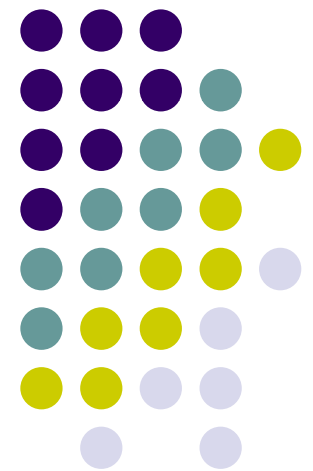
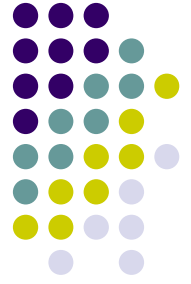


# Root Cause Analysis

---





# Root Cause Analysis

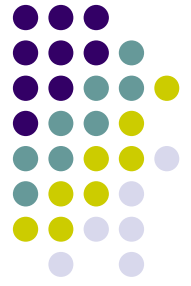
- Systematic safety process
- Series of analytical techniques
- Method for solving problems

# Objectives of Root Cause Analysis



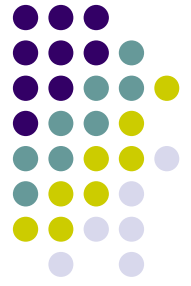
- Determine cause of failure
  - physical
  - operational
  - organizational
- Determine class of failure
  - specific
  - generic
- Take corrective action
  - short term (e.g. replacement, procedure)
  - long term (e.g. stop-use, recall, redesign)

# Objectives of Root Cause Analysis (cont'd)

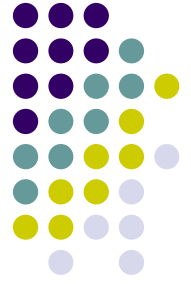


- Response to events
  - timely, objective, systematic
  - technically sound
- Documentation: factual, pertinent
- Identification: facts, conditions, circumstances, operational events
- Follow-up actions: corrective actions, design changes, dissemination of information

# Procedures for Conducting Investigations

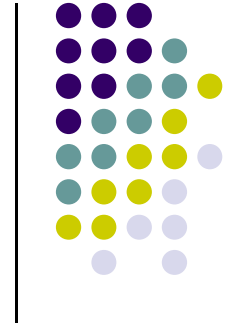


- Unique to each event
- Define the failure to be investigated
- Define individual roles
- Define authority and reporting relationships
- Information gathering needs
- Use of analytical techniques
- Use of relevant procedures



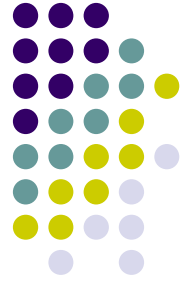
# Event Characteristics

- Multiple failures
- Possible adverse generic implication
- Complicated, unique, not understood
- Cause unknown
- Significant system interactions
- Repetitive failures
- Deficiency in design, construction, operation
- Operational or management performance
- Significant overexposure
- Significant release or contamination



## Process needs for success:

- People
- Procedures
- Plan

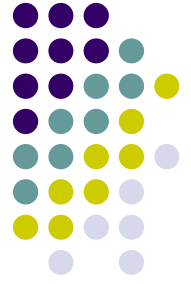


# Team Qualification

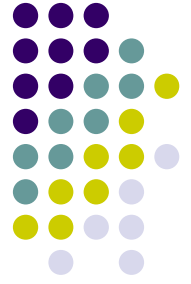
- Technical experts
- Skills to add potential contributions
- Independent, objective
- Trained in investigative techniques



# Program Philosophy

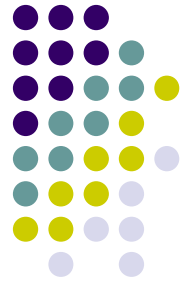


- Thoroughness, fairness, efficiency
- Safety precedence sequence
- Problem solving focus, not blaming
- Overt management support



# Procedures

- NRC Augmented Inspection Team (AIT)  
(ref. MC 0325)
- NRC Incident Investigation Team  
(ref. MC 0513, NRC Course G-600/G-601)
- Special training courses (NRC Root Cause Investigation Course G-205/G-207)



# Techniques (e.g. NRC Course G-205/G-207)

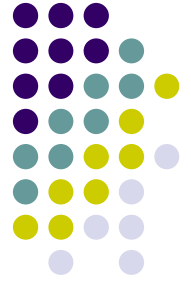
MORT1

Fault Tree Analysis

Hazard-Barrier-Target Analysis

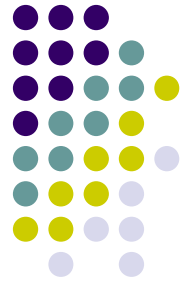
Change Analysis

W.G.Johnson, "MORT - The Management Oversight and Risk Tree," SAN 821-2, February 12, 1973, Sandia National Laboratory, U.S. Dept.of Energy. Current user manual is provided to participants of NRC Course G-205/207.



