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Use of "data" to inform expert judgment of HEPs of Ex-CR actions

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Ex-CR actions in FLEX strategies

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Example: Align FLEX generator to support the battery charger

- Transport portable generators
- Load/unload portable generator
- Connect the generator (e.g., align the generator to emergency busses)
- Start the generator using a local control panel
- Manipulate circuit breakers

Context for FLEX actions

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- Procedures -not perfect, not specific, lack details
- Staff - can be non-operators, non-licensed personnel
- Training/experience - Infrequent training, may not offer hands-on practice
- Information – can be incomplete, unreliable, not timely
- Scenario familiarity - Personnel may not know the situation
- Environmental factors – low visibility, noise, cold/heat, flooding, etc
- and more …

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We need HEPs for Ex-CR actions

- How do we get the HEPs?
- Are there Ex-CR data to support HEP estimation?

IDHEAS-G framework for generalizing Ex-CR data

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IDHEAS-G quantification model:

- Multi-level structure of cognitive failure modes (CFMs)
- Multi-level structure of PIFs
- Causal links between PIFs and CFMs through cognitive mechanisms
- HEP of a CFM is determined by its base HEP and PIFs

The framework allows to organize and generalize human error data of various levels of details, different formats, and across different fields.

Demonstration of the basic set of CFMs

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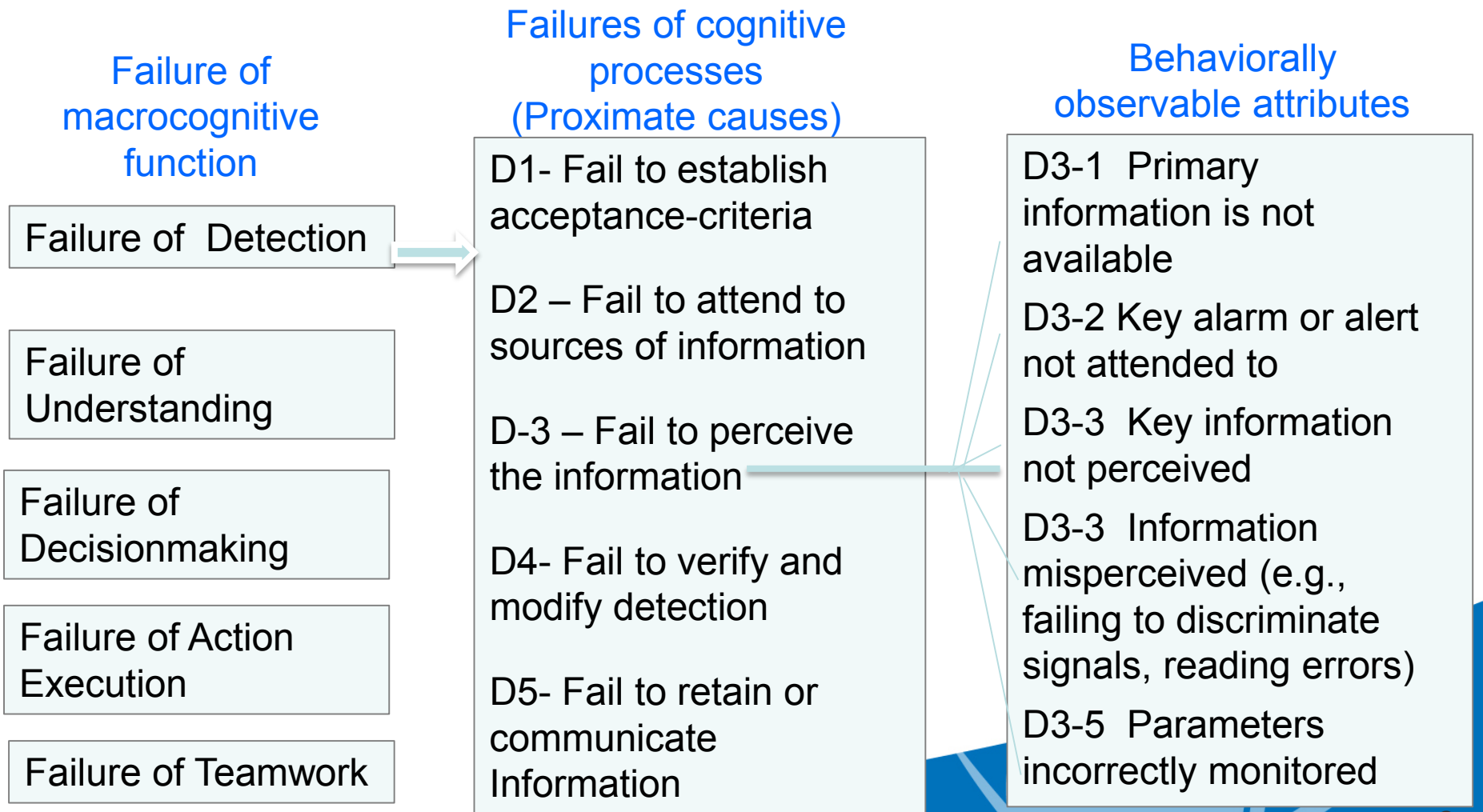
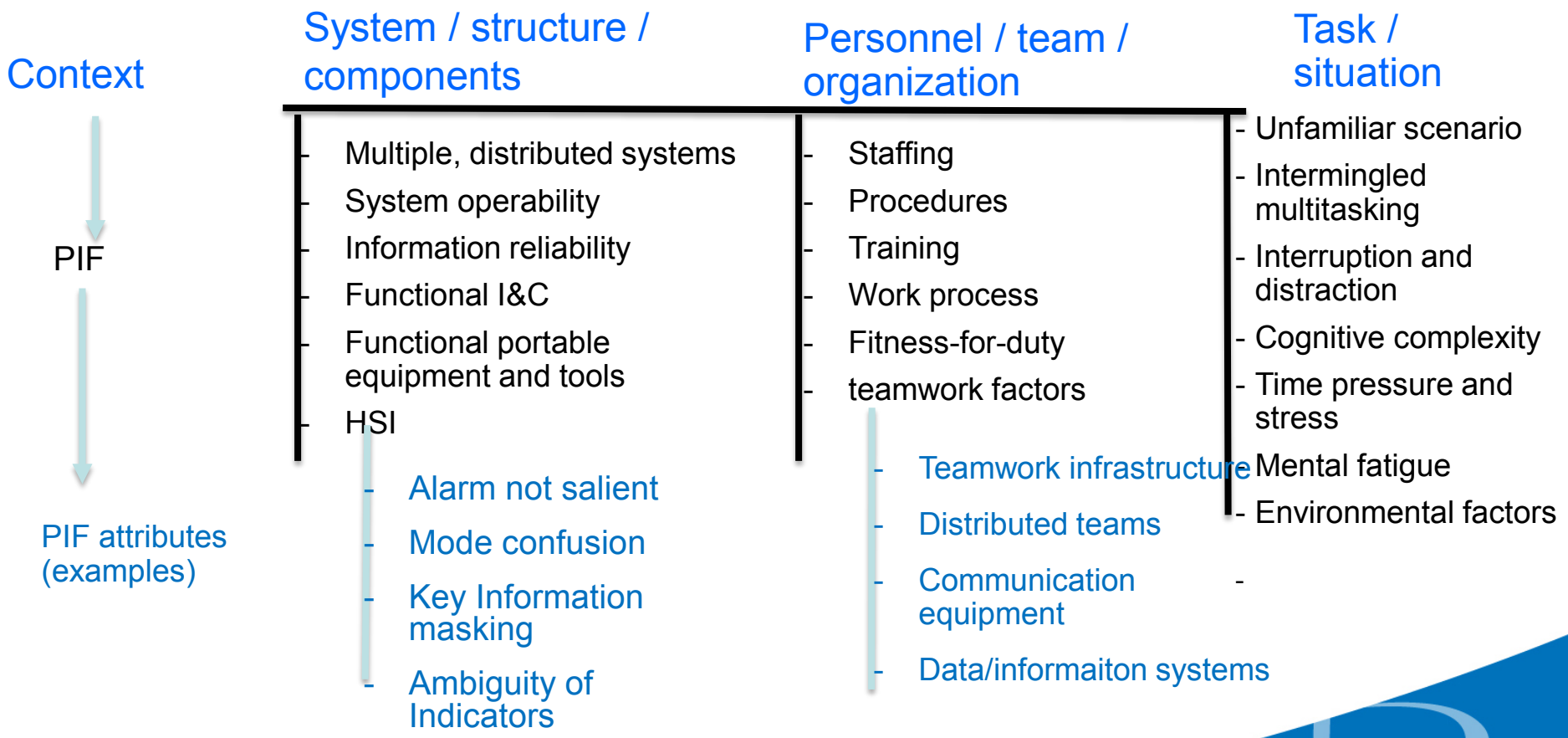


