



**U. S. Department of Transportation**

**Pipeline and Hazardous Materials  
Safety Administration**

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# Prevention Through People

## Control Room Management (CRM)

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For more information regarding PHMSA Control Room Management Project contact Byron Coy (Byron.Coy@dot.gov), Karen Butler (Karen.Butler@dot.gov), or Charlie Helm (Charles.Helm@dot.gov)

# Prevention Through People

- People are a critical element in pipeline safety
- People often play a significant role in preventing, causing, and mitigating the effects of pipeline events
- PTP is a strategy through which we hope to provide an integrated and balanced approach to assuring the effectiveness of people
- PHMSA's approach may include consolidating existing and anticipated plans (e.g., OQ, CRM, D&A, Damage Prevention)

# PTP – Regulatory Parts

PHMSA regulations and initiatives that focus on the role of people in effectively managing safety

- Damage prevention (192.614 and 195.442)
- Public Awareness (192.616 and 195.440)
- Operator Qualification (192.801 and 195 Subpart G)
- Control Room Management
- Drug and Alcohol (199)

# PTP – Regulatory Parts

- These require plans documenting how the operator achieves the program objectives
- PHMSA wishes to gather perspective on a proposal to take a more “holistic” approach to assuring the effectiveness of people
- PTP could consolidate and integrate these plans to improve effectiveness, efficiency, and to reduce regulatory burden

# PTP – Beyond Regulations

- PHMSA will consider both regulatory and non-regulatory (e.g., best practices) approaches to achieving these objectives
- Strengthening and expanding B31Q is one possible route to such a combined approach, but we are interested in hearing any and all ideas

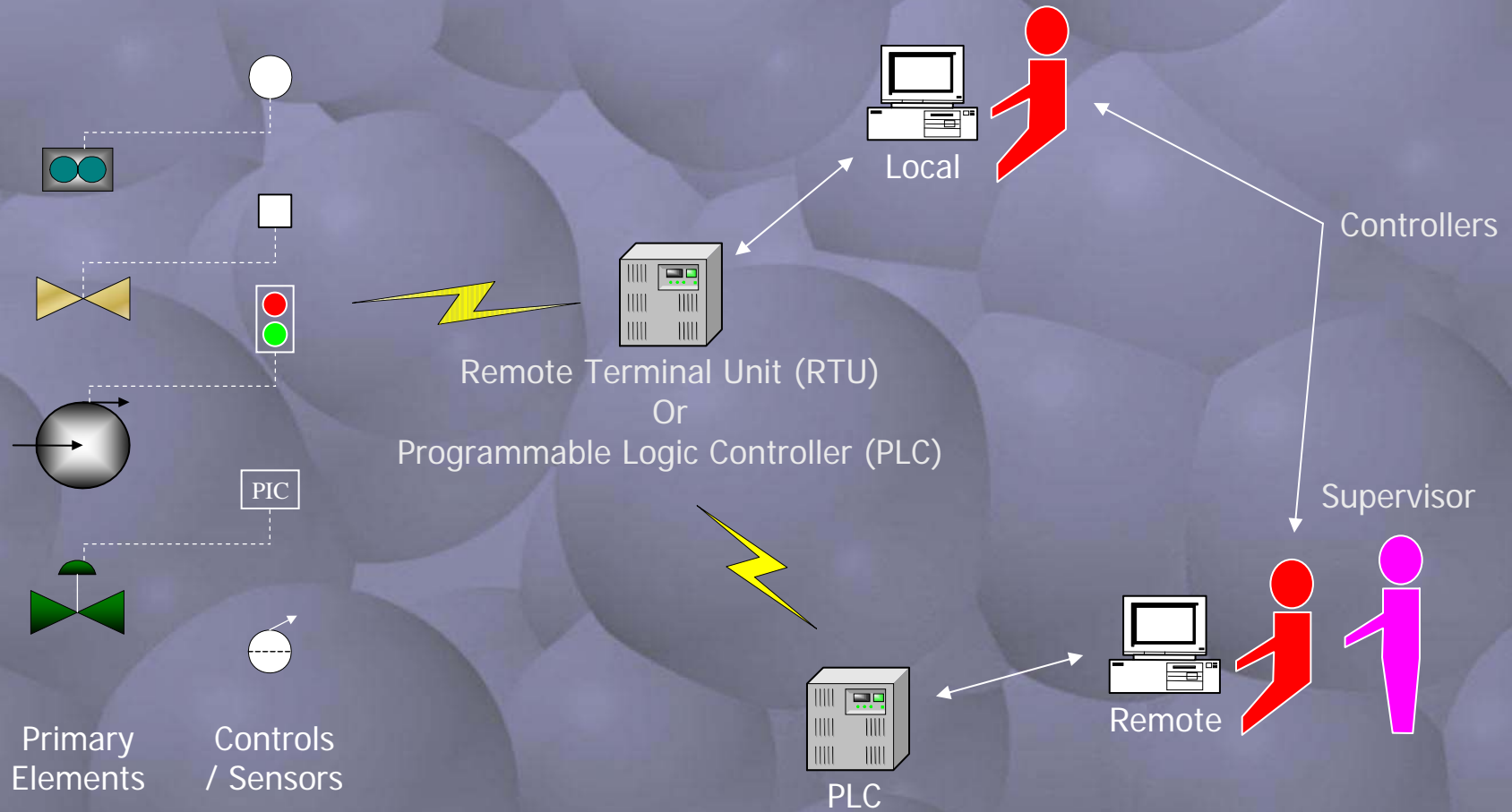
# How does Control Room Management Factor In?

