

# **Industry, Business – How Efficient, Safe and Secure?**

## **Natural Gas Technology Investment in a Healthy U.S. Energy Future**

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# Overview

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- **Improvements in Gas End-use Efficiency**
- **Safety & Security Technology**
  - Pipeline R-O-W Protection
  - NDE Technology
  - Advanced Corrosion Control
  - Secure Communications/Operations

# Electrical Sector Efficiency

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- **Increase microturbine efficiency (25kW-1,000kW) to more than 40%**
- **Increase fuel cell efficiency (SOFC) to 60%**
- **Develop hybrid fuel cell/turbine system (1 MW-200 MW) efficiency to greater than 70%**
- **Increase conversion efficiency of natural gas reciprocating engines by 20%**

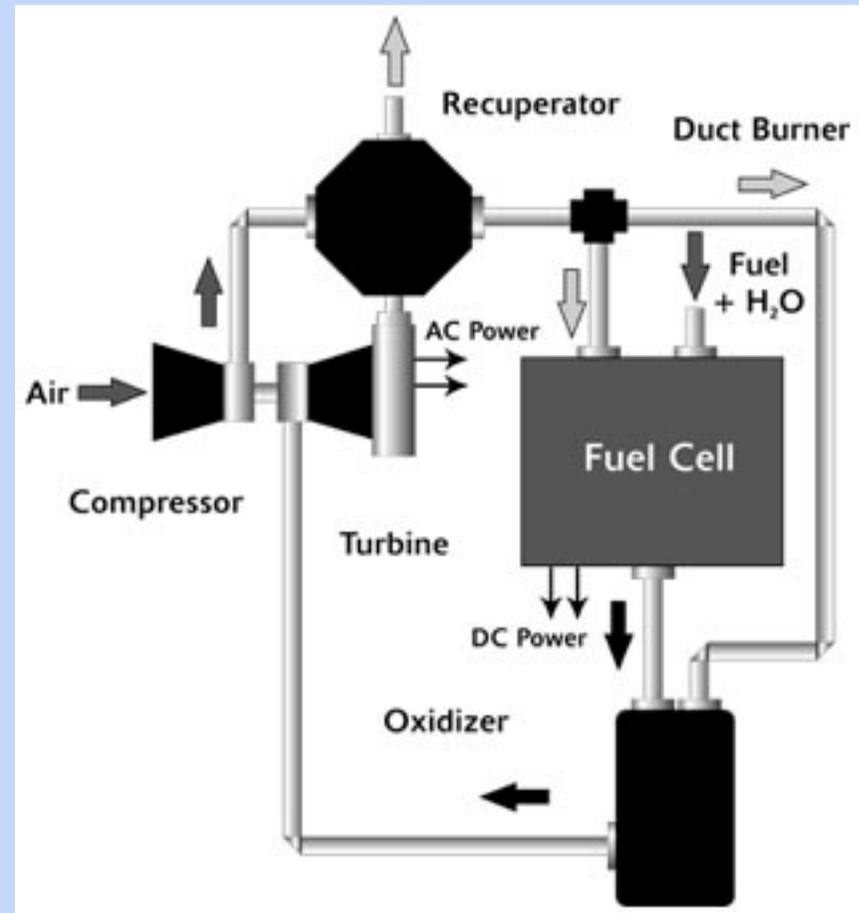
# Fuel Cell/Gas Turbine Hybrid Systems

## ■ Goals

- Synergistic Benefits from Gas Turbines & Fuel Cells
- 70% (LHV) Electric Efficiency
- 20MW or Less
- Commercialization by 2010

## ■ Players

- S-W/Rolls-Royce
- S-W/Solar Turbines
- FCE/Rolls-Royce
- FCE/Capstone
- SOFCo/Ingersoll-Rand



# Buildings Sector Efficiency

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- **Buildings consume more than 8Q of natural gas annually, mostly for space and water heating**
- **Potential exists to avoid 5Q of demand in 2020 through changes in building and appliance standards (50% improvement over 1996 Model Energy Code)**
- **Expect introduction of building combined heat and power systems based on natural gas fuel cells**

# Distributed Generation Technology

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- **System/Equipment Testing, Evaluation and Performance Certification**
- **Gas Cooling**
- **Combined Heat & Power Applications**



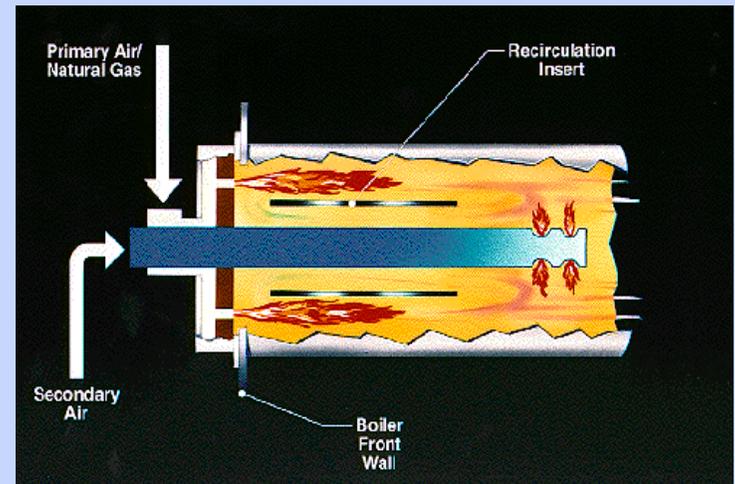
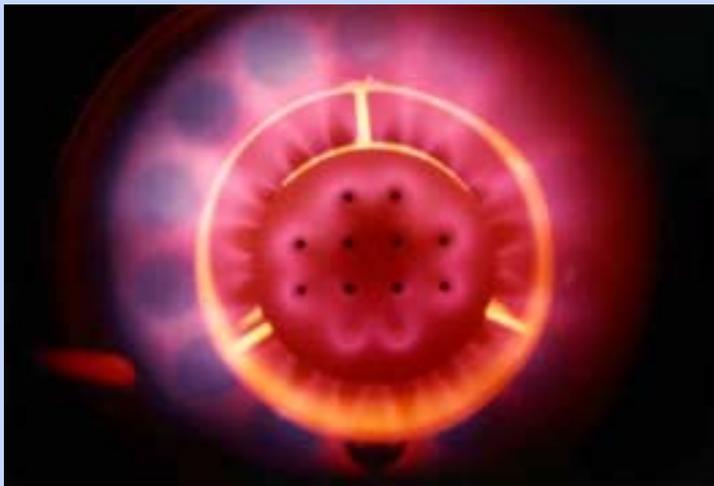
# Industrial Sector Efficiency

