Human Readiness Level (HRL) Standard

Update on Ongoing Development Efforts

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Space Station Emergency Egress Lighting System (EELS)

- Battery-powered system to provide exit path lighting to astronauts
- Design did not take into account the extensive crew time and logistics required to change out the batteries on a regular basis
- Astronauts also identified human factors concerns with the maintenance procedures
- Was later replaced with a passive photo-luminescent solution

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Overall *mission performance* enhanced by effective egress lighting. *Lifecycle cost* increased by maintenance demands and expense.


EngineeringForHumans.com
Human Readiness Level (HRL) Scale

- Nine-level scale to evaluate and communicate the readiness of a system for human use
- Intended to address all of the HSI domains: manpower, personnel, training, human factors engineering, safety and occupational health, survivability, and environment and habitability
- Also includes a small number of programmatic elements – ensure funding and schedule budgeted for HSI and HSI domain activities
- Distills results obtained from detailed HSI methods and tools into an easy-to-communicate number
- Complements and supplements the Technology Readiness Level (TRL) scale
# Human Readiness Level (HRL) Scale (Draft)

## Phase 1: Basic Research and Development

*Scientific research, analysis, and preliminary development on paper and in the laboratory occur. This phase culminates in a validated proof of concept that addresses human needs, capabilities, limitations, and characteristics.*

**HRL 1:** Relevant human capabilities, limitations, and basic human performance issues and risks identified

**HRL 2:** Human-focused concept of operations defined and human performance design principles established

**HRL 3:** Requirements for supporting human performance established

## Phase 2: Technology Demonstrations at Increasing Fidelity

*The technology is demonstrated at increasing levels of fidelity, first in the laboratory and later in relevant environments. This phase concludes with demonstration of a representative deliverable in a high-fidelity simulation or actual environment, with evaluation of human systems designs provided by representative users.*

**HRL 4:** Modeling, part-task testing, and trade studies of human systems design concepts completed

**HRL 5:** User evaluation of prototypes in mission-relevant simulations completed to inform design

**HRL 6:** Human systems design fully matured as influenced by human performance analyses, metrics, prototyping, and high-fidelity simulations

## Phase 3: Full-Scale Testing, Production, and Deployment

*Final testing, verification, validation, and qualification occur, with human performance evaluations based on representative users occur. This phase concludes with operational use of the deliverable and continued systematic monitoring of human system performance.*

**HRL 7:** Human systems design fully tested and verified in operational environment with system hardware and software and representative users

**HRL 8:** Total human-system performance fully tested, validated, and approved in mission operations, using completed system hardware and software and representative users

**HRL 9:** System successfully used in operations across the operational envelope with systematic monitoring of human-system performance
Decision Aids (Draft)

<table>
<thead>
<tr>
<th>Level</th>
<th>Description</th>
<th>Core Question</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>As practical applications are being invented or identified, implications for human involvement are analyzed concurrently. Relevant human performance design principles are developed to begin identifying human use requirements and provide inputs for preliminary conceptual designs.</td>
<td>Are human performance design principles relevant for user interactions and performance with the developing technology understood?</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Q#</th>
<th>Question</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>Have human systems professionals with requisite expertise been engaged and funded to support the lifecycle of this effort?</td>
</tr>
<tr>
<td>6</td>
<td>Have relevant human capabilities and limitations, with respect to both traits and states, been refined?</td>
</tr>
<tr>
<td>7</td>
<td>Have key human performance design principles, standards, and guidance been researched?</td>
</tr>
<tr>
<td>8</td>
<td>Are basic task descriptions for user roles being developed?</td>
</tr>
<tr>
<td>9</td>
<td>Has human performance on legacy or comparable systems been analyzed to understand key human-technology interactions?</td>
</tr>
<tr>
<td>10</td>
<td>Have potential sources of human error and mis-use been identified?</td>
</tr>
<tr>
<td>11</td>
<td>Are plausible metrics for successful human performance being identified?</td>
</tr>
</tbody>
</table>

Plus:
- Exit criteria
- Suggested supporting artifacts
- Mapping to TRLs
- Additional notes and guidance
## EELS Example

<table>
<thead>
<tr>
<th>HRL</th>
<th>Name</th>
<th>Description</th>
<th>Core Question</th>
<th>Q#</th>
<th>Question</th>
<th>Considerations</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>Requirements for supporting human performance established</td>
<td>Analyses of human operational, environmental, functional, cognitive, and physical needs completed during analytical and laboratory-based studies of the proof of concept to understand the requirements for supporting each human user role.</td>
<td>Have human user needs, capabilities, limitations, and characteristics been mapped to expected operational and system demands to establish system requirements for supporting human performance?</td>
<td>17</td>
<td>Are implications for manpower, personnel, and training being identified?</td>
<td>…Implications of the proposed technology design for all relevant HSI domains are evaluated…</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>21</td>
<td>Have relevant human performance data been evaluated to determine the feasibility of metrics for successful human performance, based on the proof of concept?</td>
<td></td>
</tr>
</tbody>
</table>
Benefits of Using an HRL

• Balances the common technology-centric focus with a human-centric perspective throughout the development lifecycle

• Promotes objective evidence to assess readiness for human use

• Provides a consistent framework for gauging and addressing system maturity

• Includes all HSI domains, reduces misunderstanding of the scope of HSI

• Emphasizes the importance of HSI and the HSI domains early and throughout the system development process

• Improves communication of HSI maturity and considerations across the program
Benefits of Using an HRL

Is it ready?

What needs attention?

Methodology, metrics, process, design, details

Senior decision makers

Program managers

Human factors practitioners

Big picture relevance

Details diagnostics

Development of the HRL Scale

• Various groups have been working on or promoting HRLs over the last 10+ years

• This scale was developed by a core team from Sandia National Labs, Old Dominion University, and Naval Postgraduate School

• Refined through workshops with broad government-industry-academia participation

• Outreach efforts have included a wide range of communities: HFES, DoD HFE TAG, NDIA, INCOSE, MIT Lincoln Labs, Military Operations Research Society, and more.

• Currently under development as a standard: ANSI/HFES 400-2021
Development of the HRL Standard

• Writing committee consists of core team plus human systems experts from across government, industry, and academia

• Developed in conjunction with the Human Factors and Ergonomics Society (HFES) and American National Standards Institute (ANSI)

• Intended for use by human system experts to conduct evaluation and communicate meaningfully with decision makers

• Complete package: Core scale content plus guidance and information

• Broad application to any type of system and system development process
  • Includes mapping to DoD Adaptive Acquisition Framework
End Goal

• **Balance** among technology, human, and lifecycle support needs
• **Communication** with decision makers on system’s human readiness
• **Investment** in Human Engineering when warranted