- The PIPES Act of 2006 directs PHMSA to address various risks to pipeline integrity in which people play a large role ... including fatigue and other issues in control room management
- PIPES Act deadline of 6/1/2008 prescribes development of a regulation specifically directed at CRM, but broader concept work is needed for the future
- PHMSA plans to use its PTP initiative explore ways to integrate people more seamlessly into integrity management

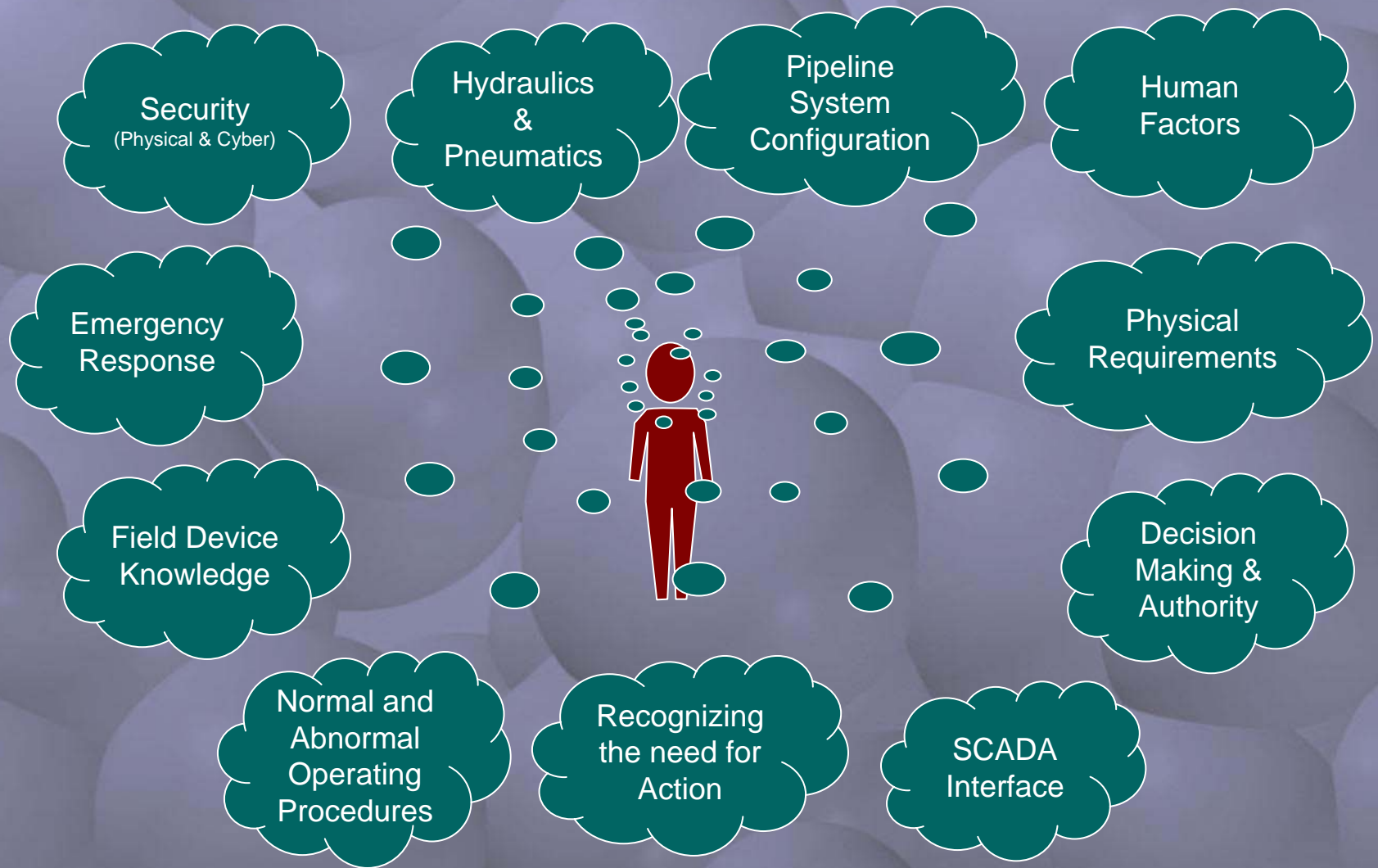
# CCERT → CRM

- Controller Certification Project (CCERT) identified measures to enhance the controller's ability to succeed
- Control Room Management (CRM) is developing a rule based on CCERT recommendations and other factors

# SCADA and Controllers



# Examples of Controller Knowledge, Skills, and Abilities



# Project Drivers

- Pipeline Safety Improvement Act of 2002
  - Study control room operations to enhance pipeline safety
  - Provide report to Congress
- NTSB
  - SCADA Safety Study
- PIPES Act of 2006 (Sections 12, 19, 20)
  - Establish human factors management plan
  - Reduce risks associated with human factors
  - Program to assure safe operation of pipelines
  - NTSB Recommendations on Displays, Alarms and Training
  - Accident/incident form changes on Fatigue by Dec. 31, 2007
  - Issue regulations by June 1, 2008
- PHMSA Objective
