US NATURAL GAS M&R: AN OVERVIEW

A Discussion of Historical and Present Day Natural Gas, Gas Storage and LNG in US.

Overview of Design of 21st Century M&R Facilities in US

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AGENDA

1. US HISTORICAL OVERVIEW OF NATURAL GAS, GAS STORAGE AND LNG DEVELOPMENT
2. DESIGN OF RESULTING M&R FACILITIES
3. CONTACT INFORMATION

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US HISTORICAL OVERVIEW:
NATURAL GAS AND LNG DEVELOPMENT

SOME GAS HISTORY 1850- PRESENT

- 500 BTU/CF Manufactured Coal Gas was being Utilized in Europe and especially UK in the early to mid-1800's
- Manufactured Coal Gas was being Utilized in Major US Cities by the Civil War as Numerous Municipal Gas Lighting and then Heavy Industrial Applications.
- Natural Gas Transmission arrived in NE in the early 1950's.
- Complete Appliance Conversion was Required because of the new 1000 BTU/CF Fuel.
- 1960's Propane Air was quickly identified as a peak shaving Fuel.
- 1960/70's LNG and NY/PA Midstream Gas Storage was Developed in Parallel.
- 1999-LNG Import peaked at 800 BCF/Y
- 21st Century Fracking Technology Shale Plays Make Import LNG unattractive
- Current Abundant Supply of Natural Gas lowers prices and creates Commodity Market

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SOME REGULATORY MILESTONES

- Natural Gas Act 1938: First Federal Regulation in Gas Industry. Rates, Section 7 Permits Public Convenience, and Section 3 Permits for Import and Export.
- 49 CFR 192: Minimum Safety Standards for Gas Distribution and Transmission established as Federal law in 1970.
- 49CFR 193: Minimum Federal Safety Standards for LNG Established as Federal Law in 1978.
- FERC Order 636 Unbundling and Open Access in 1992.
- Energy Policy Act 2005.
- Export Terminals begin receiving approvals 2014

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US GAS SUPPLY SUMMARY

1. The US uses approximately 100 Quadrillion BTU/Year of Energy
2. A Quadrillion BTUs is approximately equal to 1 TCF of Natural Gas
3. Natural Gas US use is 24 TCF/Y Use AVERAGE 66 BCF/DAY
4. 24 TCF/Y is approximately 24 Quadrillion BTU/Y
5. By Comparison The US oil market is 40 Quadrillion BTU/Year
6. Natural Gas Peak day in US is 132 BCFD
7. 20TCF of Natural Gas is produced domestically Increasing
8. 3 TCF of Natural Gas Imported from Canada and declining.
9. .1TCF/Y imported LNG declining.
10. Approximately 100 Utility LNG Facilities avoiding Peaks.
11. 8 Marine Import Terminal in the US.
12. Numerous LNG Export Facilities in Application PHASE
13. Approximately 100 BCF of LNG Storage in US.
14. 37 LNG Facilities located in Northeast.
15. Approximately 4 TCF of Underground Storage in US.
16. Approximately 400 gas storage fields in US.
17. Gas costs $3.00 per MMBTU diesel at $27/MMBTU
18. The Next New thing is LNG Source sites for Domestic use and export.

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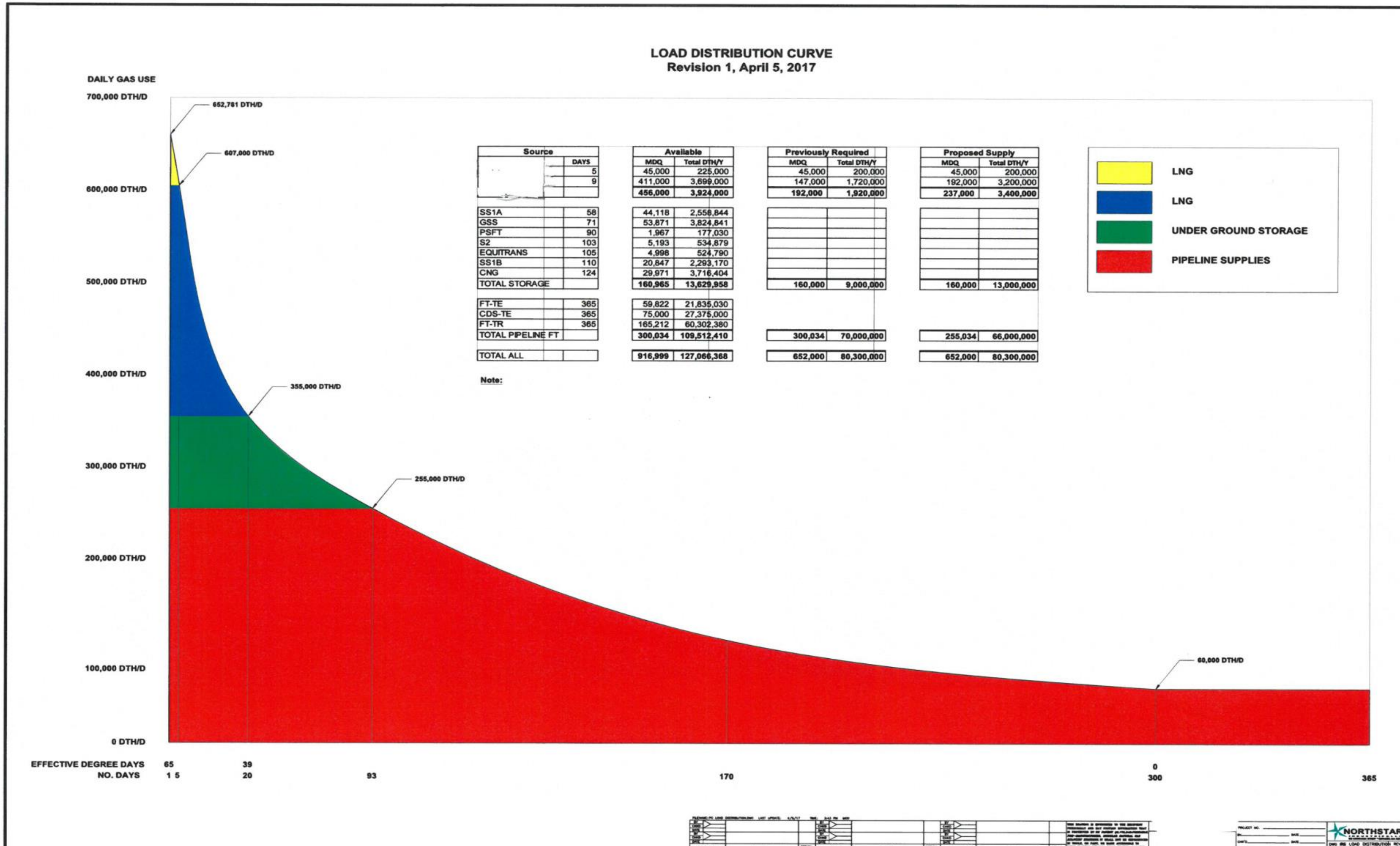
ANNUAL LOAD DURATION CURVE FOR CAPACITY PLANNING

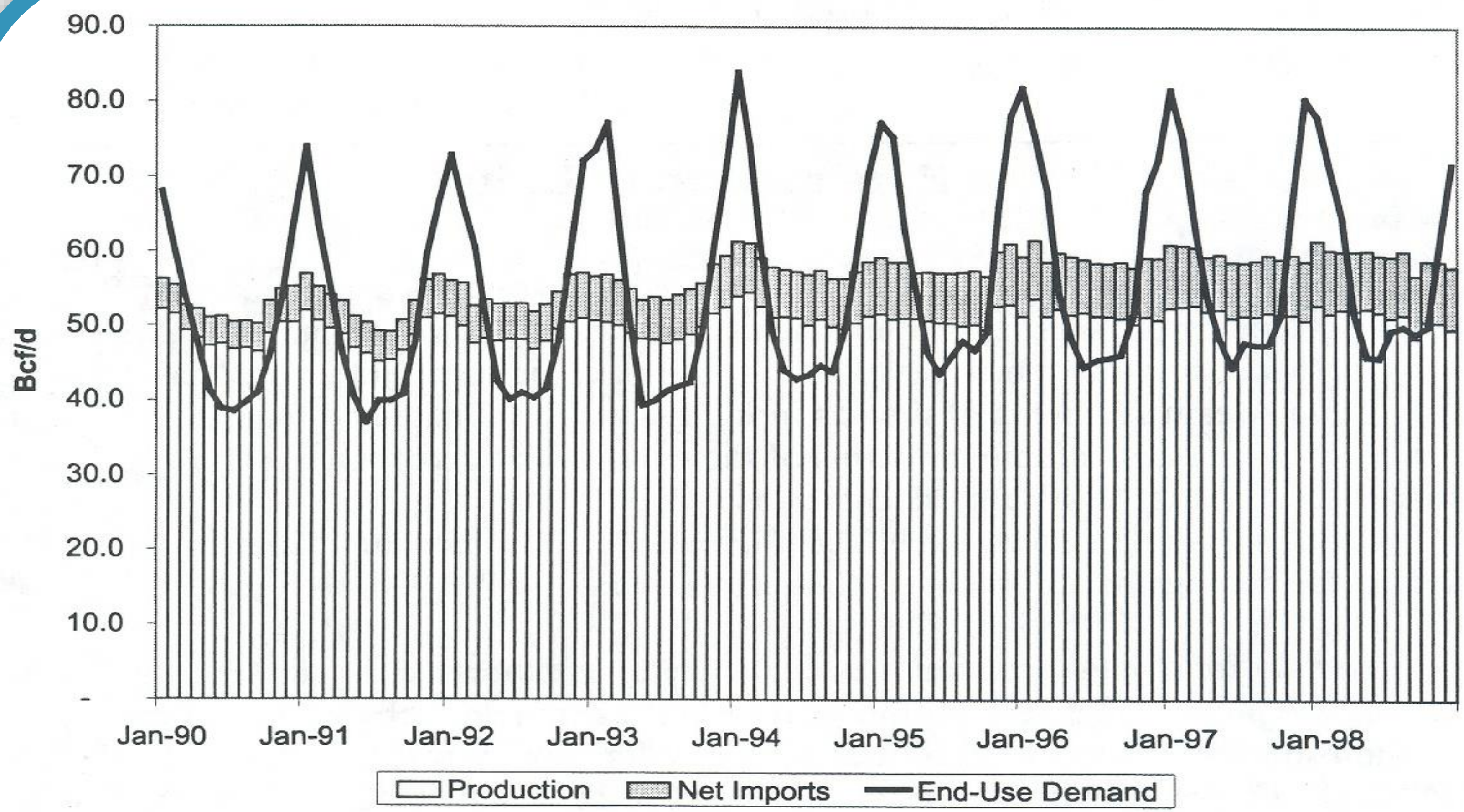
100,000 MCF PER DAY CAPACITY COSTS $36-72MM PER YEAR



