Introduction

These are guidelines and recommended practices for selection of artificial lift systems for deliquifying gas wells. They are sponsored by the Artificial Lift R&D Council (ALRDC) for all Operating and Service Company personnel who are involved with gas well deliquification.

Attendees at the 2006 Gas Well Deliquification Workshop responded to a questionnaire about selection of artificial lift systems. Seventy seven of eighty nine respondents from Operating Companies, eighty seven (87) percent, said they would benefit from a set of “best practices” for artificial lift selection. The term “best practices” raises a “red flag” for some; they are concerned that “best practices” might be interpreted as favoring one particular form of artificial lift over others, or one particular Supplier over others.

To alleviate this concern, this document is called, “Guidelines and Recommended Practices.” The purpose is to provide information to guide people in the recommended practices and processes for selecting artificial lift systems. It is not the purpose to recommend any particular form of artificial lift, and certainly not to favor any particular Supplier.

This document is prepared on a volunteer basis by various personnel from the gas well deliquification industry who are associated with ALRDC. The document is available free of charge to all people in the Industry via the ALRDC web site, www.alrdc.com. People may acquire bound copies from ALRDC for the following amounts. These bound copies, which contain a CD with selected free software and other features, are designed to be used as texts for training courses, and as reference guides for individual people.

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Contents

This document includes the following major sections:

- Guidelines for Creating an Optimum Artificial Lift Selection Process
- General Guidelines for Artificial Lift Systems
- Guidelines for Selecting the Most Appropriate Artificial Lift System for Your Application
Guidelines for Creating an Optimum Artificial Lift Selection Process

This section addresses the knowledge, information, and experience that a company and its personnel must have to effectively select, install, operate, and maintain an artificial lift system for deliquifying gas wells. The following people agree to contribute to this section:
- Cleon Dunham --- ALRDC and Oilfield Automation Consulting
- Efstathios (Stathis) Kitsios – Shell NAM
- Dr. Jim Lea – ALRDC and P. L. Tech.
- Others

- **Know your business**
  - Type of business – production, service, other
  - Scope of business – domestic, international
  - Nature of business – conservative, aggressive

- **Know your company**
  - Type of company – production, service, other
  - Type of production – primarily oil, primarily gas, other
  - Scope of company – major, independent, domestic, international
  - Nature of company – conservative, aggressive, leader, follow the leader
  - Focus of company – growth, steady as she goes, declining
  - Priorities of company – maximize income, minimize expenses, other

- **Know your economics**
  - Costs
  - Prices
  - Royalties
  - Taxes
  - Overhead costs
  - Net income per MCF

- **Know your staff**
  - Numbers
  - Experience level
  - Willingness to learn, change
  - Resources – training, staff development
  - Trends – growing, staying level, shrinking

- **Know your suppliers**
  - Equipment
  - Services
  - Relationships with customers
  - Artificial lift systems available in your area
• Know your reservoirs
  - Reserves
  - SBHP
  - FBHP
  - IPR
  - Calculate potential gain if switch to another form of artificial lift

• Know your wells
  - Depth
  - Casing size
  - Tubing size
  - Temperature
  - Production history
  - Artificial lift performance history
  - Artificial lift failure history
  - Well status – where is your well in its life expectancy?

• Know the performance of your wells
  - Fluid level in the casing
  - Fluid level in the tubing
  - Static bottom-hole pressure
  - Flowing bottom-hole pressure
  - Inflow performance relationship

**General Guidelines for Artificial Lift Systems**

This section addresses general information, tools, guidelines, and recommended practices for artificial lift in general and for each particular type of artificial lift system in particular. The following people agree to contribute to this section:
  - Cleon Dunham --- ALRDC and Oilfield Automation Consulting
  - Dr. Jim Lea – ALRDC and P. L. Tech.
  - Others

• Fundamentals of gas well deliquification
  - Critical velocity
    - Turner
    - Coleman
    - Shell
  - Types of gas
  - Types of liquids
    - Water
    - Condensate
  - Effects of solids

• Pertinent types of artificial lift
  - Sucker rod pumping
- Progressing cavity pumping
- Electrical submersible pumping
- Hydraulic pumping
- Plungers
- Soak sticks
- Batch chemical treatment
- Continuous chemical injection
- Velocity strings
- Surface compression
- Continuous gas-lift
- Intermittent gas-lift
- Vortex
- Injection

