Vehicle Maintenance Operations
Design Review Checklist

- NFPA 101-2015, Life Safety Code®
- NFPA 30A-2015, Code for Motor Fuel Dispensing Facilities and Repair Garages
- NFPA 70-2014, National Electrical Code, Article 511, Commercial Garages, Repair and Storage
- Unified Facilities Criteria (UFC) 3-600-01 Fire Protection Engineering for Facilities
- Unified Facilities Criteria (UFC) 4-214-02 Tactical Equipment Maintenance Facilities (TEMF), USACE, Savannah District, DA Facilities Standardization Program
- ACGIH Industrial Ventilation Manual, 27/28th Edition
- Unified Facilities Guide Specification UFGS-23 35 19.00 20, Industrial Ventilation and Exhaust, February 2010
- Unified Facilities Guide Specification UFGS 23 35 00.00 10, Overhead Vehicle Tailpipe [and Welding Fume] Exhaust Removal System(s), February 2009
- International Building, Mechanical and Fire Codes
- National Guard Design Guides, 2011

Occupancy Classification and Means of Egress

1. Is the vehicle maintenance area part of an Industrial Occupancy (NFPA 101)?
What is the occupant load for the area?

2. What is the exit capacity of each of the doors leading from the vehicle maintenance area? Does it seem reasonable?
Life Safety Code uses Number of occupants using exit ÷ 0.2 = clear width.

3. Are there at least 2 exits (NFPA 101)? Are they located within 300 ft (91 m) (400 ft (122 m) if sprinkled) (NFPA 101)?

4. Check the occupancy classification of adjacent occupancies on the life safety plans.
If a fire rated separation is required, is the vehicle maintenance area separated from adjacent occupancies by an appropriate fire barrier with fire doors and fire dampers (NFPA 101)?

Fire Protection

1. Is complete sprinkler protection provided (UFC 4-214-02/DG 415-5)?

2. Is there an automatic fire alarm and detection system (NFPA 101/UFC 4-214-02/DG 415-5)?

3. Is there a mass notification system (UFC 4-214-02/DG 415-5)?

Construction

1. Is the floor noncombustible, sloped to drains, and liquid-tight (NFPA 30A)?

2. Are maintenance and repair areas column free (UFC 4-214-02)?

3. Is a maintenance pit provided (UFC 4-214-02)?
    a. 40'L x 4'-4" D x 3'-6" W (12.2 m L x 1.22 m D x 1.07 m W)
    b. Floor grating covering opening is non-sparking, non-slip, removable?
    c. 4" (102 mm) minimum steel angle curb around pit opening?

4. Is a trench drain provided? (NFPA 30A/UFC 4-214-02/DG 415-2)
    a. Is it the length of maintenance areas? (UFC)
    b. Is it at the interior side of overhead doors at repair areas (3 ft (0.91 m) inside exterior walls)? (UFC)
    c. Is it along the centerline of the central vehicle corridor (if applicable)? (UFC)
    d. Is it 6 inches (152.4 mm) wide (minimum)? (UFC)
    e. Does it have a floor grate covering the entire length? (UFC)
    f. Can it be cleaned easily (grates removed)? (UFC)

HVAC

General

1. Designer has designed at least 3 previous systems which have worked successfully for at least 6 months (UFGS 23 35 00.00 10)?

2. Is general ventilation provided in repair and maintenance areas? (UFC 4-214-02)

3. Is the general ventilation operated continuously while the building is occupied (UFC 4-214-02)?
    a. 100% outdoor air with no recirculation in repair and maintenance bays (UFC 4-214-02)?
    b. Meets ASHRAE Standard 62.1: 1.5 cfm/ft^2 of outdoor air (UFC 4-214-02/DG 415-2/5)?
    c. Provided with 4 ACH or 1 cfm per square foot floor area (NFPA 70)?
    d. 85% efficient filter bank (DG 415-2/5)?
    e. Designed for ease of maintenance (DG 415-2/5)?

4. Is energy recovery from exhaust air provided for climate zones 3-8 (UFC 4-214-02)?

5. Do repair and maintenance area supply fans have variable frequency drives (UFC) and carbon monoxide (CO) (DG 415-5/UFC) and nitrous oxide (NOX) sensors (UFC 4-214-02)?

6. Are general exhaust grilles in maintenance areas within 12 inches (305 mm) of the floor (NFPA 70/UFC 4-214-02)? Are they located to effectively remove vapor accumulations from all parts of floor area (NFPA 30A/UFC 4-214-02)?