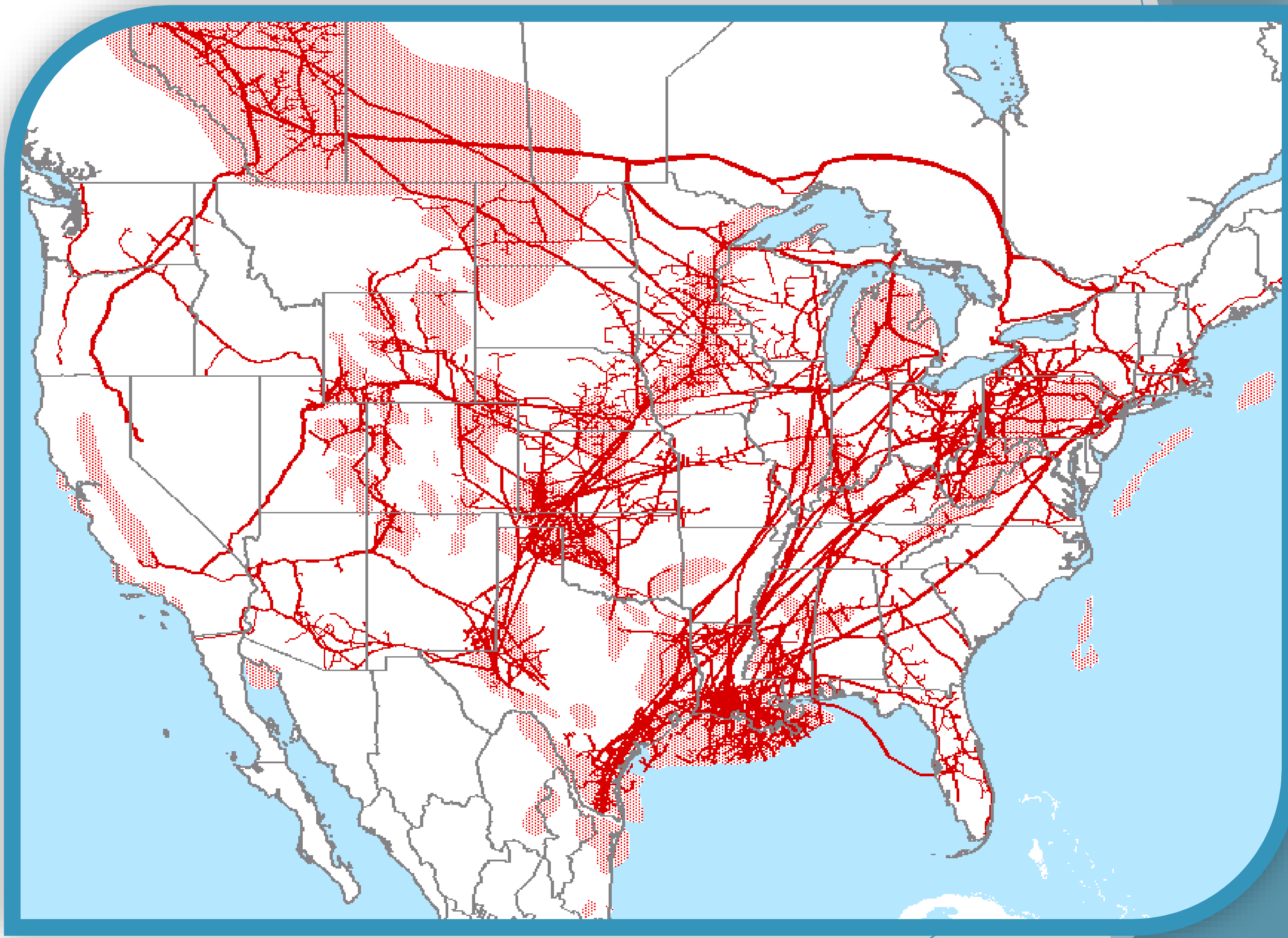
Source	DAYS	Available MDQ	Available Total DTH/Y	Previously Required MDQ	Previously Required Total DTH/Y	Proposed Supply MDQ	Proposed Supply Total DTH/Y
	5	45,000	225,000	45,000	200,000	45,000	200,000
	9	411,000	3,699,000	147,000	1,720,000	192,000	3,200,000
		456,000	3,924,000	192,000	1,920,000	237,000	3,400,000
SS1A	58	44,118	2,558,844				
GSS	71	53,871	3,824,841				
PSFT	90	1,967	177,030				
S2	103	5,193	534,879				
EQUITRANS	105	4,998	524,790				
SS1B	110	20,847	2,293,170				
CNG	124	29,971	3,716,404				
TOTAL STORAGE		160,965	13,629,958	160,000	9,000,000	160,000	13,000,000
FT-TE	365	59,822	21,835,030				
CDS-TE	365	75,000	27,375,000				
FT-TR	365	165,212	60,302,380				
TOTAL PIPELINE FT		300,034	109,512,410	300,034	70,000,000	255,034	66,000,000
TOTAL ALL		916,999	127,066,368	652,000	80,300,000	652,000	80,300,000

US GAS SUPPLY AND DEMAND CURVES

PEAK NG Daily Use in US is 130 BCFD
Peak NG Production is 70 BCFD.
How is this possible?: Pipelines, Geological Storage, LNG



US & CANADA:
MAJOR PIPELINE AND GAS PRODUCTION AREAS



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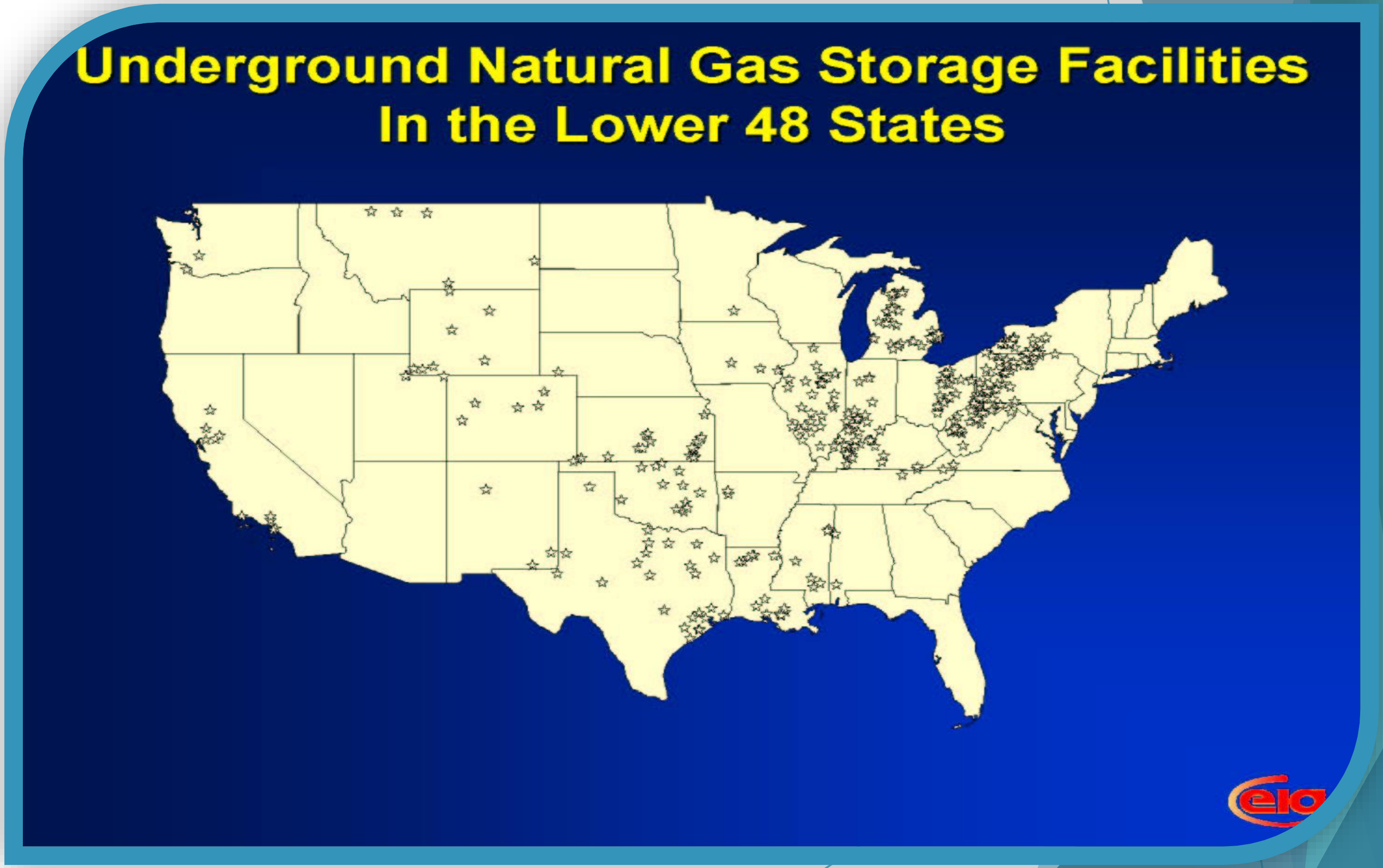
US GAS STORAGE FIELDS:

1. Approximately 400 Storage Fields in US with 3.5 TCF of working Gas:
   1. Aquifers: 10%
   2. Depleted Gas/Oil Reservoir 86%
   3. Cavern within Salt Dome 4%
2. Supply Source: Interstate or Intrastate Pipelines



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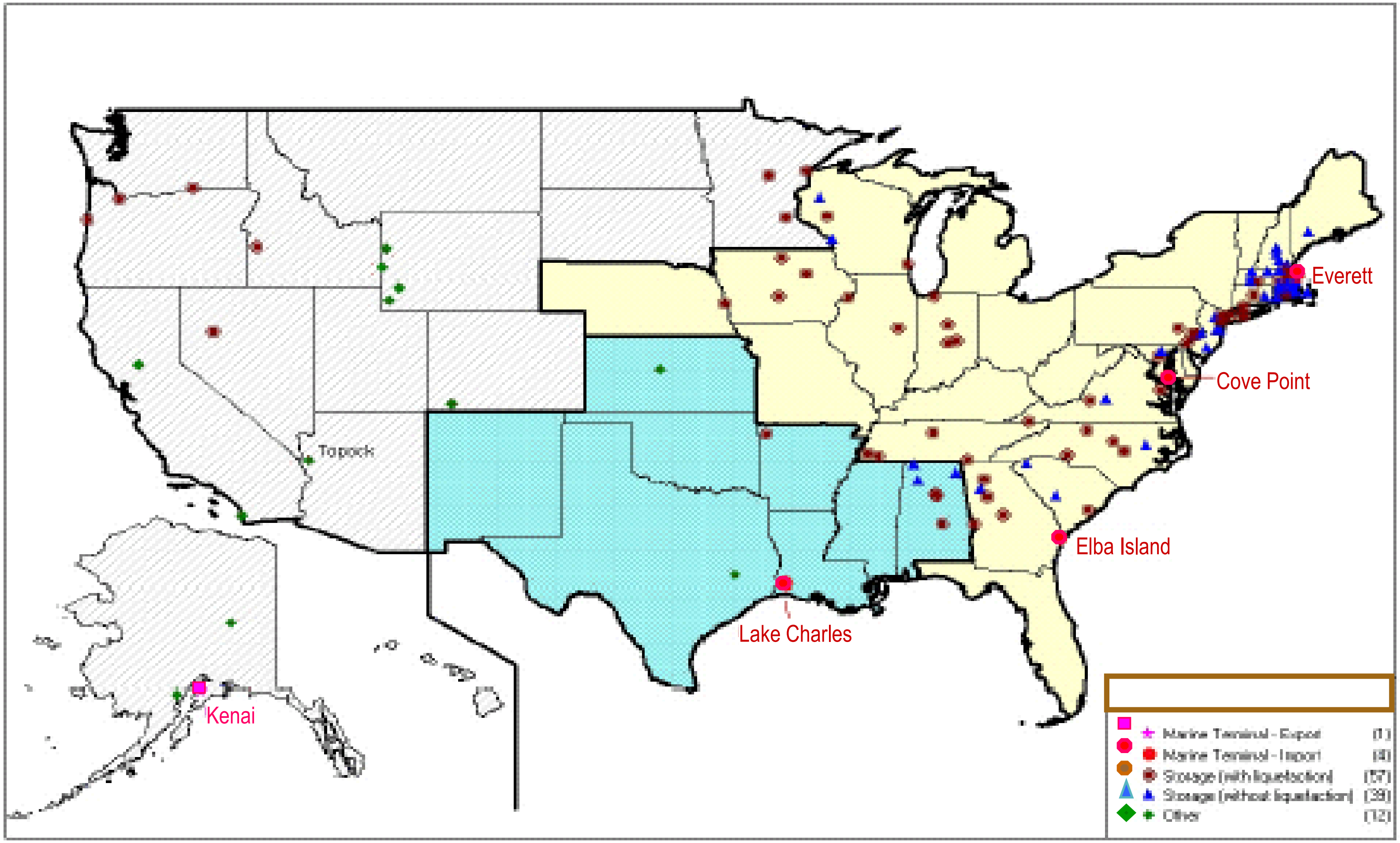
US LNG FACILITIES

(September 2002)



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3.5 TCF WORKING GAS
US GEOLOGICAL GAS STORAGE

Gas Storage Field

20 BCF working gas/20 BCF pad gas:

Header, production wells, observation wells, dehydration, scada, compression, flow control, metering and regulation

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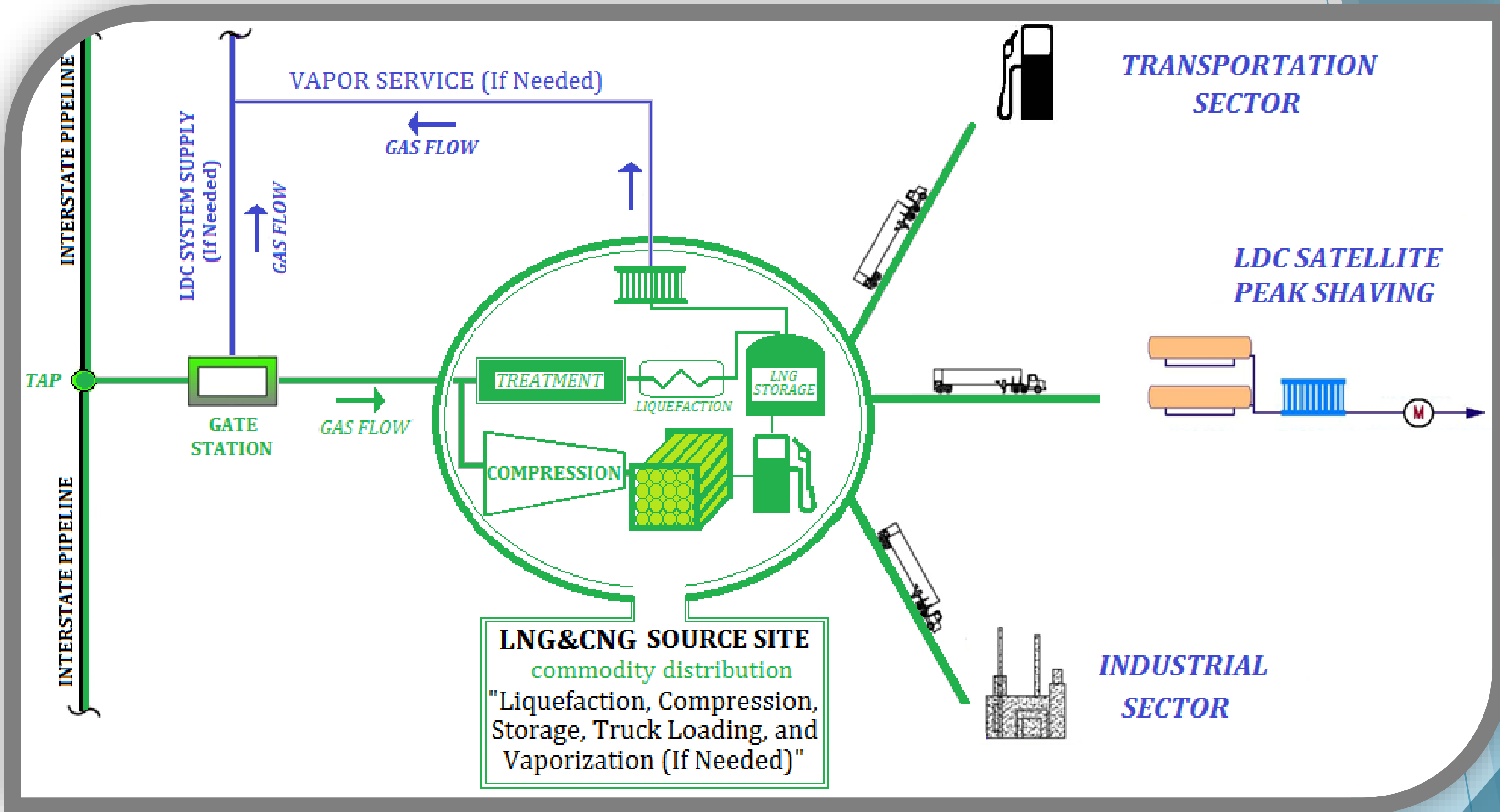
SAMSON/NORTHSTAR LNG & CNG MODEL



Samson ENERGY

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TYPES OF LNG FACILITIES

Marine Terminals

- Ship loading/unloading
- On-site storage
- Liquefaction or vaporization
- Truck loading

Peak Shaving

- Liquefaction or truck unloading
- On-site storage
- Vaporization
- Truck loading

Base-load

- Liquefaction or truck unloading
- On-site storage
- Vaporization
- Truck loading

