

EXPLORING THE EFFECTS OF HUMAN FACTORS ISSUES ON ULTRASONIC NON-DESTRUCTIVE EXAMINATION

Dr. Amy D'Agostino, Dr. Stephanie Morrow, Dr. Niav Hughes, Carmen Franklin and Carol Nove

Note: The views expressed herein are those of the author(s) and do not represent official positions of the U.S. NRC.



Research Motivation

- Indications that field performance of ultrasonic (UT) non-destructive examination (NDE) may be degraded compared to that in “qualifying” exams
- International interest in examining factors present in the field that can degrade the quality of a UT NDE
- Sporadic empirical research efforts to study human factors (HF) issues that could affect ultrasonic inspector performance in the field



Research Goals

- Systematically evaluate the human factors issues facing UT inspectors
- Determine the key differences between qualification performed in a laboratory environment vs. field inspections
- Determine the highest priority human factors issues that may be impacting UT NDE performance in the field



Research Approach Part 1: Topic Characterization

Activities :

- Visits to EPRI, licensees, and discussions with subject matter experts
- Review of relevant UT codes, standards and regulations
- Review of relevant operating experience
- Literature review
 - Identify and survey the literature that addresses human factors in NDE

Desired Outcomes:

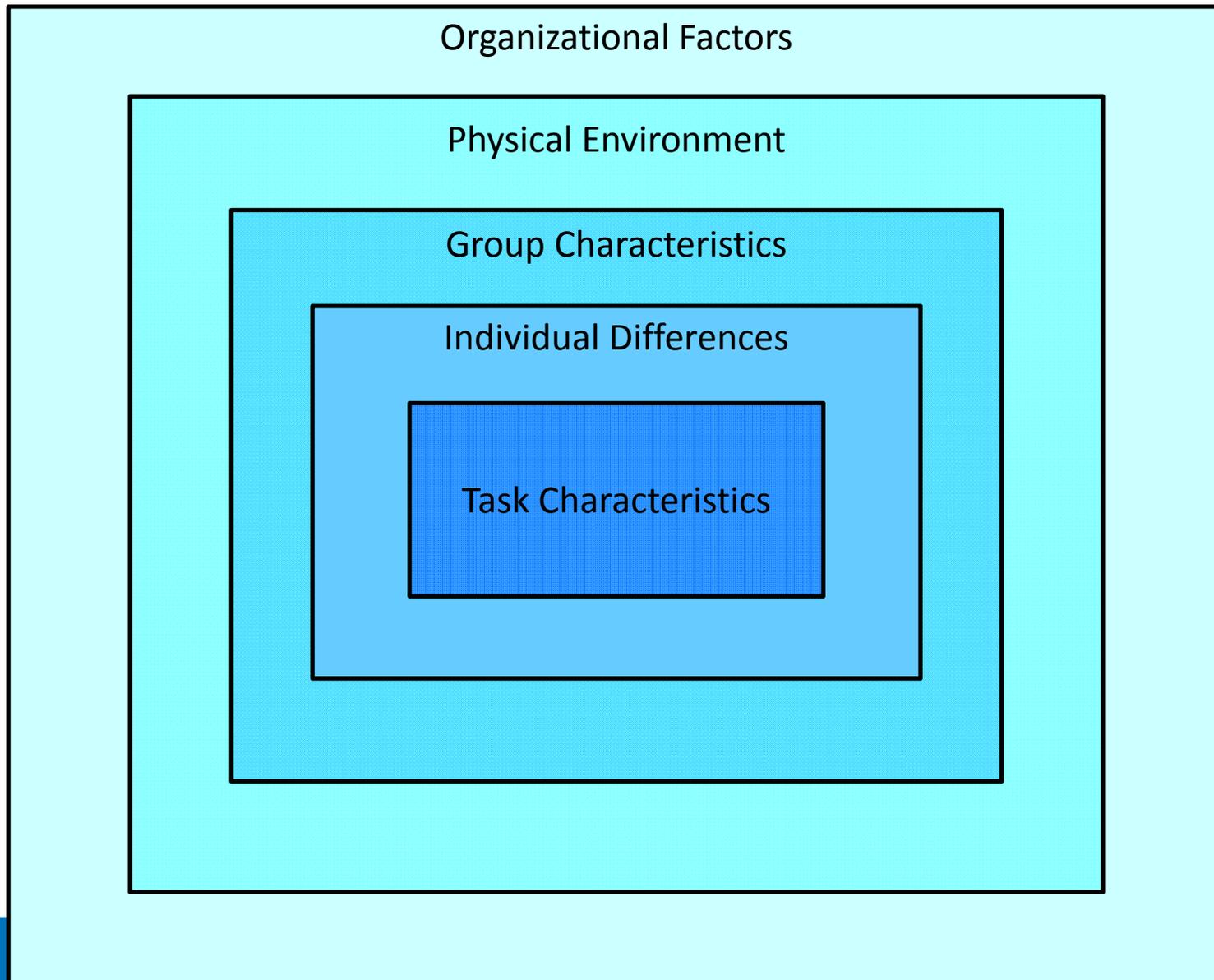
- Accurately characterize UT NDE (e.g. workflow, equipment, working environment, etc.)
- Document comprehensive literature review
- Identify HF elements germane to UT NDE that have been adequately addressed and those requiring additional research