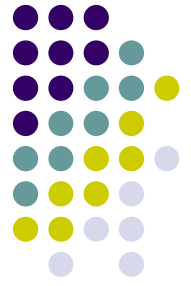
# Key Program Considerations

- Event definition
- Assigning the investigation
- Procedures for conducting the investigation
- Define post-investigation responsibilities
- Training



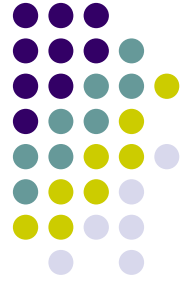
# Probabilities

- Frequent - to occur often during life
- Probable - several times during life
- Occasional - sometime in life
- Remote - unlikely, but possible sometime
- Improbable - unlikely in one particular unit, assumed in large number



# Consequences

- Catastrophic - death, loss of system or plant
- Critical - severe injury, major system damage
- Marginal - minor injury, minor system damage
- Negligible - less than the above

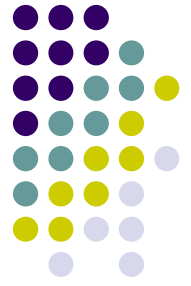


# Analysis of Hardware Failure

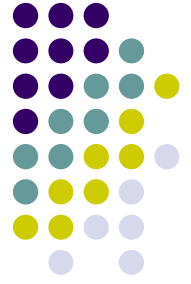
- Initial familiarization
- Consideration of consultants
- Preservation of physical evidence
- Hardware analysis
- Analysis of Equipment Use

# First Actions to Take

- Preservation of evidence
  - scene/object observation
  - testimony of personnel
- Initial documentation
  - field notes
  - photography
  - sketches
  - drawings
- Familiarization with facility, operation

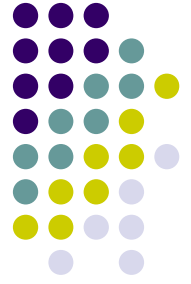






# Hardware Analysis

- Hardware tear down
- Consideration of failure modes
  - structural integrity
    - chemical
    - embrittlement
    - radiation
    - corrosion
  - functional integrity
    - unanticipated energy transfer
- Consideration of failure sequence



# Analysis of Equipment Use

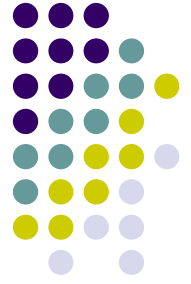
- Operating parameters (temp., pressure, etc.)
  - logs, charts, tapes
  - entire system
  - individual components
- Correlation with design/ operating limits
  - adequacy of limits
  - adherence to limits

# Analysis of Equipment Use (cont'd)

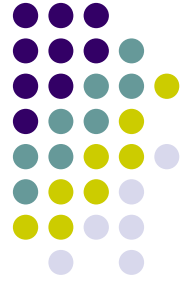


- Equipment history
  - failure history
  - mis-use history
  - maintenance history
  - QA records

# Presentation of Findings



- Main Line Events
  - central to the action
  - delineation of who did what when and where
- Off the Main Line Issues
  - secondary events (responses, less important happenings)
  - conditions
  - background
  - delineation of how and why things happened

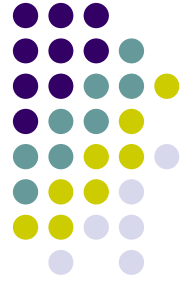


# Presentation Style

- Precisely and concisely worded
- Contain a single main idea
- Connected logically and chronologically
- Based on valid information

# Define Post-Investigation Responsibilities

- Review of results
- Implementation of corrective actions
- Response to comments
- Feedback to those involved
- Verification of completions of corrective actions
- Trending of causes





## Examples

“Source Disconnects Resulting from Radiography Drive Cable Failures,” NUREG-1631, May 1998

“Loss of an Iridium-192 Source and Therapy Misadministration at Indiana Regional Cancer Center, Indiana, Pennsylvania, on November 16, 1992,” NUREG-1480, February 1993

“Inadvertent Shipment of a Radiographic Source from Korea to Amersham Corporation, Burlington, Massachusetts,” NUREG-1405, May 1990