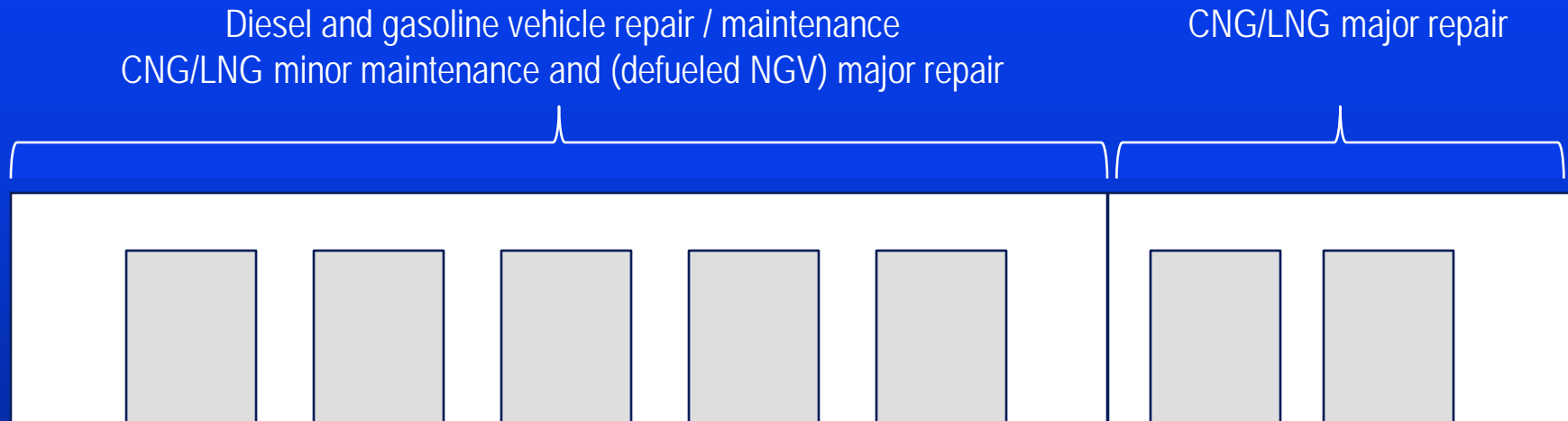
- Most CNG-/LNG-related codes developed in mid-late 1990s based on perceived hazards based on experience of code committees
 - Primary CNG concern: Unintended release in enclosed space.
 - Primary LNG concerns: Venting due to pressure build-up, and liquid release due to puncture
 - Vacuum insulated LNG tanks will still absorb energy and thus a 15psig/day energy gain leads to hold time of 6-7 days before venting. There are various operational procedures to minimize potential for release during planned maintenance activity.
 - **No record of a LNG liquid spill in a maintenance facility**
- Empirical/CFD research underway to better model NG behavior

Evaluate Shop Activities, Segregate, Modify

- IFC and NFPA 30A exempt minor repair facilities from code requirements specific to CNG and LNG.
 - IFC 2211.7 exempts garages that do not work on fuel systems or do not use open flames or welding from all additional requirements
 - NFPA 30A exempts garages that do not perform:
 - Engine overhauls, painting, body & fender work, any repairs requiring draining of vehicle fuel tanks
 - NFPA 30A define minor repair facility maintenance activity as:
 - Lubrication, inspection, engine tune-ups, replacement of parts, fluid changes, brake system repairs, tire rotations and similar routine maintenance work

Evaluate Shop Activities, Segregate, Modify

- IFC and NFPA 30A exempt minor repair facilities from code requirements specific to CNG and LNG.
- To avoid costly modifications, consider:
 - Segregating major repair and minor maintenance activities into separate physical areas; adding NGV-specific bay(s) for major repairs
 - Defueling CNG and/or LNG vehicles before entering major repair area

