



Human Factors in Encoded Exams: Planning for Task Analysis

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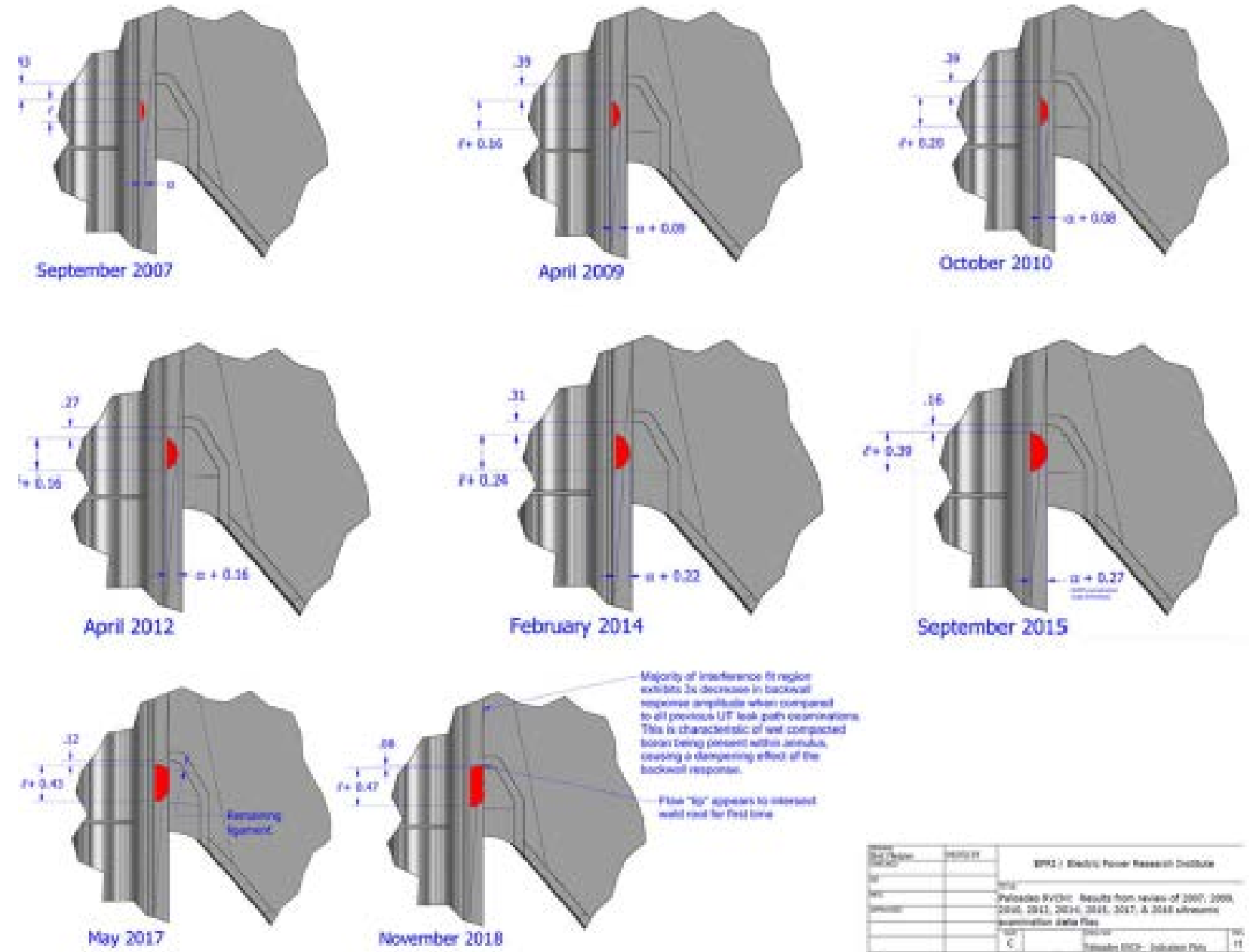
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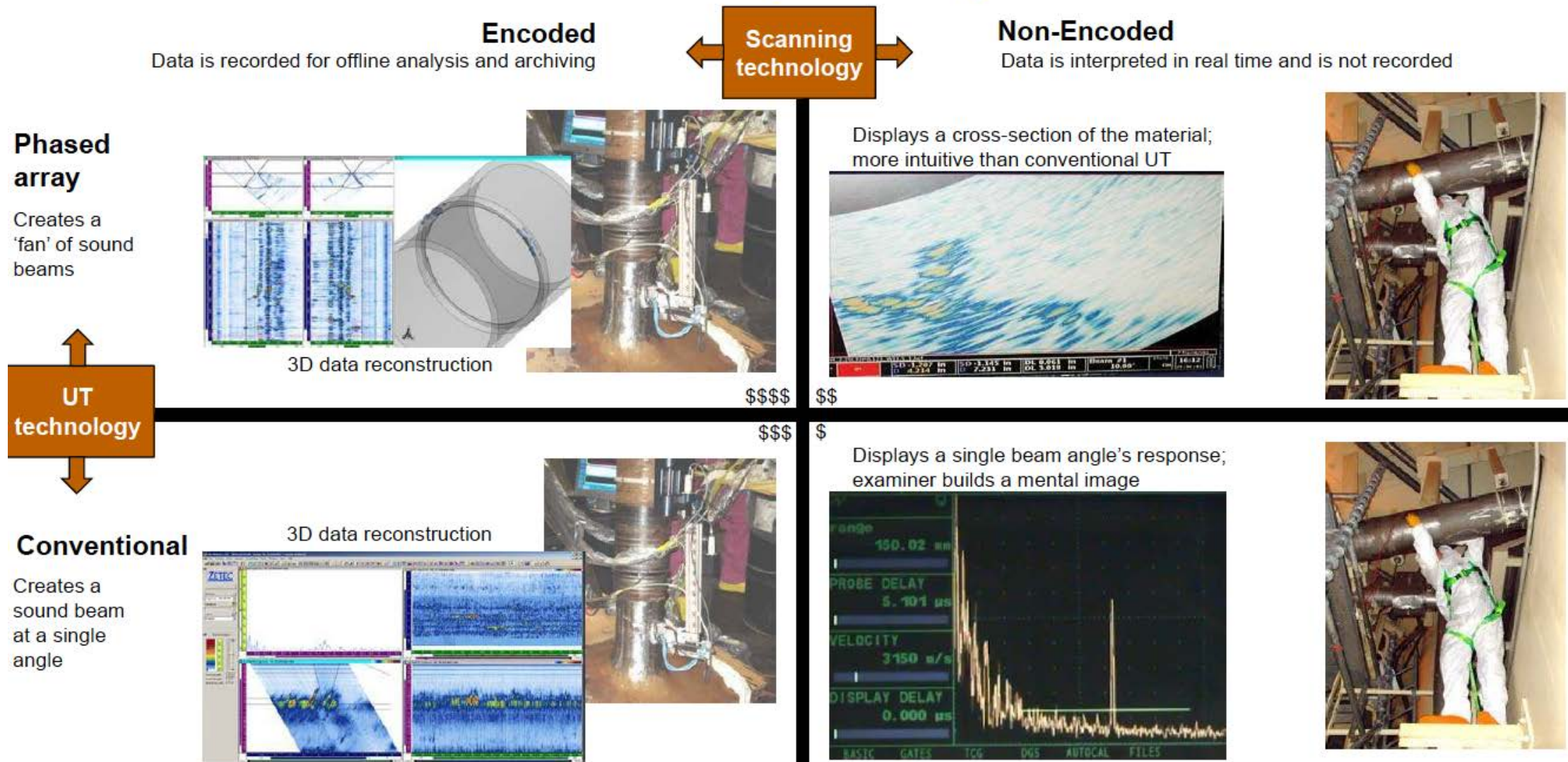