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- **Industrial sector is largest natural gas consumer (12Q = 1/3 of total industry energy)**
- **Improve industrial gas-fired systems efficiency through reduction in loss of latent heat (water produced by combustion)**
- **Increase radiant properties of natural gas flames to improve efficiency of process heating**

# FIR Burner for Boilers & Process Heaters

- Developed Sub 10/15 vppm NOx Burner for Natural Gas
- Combustion In: Commercial and Industrial Boilers, Water and Process Heaters
- Partners: Detroit Stoker Company, VAFB, Miller Brewing, US Steel, Socal Gas, Dominion and DOE
- Commercial Demonstrations: 4 (USA and Japan)



# Residential-Commercial Developments

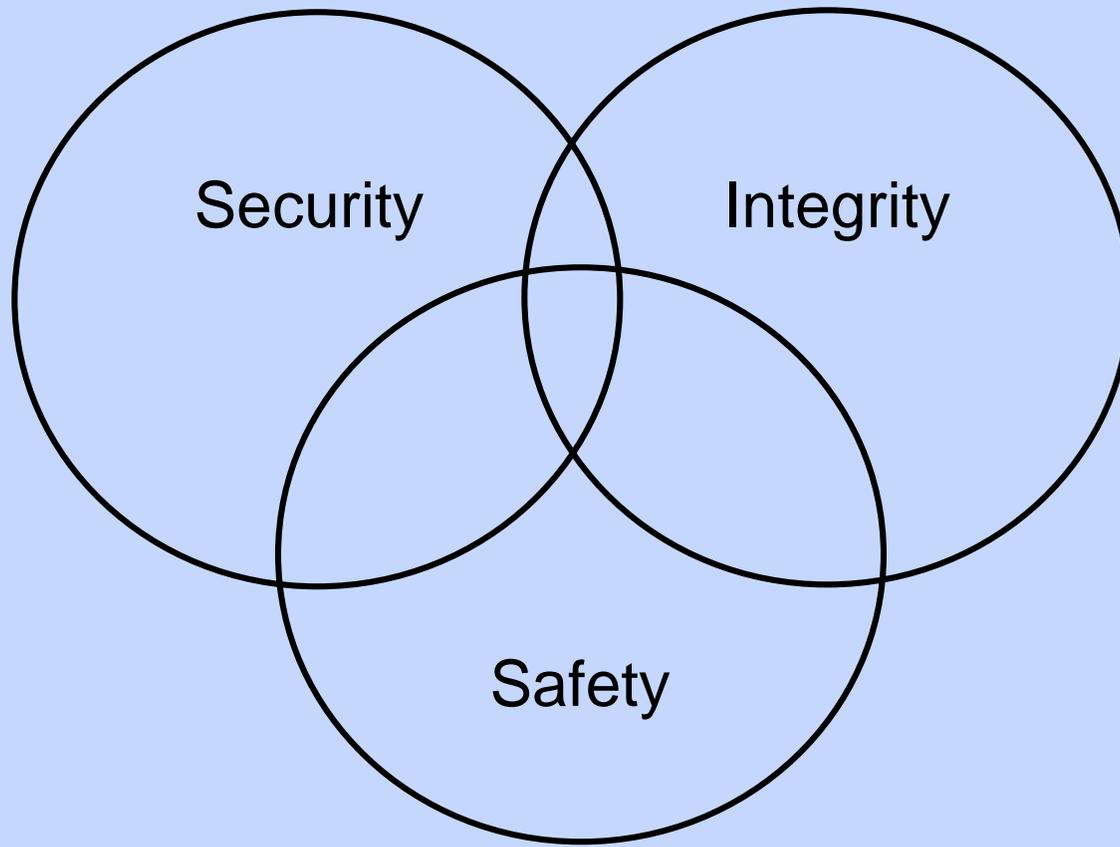
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- **Developing higher efficiency, lower emissions, faster processing and improved product quality natural gas-fired residential commercial appliances**