  - Identify CRM enhancement areas to help assure and promote the Controller's ability to succeed in maintaining pipeline safety and integrity

# Project Objectives

## • CCERT

- Review current regulations
- Evaluate the thoroughness of practices/processes used by Controllers that can impact safety and integrity
- Review the adequacy of existing Controller training and qualification requirements
- Explore validation techniques and criteria
- Determine if an additional form of validation is warranted to assure that Controllers are adequately skilled and qualified
- Account for uniformity and uniqueness of practices across the various types of pipeline operators

## • CRM

- Write Technical Report
- Notice of Proposed Rule-Making



# Field Survey Visits including Pilot Operators

Operator	Type	Mileage
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Pacific Gas & Electric	GT/LDC	6300 / 38000
Buckeye Partners	HL	4500
Colonial Pipeline	HL	5571
Gulf South Pipeline	GT	7500
Puget Sound Energy	LDC	12000
Brenham Mun. Gas	LDC	208
Olympic Pipeline	HL	400
Koch Pipeline	HL	8500
Atlanta Gas Light	LDC	30000
Enbridge Pipelines	HL/GT	50000
New Jersey Natural	GT/LDC	208 / 6000
IEC/PA Power & Light	HL/GT	86
Philadelphia Gas Works	LDC	3000
Magellan	HL	10220
ChevronTexaco	HL	8139
Duke Energy Gas	GT	11816
Alyeska Pipeline	HL	800
Kanab Pipeline	HL	4459
TransCanada	GT	26000
Terason Pipelines	HL	1865

