Upcoming Changes to NRC Human Factors Guidance

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Summer School 2016
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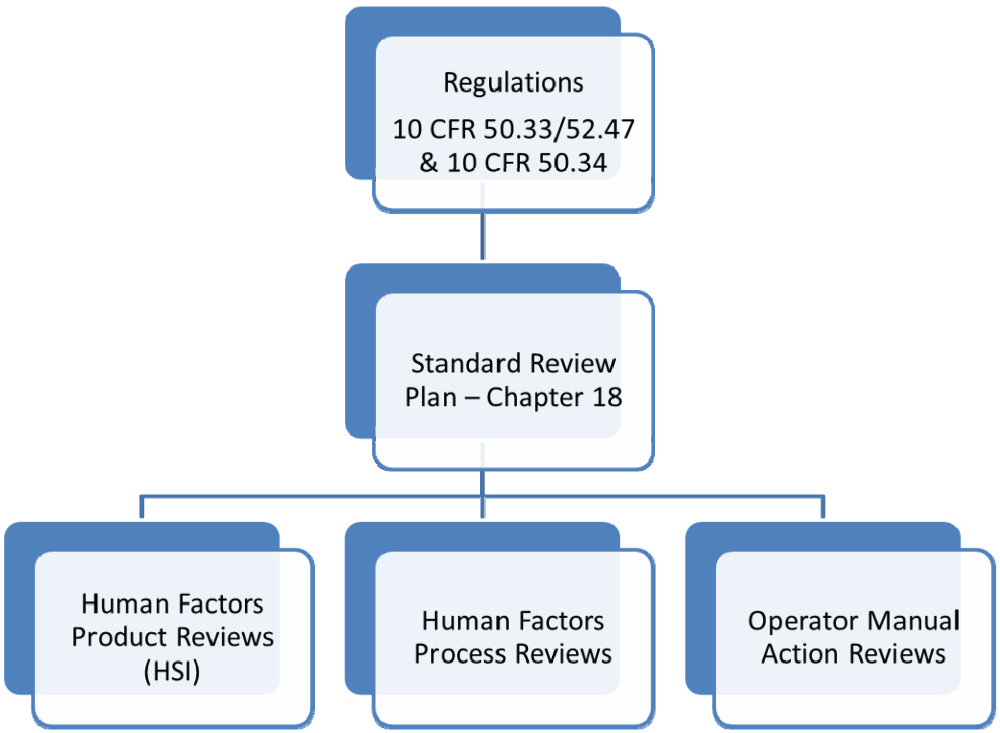
Overview

- There are recent changes and impending changes to all of the major NRC human factors guidance documents.
  - Standard Review Plan Chapter 18
  - NUREG-0711
  - NUREG-0700
  - NUREG-1764
- This presentation is a summary of these changes.

Summary of Updates



Document	Status
Standard Review Plan Ch 18	Revision in Progress (2016)
NUREG-0711 (HFE Process)	Updated 2012; Next update ~5 years
NUREG-0700 (HSI products)	Phased review in progress (2016)
NUREG-1764 (OMA reviews)	Branch Technical Position in progress (2017)

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Upcoming Changes to Standard Review Plan - Chapter 18 “Human Factors Engineering”

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Focus of Chapter 18 Revisions

- Usability, clarity, and applicability to review process for both new and operating reactors
- Better aligned with current practice
- Includes lessons learned from recent new reactor design reviews
- Updated technical references
- Improved guidance for evaluation credited manual operator actions

Status of Chapter 18 Revisions

- Draft Rev. 3 Published July 2015
  - Public comments received and addressed
  - Substantial revisions require another public comment (Summer 2016)
- Expected completion end of 2016

Upcoming Changes to NUREG-0711 (Rev. 4)

“Human Factors Engineering Program Review Model”