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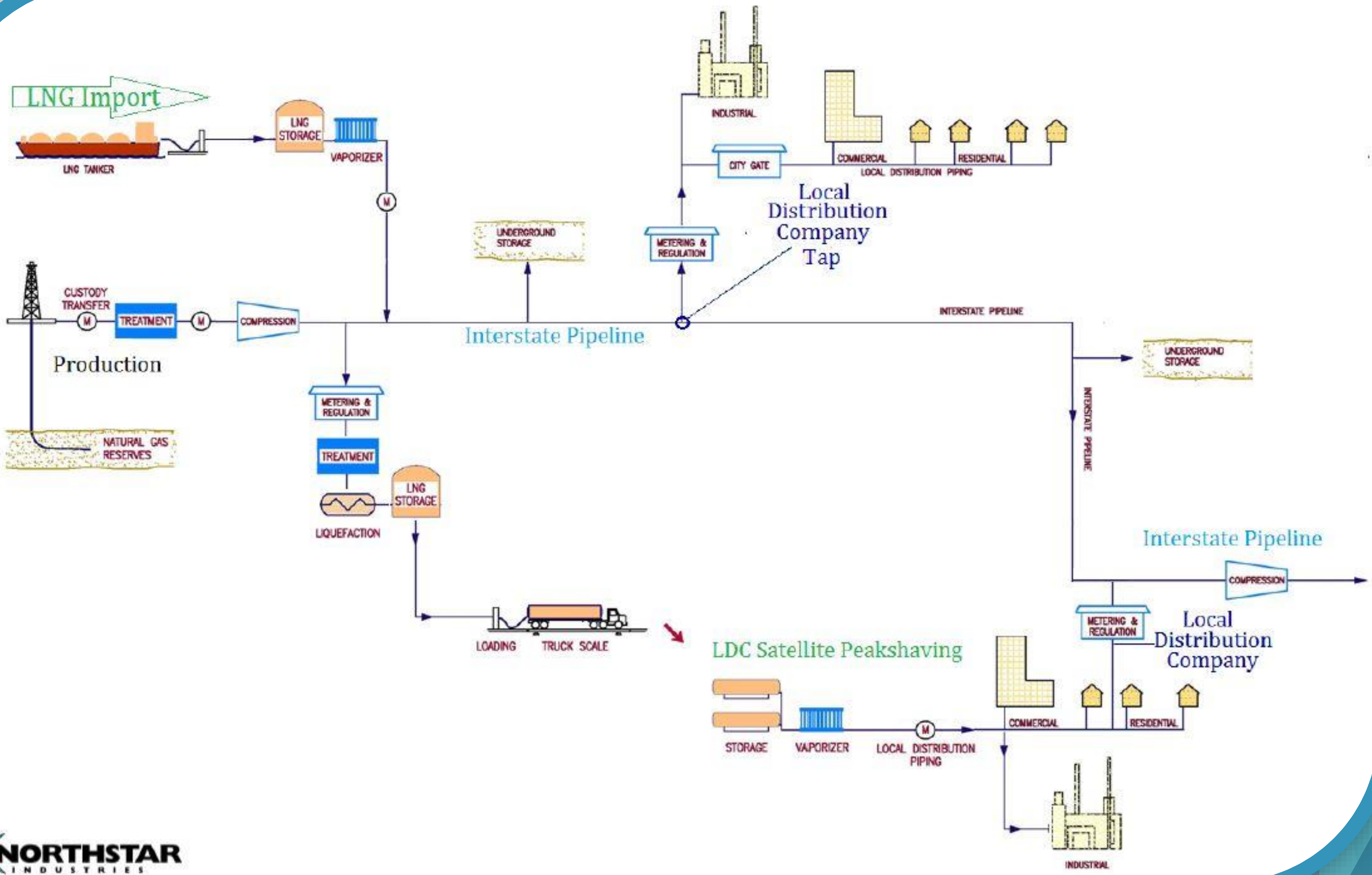
NATURAL GAS SUPPLY CHAIN



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TYPES OF INTERCONNECTS IN 2017 AND DEFINING THE INTERCONNECT PROCESS:

WHAT NEW NATURAL GAS INTERCONNECTS?

- Large Bi-directional Header System Pipeline to Pipeline with FIL/SEPS
- Large Bi-Directional Storage Field to Pipeline with FIL/SEPS
- Large pipeline interconnects requiring heat and Low NOX

These two are new and different on the front end with Bi-Di skids and Bi directional FIL/SEPS but the rest of the components are the same as other types:

- Gas Producer Sites has cooled down with low gas prices
- New Electric Generation
- Single New Franchises
- Direct Connect Industrial
- Requirements to Be Green: Heat recovery, Emissions

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PROJECT IMPLEMENTATION

- Feasibility Analysis
- Preliminary Engineering
- Interconnect Agreements/Responsibility Matrices
- Permits
- Contract Supply And Transport
- Procurement
- Final Design
- Qualified, Materials, People, & Procedures,
- Pre-manufacturing
- Installation
- Project Documentation
- Commission & Train & O&M

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PRELIMINARY ENGINEERING

- Explore The Project Background & Need
- Determine Authority Having Jurisdiction
- IA & Responsibility Matrix: Pipeline & End User
- Define Design Criteria By Discipline
- Select Major Equipment
- Determine Permits And Approval
- Establish Site Selection And Site Layout
- Create P&ID's and other Foundation Drawings
- Establish Cost & Schedule
- Present Data To Authority

SAMPLE RESPONSIBILITY MATRIX

PIPELINE / COUNTER PARTY

FACILITY	DESIGN	MATERIAL PURCHASE	INSTALL	OWN	OPERATE	MINOR MAINT.	MAJOR MAINT.
PIPELINE Hot Taps	PIPELINE	PIPELINE	PIPELINE	PIPELINE	PIPELINE	PIPELINE	PIPELINE
Connecting Piping A (Hot Tap flange to Edge of PIPELINE R/W)	PIPELINE	PIPELINE	PIPELINE	PIPELINE	PIPELINE	PIPELINE	PIPELINE
Connecting Piping B (Edge of PIPELINE R/W to M&R Inlet)	END USER PIPELINE Approve	END USER PIPELINE Approve	END USER	END USER	PIPELINE	PIPELINE	END USER
Filter/Separator and Dropout Collector	END USER PIPELINE Approve	END USER PIPELINE Approve	END USER	END USER	PIPELINE	PIPELINE	END USER
PIPELINE EGM Building	END USER PIPELINE Approve	END USER PIPELINE Approve	END USER	END USER	PIPELINE	PIPELINE	END USER
PIPELINE RTU*	END USER	END USER	END USER	END USER	PIPELINE	PIPELINE	END USER
Gas Chromatograph*	PIPELINE	PIPELINE	PIPELINE	PIPELINE	PIPELINE	PIPELINE	PIPELINE
PIPELINE Communications	PIPELINE	PIPELINE	PIPELINE	PIPELINE	PIPELINE	PIPELINE	PIPELINE
END USER EGM Building	END USER	END USER	END USER	END USER	END USER	END USER	END USER
END USER RTU	END USER	END USER	END USER	END USER	END USER	END USER	END USER
END USER Communications	END USER	END USER	END USER	END USER	END USER	END USER	END USER
Metering and Flow Control Facilities ("M&R")	END USER PIPELINE Approve	END USER PIPELINE Approve	END USER	END USER	PIPELINE	PIPELINE	END USER
Flow Control/PSO Valve Skid	END USER PIPELINE Approve	END USER PIPELINE Approve	END USER	END USER	PIPELINE	PIPELINE	END USER
M&R Building (exterior)	END USER PIPELINE Approve	END USER PIPELINE Approve	END USER	END USER	END USER	END USER	END USER
Station Piping (Downstream of Measurement & Flow Control)	END USER PIPELINE Approve	END USER	END USER	END USER	END USER	END USER	END USER
M&R Grounds (Including all-weather access road, site utilities)	END USER PIPELINE Approve	END USER	END USER	END USER	END USER	END USER	END USER

DESIGN BASELINE AND CRITERIA

Codes and Standards

The main codes and standards that govern the design include:

- US DOT 49 CFR Part 192, Transportation of Natural and Other Gas by Pipeline: Minimum Federal Safety Standards,
- Ohio Natural Gas Pipeline Safety Standards: R.C. 4905.90, et seq., and Ohio Admin. Code 4901:1-16.
- IBC 2000, International Building Code
- NFPA 70, NEC
- ASTM A53, Specifications for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless
- ASTM A106, Specifications for Seamless Carbon Steel Pipe for High-Temperature Service
- API 5L, American Petroleum Institute - Specification for Line Pipe
- API 6D, American Petroleum Institute - Specification for Pipeline Valves
- API 1104, American Petroleum Institute - Welding of Pipelines and Related Facilities
- AGA-XF-0277, American Gas Association - Recommended Practices Classification Gas Utility Areas Electrical Installations
- ASME-B31.8 Gas Transmission and Distribution Piping Systems
- Gas Measurement - Part 8, American Gas Association - Electronic Flow Computers and Transducers
- AGA-9, Measurement of Gas by Multipath Ultrasonic Meters

