



JENSEN HUGHES

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Security and Risk-Based
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**Panel Discussion – Is THERP Still Relevant after 60 Years?
Diamond Anniversary of THERP**

JEFFREY JULIUS | JUNE 2022

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Allegations against THERP

- + HRA (including THERP) is “a black art tooled by the devil”
Liz Kleinsorg, Senior VP Jensen Hughes
- + THERP is “old and outdated”;
ready for retirement
- + THERP’s Execution has decomposition
issues
- + THERP lacks a Cognitive model
- + “STRESS” is the only Performance Shaping
Factor (PSF)



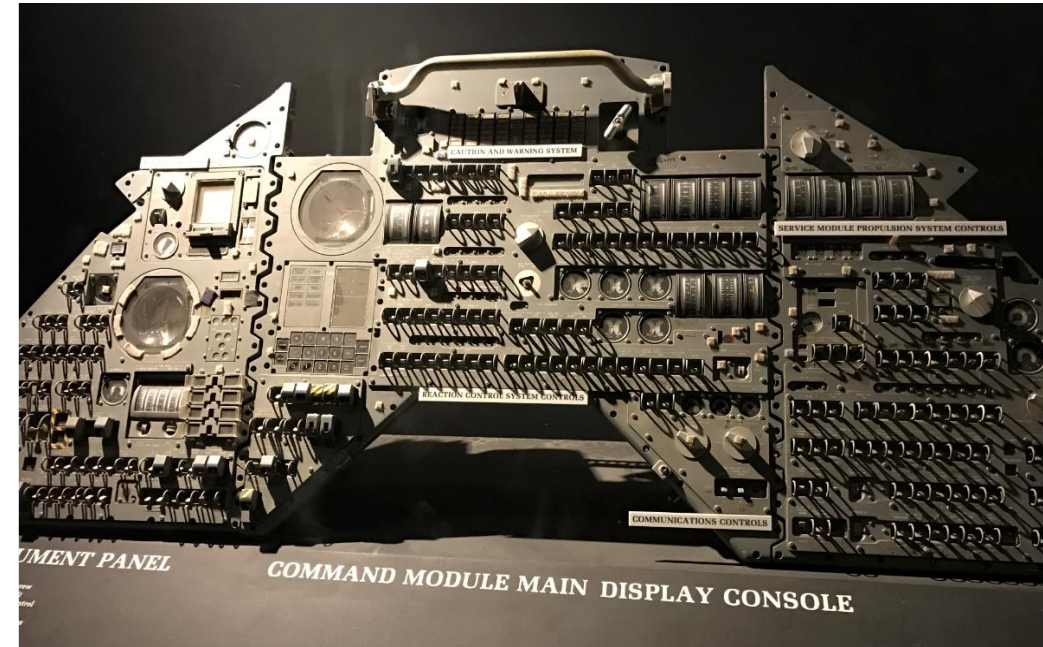
Alan Swain, Developer of THERP, 1972

Source: Alleged picture – unable to verify the source

THERP's History is Rooted in the History of Human Reliability Analysis

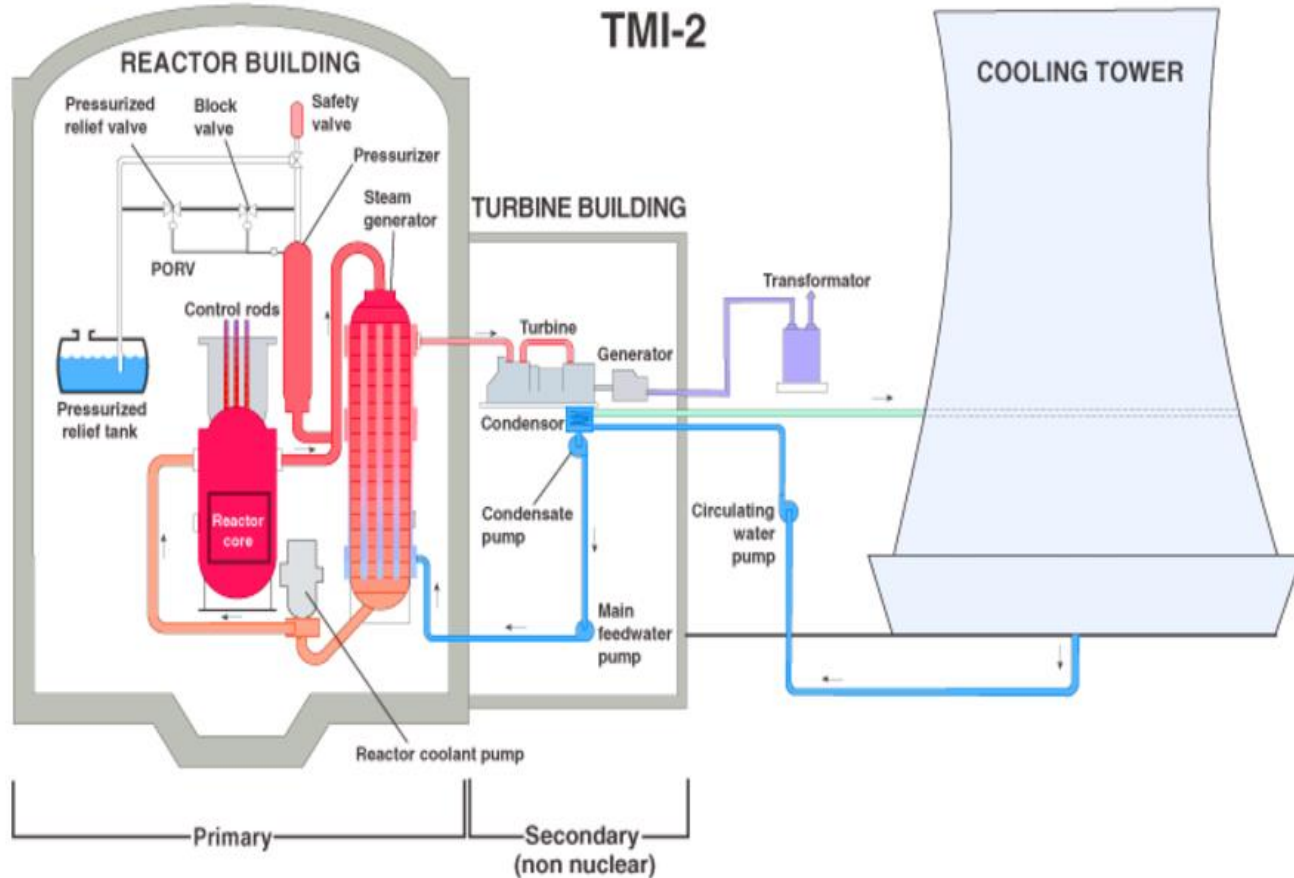
Started with military & aerospace

- + IEEE formed the Reliability Society in 1948
- + 1950 military study group started - Advisory Group on the Reliability of Electronic Equipment, AGREE
- + Statistics and data collection led to the bath-tub curve.
- + Human reliability recognized and studied:
 - **A.D. Swain T.H.E.R.P.(Techniques for Human Error Rate Prediction), SC-R-64-1338, 1964 by Sandia**
- + Navy human factors engineering and human performance reliability studies led to “Human Reliability Prediction System User’s Manual” 1977. A.I. Siegel, et al