Brian Green and Stephen Fleger
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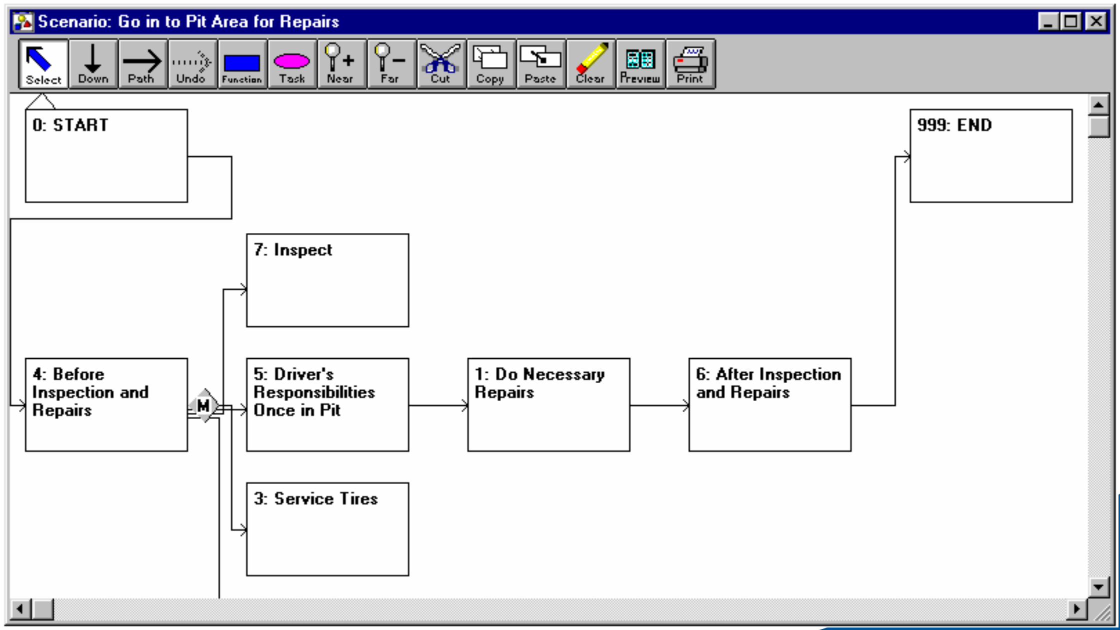
Overview:

Upcoming Changes in NUREG-0711 Rev. 4

- Cognitive task analysis
- Analyses to identify instrumentation & control system degradations impacting the performance of important human actions
- Human-performance models
- Integrated-system validation



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ISV Updates

-Background

- The review guidance were originally developed in 1997
  - NUREG/CR-6393
- While the guidance has been periodically updated, no additional research has been conducted to address ISV since its original development

NUREG/CR-6393
BNL-NUREG-52483

Integrated System Validation: Methodology and Review Criteria

Prepared by
J. O'Hara, W. Stubler, J. Higgins, W. Brown

Brookhaven National Laboratory

Prepared for
U.S. Nuclear Regulatory Commission

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Background

- The need for additional ISV guidance was identified in NRC research
  - 2008 study examined a broad range of issues associated with emerging technology
    - 14 subject matter experts (SMEs) evaluated the issues
    - ISV was identified as one of the top-priority issues
  - 2010 study focused specifically on topics related to HFE methods and tools
    - five SMEs evaluated the topics
    - ISV was the highest rated topic

- Based on these findings, the NRC initiated an effort to develop additional guidance

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Project Objectives

- Revising the ISV review guidance
  - updating existing guidance currently contained in NUREG-0711
  - preparing new guidance as necessary
- The current research is the first step in the process
  - to identify the aspects of ISV that need to be updated
  - to identify the technical basis available to support guidance development

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Results

- We identified technical issues and some tentative recommendations for addressing them

- Issues were organized into
  - *high-level issues* that capture bigger picture topics
  - *detailed issues* that capture the need for additional guidance on specific aspects of ISV methodology

- A summary of these issues is presented in following slides:

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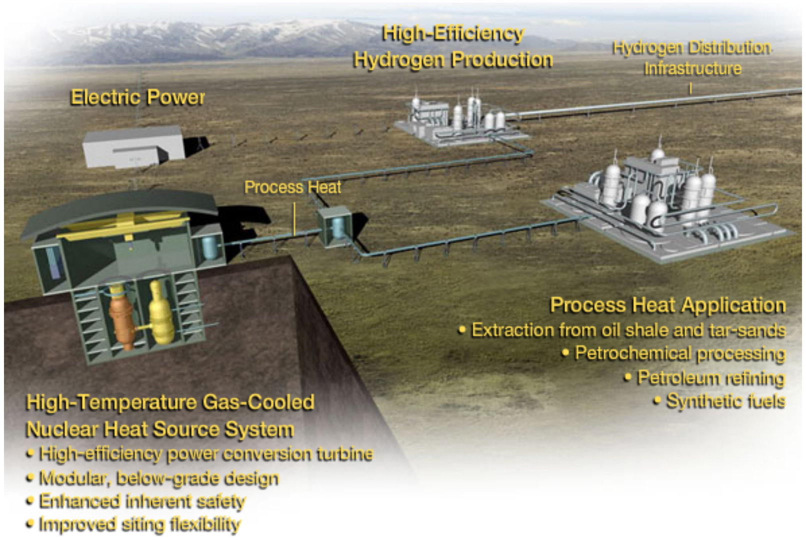
Results

-High-Level Issues

- Alternative approaches to ISV
  - phased approach
  - usability approach
  - contextual approach
- New designs vs modernizations
- Grading the ISV effort
  - scoping ISV to identify the minimum amount of testing needed
- Validating designs representing new concepts of operations
  - new missions, such as hydrogen production and industrial steam
  - multi-unit monitoring and control



From http://www.nextgenerationnuclearplant.com/facility

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Results

-Detailed Issues

- Test objectives
  - consider objectives more broadly, e.g.:
    - maintenance tasks
    - individual design features and HSIs
- Testbeds
  - consider alternative testbeds
    - simulator readiness for ISV and competing demands for its use
    - lower fidelity options
    - ISV when no simulator is available
- Plant personnel
  - additional guidance on sample size
- Scenarios
  - number of scenarios
  - selecting which scenarios to use

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Results

-Detailed Issues (continued)

- Performance measures
  - aspects of human-system performance to be measured, e.g.:
    - higher-level measures, such as measures of effectiveness
    - teamwork
    - usability and user experience
    - expert observer and operator comments
    - measures related to new ConOps and new technology (e.g., trust in automation)
  - contribution of different aspects of performance
    - such as cognitive measures
  - number of performance measures to be used
  - implications of collecting data during vs. after scenarios
    - intrusiveness of situation awareness ratings

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Results

-Detailed Issues (continued)

- Performance measures (continued)
  - establishing the suitability of measures
    - construct validity
    - inter-rater reliability
  - determining acceptance criteria
    - especially for cognitive measures and for ratings, opinions, and comments from observers and operators
  - choosing pass/fail measures
  - selecting specific metrics to be used
  - establishing an accepted standardization of measurement categories and metrics

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Results

-Detailed Issues (continued)

- Data analysis and conclusions
  - combining qualitative and quantitative analysis
  - alternatives to traditional statistical tests for data analysis and interpretation, e.g., equivalence testing (Snow, Reising, Barry & Harstock, 1999)
  - analyzing data across multiple trials, scenarios, and measures
  - interpreting results when comparing new designs to benchmarks, e.g., how much of a difference is a concern
  - establishing convergence when using multiple measures
  - integrating large data sets from many different types of measures to draw conclusions
  - identifying the factors that need to be considered when generalizing results from one context to others
    - such as when there are cultural and operational differences

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Resolution of Issues

- Resolution of these issue will require coordinated research and development efforts on the part of the commercial nuclear power community
- The issues are often more complex then they appear to be at face value
  - i.e. operator comments and evaluations
    - operators ratings of preference often are not associated with better performance (e.g., Andre & Wickens, 1995; Bailey, 1993; Barnum et al.; 2004; Nielsen & Levy, 1994)
    - we need to determine the best way to obtain and use operator comments and evaluations to best meet evaluation goals
- Issues are often inter-related
  - example – determining how many teams to participate impacts decisions concerning how to analyze the data

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Discussion

-Future Direction

- As this work continues, the NRC is seeking input from stakeholders concerned with ISV and will use that information to help prioritize the ISV needs identified

- Once this is accomplished, research will be devoted to addressing the selected issues and developing the needed review guidance

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Impending Changes to NUREG-0700

“Human-System Interface Design Review Guidelines”

