



**EXPLORING THE EFFECTS
OF HUMAN FACTORS
ON ULTRASONIC
NONDESTRUCTIVE
EXAMINATION**

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Research Motivation & Purpose



- Motivation
 - Indications that field performance of ultrasonic (UT) non-destructive examination (NDE) may be degraded compared to that in "qualifying" exams
 - Sporadic empirical research efforts to study human factors (HF) issues that could affect ultrasonic examiner performance in the field
- Purpose
 - Identify and understand the human factors that are most likely to impact personnel performance during NDE in nuclear power plants
 - Assist in planning future research, evaluating whether changes are needed in regulatory requirements, and providing technical justification for regulatory decisions



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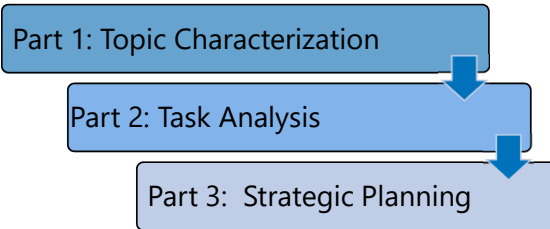
Research Goals



- Systematically evaluate the human factors that can affect UT examiners
- Identify future actions to address human factors challenges in NDE

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Research Approach



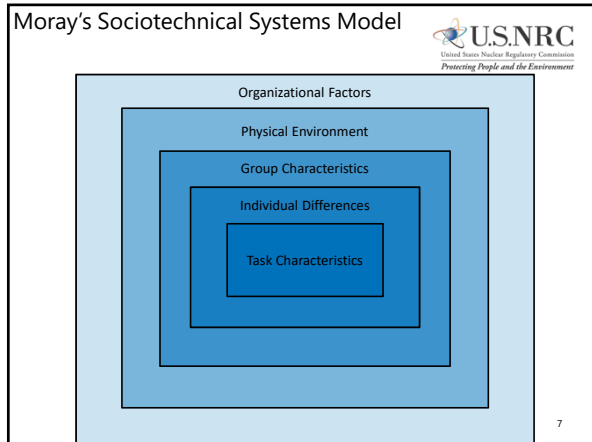
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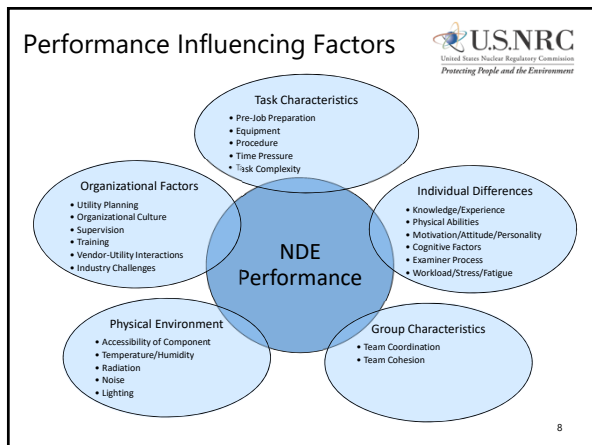
Part 1: Topic Characterization



- Objectives:
 - High-level understanding of NDE
 - Characterize current state of human factors research in NDE
- Activities:
 - Discussions with subject matter experts
 - Reviewed NDE codes, standards and regulations
 - Reviewed NDE research and technical reports
 - Collected NDE-related operational experience from NRC inspection reports
 - Multiple visits to EPRI's performance demonstration facility
- Completed Literature Review
 - Report publicly available: "Review of Human Factors Research in Nondestructive Examination"
<https://www.nrc.gov/docs/ML1705/ML17059D745.pdf>

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Part 2: Task Analysis

- Objectives:
 - Understand what UT examiners do, the environment they do it in, and the challenges they face
- Activities:
 - Interviews and focus groups with subject matter experts (N=30)
 - Observations of UT in nuclear power plants
 - Reviews of procedures and guidance documents
- Outcomes:
 - Characterization of UT NDE functions and tasks
 - Identification of performance influencing factors in the field

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Manual Ultrasonic Testing Task Analysis



FUNCTION: A group of activities generally performed together to accomplish an overall goal.

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    graph LR
      A[PLAN FOR EXAMINATION] --> B[PREPARE FOR EXAMINATION]
      B --> C[CONDUCT EXAMINATION]
      C --> D[REPORT EXAMINATION RESULTS]
  
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TASKS

1. Receive plant orientation and training
2. Review work documentation and procedure
3. Verify that the component is within the procedure and personnel qualification ranges
4. Assemble equipment and materials
5. Calibrate equipment to procedure
6. Attend pre-job briefing
7. Coordinate examiner responsibilities
8. Pack equipment and materials
9. Prepare to enter area for exam
10. Locate component

TASK: A smaller unit of behavior that provides information about the human-information processing demands, communication requirements, instrument interactions, etc.

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Sample of Topic Areas from Interviews



- Utility Planning
 - Required safety qualifications (e.g., respirator) not specified in advance
 - Craft work for exam not completed (scaffolding, insulation, surface prep)
 - Work package wrong or incomplete (observed before entry to protected area)
 - Drawings not up to date
- Time pressure
 - Schedule constraints or changes delay or impede exam
 - ALARA limits lead to exam stoppage
 - Outage Control Center intervention drives perceived pressure
 - Pressure to complete analysis of indications
- Training and practice
 - Lack of feedback opportunities during performance demonstration
 - Availability of practice samples
 - Experience hours not always applicable to job performance
 - Lack of practical on-the-job opportunities prior to qualification

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Part 3: Strategic Planning



- Objectives:
 - Present findings from Parts 1 and 2 and discuss
 - Identify areas for future action and type of action to take
- Activities:
 - Interactive workshops with stakeholders co-sponsored with EPRI
- Outcome:
 - List of human factors elements that may affect UT performance and potential future action

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Thank you!

If you have questions, please email:
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