7. If fuel is dispensed in the area. are return air openings at least 18 inches AFF (NFPA 30A)?

8. Is heat provided for maintenance bays? ($55^oF/12.8^oC$) (UFC 4-214-02/DG 415-2)

9. Is heat provided for administrative and service areas? (UFC 4-214-02)

10. Are heat producing appliances of an approved type in maintenance/repair areas (NFPA 30A)?

11. Is ventilation separate from ancillary spaces (offices)? (DG)

Local

12. Is a local exhaust system provided (UFC 4-214-02/DG 415-2/5)?
    a. Is it designed to NFPA 30 and 30A requirements (UFC 4-214-02)?
    b. ACGIH and ASHRAE (DG 415-2/5)?

13. Are fans variable so airflow volume can be adjusted (UFGS 23 35 00.00 10)?

14. Are tailpipe adapters tapered-cone type with spring clips or other suitable devices for exhaust pipe attachment (UFGS 23 35 00.00 10)?

15. Are dampers provided at local exhaust adapters (UFGS 23 35 00.00 10)?

16. Is there a maintenance pit?
    a. Is it ventilated at least 1 cfm per square foot floor area for a minor garage and 6 ACH for a major garage (NFPA 30A)? UFC requires 1-1/2 cfm per sq. ft.
    b. Are exhausts located within 12 inches of the floor (NFPA 30A)?
    c. Exhaust operates continuously (UFC 4-214-02)
    d. No recirculation from this area (NFPA 30A)?
    e. Non-sparking, explosion-proof fan (UFC 4-214-02)?

17. **When UFC 4-214-02 criteria applies**, are local exhaust outlets designed for 1400 cfm (660 L/s) unless indicated by user (UFC)?
    a. 50% duty cycle of total available capacity of vehicle exhaust may be considered by user.
    b. Are shut-off dampers provided at each outlet (for multiple outlet systems)?
    c. Is an exhaust outlet provided for at least each pair of maintenance bays? (UFC)
    d. Does the local exhaust system operate continuously while the building is occupied? (UFC)
    e. If tracked vehicles are serviced, are two exhaust outlets at 1400 cfm (660 L/S) provided? (UFC)
    f. Is the AGT 1500 Gas Turbine being services? What are the provisions for servicing this engine? (UFC)
    g. Does make-up air compensate for the vehicle exhaust system? Are the repair and maintenance areas under negative pressure wrt the core/administrative areas (UFC 4-214-02)?
    h. Is the hose designed to withstand 700^{o}F (371^{o}C) temperatures? As high as 1250^{o}F (677^{o}C) may be required for tracked vehicles? (UFC 4-214-02)

18. **When DG 415 criteria applies**, are exhaust outlets designed for 1700 cfm per drop with all drops open (DG 415-2)?

19. **When neither the UFC or NGB DG criteria apply**, does exhaust air volume meet the following if the UFC or NGB DG criteria does not apply? (SEE NOTE BELOW):

- Method 1 (UFGS 23 35 19.00 20):

Engine Type	HP	CFM / Meter/sec
Maintenance-Gasoline	229	150 / 0.07
	350	200 / 0.094
	500	400 / 0.189
Is Maintenance-Diesel	300	400 / 0.189
	500	600 / 0.283
	700	1000 / 0.472
TC Diesel	500	1400 / 0.66

- Method 2:
  - $Qe=(1.2)(D_{eng}xNx0.5)(1ft^3/1728\ in^3)[(460\ F + Teng)/530\ F]$
  - where, Qe = Exhaust Flow (acfm)
  - Teng = Engine Tailpipe Temperature (F); use 500^oF if unknown
  - Deng = Engine Displacement (ft3)
  - N = engine revolutions per minute; use 1000 rpm if unknown
  - If volumetric efficiency, VE, is known, multiply it by Qe for accuracy
  - For a 2-cycle engine multiply the Qe by 2

- Carmon Estimate for TC diesel engines (4 cycle):
  - Idle running only – Q = CID x 0.6
  - No-load testing to 2100 rpm – Q = CID x 1.5
  - Partial Load Hydraulic Testing – Q = CID x 2.05
  - Full Load Dynamometer Testing – Q = CID x 4.15
  - Multiply Q by 2 for 2 cycle engines

- *NOTE: Systems having more than four branches provided with shutoff dampers shall have a fan capacity equal to four branches plus 50 percent of the capacity of the number of branches over four (UFGS 23 35 00.00 10).*

ACGIH Industrial Ventilation Manual Design Requirements

20. Is the duct velocity 2000 fpm (10.2 m/s) or less in the main duct (IV Manual)?

21. Is the duct velocity 3500-4500 fpm (15-17.8 m/s) in the hose (IV Manual)?

22. Are the hoses 10-12 feet (3.1-3.7 m) from the floor (IV Manual)?

23. Is the stack height at least 5 feet (1.5 m) (IV Manual)?

24. Is the stack velocity 3000 fpm (15.2 m/s) (IV Manual)?

Plumbing

1. Are floor drains discharged to the sewer through an oil/water separator OR to an outside vented sump (NFPA 30A, UFC 4-214-02, DG 415-2/5)?