Part 1: Current Status

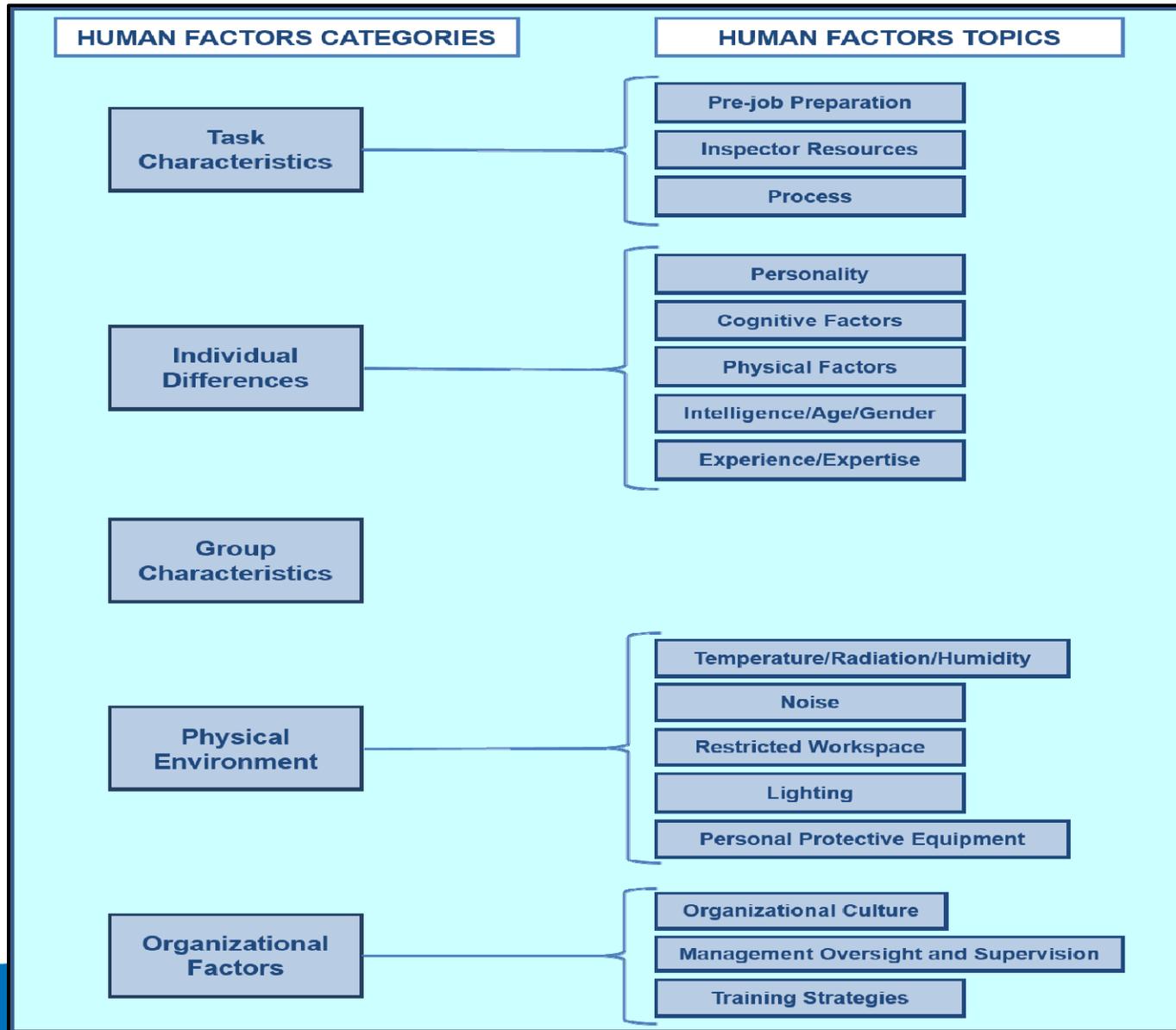
Activities:

- Multiple visits to EPRI performance demonstration facilities
- Visits to 2 Nuclear Power Plants to observe UT NDE in the field
- Completed review of all applicable codes, standards and regulations
- Collected operational experience through:
 - Reviewing NDE-related NRC inspection reports
- Literature Review
 - 200 potentially relevant articles/reports/papers dealing with HF in NDE identified
 - Of those, ~100 were found to be relevant
 - Review, analysis and report writing are underway
 - Developed a human factors categorization scheme for review based on Neville Moray's sociotechnical systems model (2000)