- Limits of each type of artificial lift technology
  - Depth limits
  - Size limits
  - Pressure limits
  - Temperature limits
  - Rate limits
  - Limits with sand, corrosion, erosion, H₂S, CO₂, etc.
  - Power requirements
  - Operating requirements
  - Maintenance requirements

- Typical artificial lift costs for each type of lift
  - CAPEX
  - OPEX
  - R&M

- Typical artificial lift system life for each type of lift
  - Infant mortality
  - Normal operating life

- How to use artificial lift system screening tools
  - Qualitative screening
  - Depth vs. rate charts
  - Performance envelopes
  - Inflow vs. outflow charts
  - Decision trees
Guidelines for Selecting the Most Appropriate Artificial Lift System for Your Application

This section presents an approach to select the most appropriate artificial lift system for a specific application. The following people agree to contribute to this section:
- Cleon Dunham --- ALRDC and Oilfield Automation Consulting
- Efstathios (Stathis) Kitsios – Shell NAM
- Dr. Jim Lea – ALRDC and P. L. Tech.
- Others

- Pertinent issues to consider
  - Company philosophy and practices
  - Common practices in your field
  - Operational experience in your field
  - Service companies available in your area – services they can provide
  - Production conditions you must accommodate
    - Reservoir pressure
    - Depth
    - Temperature
    - Production rates
    - Other issues
  - Which artificial lift systems are pertinent (fit within the necessary operating limits) for your particular conditions?
  - Is necessary infrastructure (power, etc.) available?

- Use artificial lift selection tools
  - Choose the most likely candidate(s) with the qualitative screening tools
  - Map these systems on the depth vs. rate charts for your wells
  - Map your wells on the artificial lift performance envelope charts
  - Map your wells on the inflow vs. outflow charts
  - Check your choice(s) with the decision trees

- Check artificial lift economics
  - If two or more candidates are close, check the projected CAPEX, lifetime OPEX, and lifetime R&M costs
  - In doing this, consider expected operating system life

- Choose the artificial lift system supplier
  - Consider such issues as:
    - Location and availability
    - Staff experience
    - Reputation for service
• Choose the specific artificial lift system
  - Consider such issues as:
    o Depth
    o Pressure
    o Temperature
    o Desired production liquid production rate
    o Hole size(s)
  - Use a proven design software program
  - Consult with experts in the particular form of artificial lift from:
    o Operating company(ies)
    o Service company(ies)
    o Consultant(s)
    o Others

Guidelines for Optimum Application of Each Artificial Lift System

This section presents specific guidelines and recommended practices for installation, operating, and maintenance of the artificial lift system installed in your well. The following people agree to contribute to this section:

- Cleon Dunham --- ALRDC and Oilfield Automation Consulting
- Efthathios (Stathis) Kitsios – Shell NAM
- Dr. Jim Lea – ALRDC and P. L. Tech.
- Others

• Know and practice pertinent guidelines and recommended practices for installation, operation, and maintenance of each form of artificial lift
  - Sucker rod pumping
  - Progressing cavity pumping
  - Electrical submersible pumping
  - Hydraulic pumping
  - Plunger
  - Soak sticks
  - Batch chemical treatment
  - Continuous chemical injection
  - Velocity strings
  - Surface compression
  - Continuous gas-lift
  - Intermittent gas-lift
  - Vortex
  - Injection

• Know and practice pertinent guidelines and recommended practices for automation, surveillance, and optimization of each form of artificial lift
  - Sucker rod pumping
  - Progressing cavity pumping
  - Electrical submersible pumping
Selection of Artificial Lift Systems for Deliquifying Gas Wells

- Hydraulic pumping
- Plungers
- Soak sticks
- Batch chemical treatment
- Continuous chemical injection
- Velocity strings
- Surface compression
- Continuous gas-lift
- Intermittent gas-lift
- Vortex
- Injection

- Know and take advantage of effective training programs for each form of artificial lift
  - Sucker rod pumping
  - Progressing cavity pumping
  - Electrical submersible pumping
  - Hydraulic pumping
  - Plungers
  - Soak sticks
  - Batch chemical treatment
  - Continuous chemical injection
  - Velocity strings
  - Surface compression
  - Continuous gas-lift
  - Intermittent gas-lift
  - Vortex
  - Injection