BUILDING ENCLOSED M&R

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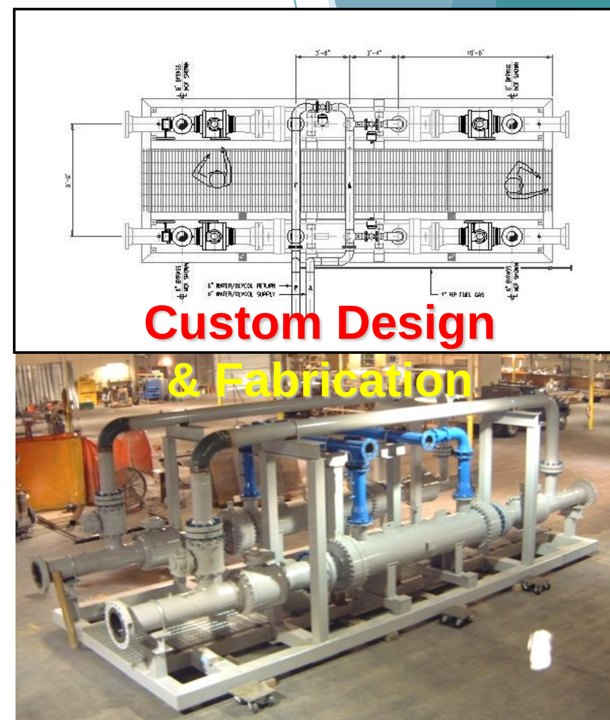
SKID MOUNTED M&R

Single & Multi-function Skids



Custom Design & Fabrication

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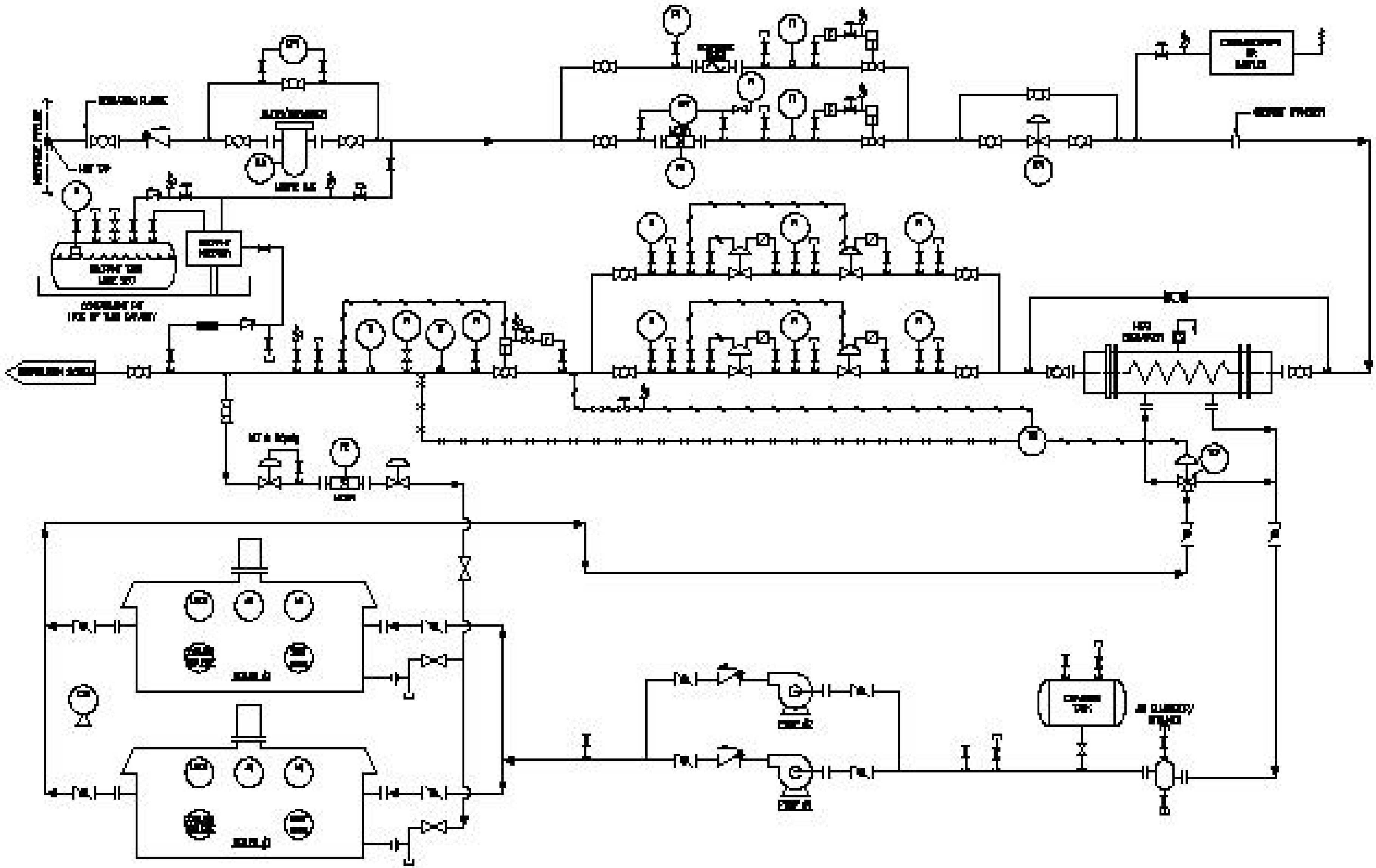
DESIRED FEATURES OF M&R FACILITIES
Safety, Reliability & Cost Effectiveness

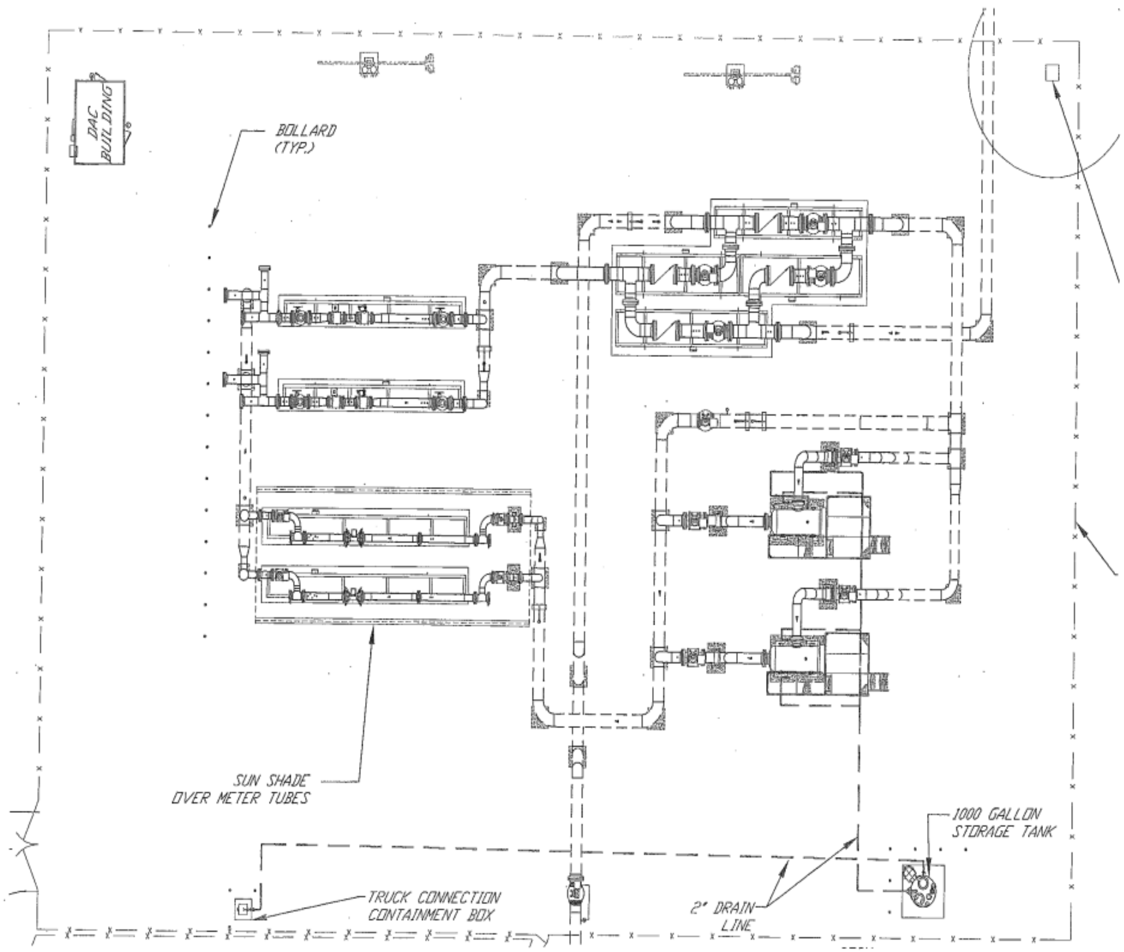
The following section illustrates traditional and Alternate designs for facilities as well as highlighting features favorable to all metering and regulating facilities.

