HUMAN ERROR QUANTIFICATION: DEVELOPING NARA FROM HEART

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Outline

- History – the need for Human Error Quantification
- HEART – what we use now
- NARA – an update and improvement of HEART

History – Early UK PSAs

- First PSAs for operational UK NPPs carried out in early/mid 1980s
- No systematic representation of operator interactions
- A few exceptional actions represented – nominal reliabilities claimed

History – Introducing HFA into PSAs

- Mid/late 80s increasing systematic representation of operator interactions, leading to the need for:
  - Systematic Human Factors Assessment (HFA), and
  - A method of Human Error Quantification (HEQ)
- HEART used for HEQ based on 'HEART - A Proposed Method for Assessing and Reducing Human Error' (Williams, 1986)

History – Maturing HFA

- 1990s – fully integrated HFA/PSA, including extensive Task Analysis
- Operator action dependencies considered
- Benefit of extended time taken into account
- A User Manual for HEART (Williams, 1992)
- CORE-DATA human error database project commences
- HEART validated against THERP and JHEDI

Principles of HEART

- Data-based
- Quick and flexible
- Not requiring extensive ‘decomposition’
- Intentionally conservative/pessimistic
- Takes account of important performance shaping factors

Using HEART – Select Generic Task Types

- Characterise the operator action being considered based on the data gathered during Task Analysis
- Select a Generic Task Type (GTT) to represent the action being quantified,

e.g. GTT F, change plant state using procedures, nominal Human Error Probability (HEP) = 3.0×10^{-3}

Using HEART – Appling Error Producing Conditions

- Consider differences between ideal and real conditions,

  e.g. operator unfamiliarity

- Select one or more Error Producing Conditions (EPCs) to represent these differences,

  e.g. EPC 1, unfamiliarity, having a maximum effect of 17

- Judge the strength of the affect of each chosen EPC on successful task performance and apply an Assessed Proportion of Affect (APOA),

  e.g. apply an APOA of 0.5 if an operator is trained to carry out an action but would be expected to perform it very rarely

Final HEART HEP Calculation

$$HEP = GTTx[(EPC^1-1)xAPOA^1]x \ldots[(EPC^n-1)xAPOA^n]$$

Task Description: Operator fails to start pump

Generic Task Type selected:

F (change plant state using procedures)

HEP = 0.003

Error Producing Conditions	**Assessed Effect**
2 - Time Pressure (x 11)	((11 - 1) x 0.1) + 1 = 2
15 - Operator inexperience (x 3)	((3 - 1) x 0.3) + 1 = 1.6

Final HEP = 0.003 x 2 x 1.6 = 0.0096

Disadvantages of HEART

- Considerable assessor judgement needed
- Dependency within a sequence of operator actions not dealt with
- Does not credit long timescales
- Based on old data, much of which not relevant to the nuclear power context
- Does not deal with violations or errors of commission

Background to NARA Development

- Over 10 years experience of HEART in UK NPP PSAs
- Regulator pressure to update data and improve transparency of GTT and EPC derivation
- Need to make the application of HEART more consistent
- Additional functionality required to cover:
  - Dependency
  - Extended time

2002 - Project Team

Ian Umbers	HFA Specialist and BE Project Officer
Jim Edmunds	PSA/HFA Expert and CRA Project Manager
Barry Kirwan	HRA Expert and Technical Leader
Huw Gibson	Human Error Data (CORE-DATA) Specialist
Richard Kennedy	HEART Development Specialist
Garry Cooksley/ Jasbir Sidhu	PSA/HFA Experts

NARA AIMS

- Specific to UK NPP application
- Transparent use of data
- Open to being updated
- Benefits of long timescales credited
- Dependency guidance given
- Consider errors of commission

NARA GTT Derivation

- Review of UK NPP PSAs led to a refinement of GTT definitions to more accurately encompass the actions being considered in the PSAs
- CORE-DATA used to quantify GTTs using a transparent data scoring methodology

NARA EPC Derivation

- Review of PSAs to identify EPCs used
- Reduced set of EPCs developed for the IMC 'Consistency in HRA' project
- Additional EPCs were also generated from reviews of other approaches to human error identification
- Maximum affects derived by review and analysis of available original HEART data sources, and some use of CORE-DATA

