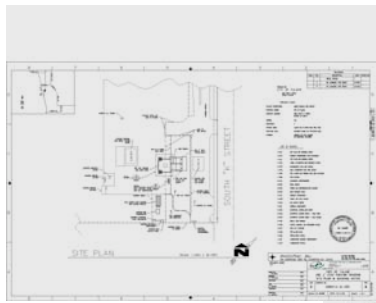




Leading the World to Better Performance



Steps to Building an LNG / LCNG Fuel Station

Prepared for

Southern California Alternative Fuel
Vehicle Expo and Natural Gas
Infrastructure Workshop
Ontario, CA

December 4, 2002

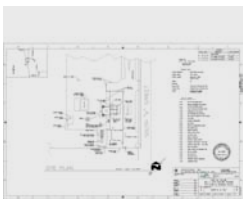
by

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The Steps

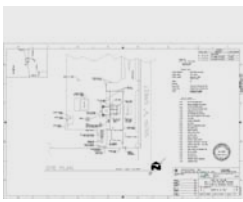
1. Funding/Grant Applications
2. Define Fleet and Its Fueling Requirements
3. Define Station Location
4. Define Existing Site Conditions
5. Permitting
6. Bid Process
7. Construction Process





1. Funding / Grant Applications

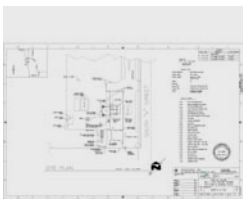
- Most grants have time limits and restrictions
- Apply early for grants
- Seek help from 3rd party firms
 - Gladstein & Associates
 - ENRG
 - USAPRO and Associates





2. Define Your Fleet and Its Fueling Requirements

- Define fuel needs (LNG, CNG, Propane, ..)
- Define daily fuel consumption and growth projections
- Define redundancy requirements
 - Can I afford downtime during repairs/maintenance?
 - How many days of fuel storage is acceptable?
 - Must the station function during power outages?





2. Define Your Fleet and Its Fueling Requirements (cont)

- Define LNG Storage Requirements

- Standard LNG storage vessel sizes:

- 15,000, 20,000, 30,000 gallons

- Horizontal or Vertical

- 10ft or 12ft diameters

- 15,000 gallon storage is minimum recommended

- full load is 9,500 gallons



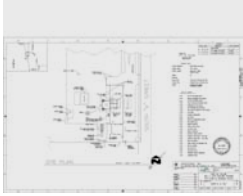
15,000 gallon vertical



20,000 gallon horizontal



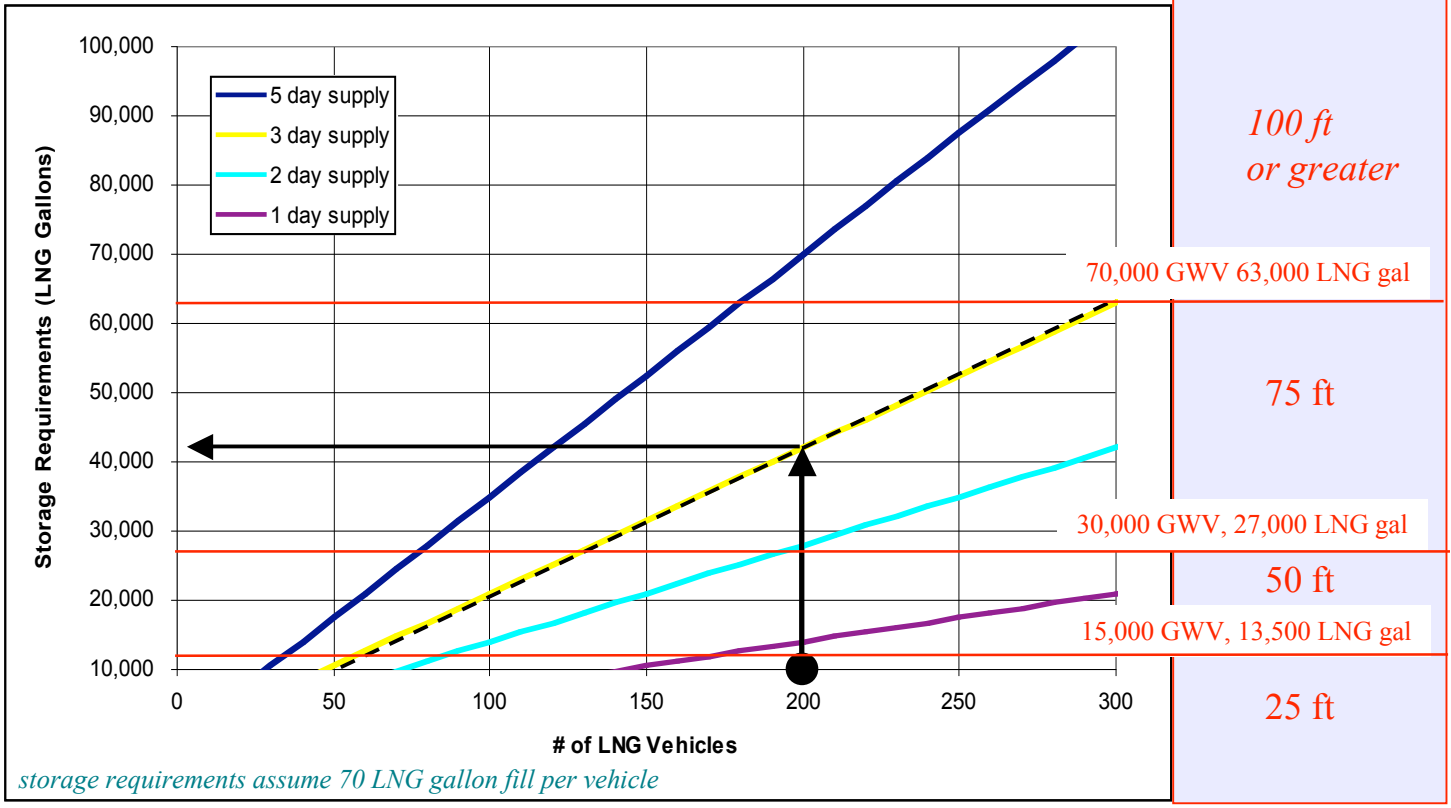
30,000 gallon horizontal





2. Define Your Fleet and Its Fueling Requirements (cont)

Define LNG Storage Requirements (cont.)



Example: 3 day supply & 200 vehicles = 42,000 gallons
Choices: 2 ea 20,000 gallon or 3 ea 15,000 gallon vessels

Required Set Backs = required building and properly line setbacks per NFPA 57 are based on gross water volume (GWV)



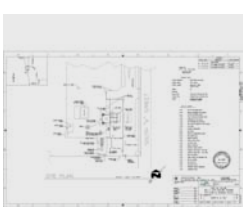


2. Define Your Fleet and Its Fueling Requirements (cont)

- Define acceptable fueling window
 - LNG Dispensing
 - Typical dispensing rates: 30-50 LNG gpm
 - Typical 70 gallon fill takes 5-6 minutes with staging
 - LCNG Dispensing
 - Dispensing rates highly dependent on LCNG pump
 - Options 4, 8, 12, 16, 20 LNG gpm (and higher)
 - CNG Dispensing (compressor station)
 - Slow or fast fill
 - Dispensing rates highly dependent on compressor size