- **That the business case is established.**
- **That it performs to the design conditions required.**
- **Ease of Maintenance & Access**
- **Ergonomic Design**
- **Simplicity**
- **Appropriate Levels of Redundancy**
- **Cost Effectiveness**

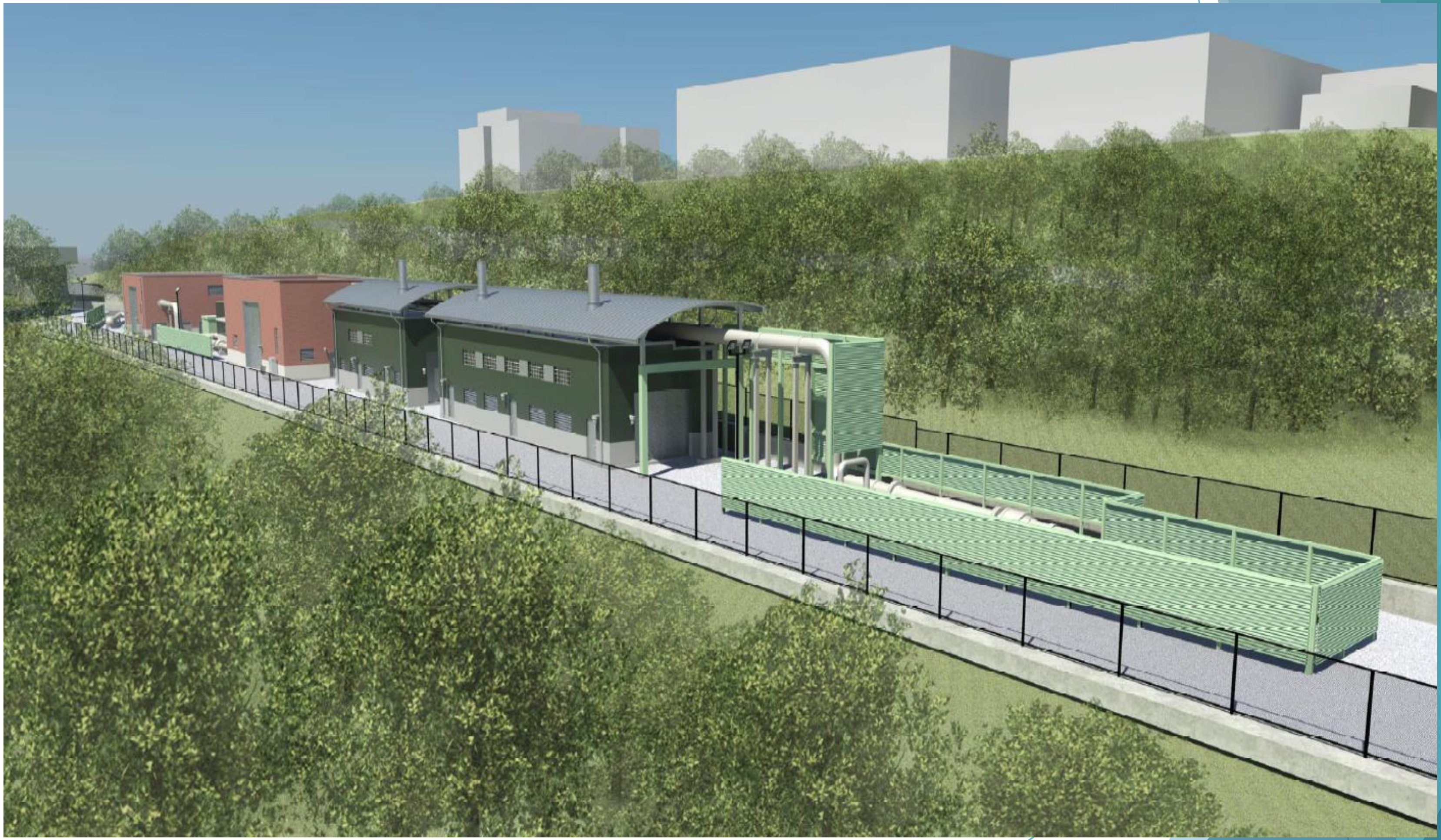
P&ID IDEAL SYSTEM



Bi-Directional M&R Facilities in Gulf Region



Large Volume Metering/Pre-Heat/Odorant/Scada Inner City From Marcellus



ERGONOMIC DESIGNS

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HIGH PRESSURE GAS

METERING AND FCV

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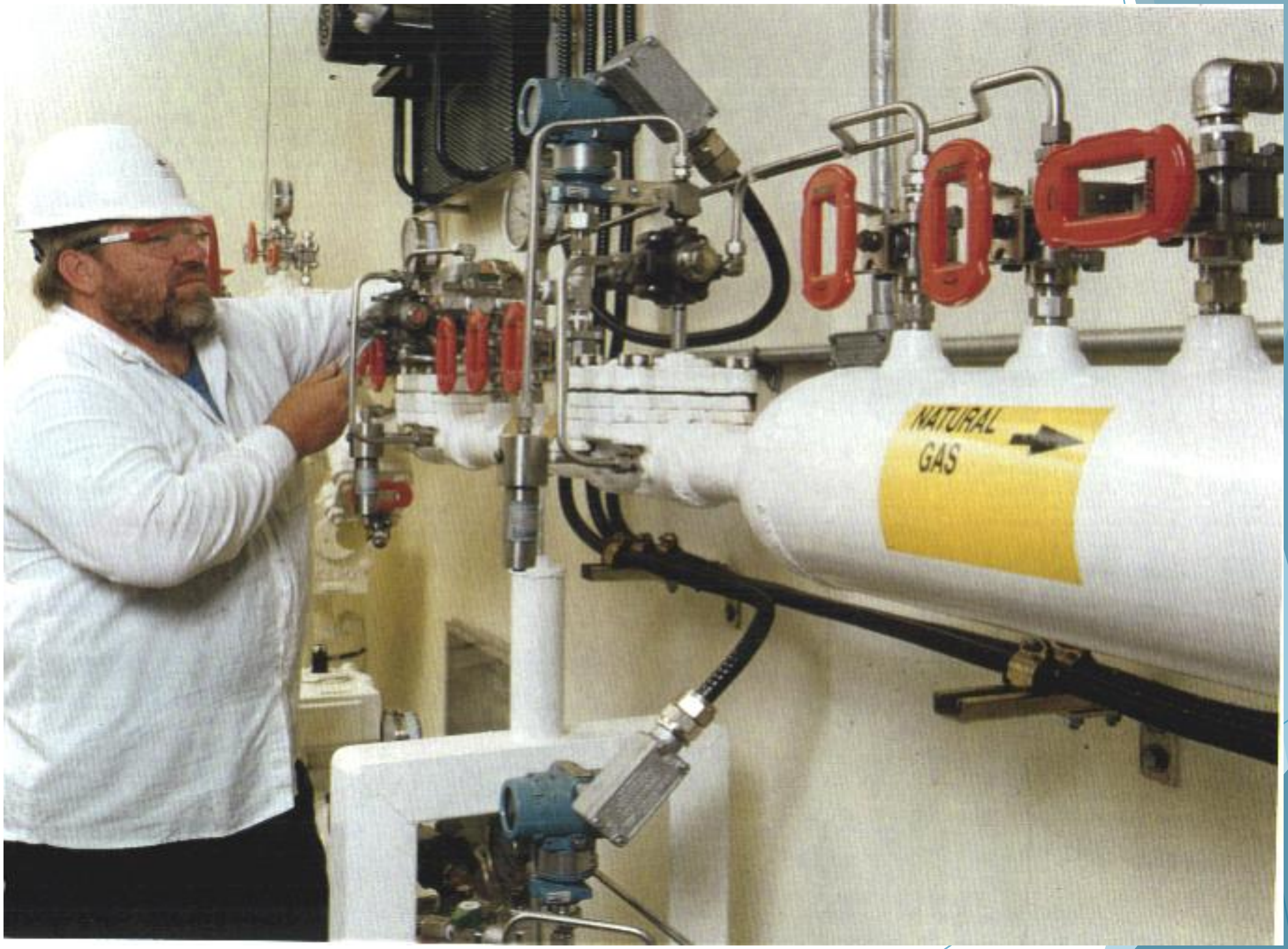
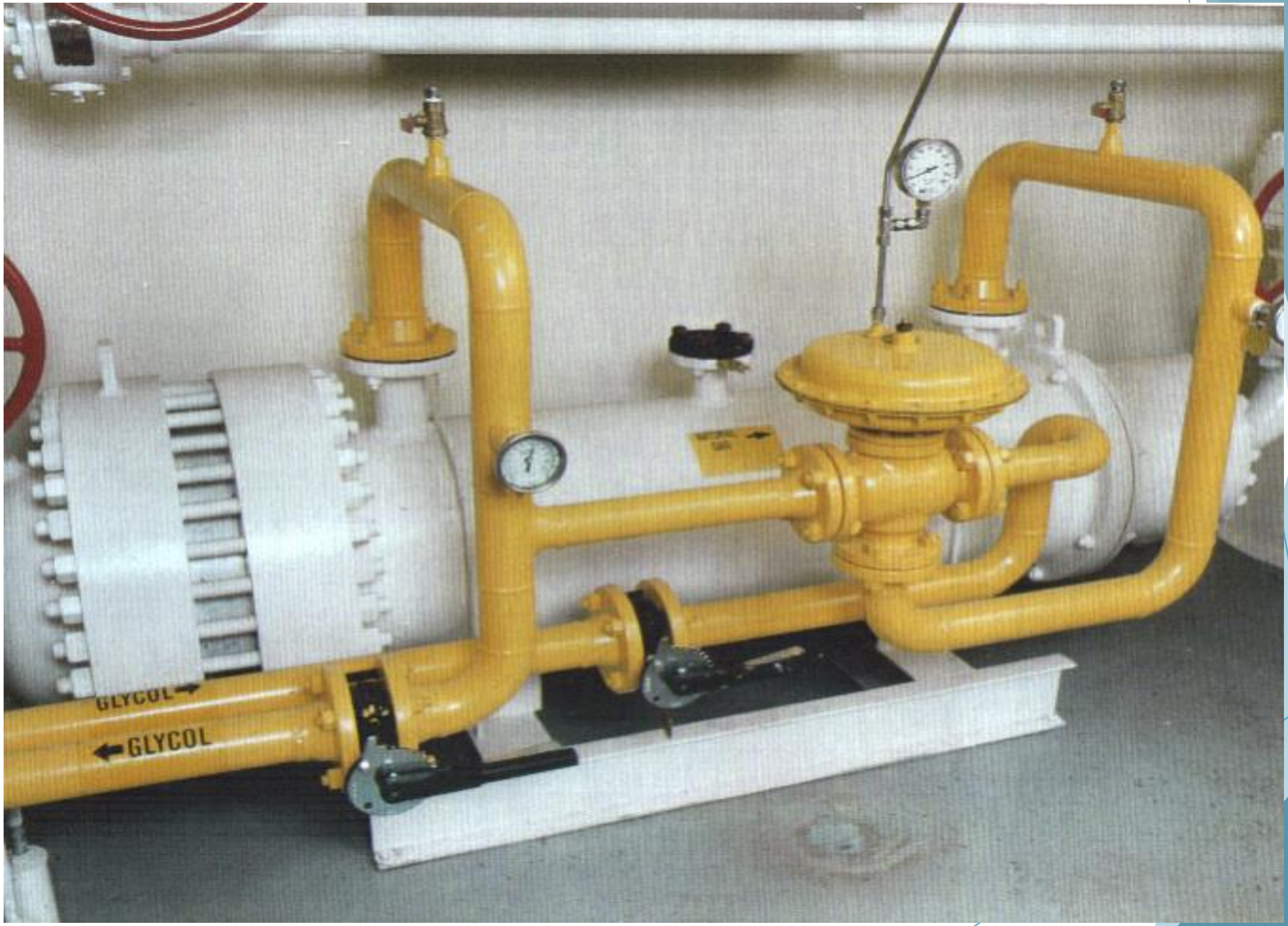
REGULATING FCV AND OPP