# Field Survey Topics

- Operator System Overview, Control Room Tour
- Process Steps for Controller Development and Qualification
- Controller Operating Logistics and Experience Base
- OQ Implementation Resources
- Task Identification
- Candidate Selection
- Initial Training
- Computer Modeling and Operations Support Systems
- Qualification
- Ongoing Controller Performance Monitoring
- Re-Qualification
- Qualification Revocation and Restoration
- Root Cause Analysis and Feedback
- Global Metrics
- SCADA Controller Operations Interface
- SCADA System Design/Configuration
- Alarm Configuration, Management and Operations
- Security and Access Control
- Controller Interview
- Control Management Interview
- Management of Change
- Ancillary Procedures, Systems and Work Environment
- Administrative Support and Records Management
- Upcoming Systems and Procedure Changes

# Comparative Industries

- FAA, Air Traffic Controllers and Pilots
- FRA, Railroad Engineers and Dispatchers
- Nuclear, Plant Operators
- Electric Energy Grid, Network Operations
- OSHA and EPA Procedures

# Key Information Resources

- Cross-section of pipeline operators
- Pilot Operators
- Comparative industries
- Focus Group
- Public Workshops
- Technical Publications
- Pipeline Modeling & SCADA Vendors
- Established Research
- NTSB
- PHMSA data – incl. public inquiries and complaints

# Observations Summary-1

- Pipeline incidents/accidents are usually caused by mechanical damage, material defects, or corrosion
- Controllers frequently have a key role in emergency response
- A Controller's job frequently places them in a critical position to aid in the prevention, identification or mitigation of abnormal situations
- The established OQ framework is well-suited for administering OQ for Controllers
- Controllers know how to complete actions but on rare occasions they do not:
  - Detect and react as expected
  - Choose the right action
- From a risk perspective, low probability of controller error can be offset by the potential consequences of their actions/errors

# Observations Summary-2

- Gas and Liquid controllers require similar cognitive and analytical skills
- The speed of response is especially critical for liquid pipeline controllers
- Natural gas compressibility:
  - Can temporarily mask situations from controllers' view
  - Affords more time for controllers to react to developing problems (developing problems do not include ruptures)
- A Controller can be qualified but not always successful in managing abnormal situations due to many other factors (such as thoroughness of procedures, SCADA system design, fatigue, etc.)
- Many pipeline operators use SCADA systems to enhance safety and efficiency

# Safety Pyramid

Serious Failure

Significant and  
Minor Events

Intervention by Controllers,  
other Personnel or  
Safety Systems

Near Miss, Identified

Near Miss, Undetected

Reportable

Un-reportable

Recorded

Un-recorded

Control Room Management Processes can help assure that developing situations don't climb the pyramid to become Significant Events or Serious Failures

# Most Significant Project Outcomes

*Controllers have a strong record of knowing how to execute tasks. They do not always know when and why tasks need to be performed.*

Safety could be enhanced by:

- Identifying key attributes in Controller training, qualification and skills validation processes
- Assuring thoroughness in control room procedures and practices affecting safety and integrity

# NTSB SCADA Safety Study on Liquid Pipelines Recommendations

- API RP-1165, Display Graphics
- Review/Audit of SCADA Alarms
- Simulator and Table-Top AOC Training
- Report Fatigue Data for Accidents
- Computer-based Leak Detection Systems for Hazardous Liquid Pipelines

CRM (NPRM) will address the first three recommendations

CRM and other development work will address report data

PHMSA will address Computer-based Leak Detection Systems separately

# Executive Summary Highlights

As a part of the OQ Report to Congress in Dec-2006

- The cognitive and analytical skills required of controllers is universal
- Hazardous liquid operators generally need their controllers to detect and react to upset conditions more quickly than natural gas operators
- Control room working environments should include fatigue mitigation strategies

# Executive Summary Highlights

As a part of the OQ Report to Congress in Dec-2006

(Continued)

- A uniform certification test for controllers would provide only limited value due to the diversity in control room equipment and the differences in tasks the controllers perform
- Validating the adequacy of CRM processes, procedures, training and the controllers' qualifications would improve management of control rooms and enhance safety
- Several specific areas have been identified to enhance the safety performance of control rooms

