

Accelerator Safety Workshop

Human Performance Initiative at Collider-Accelerator Department, Brookhaven National Laboratory

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Outline

- C-AD Facilities and Hazards
- Summary of Requirements
- Safety Management Model
- Performance Indicators
- Human Performance
- Summary

Summary of C-AD Facility Characteristics

- 120 Buildings
- 7 Accelerators
- 3 Major Experimental Areas
- 6.2 Miles Of Vacuum Pipe
- 24 Miles Of Cable Tray
- 1000s Of Electro-magnets / Power Supplies
- 10s Of Compressors For Cryogenics Systems
- 62 Electrical Substations
- 1000s Of Electrical Distribution Circuits
- 15 Cooling Towers In Service
- 52 Cooling Systems In Service
- 1.2 Million Ft² Of Office And Laboratory Space
- 1000 Acres Of Land
- 1200 Users
- 380 FTE Direct Staff
- 40 FTE Allocated Staff



Summary of Environmental Aspects

- Regulated Industrial Waste
- Hazardous Waste
- Mixed Waste
- Radioactive Waste
- Atmospheric Discharges
- Liquid Discharges
- Storage / Use Of Chemicals Or Radioactive Material
- Soil Activation
- Power And Water Consumption
- Sensitive / Endangered Species And Sensitive Habitats

Summary of Radiological Hazards

- Low-level Contamination
- Residual-radiation Levels At Collimators and Beam Dumps
- Tritium Production In Helium Gas And Cooling Water
- Radioactive Waste
- Radioactive Atmospheric Discharges
- Radioactive Liquid Effluents
- Storage / Use Of Radioactive Material
- Soil Activation
- Residual-radiation From Activated Materials
- Very High In-beam Radiation Levels
- Sky-shine

Summary of OSH Hazards

- Non-ionizing Radiation (Lasers, RF, UV)
- Magnetic Fields
- Working With Hazardous Or Toxic Materials
- Exposure To Electrical Energy
- Oxygen Deficiency
- Confined Spaces
- Being Struck By An Object; Cranes; Lifting Devices
- Falls; Vacuum; Pressure
- Contact With Temperature Extremes

Applicable Safety Requirements

- DOE Orders and Federal Regulations
 - DOE Order 5480.19, Conduct of Operations
 - DOE Order 420.2B, Accelerator Safety
 - DOE Order 420.1A, Facility Safety, §§ 4.2 and 4.4
 - DOE Order 414.1C, Quality Assurance
 - 10CFR835, Radiation Worker Protection
 - 10CFR851, Occupational Worker Protection
- BNL SBMS Subject Areas
 - 98 Subject Areas Contain ESH Requirements
- Voluntary Management Systems
 - OSH Management System, OHSAS 18001
 - Environmental Management System, ISO 14001
 - Human Performance Initiative, INPO



Registered to
OHSAS 18001



Safety Management Model at C-AD

Values (Integrity, Concern for Others, Concern for Environment)

3 Root Factors

- Management Commitment
- Line Responsibility For Injuries
- Worker Involvement



3 Driver Factors

- Clear Rules
- Competent Safety Specialists
- Comprehensive Safety Systems

Desired Outcomes



- Safe Equipment And Facilities
- Safe-aware People
- Excellent Injury Record
- ...

ESH Rules Versus Safety Model

Some ESH Requirement Sets	Comprehensive Safety System (Driver Factor)	Safety Management Factors:	
		Worker Involvement (Root Factor)	Management Commitment (Root Factor)
Integrated Safety Management (ISM)*	DOE Manual	5 Core Functions	5 Core Principles
Worker Safety and Health 10CFR851*	National and Consensus Standards	Worker Rights Responsibilities	Management Responsibilities
Safety Management System**	OHSAS 18001	Job Risk Assessment	Management Review
Environmental Management System**	ISO 14001	Process Assessment	Management Review
Human Performance** ***	Fisher Improvement Technologies	<ul style="list-style-type: none"> ■ Self-Check Tool ■ Step-By-Step Tool ■ Stop When Unsure Tool 	<ul style="list-style-type: none"> ■ Safety Culture Program ■ SMART Model for Procedures ■ Just Culture for Deviations

Beliefs
Practices

*DOE Mandated Requirements **Voluntary Requirements ***Improves Operations and ESH Performance



Audits - Where Do They Fit?