Conversions

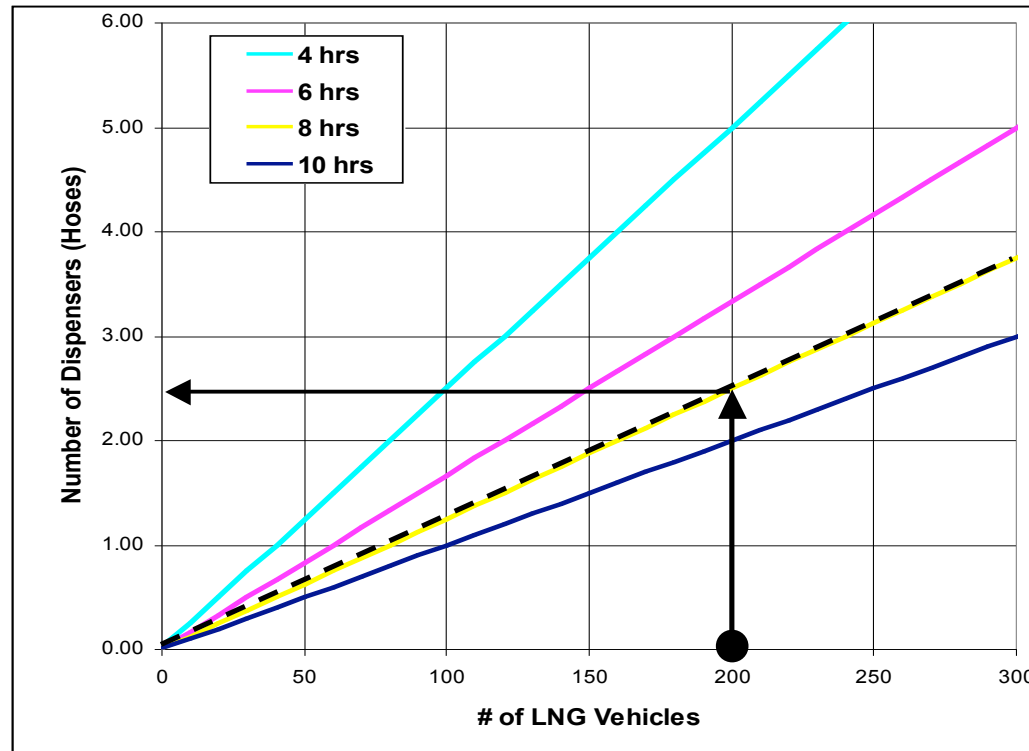
- 1.6 LNG gallons = 1 gasoline gallon equivalent
- 1.7 LNG gallons = 1 diesel gallon equivalent
- 1 LNG gallon = 85 SCF CNG





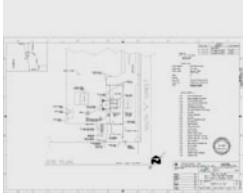
2. Define Your Fleet and Its Fueling Requirements (cont)

- Determine how many dispensers are required



Example: 8 hour fuel window & 200 vehicles = 3 LNG hoses

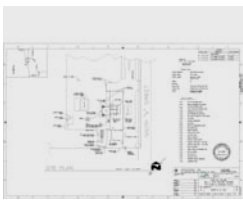
Assumes: 6 minutes per vehicle including staging time





3. Defining LNG/LCNG Fuel Station Layout

- Define Traffic Flow Patterns
 - LNG delivery tractor/trailer
 - Which side is vehicle's fuel receptacle?
 - Vehicle traffic flow; vehicle staging
 - Security gates
 - Fuel management system
 - Wash and vacuum systems





3. Defining LNG/LCNG Fuel Station Layout (cont)

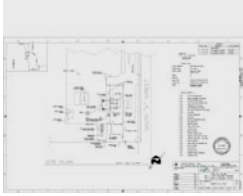
Define LNG storage and containment footprints and setbacks

| Number and Size of LNG Vessels | Vertical Footprint | Horizontal Vessel Footprint | Setbacks |
|--------------------------------|--------------------|-----------------------------|----------|
| 1 x 15,000 gal (10' dia) | 30 ft x 32 ft | 18 ft x 55 ft | 50 ft |
| 2 x 15,000 gal | 30 ft x 50 ft | 33 ft x 55 ft | 75 ft |
| 3 x 15,000 gal | 30 ft x 65 ft | 48 ft x 55 ft | 75 ft |
| 1 x 20,000 gal (10' diam) | NR (siesmic) | 18 ft x 70 ft | 50 ft |
| 2 x 20,000 gal | NR (siesmic) | 33 ft x 70 ft | 75 ft |
| 3 x 20,000 gal | NR (siesmic) | 48 ft x 70 ft | 75 ft |
| 1 x 20,000 gal (12' diam) | 32 ft x 32 ft | 20 ft x 47 ft | 50 ft |
| 2 x 20,000 gal | 32 ft x 50 ft | 37 ft x 47 ft | 75 ft |
| 3 x 20,000 gal | 32 ft x 65 ft | 54 ft x 47 ft | 75 ft |
| 1 x 30,000 gal (12' diam) | NR (siesmic) | 29 ft x 70 ft | 75 ft |
| 2 x 30,000 gal | NR (siesmic) | 37 ft x 70 ft | 75 ft |
| 3 x 30,000 gal | NR (siesmic) | 54 ft x 70 ft | 100 ft |