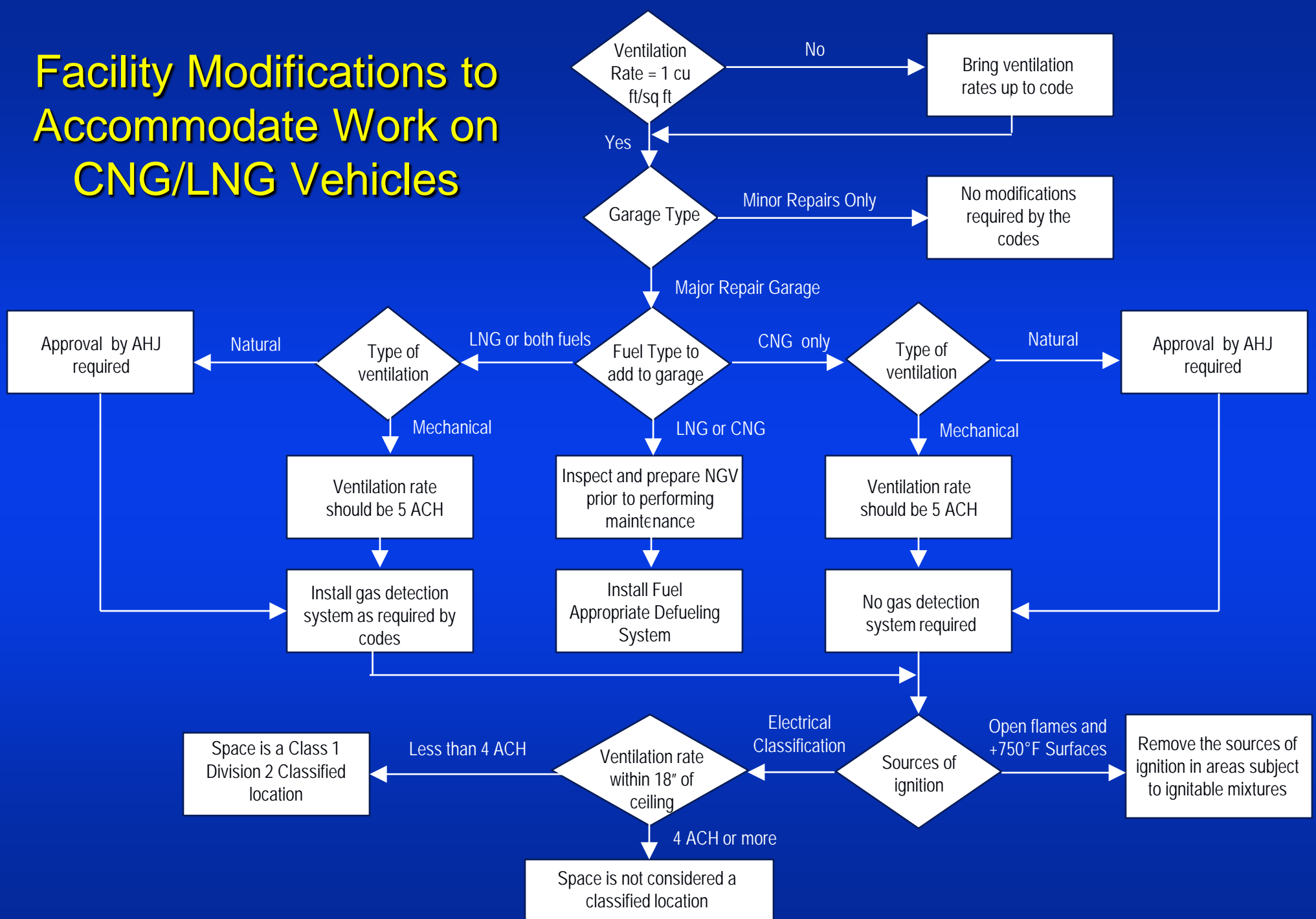


Existing Code Requirements by Category

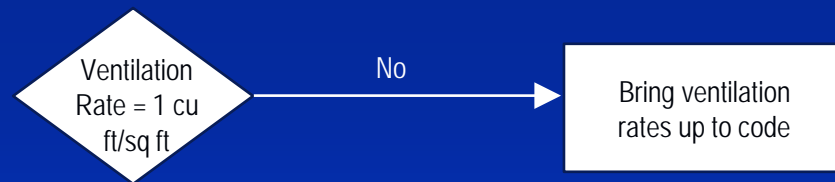
(as it relates to maintenance/repair and parking* facilities)

Modification Category	Code Reference
Ventilation Category	IMC (2012) Table 403.3; NFPA 88A (2007) 5.3.2 IFC (2009) 2211.7.1, 2211.1.1, 2211.7.1.2; NFPA 30A (2012) 7.5.1, 7.5.2, 7.5.3, 7.5.4, 7.4.7.2, 7.4.7.3
Ventilation in Pits	IFC (2009) 2211.3; NFPA 30A 7.4.5.4
Gas Detection	IFC (2009) 2211.7.2, 2211.7.2.1, 2211.7.2.2, 2211.7.2.3; NFPA 30A (2012) 7.4.7, 7.4.7.1, 7.4.7.2, 7.4.7.3, 7.4.7.4
Sources of Ignition	NFPA 30A (2012) 7.6.6
Electrical Classification	NFPA 30A (2012) 8.2.1
Preparation of vehicles For Maintenance	IFC (2009) 2211.5
Maintenance and Decommissioning of containers	NFPA 52 (2010) 6.13, 6.14

Facility Modifications to Accommodate Work on CNG/LNG Vehicles



Facility Modifications to Accommodate Work on CNG/LNG Vehicles



1. Does existing maintenance facility meet ventilation code?

- A. IMC 403.3 requires repair garages (of all vehicle fuel types) to have minimum ventilation rate of .75 cfm/sqft
- B. NFPA 88A 5.3.2 requires 1.0 cfm/sqft for all parking structures. Would seem to indicate that all service garages be considered parking structures