- By their nature, observational audits suffer serious handicaps
- They are subjective, both in judgments made by observers and in input shared by those observed
- What they see is colored by their experience and what they say is largely based on opinion
- To the auditor, past performance could have just been good luck

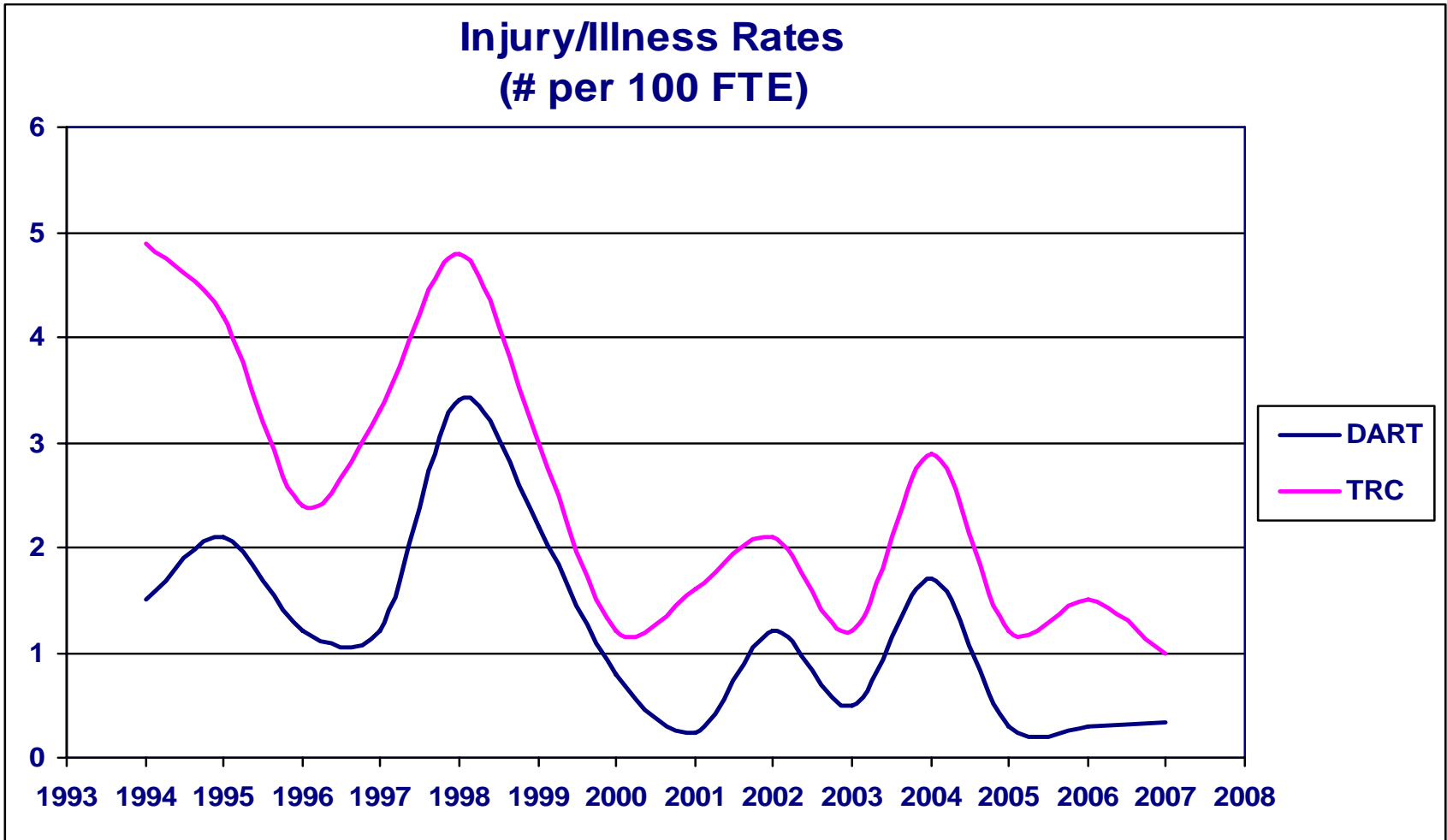
Past Performance

- What does it mean?