NR = not recommended due to seismic zone and 60ft vessel height

All footprint values are typical, actual footprints depend of foundation design and site geotechnical conditions

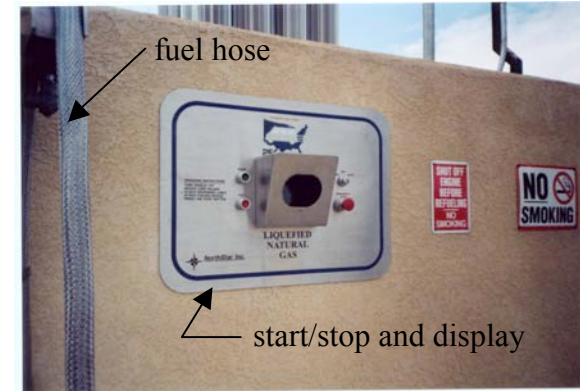
Setbacks are minimum required distance from edge of containment to buildings and property lines



3. Defining LNG/LCNG Fuel Station Layout (cont)

Dispenser Options

- Wall mounted LNG dispensers (single hose)
 - Integral to LNG containment wall - saves space
 - Most cost effective
 - Single side fueling only
- Island mounted LNG dispensers (single or dual hose)
 - Looks like typical gas station
 - Fueling from both sides
 - Adds cost
 - Preferred method is to install piping in concrete lined trench



wall mounted dispenser



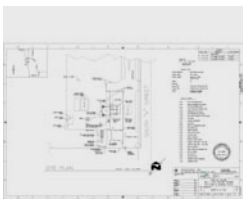
dual hose island mounted dispenser





3. Defining LNG/LCNG Fuel Station Layout (cont)

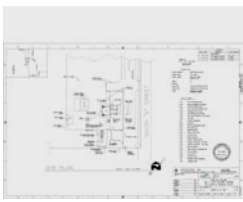
- Methods to reduce setbacks
 - The 50ft-100ft+ code required setbacks from property line and buildings may be reduced under special circumstances
 - Requires site specific engineering and hazard analysis and greatly increases capital costs
 - Reduced building setbacks may require:
 - Fire rated barrier/wall
 - Special electrical classification inside building
 - Positive building ventilation
 - Building power shunt trips if gas leak/flames detected
 - Reduced properly line setback may require:
 - Fire rated barrier/wall
 - High expansion foam fire suppression system
 - Vaulted or buried LNG storage system
 - May require shunt trips if gas leak/flames detected





4. Defining Existing Site Conditions

- Phone
 - Determine if existing phone service can support station
 - 2-3 phone dedicated lines for required communications: (alarm callout, fire reporting, maintenance callout & fuel management systems)
- Power
 - Determine if existing MCC can support additional station loads or if a new electrical service is required.
 - New service can add \$25K - \$100K+ cost to station.
 - Determine if emergency generator is required.
 - Generator adds \$30K - \$100K+ cost to station
 - Need to determine what facilities in addition to the LNG fuel station requires backup power (facility lights, security gates, FMS, ... etc.)
 - May not require 100% emergency generator
 - Consider backup of buildings/operations in addition to the LNG fuel station as incremental costs are low.
 - Prime power generators required additional permitting