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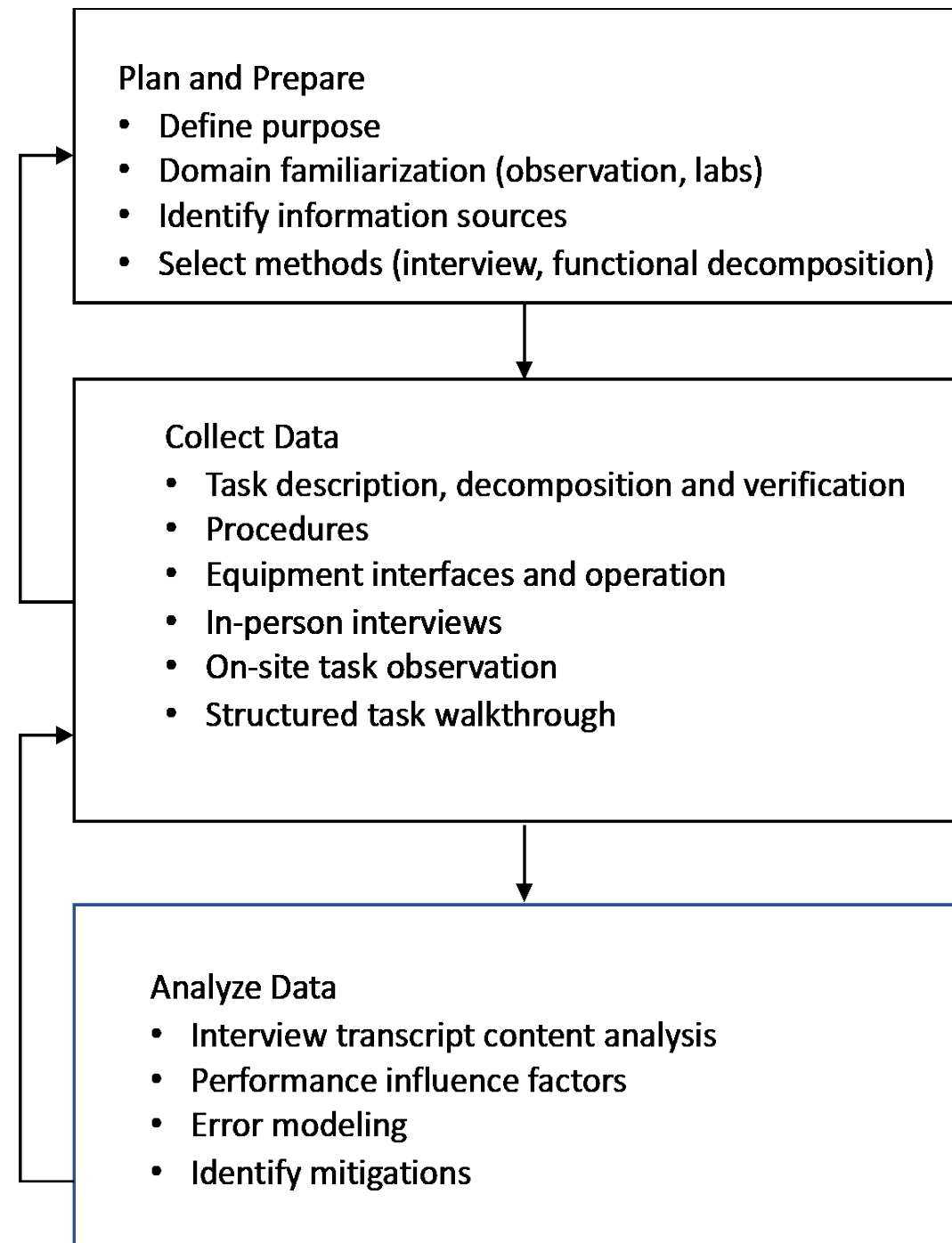
- Initiating Event (Palisades):
 - Missed flaw in upper head penetration for 10 years
 - Discovered via leakage
- Initially attributed to geometry, and subsequent inspections did not differ in interpretation
- Similar “miss” at Sharon Harris in 2012 (discovered by independent review)
- Encoded is more complex
 - More people, more data
- Objective: identify reliability influences and error precipitating factors
 - Extend task analysis demonstrated in manual UT to encoded exams