Moray's Sociotechnical Systems Model



Expanded Model Based on NRC/RES Literature Review



Literature Review: Items of Note



- Much of the literature is either qualitative/experiential in nature- very few empirical articles
- Organizational factors
 - Difficult to simulate in laboratory conditions, but may be a primary contributor to NDE reliability
 - Interactions between the NDE vendor and utility can affect quality of planning and preparation
 - Management can influence inspector's decision criteria (i.e. propensity to make false calls versus missing defects)
 - Training strategies (e.g., use of job aids and simulations) can affect inspector's reliability
- Physical Environment
 - Degraded physical environment may have a greater impact on performance when combined with other factors, such as task difficulty

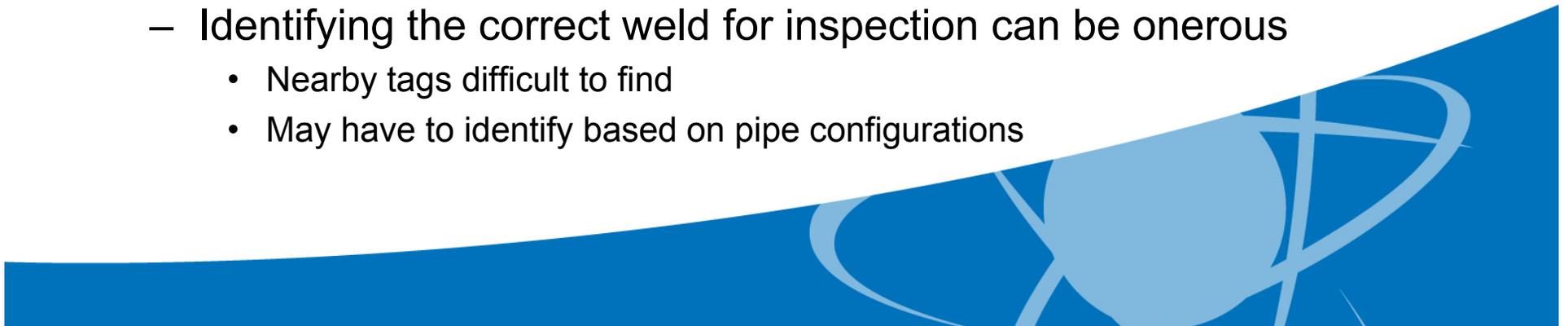
Literature Review: Items of Note



- Individual Differences
 - Personality factors, conscientiousness & extraversion, found to impact NDE performance
 - Mechanical comprehension correlated with better performance
 - Visual capacity impacts NDE inspection success
 - Inspector attitude & motivation influences NDE performance
- Task Factors
 - Equipment design issues are widely acknowledged, multiple calls for design guidance
 - Pre-job prep can impact the quality of the NDE
 - One strategy suggested in the literature to improve performance is more frequent and realistic practice
 - Information attended to and processed, scanning technique and speed, posture one is in and how one interprets signals are all process elements that can impact performance

Observations

- Inspection reports:
 - Inadequate procedures, inadequate oversight, inadequate calibration, improper method/equipment, failure to follow procedures, exam conducted on wrong component/weld, proper documentation not provided or maintained
- Information/observations from the field:
 - Many personnel are not employed year-round doing NDE (may only work in Fall and Spring)
 - Conditions for exam vary widely (e.g. heat, noise, ease of access, space restriction)
 - Identifying the correct weld for inspection can be onerous
 - Nearby tags difficult to find
 - May have to identify based on pipe configurations



Research Approach Part 2: Compare Lab vs. Field



Activity: Exploratory study of manual conventional UT and PAUT in the laboratory environment and field inspections

- Proposed Method- Job/Task Analysis
 - Job Analysis- high-level description and analysis of a group of positions which are identical with respect to their major or significant tasks
 - Task Analysis- A study of what people are required to do to achieve a specified objective.

Research Approach Part 2: Compare Lab vs. Field



- Collect data via interview, observation, table-top discussions, procedure analysis, document review
- Subject matter experts are critical to JTA
 - NDE science/engineering background
 - NDE trainers/testers
 - Active Inspectors (all levels)
 - Utility and Vendor
 - Regulatory Personnel



Research Approach Part 3: Prioritization



Activity: Prioritize the human factors issues identified in Parts 1 and 2 using appropriate criteria

Desired Outcome: The prioritization serves as input to the development of a plan for future research.

Status of MOU



- Objective: This effort is intended to inform industry and the NRC about human factors issues associated with NDE and practices that may improve NDE reliability in the field
- Due to delays in MOU approval, collaborative activities are just beginning
- 4 Tasks
 - Systematically evaluate the human performance issues facing inspectors
 - Independent literature reviews have been completed, reports will be shared
 - Identify the key differences between human performance in qualification versus in the field
 - Collaborative data collection effort; independent reports
 - Prioritize the human performance issues for examinations in the field
 - Collaboration on prioritization
 - Combined finalized list
 - Outline the potential applicability of the research results to other NDE methods
 - Collaboration in form of work-shop
 - Combined workshop report





Thank you!

If you have questions, please email:
Amy.Dagostino@nrc.gov