# Pipeline Security/Integrity/Safety

## Technology & Research Needs



**GTI's program includes protection for both physical assets and operational communications.**

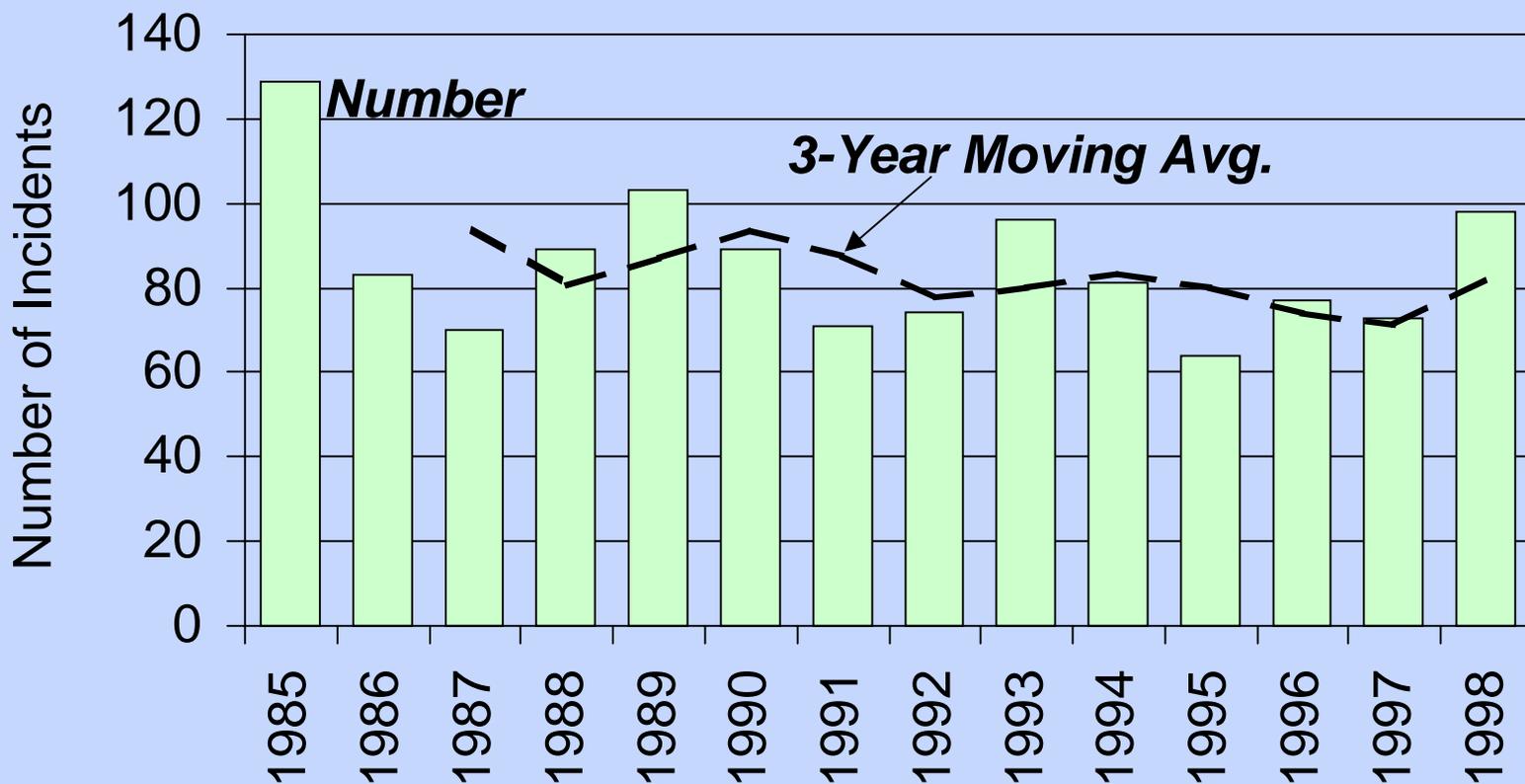
# Gas Transmission Pipeline Sectors

- **Transmission defined as >20% SMYS was reported @ 325,000 miles**
  - **INGAA Members 180,000 miles**
    - Larger diameters, mostly rural
  - **AGA Members 40,000 miles**
    - Smaller diameters, more urban
  - **Municipals 4,000 miles**
    - Smaller diameters, mainly urban



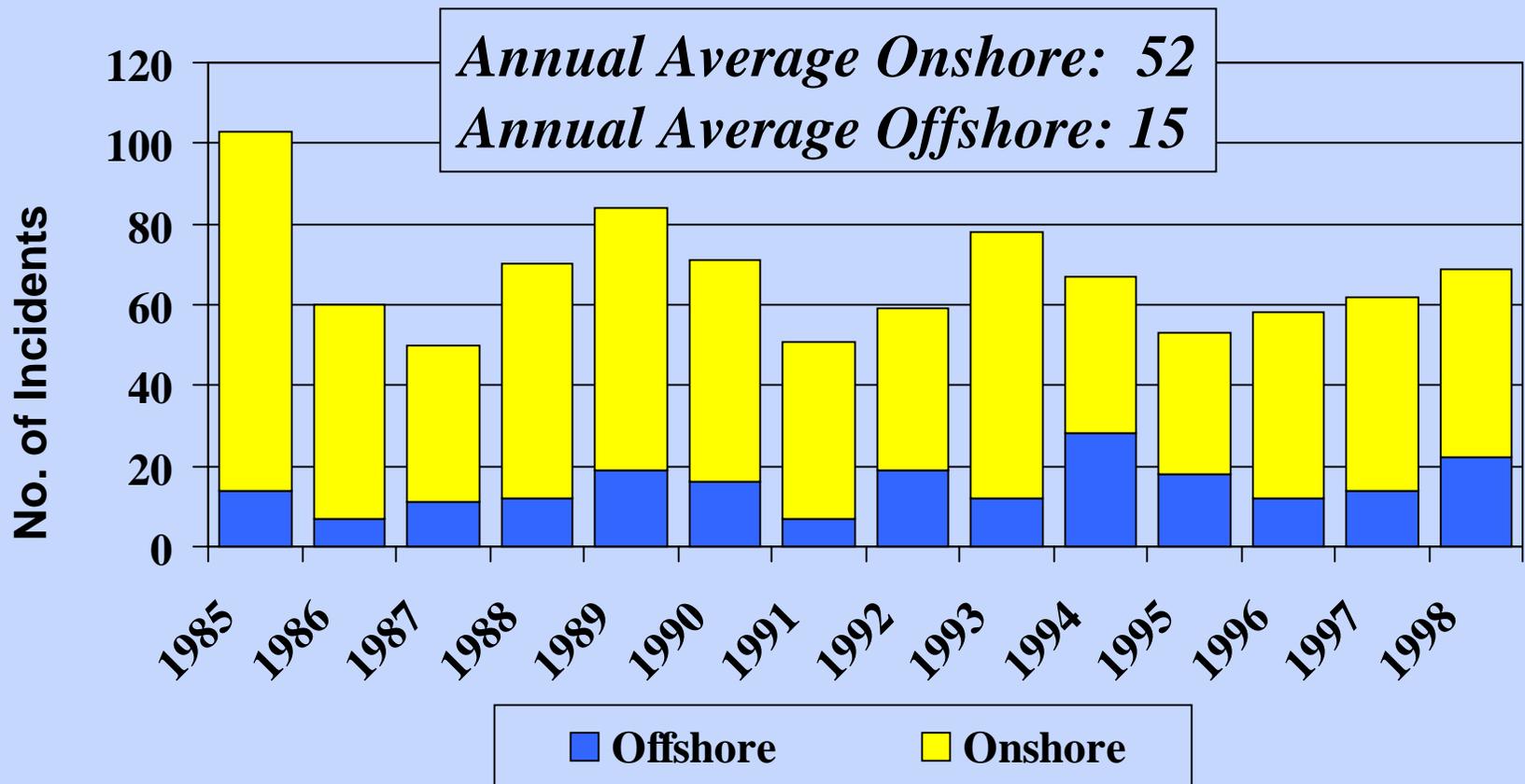
Pipeline & Gas Journal

# All Operators Reported Slight Downward Trend in Incidents 1985-98



Source: Allegro Energy Group; based upon Office of Pipeline Safety database of RSPA Form 7100.2 filings for all operators.