- + Nuclear Power incorporated HRA into its PRA modeling



Source: Photo from National Air and Space Museum;
Text from “Short History of Reliability” James McLinn CRE, ASQ Fellow
April 28, 2010

PRA & HRA in Nuclear Power – WASH-1400 (1974) & TMI Unit 2 (1979)



- + WASH-1400 shows how PRA complements deterministic design
- + Three Mile Island event confirmed the usefulness of PRA – multiple failures challenged the design basis for decay heat removal
- + TMI-2 also confirmed usefulness of HRA
 - Pre-initiating event (misalignment) contributed to the initial loss of AFW
 - Failure to recognize a LOCA
 - Failure to recognize actual Pressurizer level led to premature termination of injection
- + Following TMI, an update to THERP was published in 1983

Sources: “Nuclear Engineering: Theory and Technology of Nuclear Power” by Ronald Knief and <https://www.nrc.gov/reading-rm/doc-collections/fact-sheets/3mile-isle.html#tmiview>

“Fact Checking” THERP – One Panelist’s Assessment



What is Working

- + “Old” does not mean “Dead”
- + EPRI HRA Users Group evolutionary approach to applying THERP provides training, guidance, and adaptations
- + Qualitative portions of the method are sound
 - Task analysis leading to critical tasks
 - Structured look helps identify challenges such as failure modes, HSI, & dependency
- + HEPs are based on empirical data
- + HEPs are independent of the context
- + THERP Execution works well for many NPP scenarios