Ultrasonic Examination Technique Categories



Flow of Research Tasks



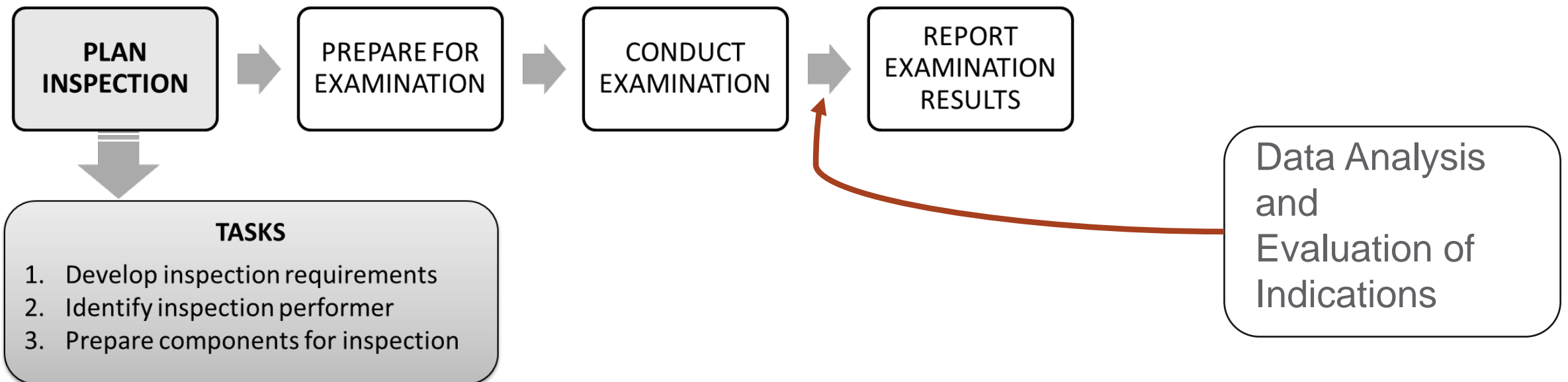
Selection from structured interview protocol

Planning Inspection

First, let's start with what happens before you even get to a site to perform a UT exam *[Show graphic]*

[Note: This function may not apply to all interviewees – skip if needed.]

FUNCTIONS



- As an examiner, what is your role in planning for the inspection?
- When planning the inspection, what tasks are most important to get right? Why?
- What factors can influence how well these tasks are performed? What kinds of problems are encountered if these tasks are not performed well?
- Task Check: Are there any tasks not on this list that you think are important?

From PNNL-27441, *Human Factors in Nondestructive Examination: Manual Ultrasonic Testing Task Analysis and Field Research*, June 2018, ML18176A055