4. Defining Existing Site Conditions (cont)

- Power (cont)

| LNG Station Power Requirements (Typical) | 480VAC 3ph service required (AMPS) |
|---|------------------------------------|
| <p><u>Small LNG Station</u> (1 LNG hose)</p> <ul style="list-style-type: none">• 1 each dual purpose LNG offload and dispenser pump – 25 hp• 1 each wall mounted LNG dispenser, (40 gpm)• 1 each fan assisted saturation vaporizer – 5 hp• Controls and lights | 100A (Max load = 77A) |
| <p><u>Medium LNG Station</u> (2 LNG hoses)</p> <ul style="list-style-type: none">• 1 each dedicated offload pump – 25 hp• 2 each LNG dispenser pump – 25 hp each• 2 each LNG dispenser hoses, (40 gpm)• 1 each fan assisted saturation vaporizer – 5 hp• Controls and lights | 200A (Max load = 140A) |
| <p><u>Large LNG Station</u> (3-4 LNG hoses)</p> <ul style="list-style-type: none">• 2 each dedicated offload pump - 25 hp each• 3 each LNG dispenser pump- 25 hp each• 3-4 each LNG dispenser, (40 gpm)• 1 each fan assisted saturation vaporizer – 5 hp• Controls and lights | 250A (Max load = 170A) |

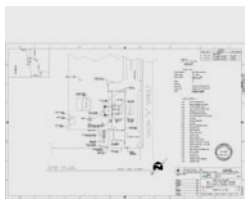




4. Defining Existing Site Conditions (cont)

- Power (cont)

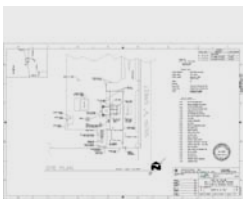
| LCNG Station Power Requirements (Typical) | 480VAC 3ph service required (AMPS) |
|---|------------------------------------|
| <p><u>Small LCNG Station</u> (Single Dispenser)</p> <ul style="list-style-type: none">• 1 each dual purpose LNG offload and boost pump – 25 hp• 1 each 4 gpm LCNG pump – 30 hp• Controls and lights | 200A (Max load = 120A) |
| <p><u>Medium LCNG Station</u> (two transit dispenser)</p> <ul style="list-style-type: none">• 1 each dedicated offload pump – 25 hp• 2 each LNG boost pumps (one spare) - 25 hp each• 2 each 16 gpm LCNG pumps – 60 hp each• 1 each fan assisted vaporizer – 7.5 hp each• Controls and lights | 300A (Max load = 210A) |
| <p><u>Large LCNG Station</u> (two high flow transit dispensers – 100 CNG busses in < 5 hrs)</p> <ul style="list-style-type: none">• 1 each dedicated offload pump – 25 hp• 2 each LNG boost pumps (one spare) – 25 hp each• 2 each 20 gpm LCNG pumps – 100 hp each• 2 each fan assisted vaporizers – 10 hp each• Controls and lights | 600A (Max load = 400A) |





4. Defining Existing Site Conditions (cont)

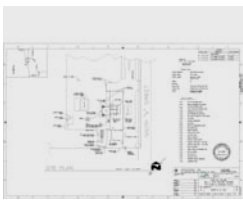
- Geotechnical
 - 1500 to 2000 psf bearing typical for LNG tank foundations
 - Liquefaction potential
 - Existing landfill, un-compacted fills, and poor soil conditions may make vertical tank configurations costly.
 - **Recommend obtaining geotechnical study prior to RFP.**
- Height Restrictions and other local ordinances
 - Vertical LNG vessel heights range from 30 – 45 ft
 - Local ordinance/planning commissions may have height restriction that would dictate horizontal tanks.
 - **Determine zone restrictions prior to RFP.**





5. Permitting

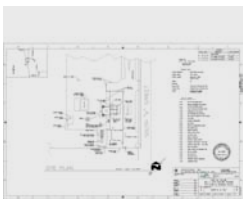
- **Planning commission**
 - Landscaping requirements
 - May prohibit vertical tank installation
- **Local city / county ordinance**
 - May have limits to storage volumes
 - May prohibit vertical tank installation
- **AHJ (authority having jurisdiction)**
 - Typically local fire department
- **Title 8**
 - Revisions to current Title 8 pending approval