Result: 1cfm/sqft

Facility Modifications to Accommodate Work on CNG/LNG Vehicles

1. Operation of Ventilation in Major Repair Facility with CNG Vehicles

A. IFC 2211.7.1

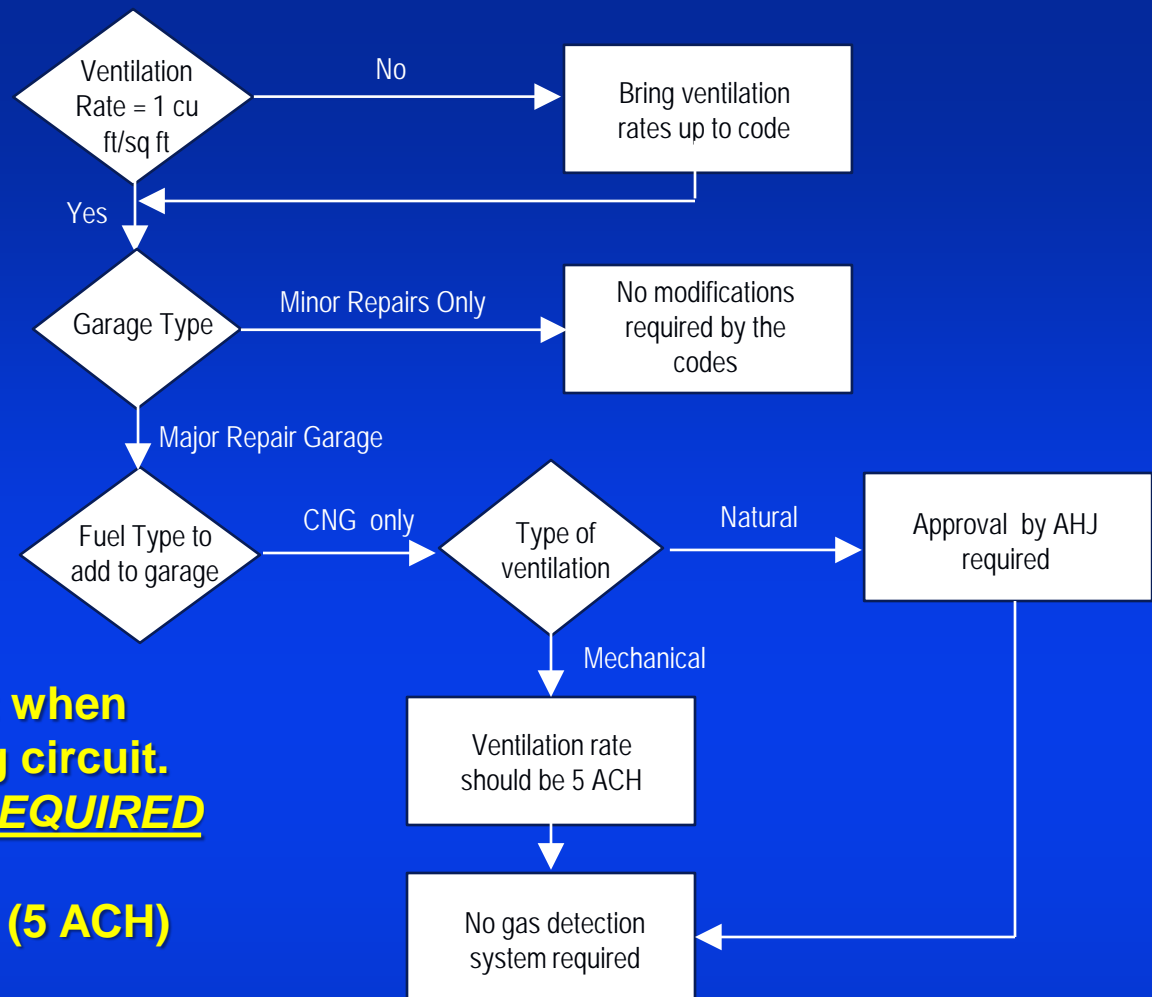
- i. Continuous operation except when interlocked with lighting circuit. **NO METHANE DETECTION REQUIRED FOR ODORIZED CNG.**

B. NFPA 30A

- i. Silent on operation requirements for CNG repair facilities (only for fuel dispensing facilities). **NO METHANE DETECTION FOR ODORIZED CNG.**