GAS HEATING



REMOTE HEAT SOURCE

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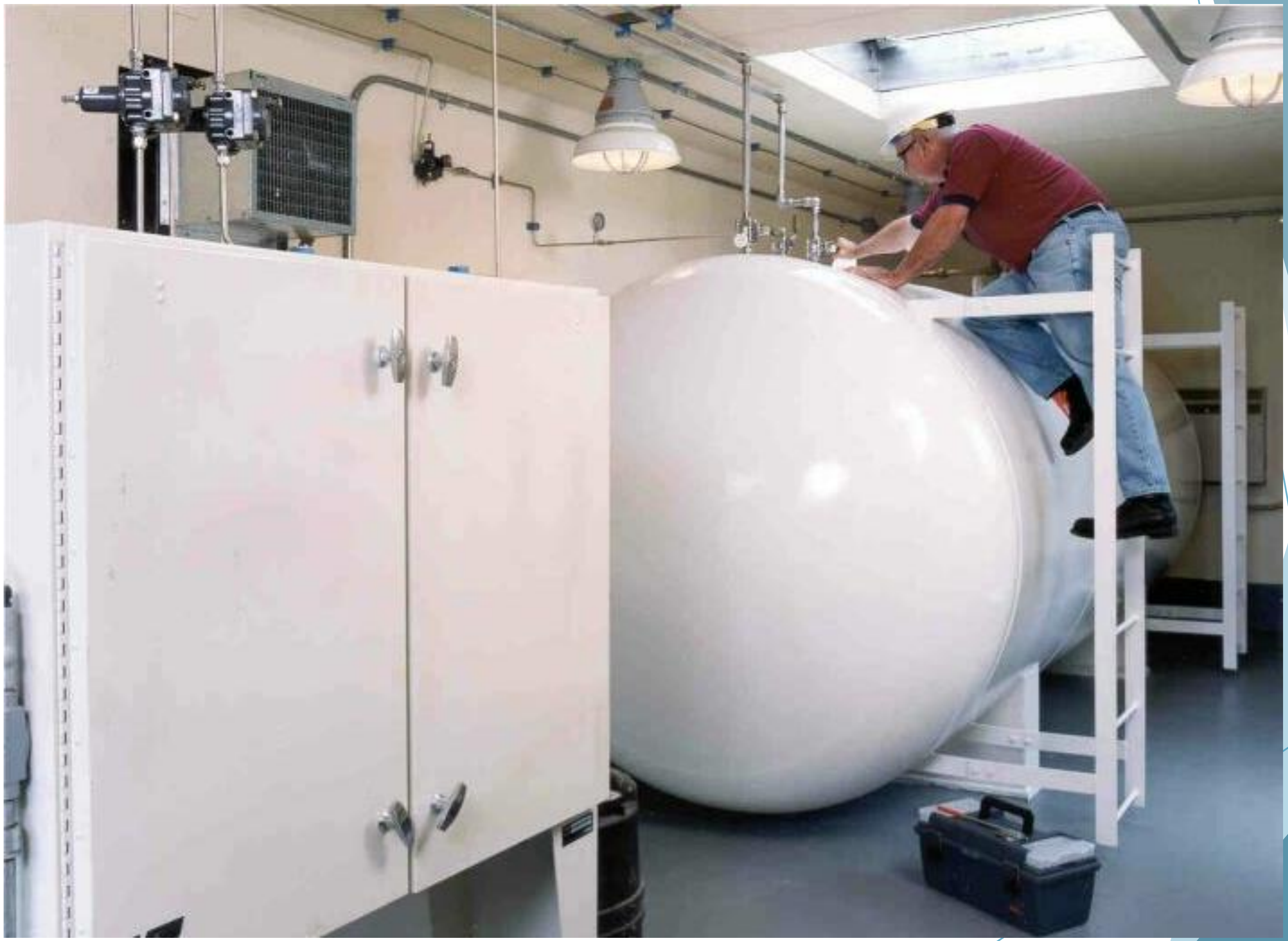
ODORIZATION



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SCADA SECURITY AND POWER

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CUSTODY TRANSFER CONCEPTS

When we transfer custody of Natural Gas, we are concerned with establishing a common standard to define volume of flowing gas and the energy content for each SCF of the flowing gas.

Ideal Gas Law (Compressible fluid) : PV = nRT: Pressure, volume, amount of gas, gas constant and temperature.
Originally empirically derived. (Supercompressibility and composition are factors as natural gas is not an ideal gas)

Standard Cubic Foot (SCF) : In order to transfer custody of gas, we convert the gas to an agreed standard pressure and temperature such as 60 degrees Fahrenheit and 14.73 pounds atmospheric temperature for billing. (Should be defined in IA. RTU load consistent)

BTU (British Thermal Unit): Amount of heat required to raise the temperature of one pound of water by one Fahrenheit Degree.

Therm: 100,000 BTU's

Dekatherm (from Greek number ten, DEKA): Ten Therms or 1,000,000 BTU's

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CUSTODY TRANSFER CONCEPTS

Heating value: The custody transfer heating value of gas defines the amount of energy available for the combustion process.
Combustion is a chemical reaction with the gas reacting with oxygen to form carbon dioxide, water, and heat. It is measured
in units of BTU/SCF. For billing, the heating Value is expressed in three different ways HHV, LHV, or GHV:
(The scale to be used, should be defined in IA. RTU load consistent.)

HHV: The quantity known as higher heating value does not take into account that water vapor is formed in combustion
and that the heat of vaporization of water consumes some of the heat .

LHV: lower heating value (or *net calorific value*) is determined by subtracting the heat of vaporization of the water vapor
from the higher heating value. The energy required to vaporize the water therefore is not realized as heat.

GHV: Gross heating value accounts for water in the exhaust leaving as vapor, and includes liquid water in the fuel
prior to combustion.

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ELECTRICAL DESIGN

ESTABLISH HAZARDOUS AREA PLAN IN PHASE 1:
Design, Procure & Install Equipment Accordingly

CONDUCT AC - MITIGATION WHERE NECESSARY:
Personnel and Equipment Protection

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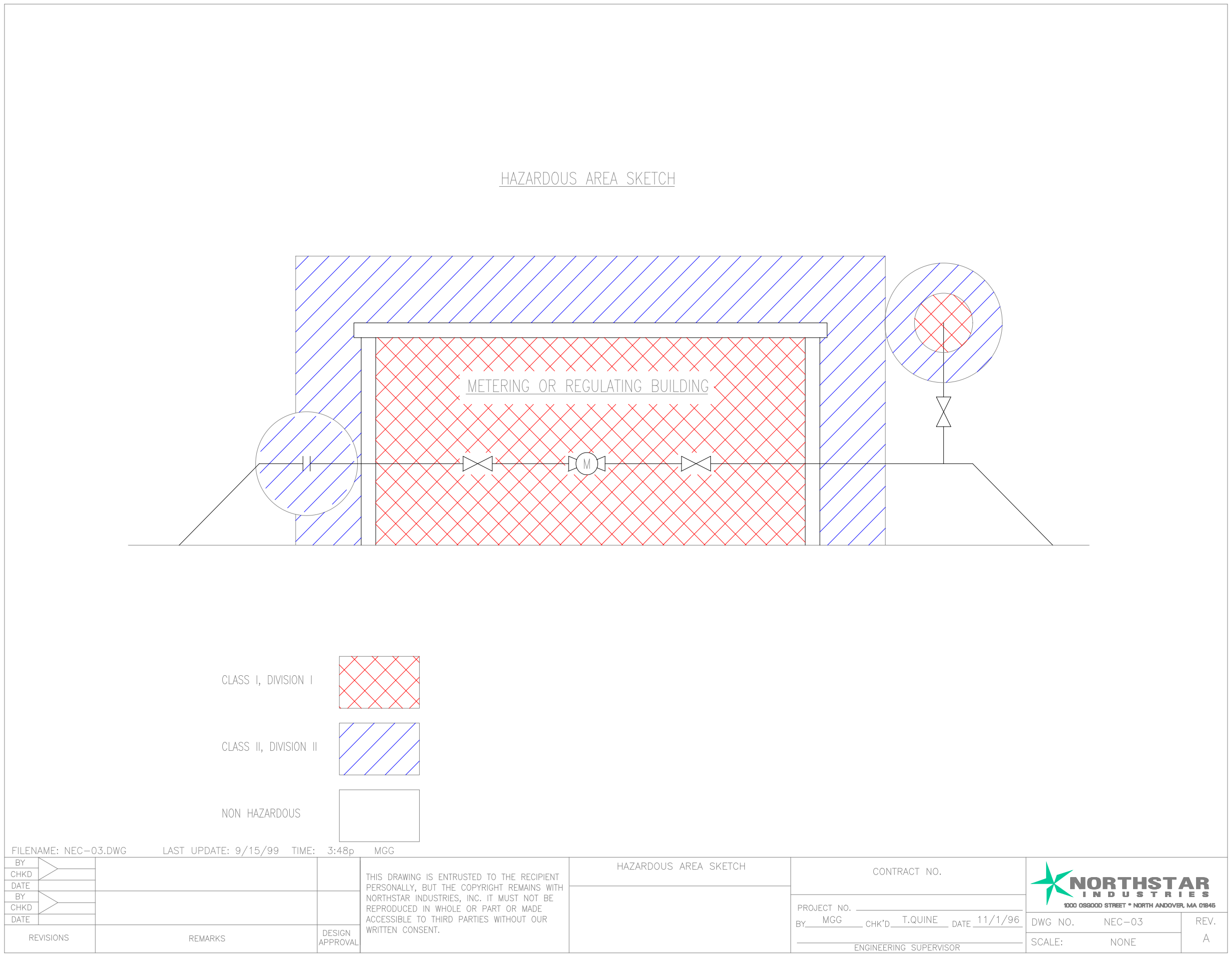
HAZARDOUS AREA PLAN