Demonstration of IDHEAS-G PIF structure



IDHEAS-G on HEP calculation

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1) HEP = Pt +Pc, where Pt is the HEP attributing to the likelihood of time available being less then time needed for the action;

2) Pc = P1 + P2 +P3 … where P1, P2, P3 … are the HEPs of individual cognitive failure modes;

3) Pi = Base- Pi x f(W1, W2, W3…), where Base-Pi is the base HEP of the failure mode, W1, W2, W3 … are the weights of the relevant PIF or PIF attributes.

Generalize data for FLEX-HRA expert elicitation - What we do with the expert elicitation

- Identify the unique PIFs associated with the use of FLEX portable equipment,
- Evaluate the contribution of the these PIFs on the total HEP of FLEX actions, and
- Quantify the total HEPs associated with a few typical FLEX strategies for using portable equipment during normal accident scenarios and during FLEX-type scenarios (such as transportation, placement, connection, and local control of portable pumps and generators, refilling water storage tanks using alternate water sources, DC load shedding, and restoring equipment from DC load shedding).

Data compiled for the expert elicitation

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The NRC project team compiles an information package for the experts to review, evaluate, and use as the basis of their judgment. The package has four parts:

I. Examples of human errors in NPP external control actions similar to those in the use of portable equipment

II. HEPs or human error rates for human actions similar to portable equipment actions in NPPs and other fields (off-shore oil drills, space-shuttle operation, railroad operation, etc)

III. PIFs that are demonstrated being important to human tasks similar to portable equipment actions.

IV. Quantification on how individual PIFs change human error rates

Part I: Personnel errors Ex-CR actions documented in LERs

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We reviewed 300+ LERs involving personnel errors in external actions.

Examples:

- "Inoperable Diesel Generator Due To Overcurrent Logic Wiring Error"
- "Loss of Emergency Bus 23-1 Due to a Shorted 2 Conductor Cable while Performing Wiring Verification"
- "Unplanned Diesel Generator Start (ESF Actuation) When a Potential Transformer Sensing Circuit Shorted-to-Ground due to Personnel Error"
- "Primary Containment System Isolation Valve Unable to Close Fully on Automatic Signal due to Wiring Discrepancy"
- "Failure To Perform Valve Testing Leads to Unit Operation in a Condition Prohibited by the Tech. Specs."
- "Inadvertent Group IV & V Isolation when Replacing PCIS Coils"
- "RHR Reservoir Inoperable due to Blocked Divisional Cross- Connect Line Results in Condition Prohibited by Technical Specifications"
- "Auxiliary Feedwater Pumps Inoperable due to Inadvertent Blockage of a Ventilation Flow Path Assumed to be Open in an Accident Analysis"

Part II: HEPs or human error rates for human actions similar to portable equipment actions in NPPs and other fields

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- HEP= **2E-2** for ideal conditions and **0.57** for challenging conditions (NUREG/CR-5572 An Evaluation of the Effects of Local Control Station Design Configurations on Human Performance and Nuclear Power Plant Risk)

- Error rates: **1/490** for operating a circuit breaker in a switchgear cabinet under normal conditions; **1/33** for connecting a cable between an external test facility and a control cabinet; **1/36** for reassembly of component elements; **1/7** for transporting fuel assemblies (Germany maintenance operation database)

- HEP in in maintenance for process plants: Milling = 5E-1; Electric installation= **E-1**; Panel Wiring = 2E-3

Part III: PIFs important to human tasks similar to some FLEX actions.