Performance, Backward-Looking Indicators

	2004	2005	2006	10-1-06 to 6-30-07
Collective Dose (person-rem)	5.3	1.4	0.95	0.55
Skin and Clothing Contaminations	0	0	0	0
Internal Contaminations	0	0	0	0
Hazardous Materials Overexposures	0	0	0	0
Annual DART Rate (# / 100 FTEs)	1.7	0.29	0.30	0.33
Number of Injury Cases	7	1	1	1
Annual Recordable Rate (# / 100 FTEs)	2.9	1.2	1.5	1.0
Number of Injury Cases	12	4	5	3
First Aid Cases Excluding Athletic Injury	5	1	1	4
Occurrences	7	3	2	1

Injury Performance - Long Term



Injuries In FY 2007

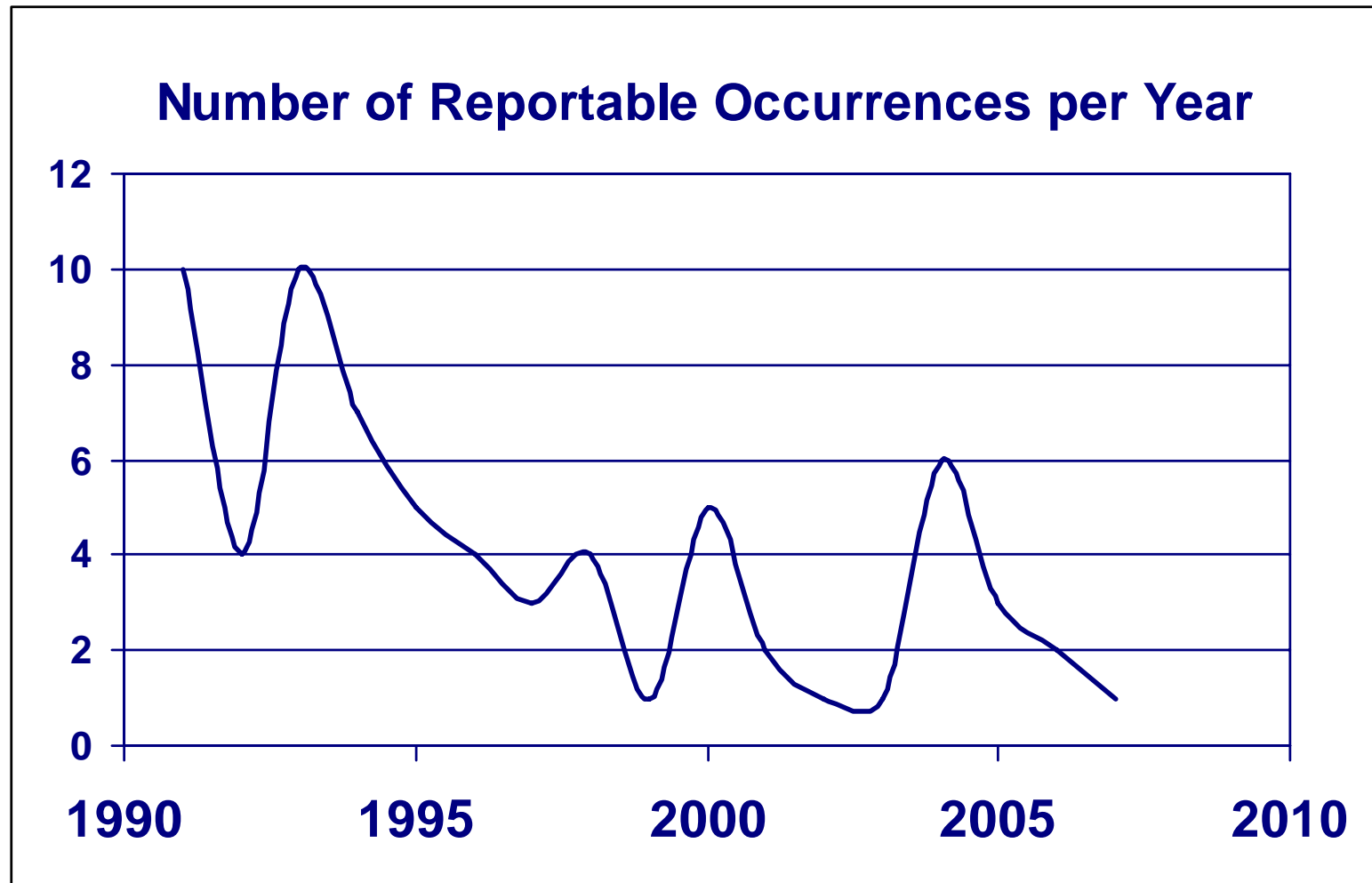
■ Recordable Cases

- Bookshelf fell, caused laceration of forehead, DART
- Cut hand on sharp edge of waste can, antibiotics given
- Dirt from air conditioner floated into eye, antibiotics given

■ First Aid

- Bruise from walking into stanchion
- Stood up and hit head on metal tank
- Cut finger on metal shelf
- Cut finger on tie wrap