C. Both allow AHJ to allow natural ventilation

D. No mention by either code re CNG-specific ventilation rate for pits (Clue: lighter than air)



Facility Modifications to Accommodate Work on CNG/LNG Vehicles

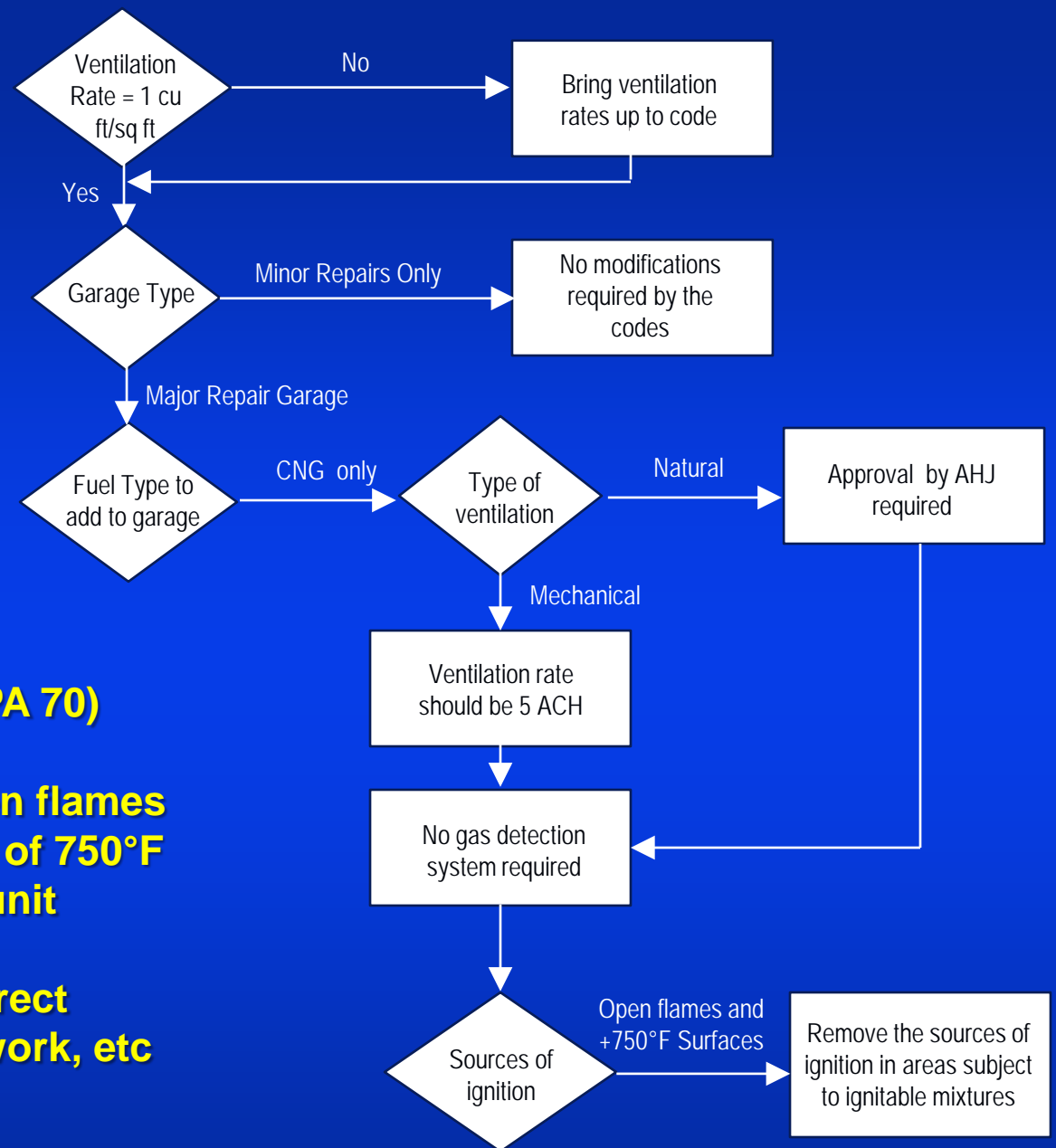
1. Sources of Ignition

A. IFC 2211.3

- i. Only addresses liquid fuels re no ignition sources within 18" of FLOOR (also referenced in IBC, IMC, NFPA 70)

B. NFPA 30A 7.6.6

- i. Requires elimination of open flames and/or surfaces with temps of 750°F or more (e.g. , direct-fired unit heaters, infrared heaters).
- ii. Typically means use of indirect heating systems with ductwork, etc



Facility Modifications to Accommodate Work on CNG/LNG Vehicles

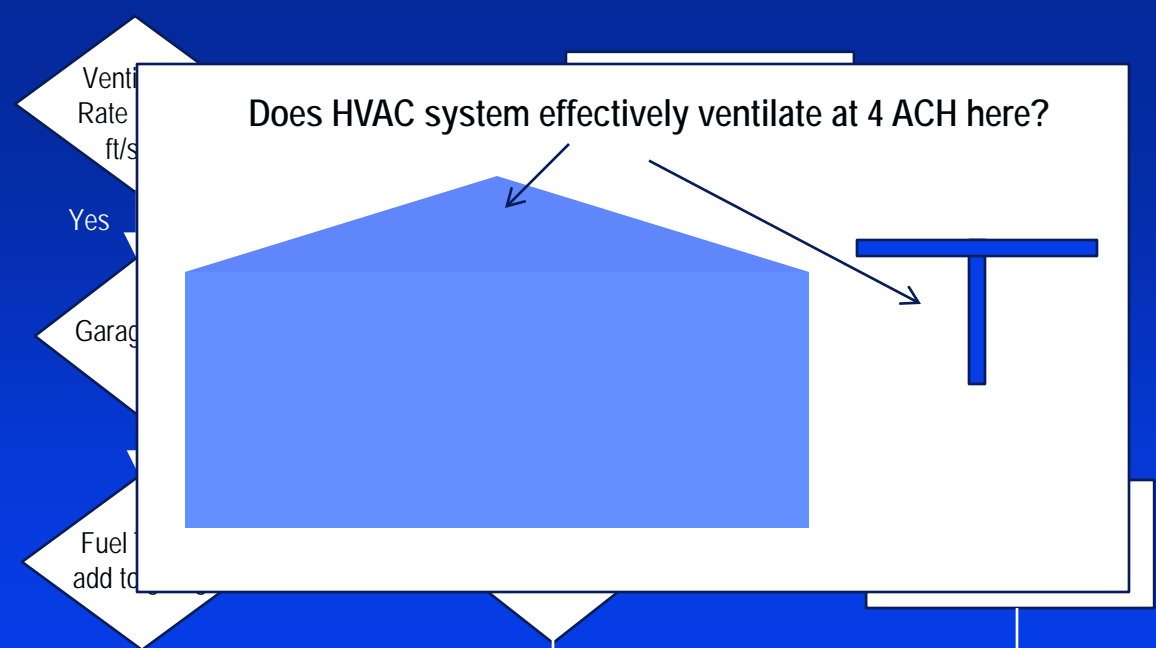
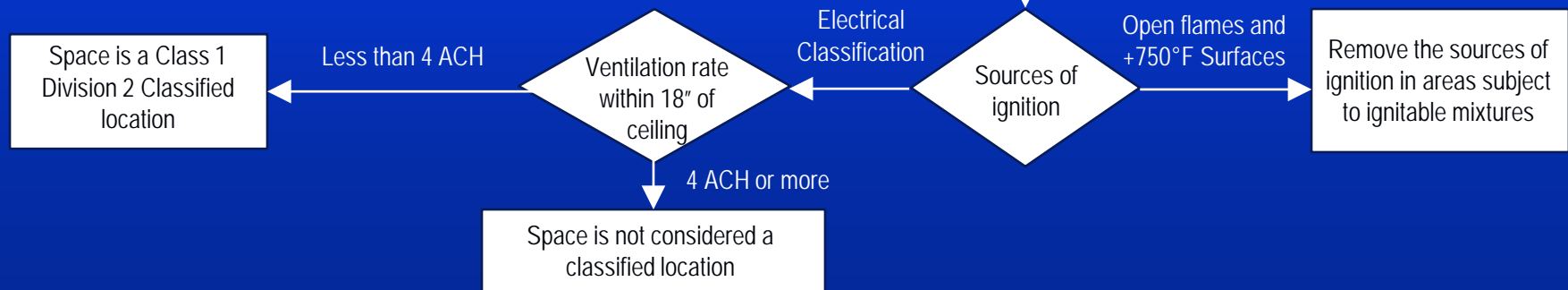
1. Sources of Ignition - Electrical