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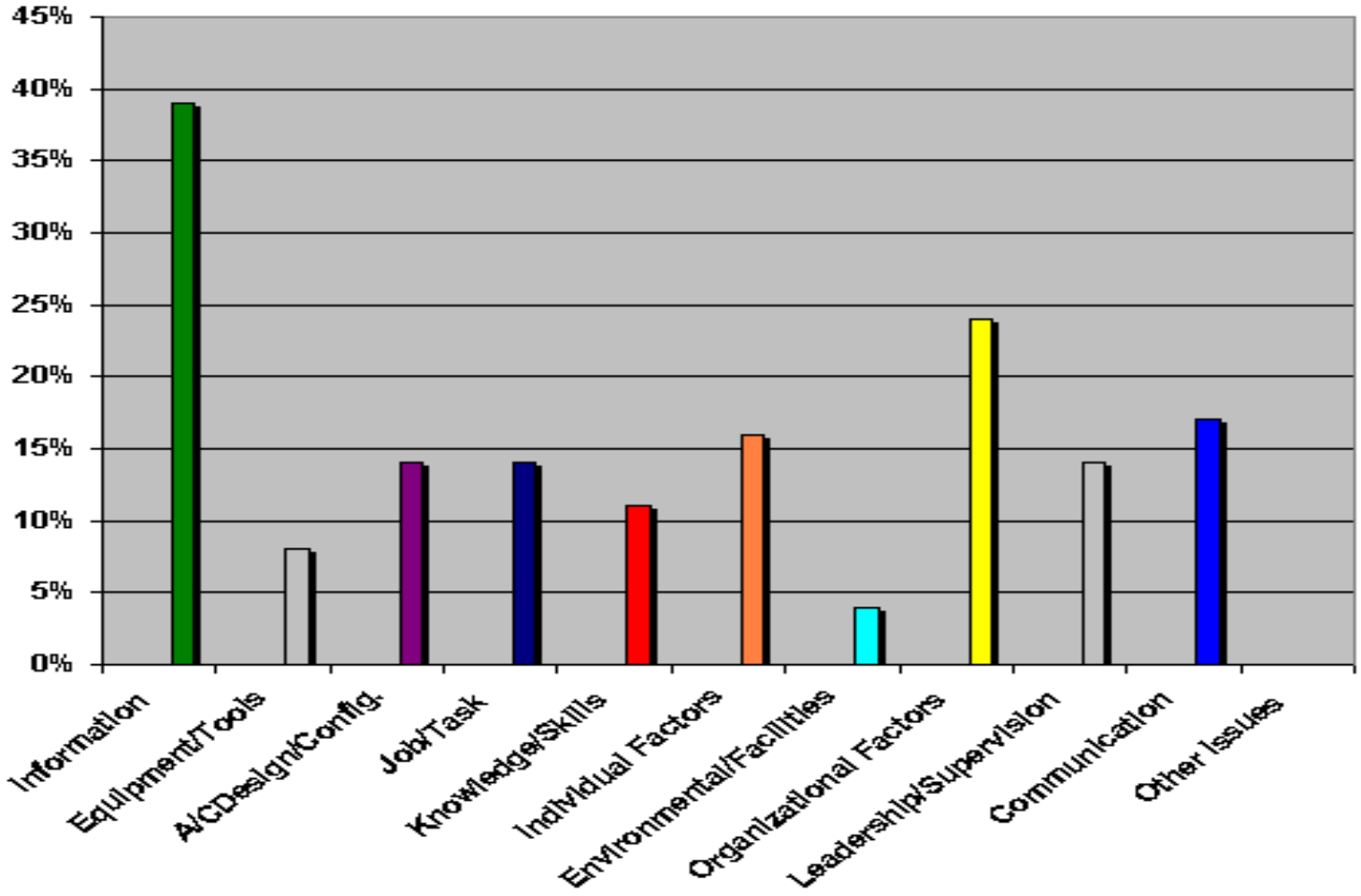
Airplane maintenance error contributing factors:



Part IV: Quantification on how individual PIFs change human error rates

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- Error rates for NPP maintenance tasks: **1/888** for frequently performed tasks and **4/173** for rarely performed tasks in normal conditions; **3/22** for rarely performed tasks with additional PIFs.

- Percent of airplane pilot deicing decision-making errors: **8%** with accurate and adequate information; **21%** with accurate but inadequate information; **73%** with misleading information.