Occurrence Performance - Long Term

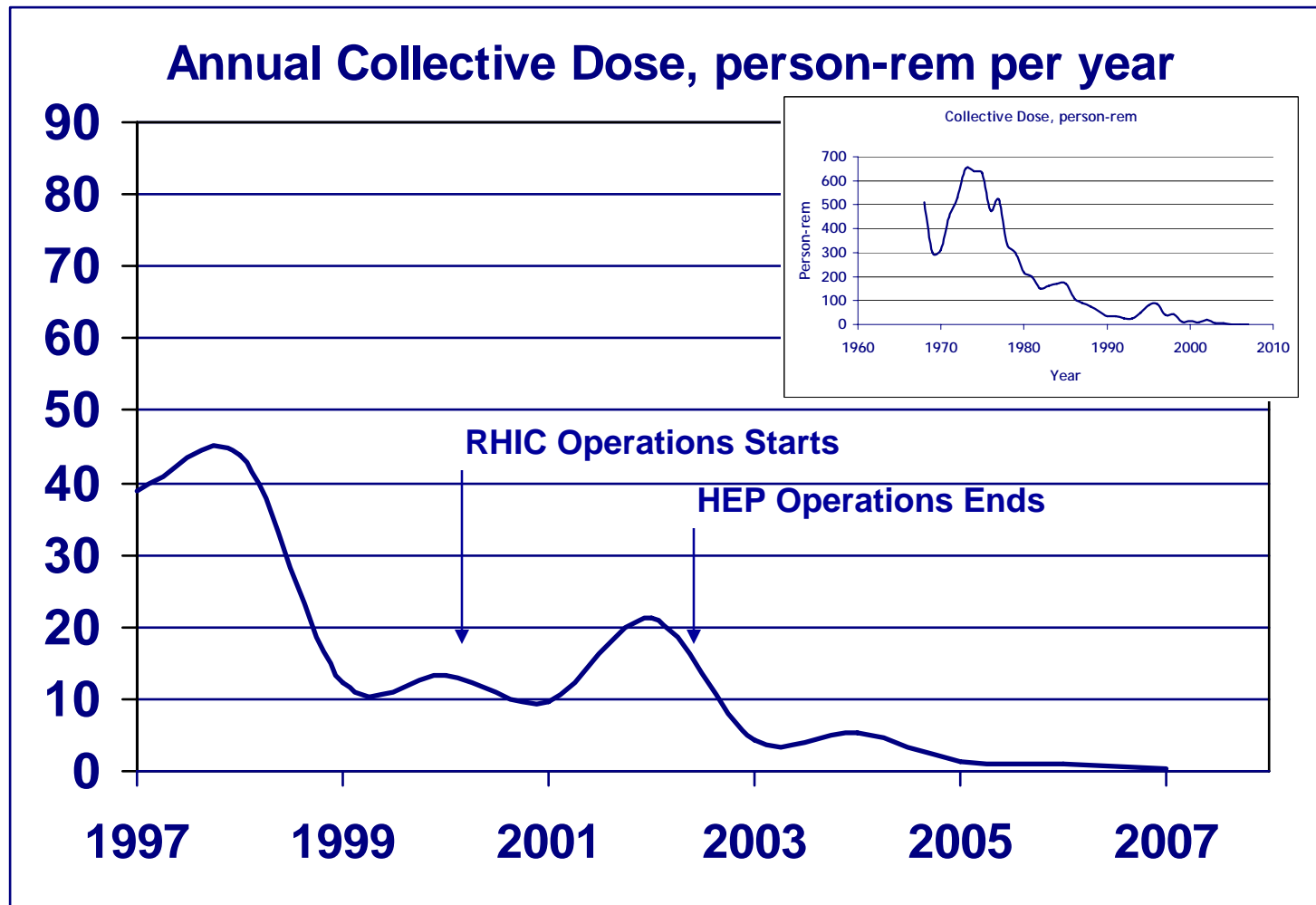


Occurrences In FY 2007

■ 2007

- Coffee-Room Microwave Oven Fire Causes Building Evacuation

Radiological Performance - Long Term

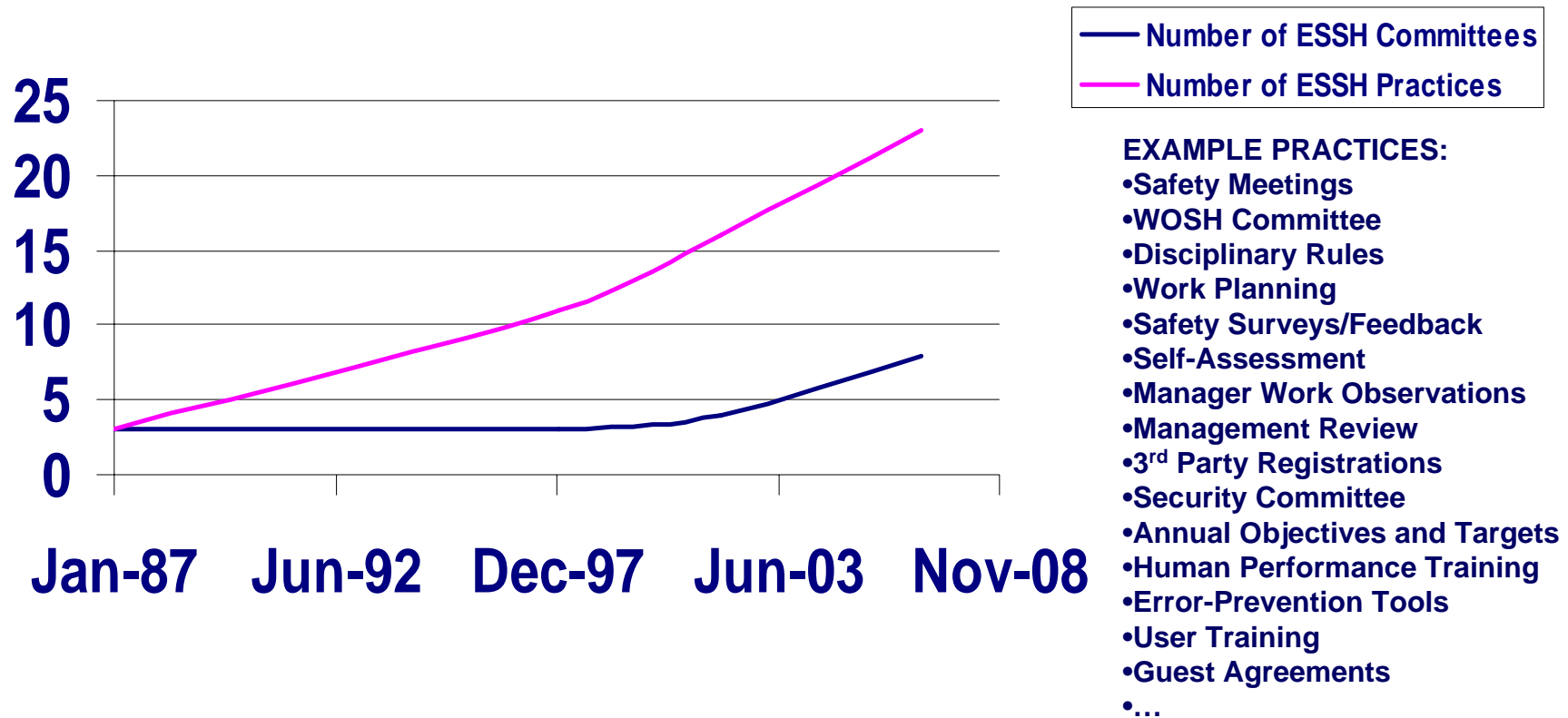


Backward-Looking Indicators

- C-AD Injury Performance Indicators Are In The Noise
- C-AD Technical Performance Indicators Are Declining:
 - OSHA Deficiencies
 - Occurrences and Environmental Non-Compliances
 - Radiation Exposure
- Backward-Looking Indicators Do Not Measure:
 - Organizational Deficiencies
 - Failure To Maintain And Modernize Critical Equipment
 - Operations Pressures
 - Cost-cutting In Maintenance, Training, Personnel
 - Management Commitment
 - Worker Involvement
 - Line Accountability For Injuries

Performance, Forward-Looking Indicators

Growth In ESSH Practices



Human Performance Initiative at C-AD

- C-AD managers and supervisors trained on fundamentals
 - Some discussion of specific human performance (HU) practices
 - 8 Hour Course
- Workers trained in HU practices
 - We chose practices associated with:
 - Worker planned work
 - Design of equipment
 - Event reporting
 - 12 Hour Course
 - Well Received - Supervisors want to start an HU team
- Annual re-training is planned
 - 2 to 4 Hours
- BNL likely to go forward and train whole lab in HU in September