# Enhancement Areas

- Roles and Responsibilities
- Controller Qualifications
- Fatigue Mitigation
- Shift Change
- SCADA Displays
- Alarm Management
- Operating Experience
- Change Management
- Validation

# Enhancement Areas

## Roles and Responsibilities

- Many pipeline operators have established job descriptions for controllers, but these frequently do not include clear language about the controller's authority and responsibility for safety-related decision making and action
- Controllers frequently have a key role in emergency response even if they were not the first to detect a problem

# Enhancement Areas

## Roles and Responsibilities

(continued)

- Some operators have not provided Controllers with the fundamental information being provided to the public as the result of the PSIA 2002 Public Education Program requirements and RP1162.
- When Controllers answer “800” calls from stakeholders, some operators have not trained Controllers about “how to respond” in the event of an emergency and to coordinate with other operators in common corridors.

# Enhancement Areas

## Controller Qualifications

- Most operators do not measure or verify a controllers performance in regards to aspects of detecting abnormal and upset conditions, as well as their ability to take appropriate action as needed
- Many pipeline operators do not apply interim controller performance verification between formal re-qualification intervals.
- Many operators do not verify hearing, colorblindness (color perception) or vision abilities as required in order to operate their system.

# Enhancement Areas

## Controller Qualifications

(continued)

- Many pipeline operators do not place enough training and qualification emphasis on abnormal conditions that are likely to occur simultaneously or in sequence, as indicators or precursors of more serious situations
- Many operators' training programs do not include a review of procedures for pipeline operating setups that are periodically, but infrequently used.

# Enhancement Areas

## Fatigue Mitigation

- The control room shift schedule of many pipeline operators was chosen for the convenience of controllers. Few pipeline operators have studied the effect of shift schedule on work diligence, safety performance, circadian rhythms, or fatigue.
- Many operators do not review shift rotation schedules, shift length, and hours of service for their impact on Controller fatigue

# Enhancement Areas

## Shift Change

- Many operators expect Controllers to overlap their shifts, but there are usually no formalized procedures requiring overlap
- Many pipeline operating companies do not have formalized shift-change procedures or associated check-off sheets.

# Enhancement Areas

## SCADA Displays

- Few pipeline operators perform routine point to point checks verifying modifications in the field have not affected controller screens.
- Many operators do not have a structured plan for determining which and how many colors should be used on their SCADA displays
- The American Petroleum Institute has published Recommended Practice 1165 for the use of graphics on the SCADA screens.

# Enhancement Areas

## Alarm Management

- Many operators are not performing alarms reviews that include consideration of: number of alarms; unnecessary alarms; controller's performance changing regarding alarm or event response; alarm indication of AOC
- Many pipeline operators do not perform a periodic structured alarm analysis to identify chronic or systemic equipment problems, the need for procedure revisions, or to help monitor controller performance.

# Enhancement Areas

## Operating Experience

- Operators consider table-top “what-if” exercises as valuable training aids
- Computer-based simulators were frequently characterized by Controllers as a valuable tool, but seen as cost prohibitive by many operators

# Enhancement Areas

## Operating Experience

(continued)

- Simulators and table-tops can be valuable tools for the recognition of abnormal operating conditions, in particular leak events.
- Controllers were seldom asked about how table-top exercises could be improved or were involved in table-top exercise scenario development.
- Some operators collect and analyze near miss and close call events and take corrective actions including training activities

# Enhancement Areas

## Change Management

- Many operators do not have maintenance procedures by which Controller identified problems with the SCADA system or field instrumentation are tracked, nor the ability for Controllers to prioritize outstanding work.
- Many operators do not have procedures or processes to ensure SCADA system modifications are coordinated with Controllers and pipeline operating logistics.

# Enhancement Areas

## Change Management

(continued)

- Controller field visits were commonly seen as valuable with respect to acquainting the Controller with the physical aspects of the controlled equipment and facilities
- Controllers indicated it was especially significant for field visits to be conducted with the associated field personnel that the Controller would be communicating with during the normal course of duties and emergency situations.
- Controllers are not always represented when pipeline hydraulic or configuration changes are being considered.