Part IV: Quantification on how individual PIFs change human error rates

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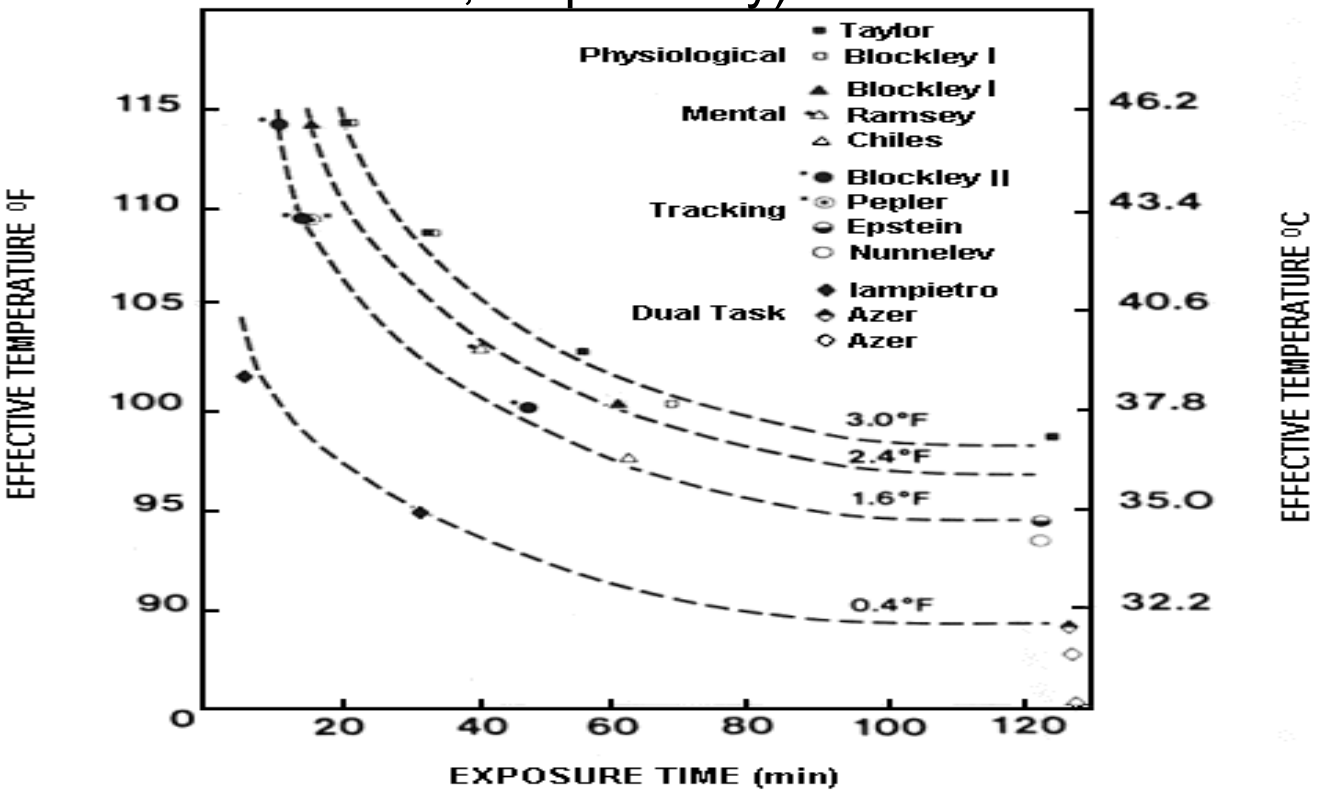
- Effect of cold and heat on human performance:

Hot temperatures of 90 degrees F or above and cold temperatures of 50 degrees F (or less resulted in the greatest decrement in performance in comparison to neutral temperature conditions (**14.88%** decrement and **13.91%** decrement, respectively).



Summary

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- We are not aware of any systematic numeric data collection effort for HRA of Ex-CR actions.

- We are approaching HRA of Ex-CR actions through modeling (IDHEAS) and expert judgment, informed by existing data in different levels of detail, formats, and types of actions.

- We need systematic HRA data collection for Ex-CR actions.

Questions for the group: Can we use CR data for ex-CR actions?

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For examples,

SACADA:

Error rate for TOE 1 = 1/202 when SF1 was nominal

Error rare for TOE 1= 3/202 when SF 1 was poor all other SFs the same)

HuPEX:

HEP IG-alarm I = 3E-03, HEP IG-comparison = 6E-02

Should the HEP for TOE 1 or IG-comparison the same for ex-CR actions provided that all the SFs or PSFs are the same?