# Transmission & Gathering Systems – Offshore Incidents account for 23%

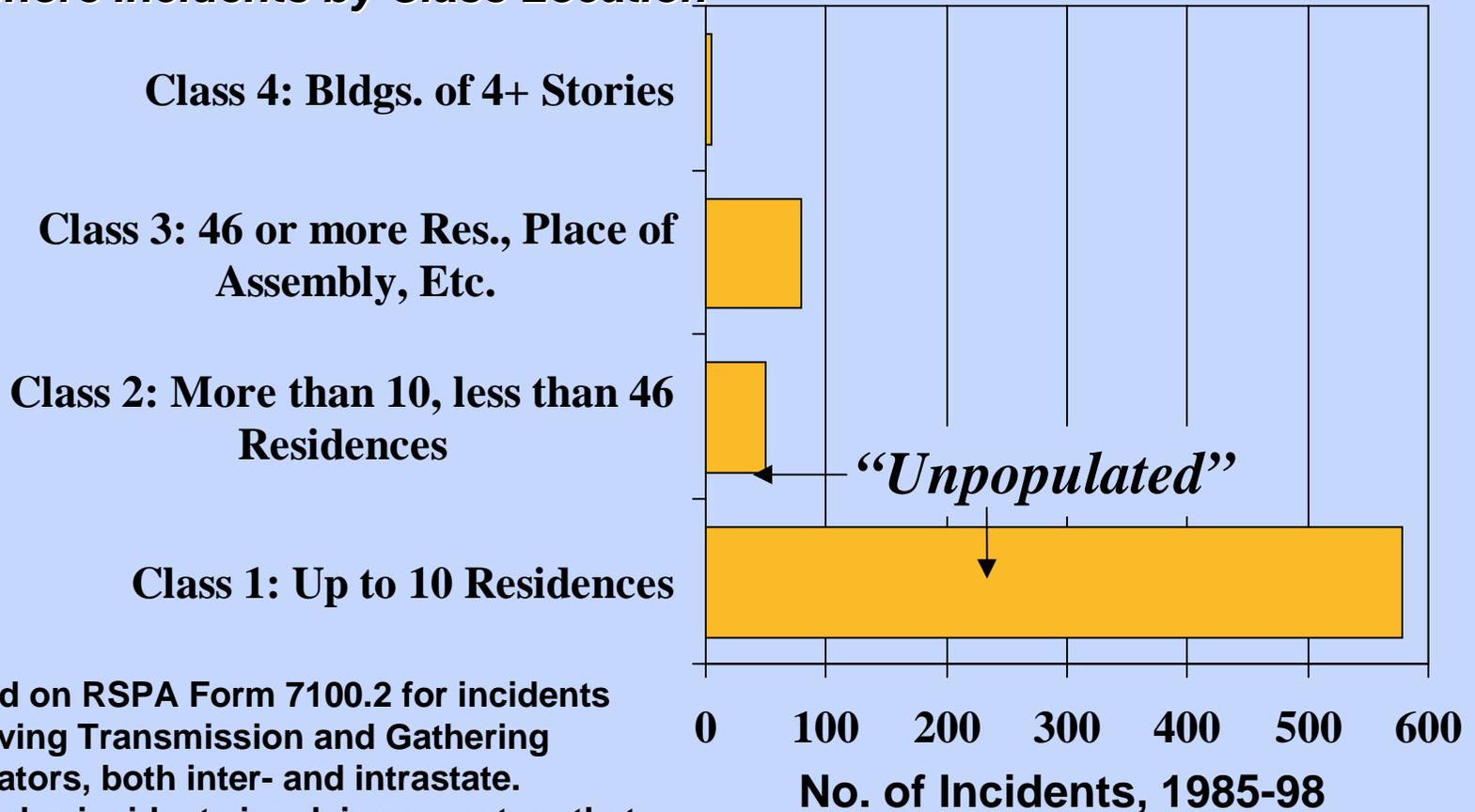


Based on RSPA Form 7100.2 for incidents involving Transmission and Gathering Operators, both inter- and intrastate. Excludes incidents involving operators that file a RSPA's Distribution System Annual Report.