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HSI Reviews

- As new HFE methods and HSI technologies continue to be developed, the NRC is committed to keeping its review guidance up-to-date

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Phased Update Strategy

- Revision 2 (2002) is ~600 pages
  - Analog guidance is <u>not</u> out of date
  - Digital guidance needs to be improved
- Prioritized topics based on topic/chapter
  - Guidance is needed now for SMR and other new reactor work
  - Phased approach minimizes delays associated with updating full document

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NUREG-0700 Description

- Addresses the detailed design of HSIs

Part I Basic HSI Elements
1 Information Display
2 User-Interface Interaction and Management
3 Controls

Part II HSI Systems
4 Alarm System
5 Safety Function Monitoring System
6 Group-View Display System
7 Soft Control System
8 Computer-Based Procedure System
9 Computerized Operator Support System
10 Communication System

Part III Workstations and Workplaces
11 Workstation Design
12 Workplace Design

Part IV HSI Support –
13 Maintaining Digital Systems

8.1.2-1 Overall Representation of an Automation System
The HSI should accurately represent automation and its plant interfaces.
Additional Information: Providing a representation of the automation and the aspects of the plant with which it interfaces helps operators to link the actions of automation to its goals for the plant itself. For example, if automation is maintaining a level in a tank that has a leak, so long as automation can pump water in, the level is achieved and operators may not know there is a problem. When the level can no longer be maintained, operators need to quickly determine whether the failure is in the automation or the controlled system. Offering an overall representation of both automation and its plant interfaces helps operators assess this situation.[91017]

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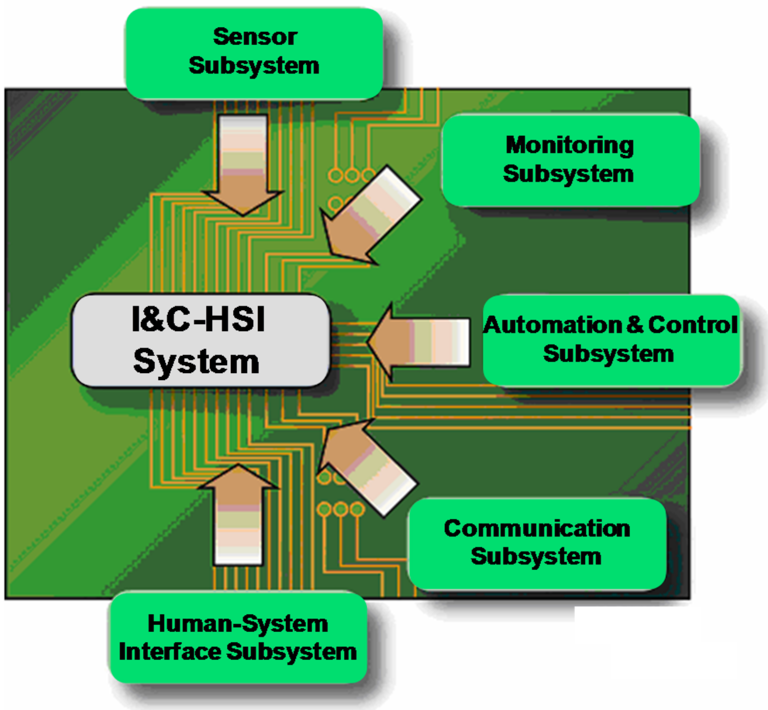
NUREG-0700 Technical Updates

- New automation section
  - levels, functions, processes, modes, flexibility, reliability, failure management
- New degraded instrumentation and control (I&C) and HSI system section
  - HSI characteristics to detection and management such conditions
- Safety function monitoring
- Workstation design
- Workplace design
  - control rooms
  - local control stations
  - environment



HSIs and I&C Subsystems

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NUREG-0700
Phased Update Status

Drafts out for comment (expected end of 2016)

- Controls
- Alarm Systems
- Safety Function and Parameter Monitoring System
- Automation Systems (COSS)
- Workstation Design
- Workplace Design
- Degraded HSI and I&C Conditions

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Potential Changes to NUREG-1764

“Guidance for the Review of Changes to Human Actions”

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Operator Manual Action Reviews

- Use NUREG-1764 Rev. 1 (2007)
- NUREG-0711 "Lite"
  - Uses 12 elements like NUREG-0711 but with a reduced set of review criteria
  - Risk-informed process that scales the review up or down depending on the risk associate with an action
    - Scoping: High risk actions get more review than lower risk action.