Function	Task	Subtask
1. Plan for Examination	1.1 Develop plan based on requirements and previous data	1.1.a Review and revise procedures
	1.2 Identify qualified examiners	1.2.a Bid contract if necessary
	1.3 Ensure component prepared for examination in the field	1.3.a Walk-down areas to be examined
		1.3.b Determine special equipment, personnel, and access requirements
		1.3.c Measure components and access routes
2. Prepare for Examination	2.1 Receive plant orientation and training	1.3.d Prepare work packages
	2.2 Review work package and procedure	2.2.a Obtain work package
		2.2.b Review drawings, operating experience, location of component, weld history, weld profile, previous scanning technique, etc.
		2.2+ <i>Review prior exam results</i>
		2.2+ <i>Check system linearity and channel function (element check)</i>
		2.2.c Develop scan plan according to procedure
		<i>Raster or line scan (circumferentially oriented flaws)</i>
		<i>Raster scan (axially oriented flaws)</i>
		<i>Select manual or fully automated drive</i>
		<i>Select reference system associated with technique</i>
		<i>Create data acquisition layout to allow operator to observe and monitor data acquisition</i>
		<i>Calculate focal laws for probes</i>
		<i>Conduct channel function check</i>
		<i>Create examination setup file detailing parameters of inspection</i>
		2.2.d. Determine recording criteria for indications according to procedure
	2.3 Verify that the component is within the procedure and personnel qualification ranges	
	2.4 Assemble equipment and materials	2.4.a Select scope, transducers, cables, couplant gel, <i>drive mechanisms</i> , etc. according to procedure
		2.4.b Re-familiarize self with equipment
	2.5 Calibrate equipment to procedure	2.5.a Save calibration files
		2.5.b Complete calibration forms

Data Analysis Functions for Encoded PA Exams

Function	Task	Subtask
<i>Data Analysis and Evaluation of Indications</i>	<p>Verify post-examination calibration</p> <p><i>Verify data quality; re-examine areas as necessary</i></p> <p><i>Flaw Detection Analysis</i></p> <p><i>Classify indications as flaw or geometry</i></p> <p><i>Determine size and depth per procedure</i></p> <p><i>Record non-relevant indications in sufficient detail to assist future examinations.</i></p>	<p><i>Gate volume to identify benchmark information</i></p> <p><i>Gate regions within volume. Compare patterns and responses from different wave modes, angles, skews and beam directions</i></p> <p><i>Adjust sensitivity (gain or palette) to improve contrast as necessary</i></p>

Content Analysis of Interview Data to Identify Themes

- The statement needed to convey a positive or negative influence on examination outcome. All other material was considered task description or extraneous comment.
- The block of text should be limited to only the content needed to capture the nature of the comment. This may be one or several sentences, but generally brief.

Original Order	Number	Quotation	Performance Influencing Factor	HF Category
1	1	Kind of get a feel for what exams take a little more work as far as pre calibrations etc. So when he pulls it out, he might give more lead time when he knows who is going to be doing it.	Utility Planning	Organizational Factors
2	2.1		Utility Planning	Organizational Factors
3	2.2	understanding if there is industry OE e.g. dissimilar metal welds - that you do all the pre planning actions that are associated with that type of examination they are not all equal - some require more effort	Task Complexity	Task Characteristics
4	3	if you don't do a good job of finding out the history, you can set the guy up who goes to do it, if it's in a high radiation area, he might spend more time into it. e.g. weld profiles, previous geometry that had been recorded previously	Utility Planning	Organizational Factors

Issues for Discussion

- Manual UT Task Analysis demonstrated utility of method – SME interviews and job functional decomposition
- Extension to Encoded UT will require more focus due to complexity
 - Equipment Operators
 - Data Analysts
 - Off-line analysis
- Can we use findings from project 1 to narrow our focus to areas most likely affect reliability?
 - Functions
 - Tasks and subtasks within functions
 - Performance Influence Factor definitions
- Opportunities for observation and interviewing in coming outage seasons – do plants in your utility have encoded exams in scope of Spring ISI?

Potential Areas of Focus

- Division of responsibility and communication between Equipment Operator and Data Analyst
- Task Complexity:
 - Factors such as ambiguity in assessing or executing the task, the degree of mental effort or knowledge involved, whether special sequencing or coordination is required, or whether the task requires sensitive and careful manipulations
- Knowledge/Experience
 - What the examiner knows, level of experience on the job, and certifications and qualifications
- Time Pressure
 - Temporal constraints due to specific exam performance or the overall inspection schedule
- Workload/Stress/Fatigue
 - Pace, intensity, and duration of exam, work shifts or assignments