Source: Allegro Energy Group

# Almost 90% Occur in Unpopulated Areas

## Onshore Incidents by Class Location

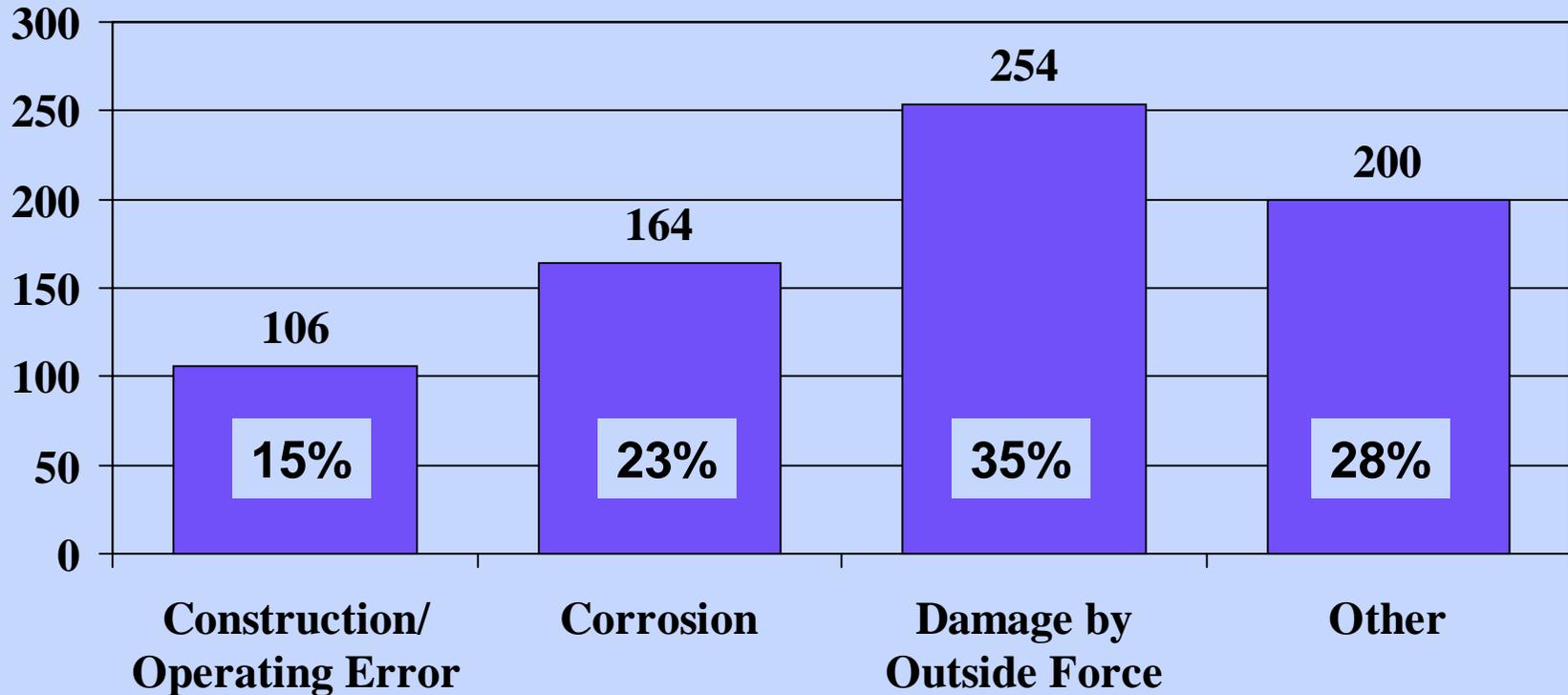


Based on RSPA Form 7100.2 for incidents involving Transmission and Gathering Operators, both inter- and intrastate. Excludes incidents involving operators that file a RSPA's Distribution System Annual Report. Excludes 12 (out of 724) onshore incidents where Class Location is unknown.

Source: Allegro Energy Group

# Damage by Outside Force is Most Important

No. of Onshore Incidents, 1985-98

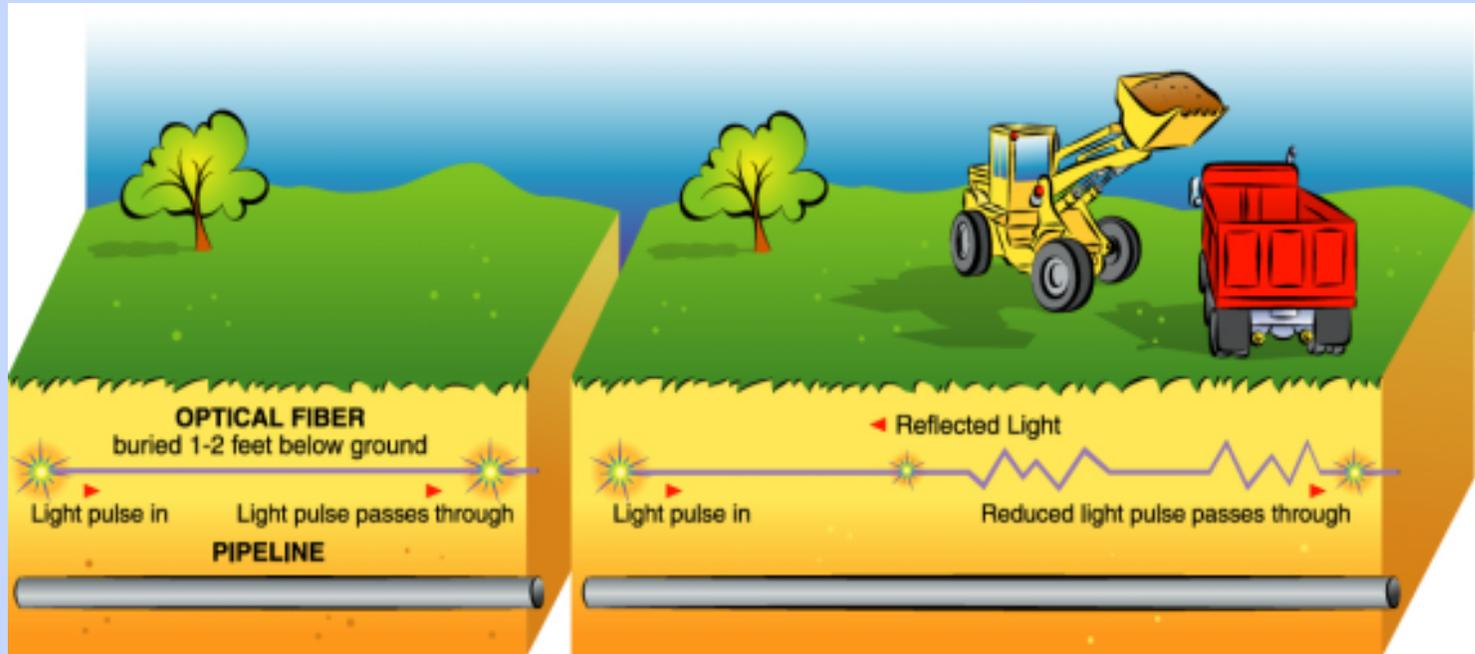


Based on RSPA Form 7100.2 for incidents involving Transmission and Gathering Operators, both inter- and intrastate. Excludes incidents involving operators that file a RSPA's Distribution System Annual Report.