Understanding Human Performance Improvement



You cannot engineer out the human element

Need a systems approach

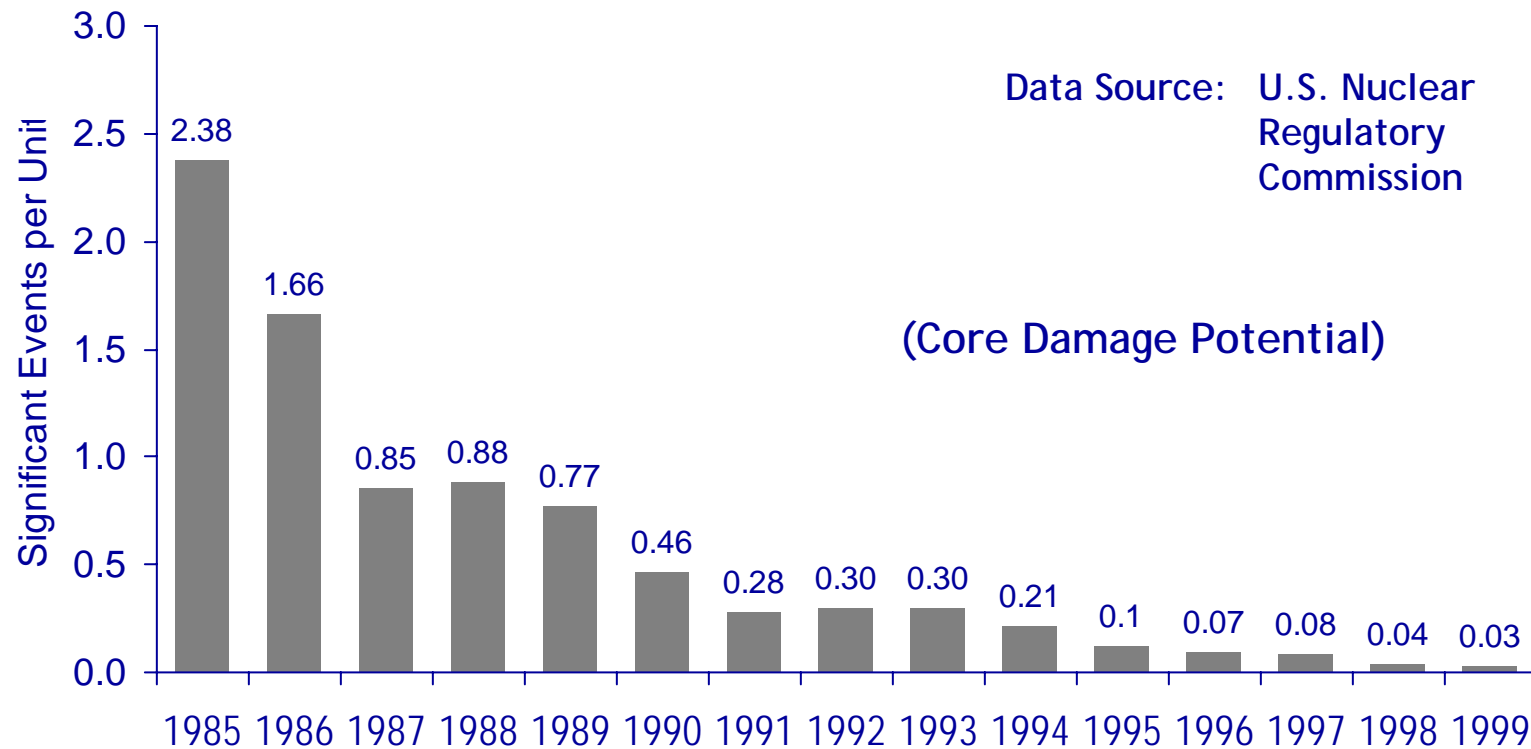
Purpose: Minimize the frequency and severity of events

Benefit: Improves performance in all areas, not just safety