# Enhancement Areas Validation

These observations lead to a conclusion that validation through executive signature would be appropriate for:

- Review of controller qualifications and training program,
- Verification that only qualified controllers have operated the pipeline,
- Verification that enhancement areas have been implemented as required,
- Verification that ergonomic and fatigue factors continue to be addressed,
- Verification that controllers have a voice in finding ways to sustain and improve control room management

# PHMSA is also considering the following actions

- Participating and planning events to enhance communication with other modes of transportation regarding control room lessons learned
- Sponsoring workshops for pipeline operators to share control room management best practices
- Encouraging the development of consensus-based best practices to promote controller success
- Initiating a research and development project to establish a web-based generic simulation tool to help train controllers of smaller pipeline operators

# Conceptual Pipeline CRM Risk Matrix

--- Risk derived from monitor and control ---  
 Red indicates higher risk, Yellow indicates lower risk

Pipeline Control Risk Matrix		Hazardous Liquids	Gas Transmission	Gas Distribution
Remote Operation	Remote monitor & remote control	Red	Orange	Yellow
	Remote monitor; action by others			
Individual Field Station Operation	Local facility with centralized control panel			
	Individual equip. with status control and indicators			

Matrix coding principally represents the combination of frequency and consequence of pipeline upset conditions and failures, where CRM may be a contributing factor

# CRM Risk Considerations

- Control rooms rank very low as a cause of failures compared to mechanical damage, material defects and corrosion; but controllers are frequently involved in identifying and/or responding to most situations, including the mentioned types of failures
- Low probability of controller error can be offset by the potential consequences of their actions/errors
- Remote monitor/control may be performed in a formal control room, or numerous less formal settings such as individual office, service vehicle or residence. Location of monitor or control does not define the nature, complexity or risks to pipeline safety

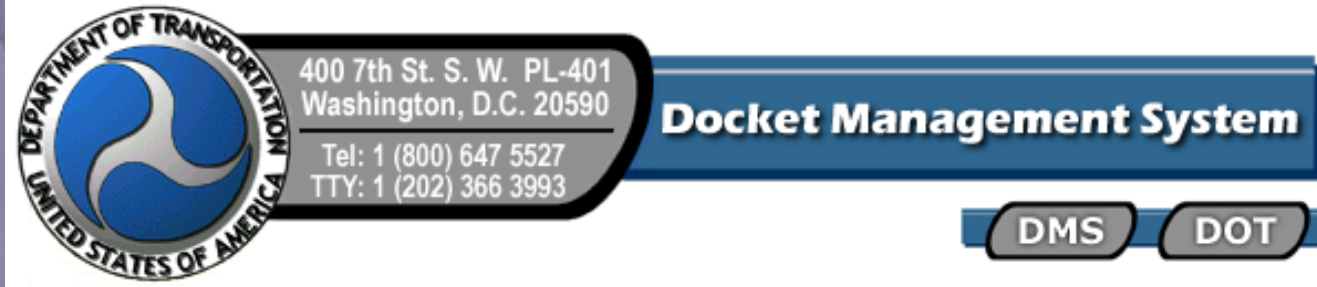
# CRM Risk Considerations

(continued)

- Many Controllers monitor only, consulting or deferring to field personnel for actions to be taken. In these cases, actions of field personnel can mitigate or contribute to CRM risks.
- Established definitions such as large and small operators, and “less than 20% SMYS”, are not good qualifiers in defining control room risks
- More complex and diverse operations call for more thorough control room systems and processes

# CRM Rule-Making Considerations

- NPRM Development, just beginning
- Performance & Risk based approach (similar to IMP)
- NPRM to account for both gas and liquid
- Operators to address all applicable CRM risk factors
- Compliance criteria and implementation timeline, TBD
- Timeliness of required NPRM
- Most operators account for many of the enhancement areas, some without a documented basis for their design choices, and some without formalized procedures



<http://dms.dot.gov>

- New Docket No. PHMSA-2007- 27954
- Old Docket No. RSPA-2004 -18584

Simple search on 27954 or 18584



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