Source: Allegro Energy Group

# Pipeline R-O-W Protection

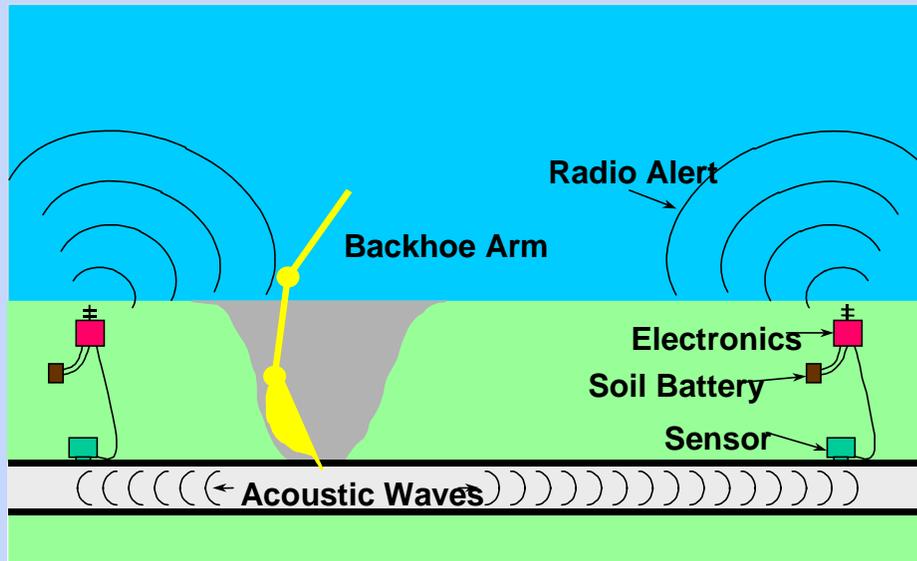
- Right-of-Way encroachment Detection



- Buried optical fiber system detects and warns of the presence of heavy equipment in pipeline R-O-W, identifies approximate location
- DOE/FERC funded; 2004 deployment
- Possible application for perimeter security

# Pipeline R-O-W Protection

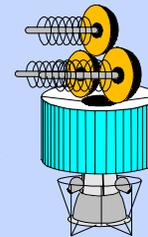
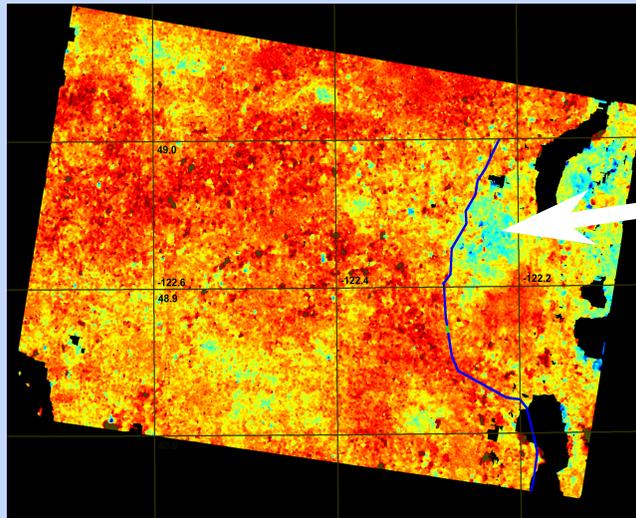
## ■ Third-Party Damage Detection



- Real-time monitoring and alert of third-party damage to buried pipelines; acoustic sensing of hard contact
- DOE/Industry/FERC funded; 2003 deployment

# Pipeline R-O-W Protection

- **Satellite R-O-W Monitoring (future)**



**3.5" over 6 months**

**Deformation Map, Everson, WA**

- **Remote Detection of R-O-W Encroachment**
- **Subsidence & Earth Movement**

# Pipeline R-O-W Protection

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- Publicly available monitoring capabilities off the Web
- Commercial/military capabilities significantly better

# NDE Technology

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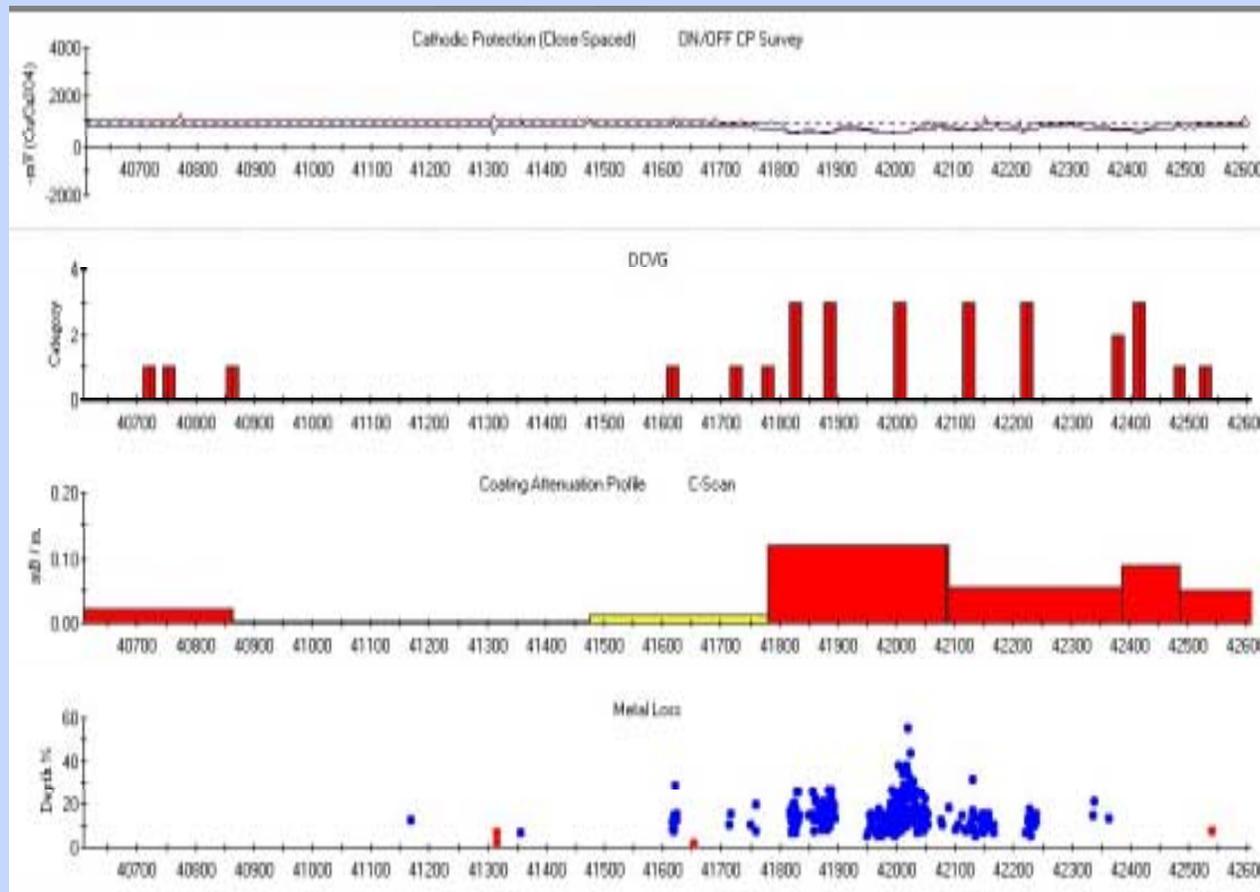