Commercial Nuclear Experience

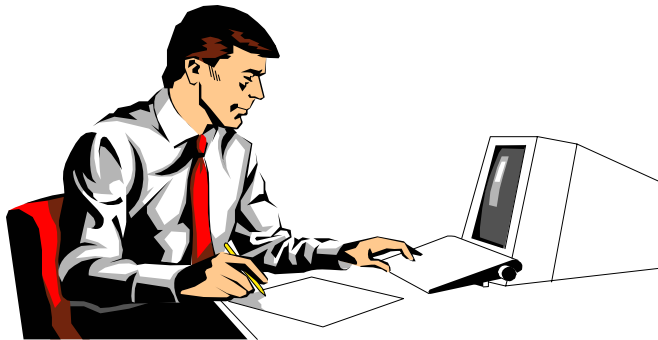
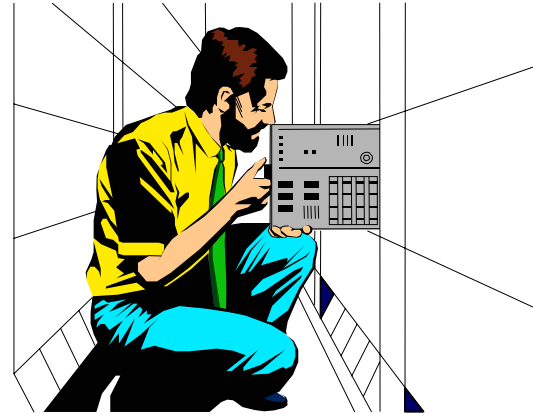
- 80% fuel-damaging accidents due to human error
- Three out of four significant events due to human error
- Greatest contributor to costs
- 70% of causes due to weaknesses in organization