A. IFC 2211

- i. No specific reference to CNG, LNG

B. NFPA 30A 8.2.1

- i. Areas within 18" of CEILING are Class 1, Division 2 unless that area has at least 4 ACH. AHJ will have to evaluate if roof type and construction methodology allows for effective ventilation to meet 4 ACH
- ii. If < 4 ACH, then electrical must meet Class 1, Division 2 or be moved out of 18" ceiling zone



Vent
Rate
ft/s

Yes

Garage

Fuel
add to

Mechanical

Ventilation rate
should be 5 ACH

No gas detection
system required

Electrical
Classification

Sources of
ignition

Open flames and
+750°F Surfaces

Remove the sources of
ignition in areas subject
to ignitable mixtures

Space is a Class 1
Division 2 Classified
location

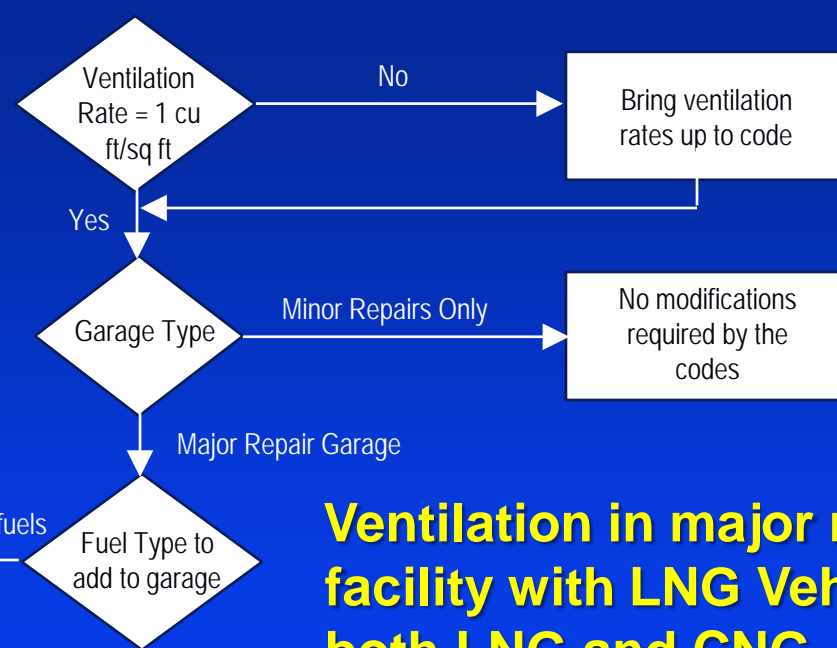
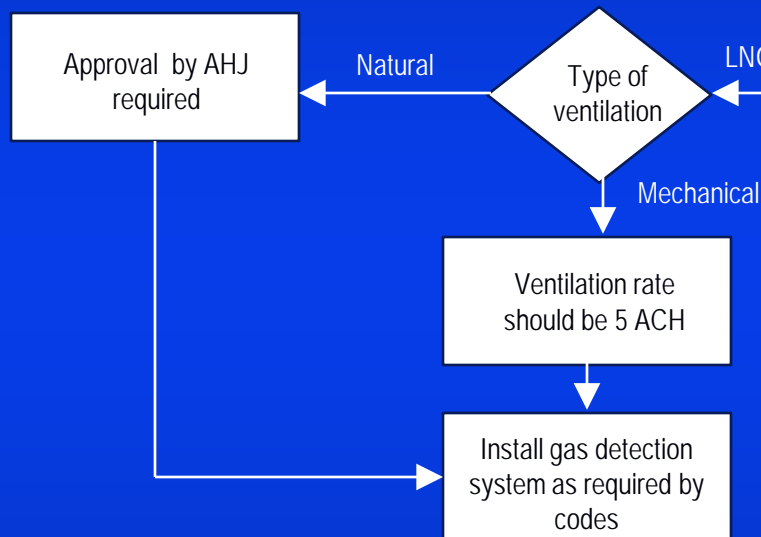
Less than 4 ACH