- **Advanced ILI (in-line inspection) sensors and data interpretation; magnetic flux leakage (MFL), remote field eddy current, gas coupled ultrasonic. Locate and characterize mechanical damage, corrosion, SCC, coating disbondment;**
- **DOE/DOT/FERC funding; 2004 & beyond deployment.**
- **ILI sensors and delivery vehicles for unpiggable lines (future).**



# NDE Technology

- External/Internal Corrosion Direct Assessment Validation



CIS

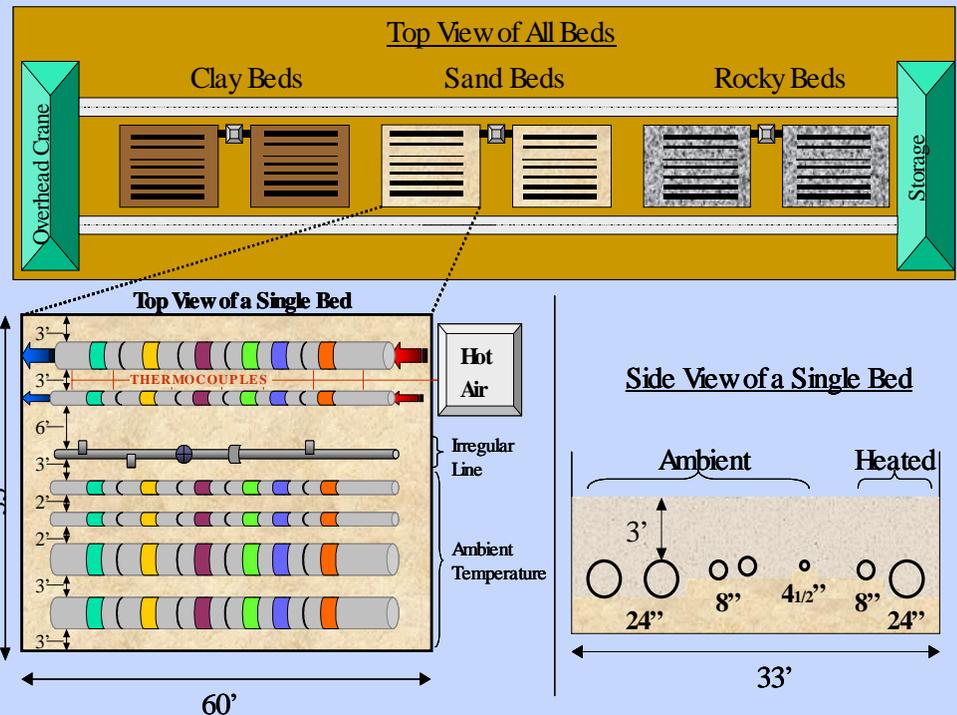
DCVG

Coating

MFL- ILI

# Advanced Corrosion Control

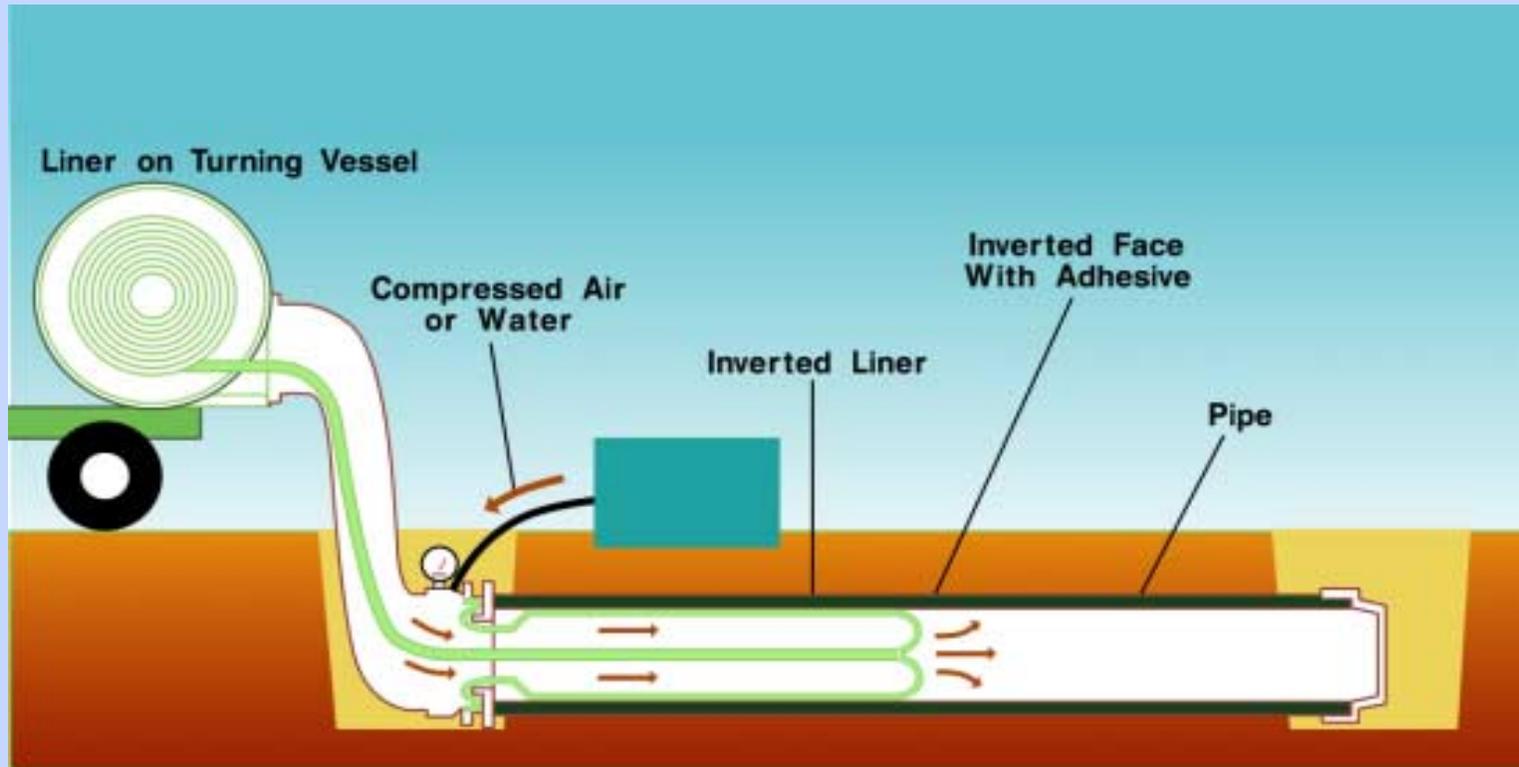
- Develop high performing, cost-effective field applied pipeline coatings
- Testing and certification of commercially available pipeline coating systems, in-ground on full-size line pipe
- Industry/FERC funded; 2003 deployment
- Jobsite training for the proper application of field applied coatings (future)