Significant Events at Commercial Nuclear Plants, US Annual Industry Averages



Definition of human error: an action (behavior) that unintentionally departs from an expected behavior

Active Error ←



→ Latent Error

(leading to latent weakness)

More About Errors (Failures)

■ Active Errors

- Tend to be variable errors (slips, lapses, mistakes)
- Consequences often immediate
- Focus mainly sharp-end of the tool

■ Latent Errors

- Tends to be a consistent error
- Consequences lie dormant - act in the future
- Focus mainly on 3 root-factors and 3 drivers
 - Poor design, unworkable procedures, unworkable schedules, gaps in supervision, shortfalls in training, inadequate tools or equipment at work site, clumsy automation

Human Performance as a System

Guiding Principles

- **Organizational values influence individual behavior**
 - Small organization values always trump big organization values
- **Performance is based on reinforcement and self-motivation**
 - Managers must foster a culture that values prevention of errors
 - Supervisors must promote teamwork to eliminate error-likely situations
 - Individuals must want to improve personal capabilities
- **People are fallible**
 - The best make mistakes
- **Error-likely situations are predictable and preventable**
 - Only if you recognize them
- **Events can be avoided by knowing causes and applying lessons learned**
 - Human error is a consequence and not a cause

Strategic Approach

- Anticipate and prevent active error at the job-site
- Identify and eliminate latent organizational weaknesses

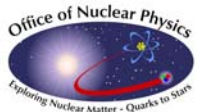
Examples of Error-Reduction Practices

- Practices aimed at preventing active errors:
 - Place Keeping
 - Peer Checking
 - Co-Worker Coaching
 - 'Am I Ready' Checklist

Performance Modes

Mode	Key Words	Known Error Rate When Not Using Error Reduction Practices
Skill Based	Habit; < 7 to 15 Steps; Low or No Conscious Thought	1:1000
Rule Based	There Is a Rule And I Know There Is a Rule	1:100 - 1:1000 (Memory - Written Procedure)
Lack-of-Knowledge Based	You Don't Know What You Don't Know	1:2 - 1:10

Performance Modes



Management Practices for Error Reduction

- Practices aimed at preventing latent errors:
 - Set standards, expectations and requirements that are tied to the mission and to values
 - Communicate standards to personnel through training and procedures
 - Observe work against the standards
- Failure to perform the practice in the above sequence can result in major failures

HU's SMART Model for Procedures

- **Specific** - level of detail is specific enough so individual can understand both the action and the reason for the action
- **Measurable** - Desired outcome should be clearly described such that it can be seen or the physical outcome is obvious
- **Action Oriented** - When describing actions or behaviors use active voice (shoulds and shalls are passive voice)
- **Realistic** - Individual must be capable of completing the task
- **Time Specific** - Actions need to have a specific time for completion

HU and Safety Management System

- HU addresses:
 - Organizational Deficiencies
 - Failure To Maintain And Modernize Critical Equipment
 - Operations Pressures
 - Cost-cutting In Maintenance, Training, Personnel
 - Management Commitment
 - Worker Involvement
 - Line Accountability For Injuries

Summary

- C-AD Has Large Facilities With Complex Hazards
 - Potential For Organizational Accidents With Multiple Causes
- ESSH Performance Is Approaching Excellence
 - Safety Systems Are Comprehensive (Rules, Training, Safety Experts)
 - Users / Workers Perform Work To The Same Safety Standards
 - Workers / Managers Involved In Safety Program Development
 - Line Held Accountable For Performance
 - Managers And Supervisors Are Committed To Excellence In ESSH
 - The Number Of ESSH Practices Is Increasing
 - Organizations Rated World Class In Safety Have 25 To 40 Practices
 - Human Performance Practices Are Being Implemented Currently
 - Events/Injuries Declining Toward Zero