Ventilation rate
within 18" of
ceiling

4 ACH or more

Space is not considered a
classified location

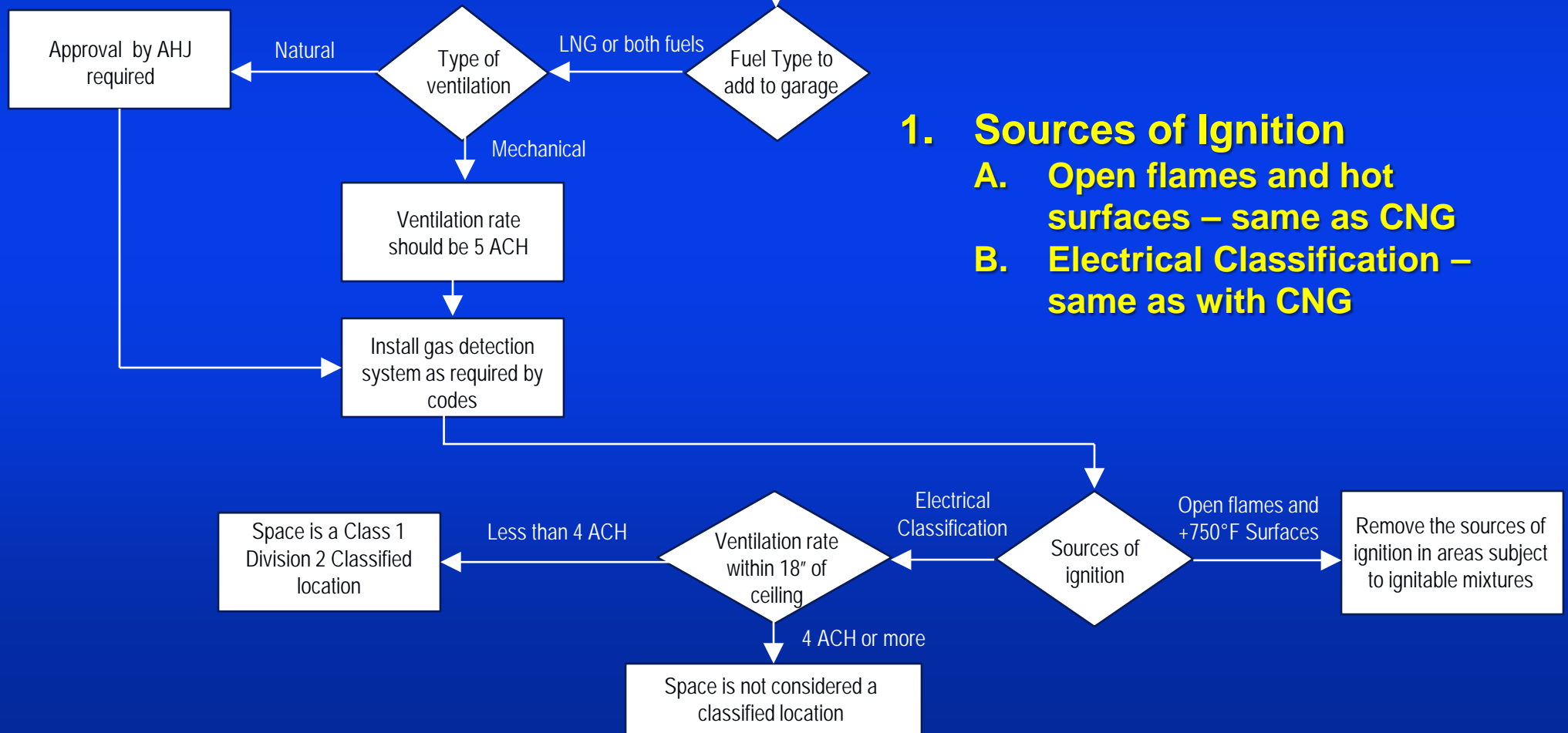
Facility Modifications to Accommodate Work on CNG/LNG Vehicles



Ventilation in major repair facility with LNG Vehicles or both LNG and CNG Vehicles

- A. IFC 2211 IFC 221.7.1
 - i. Continuous operation of ventilation system @ 1cfm/12cu ft (5 ACH) except when interlocked with gas detection system for LNG.
- B. NFPA 30A 7.4.7
 - i. Must interlock ventilation system and methane detection system
- C. Both permit AHJ to allow natural ventilation. Regardless of ventilation strategy, LNG requires methane detection system