What Needs Improvement

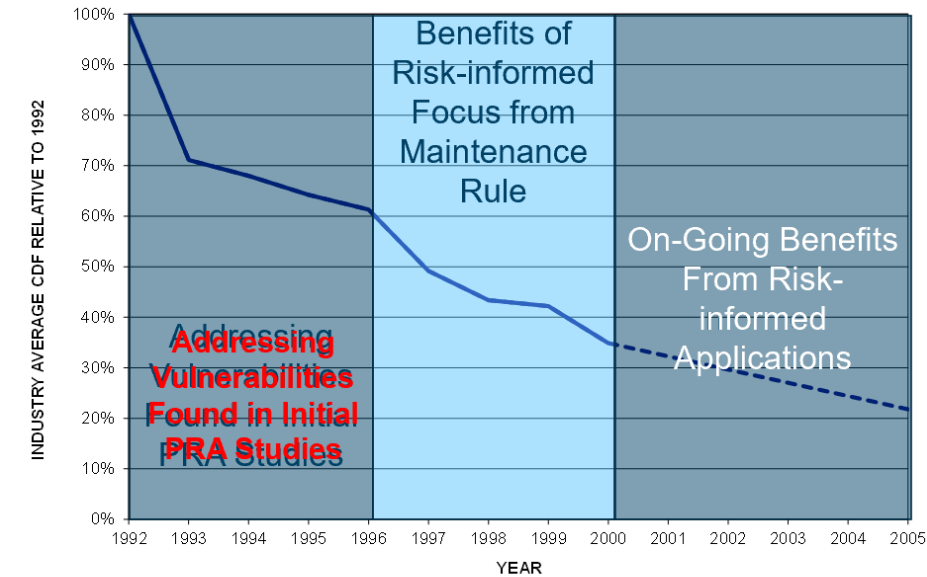
- + Parts of THERP are “outdated”
- + THERP self-recognizes that the Time Reliability Correlation is wildly speculative
- + THERP lacks a Cognitive model
- + Difficult to measure “STRESS” and to relate to PSFs used in other HRA methods
- + Data is lacking for some plant operations such as installing drain plugs
- + Wider range of plant contexts when modeling external hazards (e.g. Post-Fukushima)
- + THERP Execution decomposition issue

Any part of “what is working well” can always be improved!

Response to “Is THERP Still Relevant after 60-Years”?

Summary

- + Experience shows that THERP works well for operating NPP's
 - THERP as implemented by the EPRI HRA Users Group
 - HRA as part of PRA have led to risk reductions in the USA
- + Improved by EPRI HRA Users Group adaptations and guidance
 - Fire PRA (led to NUREG-1921)
 - External hazards such as seismic (EPRI 3002008093)
 - Portable equipment such as FLEX (EPRI 3002013018)
- + Improvements needed such as to address the decomposition issue & collect data for additional actions
- + Bigger question on the applicability to advanced reactors
 - Additional data collection associated with new human-systems interfaces
 - Assessment on the ability to model digital Instrumentation & Controls, automation, and computer-based procedures



Ref. – Data from EPRI, “Safety and Operational Benefits of Risk-informed Initiatives”, 1016308, February 2008

Questions?





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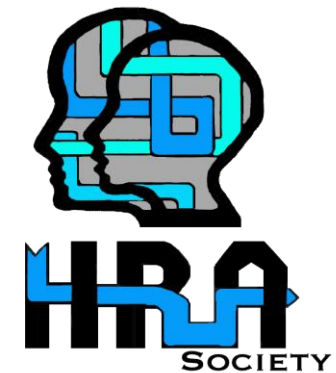
HRA Society

Professional society to promote the sharing of research, methods and data.

Members are regulators, researchers, consultants, & engineers.

History:

- + *Initial meeting in Seattle at PSAM'11 conference (2010)*
- + *Charter meeting in Honolulu at PSAM'12 (2012)*
- + *HRA Master Class in Paris (2015) 50 participants from 8 countries*
- + *HRA Special Session at PSAM'13 (Seoul, 2016)*
- + *PSAM HRA Topical Meeting (Munich, 2017)*
- + *PSAM'14 HRA Workshop (Los Angeles, 2018)*
- + *PSAM'15 HRA Panels (Venice, 2020)*



HRA Society Vision

- **Integrating Human Factors Engineering and Human Reliability Analysis**
- **3 Elements, each involving Research, Modeling, Data, & Applications**
 - Error Identification
 - Error Assessment
 - Error Reduction
- **Improve Technical Bases**
- **Support the Needs of Stakeholders as Technology Expands & Grow**
 - Support advancing technologies (beyond digital)
 - Support for emerging countries – Regulators & Utilities
 - Looking to expand with “regional” chapters such as USA, EU & Asia