2. Are trench drains provided basket strainers (trash removal) where discharging to piping systems (UFC 4-214-02)?

3. Is compressed air provided (DG 415-2, UFC) Does it have quick disconnect couplings in maintenance and repair areas and along vehicle corridor (UFC 4-214-02)?
    a. Are 2 outlets 3 inches above the floor provided for each part of repair areas (UFC 4-214-02)? Not required for NGB.
    b. 10 CFM (4.72 L/s) per outlet in repair and maintenance areas (UFC 4-214-02)? (60% diversity permitted).

4. If a maintenance pit is provided is the sump pump (UFC 4-214-02)?
    a. Explosion-proof if required?
    b. Submersible?
    c. Capable of handling small amounts of oil and anti-freeze?
    d. Equipped with compressed air outlets at 2 places?

5. Is an emergency shower/eyewash permanently installed at each maintenance circulation bay adjacent to a core area and in other bays as required OR where an area is subject to CO contamination (UFC 4-214-02, DG 415-2/5)?
    a. Installed IAW OSHA Standard 1910.151(c) and ANSI Z358.1?
    b. Provided with an audible alarm that is activated when operated and located so that action can be initiated by staff (DG 415-5/2)?
    c. Tempered water provided 60-100^{o}F (DG 415-5)?
    d. Located in an area identified with a highly visible sign (DG 415-2)?
    e. In a well lit area (DG 415-2)?
    f. Located with easy access (no obstructions, approximately 55 feet or less, on same level as hazard, close to areas with strong caustic or acids) (DG 415-2)?
    g. Flushing nozzles 33-45 inches from floor and 6 inches from wall or nearest obstruction (DG 415-2)
    h. Connected to a supply of flushing fluid capable of delivering a minimum of 0.4 gpm for 15 minutes (DG 415-2)?
        i. Protected from freezing?
        ii. Protected from unauthorized shutoff?

Electrical

1. Is 1 duplex outlet per 10 linear feet of wall provided (DG 415-1)?

2. Is a generator provided for readiness centers, AASFs, Barracks, Dining Facilities, and USPFO/Warehouse (DG 415-5)?
    a. Are emergency power receptacles red in color (DG 415-5)?

3. Are hazardous locations clearly indicated on the drawings (UFC 4-214-02)?

4. Where Class I liquids are dispensed, handled or stored is electrical wiring and utilization equipment designed for Class 1, Division 1 or Division 2 locations (NFPA 30A)?

5. Are lighting and power supply systems explosion-proof for classified locations? (DG 415-2, NFPA 30A)

6. Grounding:
    a. Are ground straps provided on wall and grounding points in floor at repair and maintenance areas (UFC 4-214-02)?
    b. Is wiring and equipment in Class 1, Division 1 and 2 locations grounded (NFPA 30A)?

7. Lightning: Is lightning protection provided to meet NFPA 780 and NFPA 70 (DG 415-5, UFC)?

8. Maintenance Pits: Is ventilation provided at the floor and ceiling levels and in maintenance pits (major repair garages) (NFPA 30A)?
   Does it meet 1 cfm/ft^2 of floor or ceiling area (NFPA 30A)?
    a. In major repair garages if no ventilation is provided is the floor classified as Class 1 Division 2 up to 18 inches (457 mm) above the floor (NFPA 70)?
    b. In major repair garages if no ventilation is provided (ceiling level) is the ceiling classified as Class 1 Division 2 (NFPA 70)?
    c. In major repair garages if there is a pit with no ventilation, is the pit classified as Class I Division 2 (NFPA 70)?

9. Adjacent Areas: Are areas adjacent to classified locations in which flammable vapors are not likely to be released not classified where mechanically ventilated at a rate of 4 ACH, or designed with positive air pressure, or where effectively cut off by walls or partitions (NFPA 30A)?

Lighting

10. Is emergency lighting provided (NFPA 101)?

11. Is general lighting provided (UFC 4-214-02)?
    a. 50 fc (538 lux) for repair and maintenance areas (DG 415-2, UFC)?
    b. 15 fc (161 lux) for maintenance pits with task illumination by at least 4 pit-mounted lights suitable for electrical hazard classification of pit (UFC)?

12. Are exit signs provided and continuously illuminated (NFPA 101)?