# Advanced Corrosion Control

## ■ High Pressure Pipe Liner

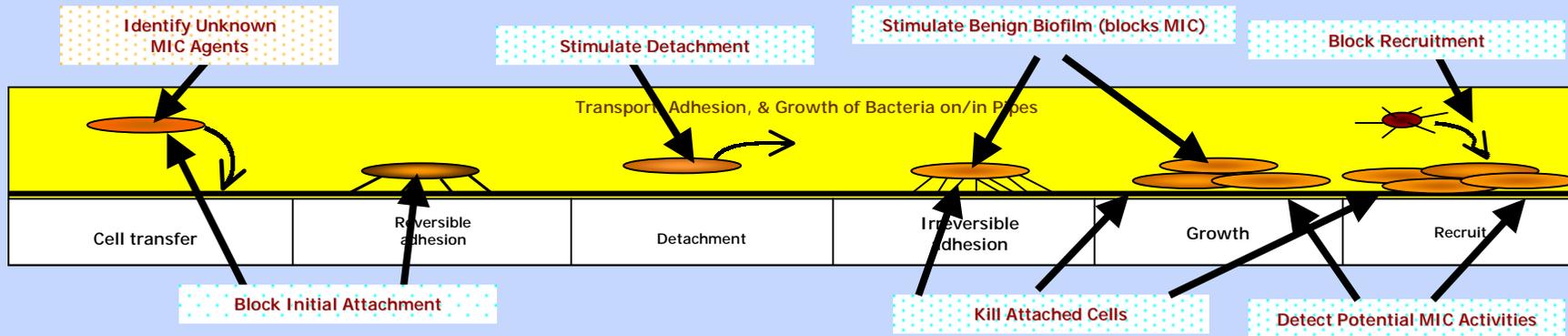
- High strength composite pipe liner; seal existing leaks, prevent future leakage due to corrosion or third-party damage, prevent internal corrosion, prevent propagating ductile fractures; Industry/FERC funded; 2003 deployment



*The HPL will be made for a full range of gas pipeline diameters and pressures to 1000 psi. Depending on the diameter, the HPL will install in 2,250 ft of pipe with a single inversion.*

# Advanced Corrosion Control

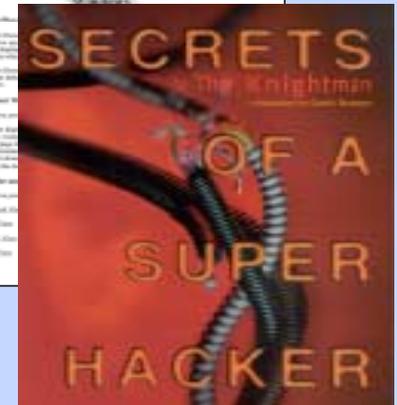
- Microbial Corrosion – Analysis and Remedies
  - 30% or more corrosion events include microbiological agent
  - Most biocides are toxic and under regulatory scrutiny
  - Pepper oil is a short-term environmentally acceptable solution
  - Current research is focused on
    - identifying corrosion causing microbes and their removal
    - develop biosensors to pinpoint and prevent MIC



# Secure Communications/Operations

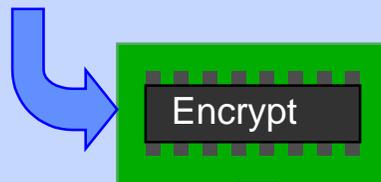
## ■ Encrypted SCADA Communications

- Secure SCADA communications against competitors, hackers, terrorists.
- Suite of encryption algorithms developed and tested
- Commercially available
- FEDERAL/FERC funded



*Information on Entering Your System Is Readily Available*

**“Reduce Pressure!”**



**“^fD%b\*m>s#H!j<”**

**“Reduce Pressure!”**



*Encrypted SCADA Commands Are Secure Until They Reach Their Destination*

# Secure Communications/Operations

- **Corporate Risk Assessment**
  - Utilize recognized methodologies to quantify and mitigate threats and risks
  - Identify threats, quantify possible impacts, assess value of existing security, evaluate cost/benefit of potential new security measures
  - Analyze unsecured SCADA, personnel policies, physical security, labor disputes.
  - FERC funded; currently available



*Utilities Need a Rational Methodology for Analyzing Security Concerns*