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Opportunity to Improve Risk Assessment

- 4 methods for risk-informing a review
  - Traditionally, only one has been used.
  - Overly conservative, and not consistent with NRC PRA Policy Statement
- Can make OMA reviews more efficient and reduce burden on licensees by improving the process
- APHB is in Div. of Risk Assessment providing improved access to risk analysists

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Comparison with Qualitative Tables

Table A.1 Generic BWR Human Actions That Are Risk-Important

Group 1: BWR Human Actions That Are Risk-Important	
Human Actions	**Description and Reasons for Risk-Importance**
Perform manual depressurization	On selected sequences, such as station blackout (SBO), manual depressurization is required after failure of high pressure injection systems to allow for injection with low pressure systems. A complicating factor is that some procedures initially direct the operator to inhibit ADS. In some PRAs, this appears in cutsets up to 45% of CDF. Operators typically depressurize by manually operating the safety relief valves (SRVs).
Vent containment Align containment or suppression pool cooling	On a transient or loss-of-coolant accident (LOCA) sequence, with failure of the PCS, containment temperature and pressure increase and must be controlled. This can be done by containment heat removal, suppression pool cooling, or containment venting. Actions are required to remove decay heat before adverse conditions are reached (e.g., high suppression pool temperature leading to loss of ECCS pumps).
Actions during shutdown	Almost all actions, including actuation of various equipment, are done manually during shutdown. The operator's understanding of the plant configuration is necessary for the successful manual actions.

Group 2: BWR Potentially Risk-Important Human Actions	
Human Actions	**Description and Reasons for Risk-Importance**
Level Control in anticipated transient without scram (ATWS)	Effective reactor vessel level manual control at lower than normal levels (e.g., near the top of the active fuel) is needed during an ATWS in order to reduce core power.
Initiate standby liquid control (SLC)	Manual initiation of SLC is needed for ATWS sequences.
Inhibit automatic depressurization system (ADS)	Some IPEs conclude that core damage will occur if ADS is not manually inhibited in an ATWS event due to instabilities created at low pressures.
Miscalibrate pressure switches	Various pressure switches are important for initiating ECCS and operating ECCS permissives. Common cause mis-calibration of these switches can affect multiple trains of safety systems.
Initiate isolation condenser (IC)	For early design BWR plants, this action is important during accidents to ensure continued viability of the cooling from the IC.
Control feedwater (FW) events	The actions of operators to properly control the FW system as an injection source after loss-of-instrument air or other loss of FW events can be important in various sequences, such as transients and small LOCAs.
Recover offsite power	The actions of operators to recover offsite power after a total loss of offsite power (LOOP) is important to limit the risk due to station blackout and other LOOP core damage sequences. These are modeled with various recovery times in PRAs.
Shedding of direct current (DC) load after SBO	While often not well modeled, operator action to shed DC loads is needed to extend the battery charge in order to operate the alternating current (AC)-powered independent high-pressure coolant injection (HPCI) and reactor core isolation cooling (RCIC) systems and to keep the SRVs open (to allow low pressure vessel injection from a diesel-driven fire pump). This extends the time to core damage and the time that operators have for recovery of AC power.
Similar actions to those in Group I	Actions that are substantially similar (but not identical) to those contained in Group 1 of this table should be considered as potentially risk-important, if they involve the same systems, components, or actions.
Actions involving the risk-important systems	Each plant has a few systems that are clearly the most risk-significant in the plant. Human actions associated with these systems should be considered as potentially risk-important. When modifications associated with these risk-important systems are being considered, new human actions may be created that were not in the original PRA, but that will be risk-important. (See Section 2.4.3.2.)

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Branch Technical Position Development

- Formal document that describes how APHB intends to implement the guidance in NUREG-1764
- Focus on improving the risk assessment process
  - Rely on quantitative models more than qualitative assessments
  - Better integration with qualified Risk Analysts
  - Appropriate use of Risk Analysis staff

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Questions

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