Facility Modifications to Accommodate Work on CNG/LNG Vehicles



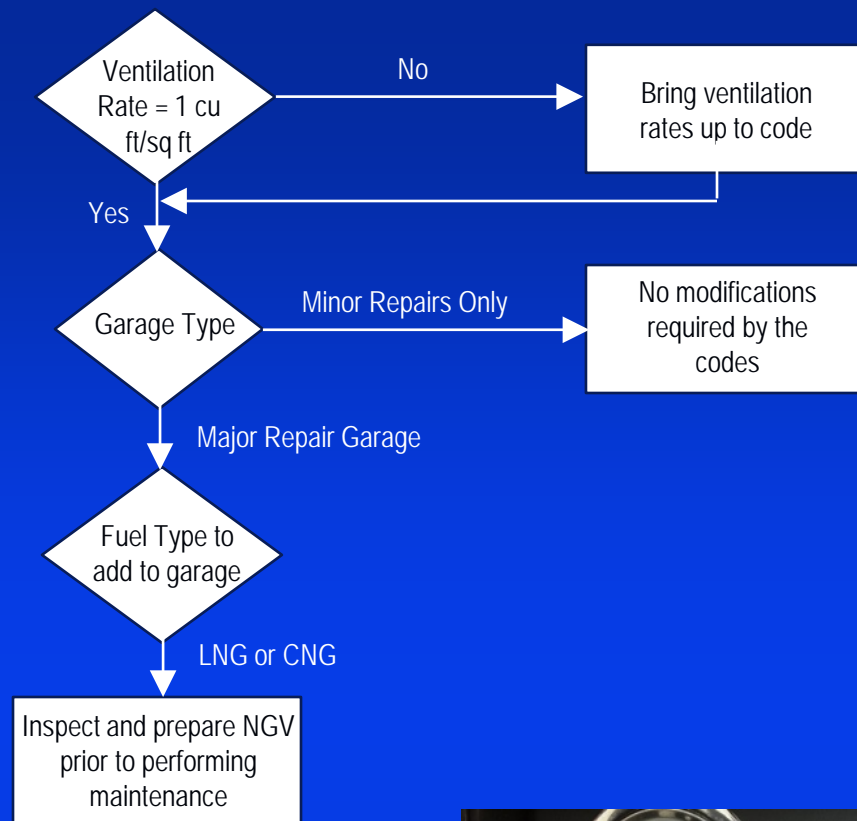
1. Sources of Ignition

- A. Open flames and hot surfaces – same as CNG
- B. Electrical Classification – same as with CNG

Facility Modifications to Accommodate Work on CNG/LNG Vehicles

1. Regardless of ventilation system operation, methane detection requirements, interlocking, etc....

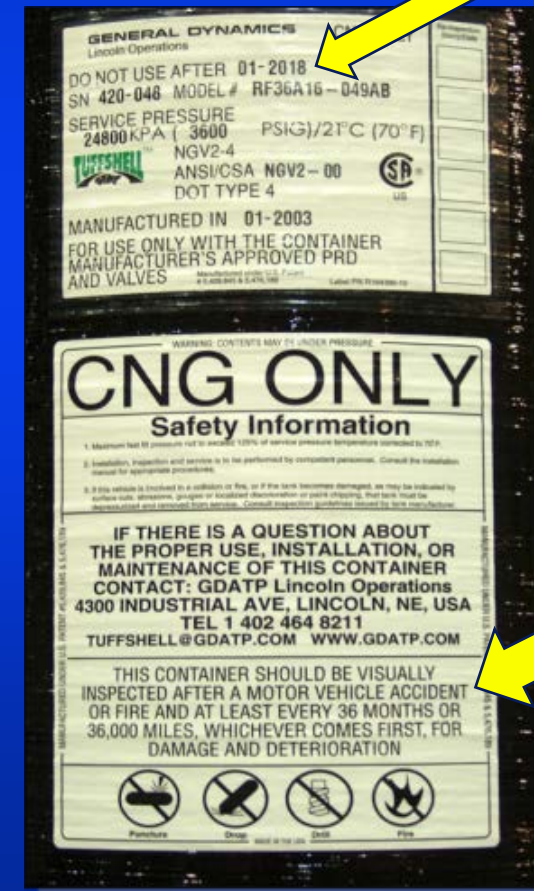
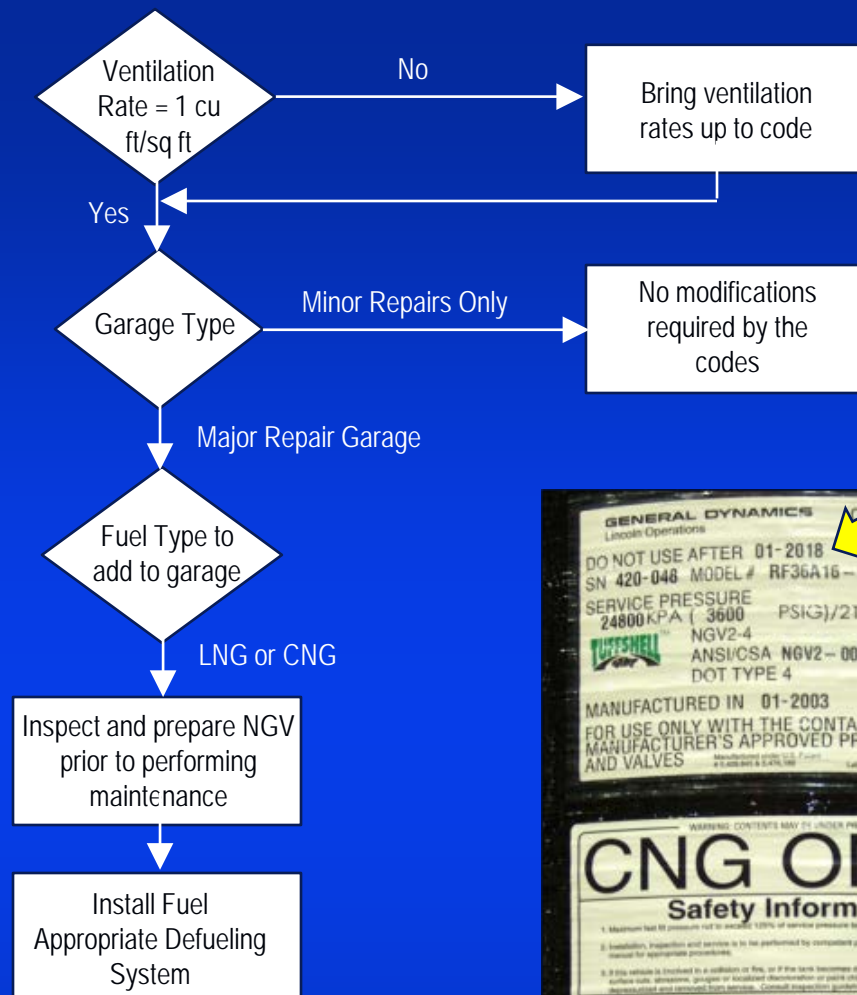
- A. Inspect/prepare your NGV
 - i. IFC 2211.5 – Isolate fuel container from rest of system
 - ii. Inspect for leakage
- B. NFPA 30A – No mention
- C. RP: Operate NGV until it stalls after isolating fuel source