6. Bid Process

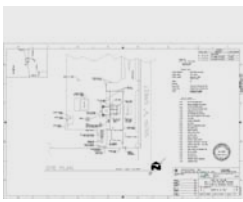
- GOAL: receive competitive & comparable bids
- License Requirements:
 - California Class A Contractors License
 - Civil, Mechanical, Electrical California Registered Professional Engineers
 - Title 8: minimum experience requirements for Engineers
- As a minimum, in the RFP:
 - Define existing and projected fleets
 - Define desired station location and general traffic patterns
 - Define redundancy requirements (backup generator, spare pumps, storage)
 - Define fuel window (# of dispensers, flow rates)
 - Define soil conditions
 - Define location for electrical tie-in (existing MCC or new service)





6. Bid Process (cont)

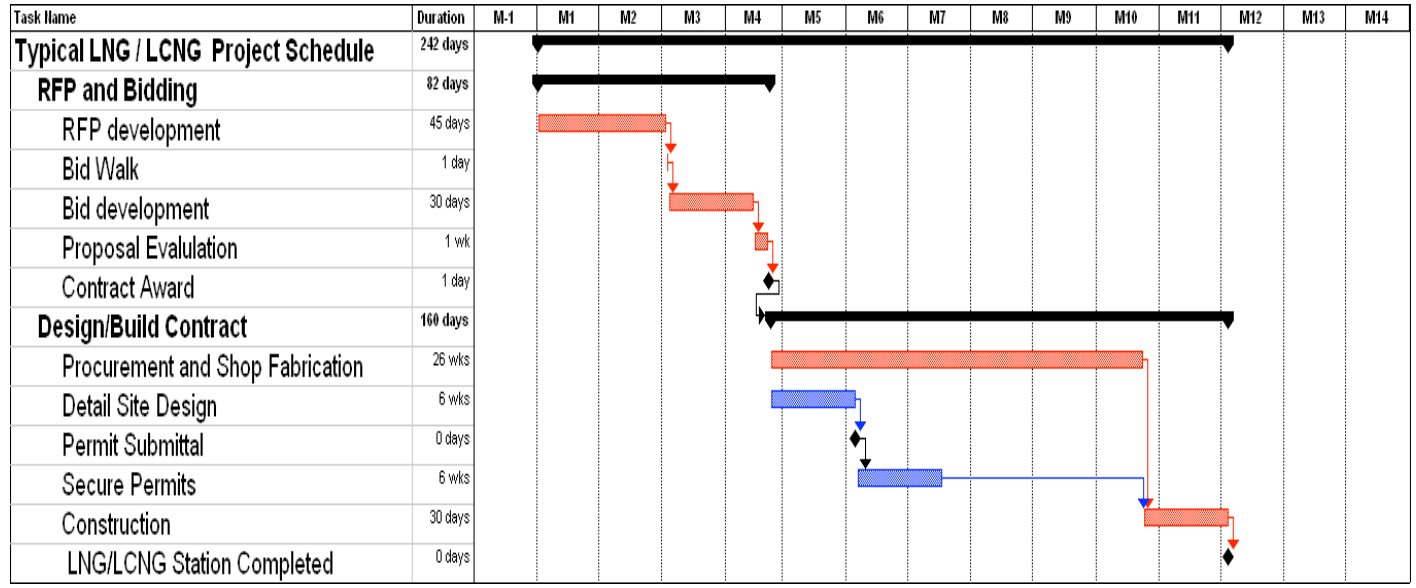
- RFP pitfalls to avoid:
 - “Detailed system design” and detailed “performance specifications” (choose one, not both)
 - Is the design firm or the contractor responsible for station performance?
 - Under estimating project costs.
 - Re-bids are costly to owners and contractors.
 - Additional grant money may not be available
 - Over-estimating or under estimating fleet demands
 - Oversized system results in inefficient pump utilization
 - Undersized station will result in maintenance issues





7. Construction Process

- Design/Build Schedule



Steps to Building an LNG / LCNG Fuel Station



Questions? Thank You

For Additional Information, please contact:

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