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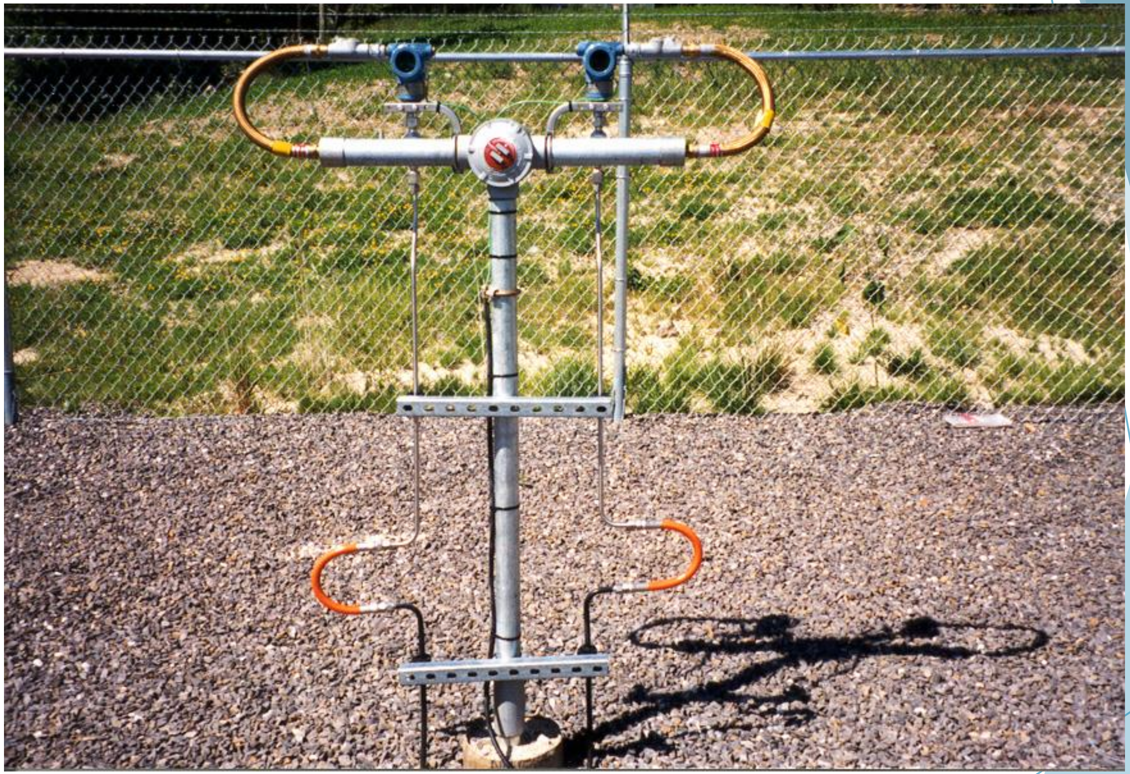
AC- MITIGATION GOALS

People Protection

Equipment Protection



SCADA DESIGN

- DEVELOP CONTROLS PHILOSOPHY
- DEVELOP P&ID
- DEVELOP I/O LIST
- DEVELOP SYSTEM ARCHITECTURE
  - Select Equipment
  - Determine HMI
  - Select Communication Links

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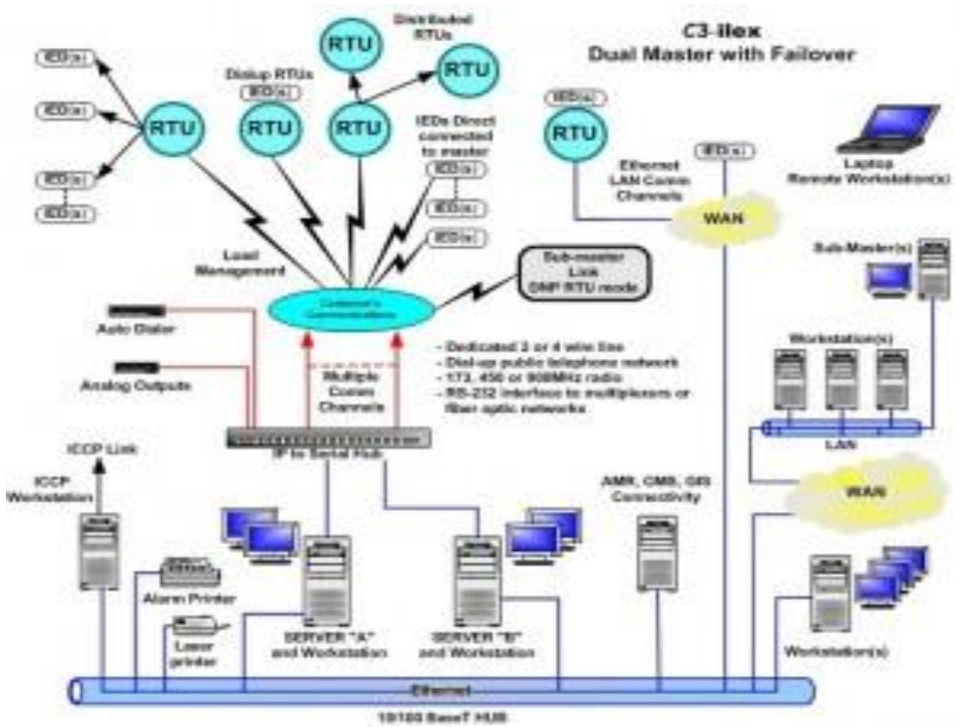
SYSTEM ARCHITECTURE PLAN



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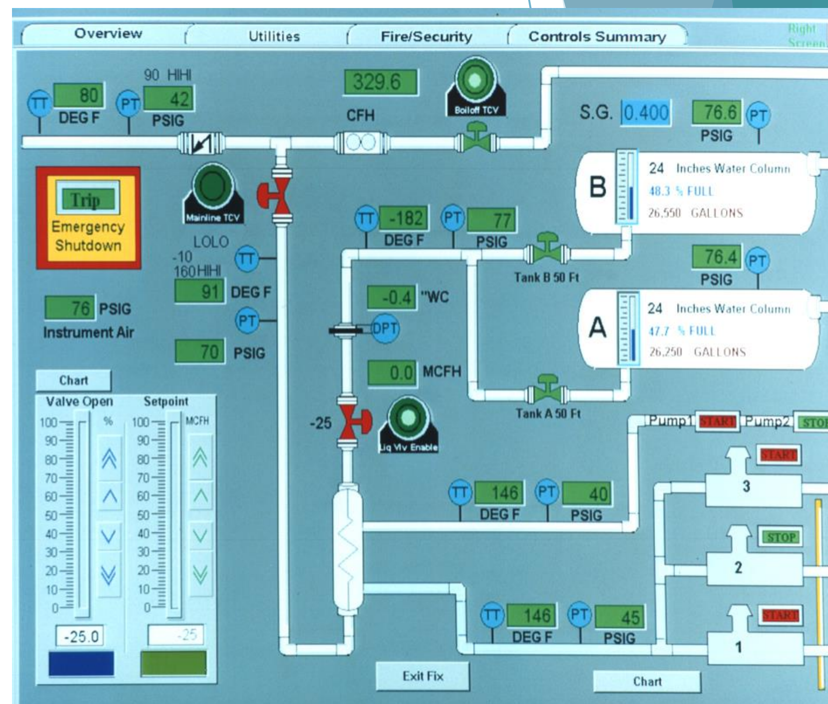
CONTROL ROOM:
SCADA, COMMUNICATIONS, SECURITY DOCUMENTATION AND HMI

CONTROL ROOM HARDWARE



SOFTWARE

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CONCLUSION

This is a great business that we've chosen, The US needs stable pricing And reliable supply for our security and growth.

The implementation of a successful project depends upon a capable team performing preliminary engineering, design, procurement, installation, training, and documentation. Deregulation has added new pipeline interconnects, shortened the schedules, created the need for new types of facilities and created market based projects.

The successful players in this century will accomplish their objectives in concert with customers and suppliers by sharing facilities, sharing information, finding win-win situations and ……...

UNDERSTANDING OUR ROLES IN THE MARKETPLACE

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