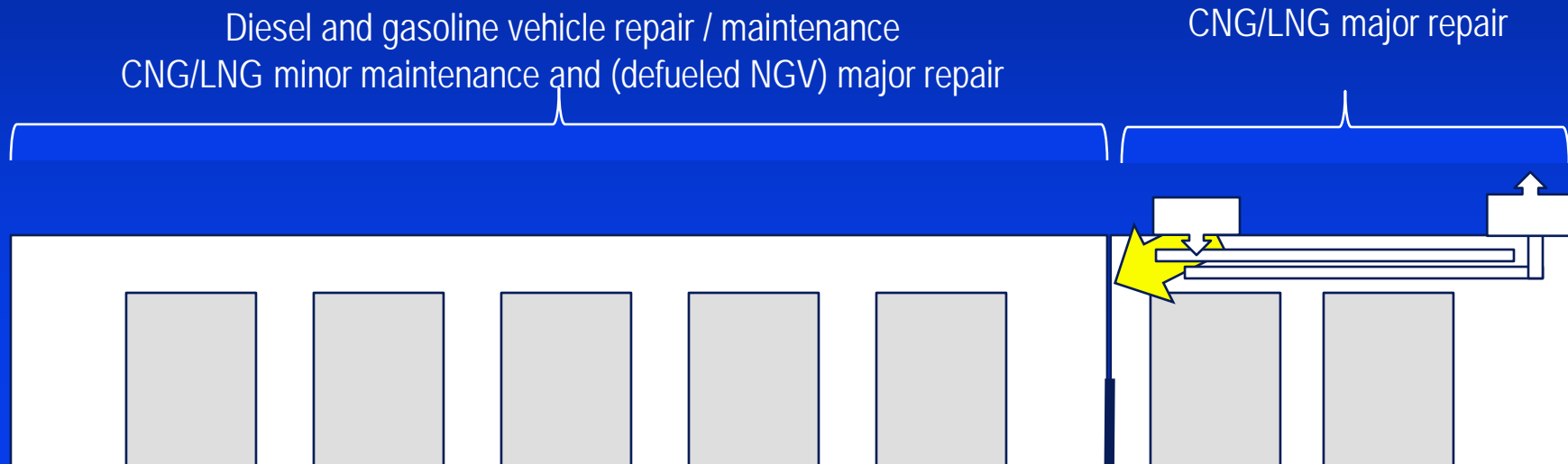
Facility Modifications to Accommodate Work on CNG/LNG Vehicles

1. Maintenance/decommissioning of fuel containers

- A. CNG cylinders have specific end-of-useful life date (see label). LNG tanks do not.
- B. NFPA 52.6.13 (2013): Written procedures should be in place for inspection and decommissioning of CNG cylinders. (Training of staff is recommended)
- C. NFPA 52.6.14 (2013): Major repair garage should install appropriate defueling apparatus (capture or direct atmospheric venting)



Shop Design/Modification Considerations



- Interior walls will have a 2-hr fire rating and be continuous from floor to ceiling
- For major repair area, at least one wall shall be an exterior wall and primary access shall be from the outside
- Interior access between minor and major repair areas shall be through self-closing fire door with AHJ approved rating
- The minor and major repair areas shall have separate ventilation systems

Summary

- Current guidance is vague; many costly “myths” about requirements prevail; confusion within design, vendor and code enforcement community
- Guidance is based on assessing risks and modifying accordingly
- Modifications only if “major repairs” are to be performed
 - If no CNG system work is to be performed, i.e., basic maintenance (e.g. brakes, etc)
 - no modifications required
 - If CNG work is to be performed, modifications may be needed
 - Consider segregating major repair and minor maintenance areas
- Key considerations in whether or not – and to what extent – to modify:
 - Ventilation levels; properly designed ventilation should eliminate “ignitable mixture”
 - Elimination of hot surfaces above 750°F (e.g. indirect heat or AHUs)
 - Modification of electric only if within 18” of ceiling if minimum ACH is not achieved
 - Methane detectors not needed for CNG; only for non-odorized gas (i.e., LNG)
 - Not necessary to install “explosion proof” switches, sockets or redo all electrical systems
- R&D underway to determine ppm levels, dispersion models, etc