Benefits of Extended Timescales

- Some scenarios in gas-cooled reactors offer extended timescales, from 3 - 24 hours
- Further attempts to complete a task can be made in this time, if first attempts have failed
- Almost no data on such long timescale events
- NARA has built on the prior IMC DORRET work on human error in long timescale events

Pre-Conditions for Crediting Extended Timescales

- Need for action remains clear
- Options for completing the action are apparent
- Enough people available to respond
- Increasing benefits can only be claimed with increasingly good key determining factors
- NARA provides a detailed checklist for claiming ETFs

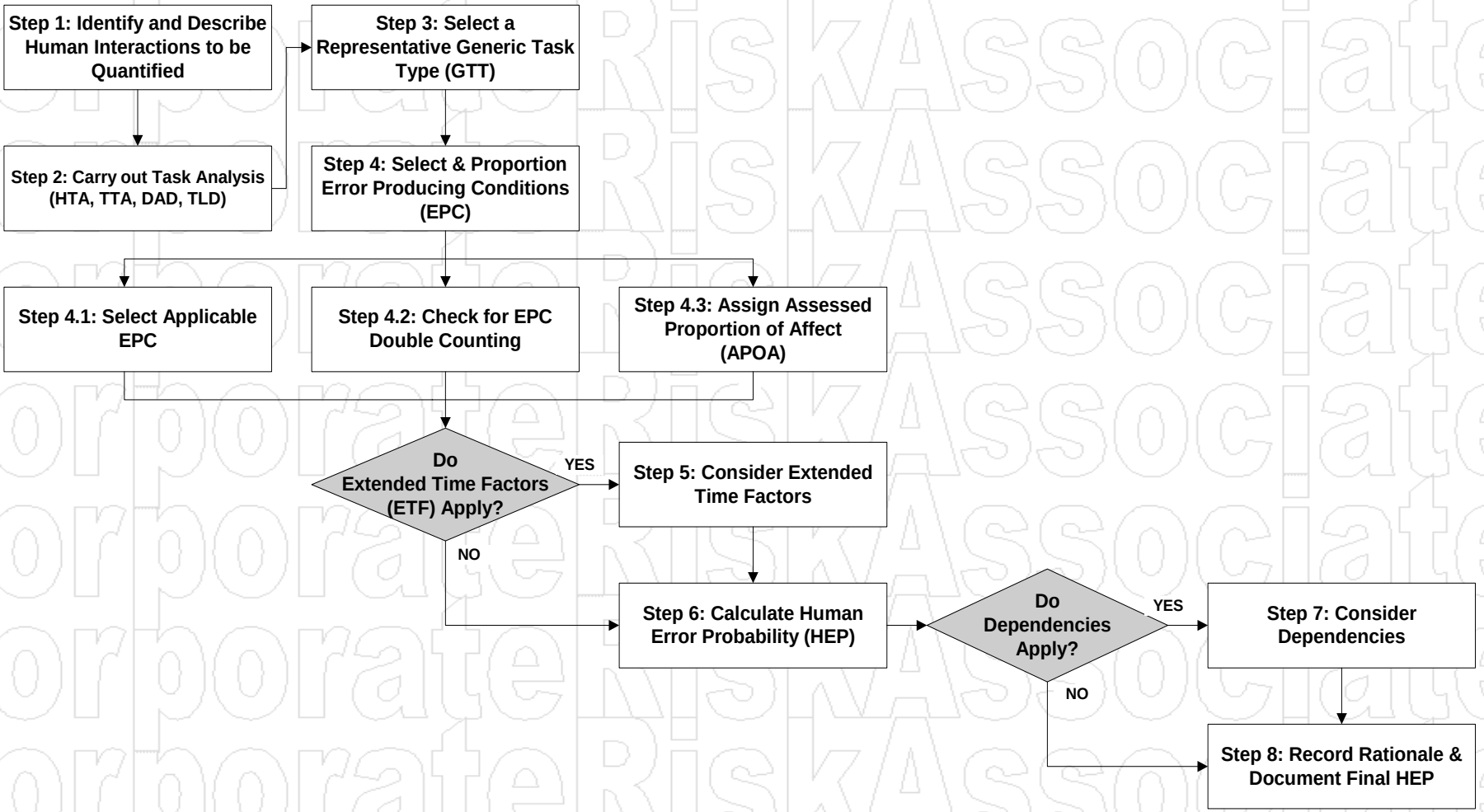
Considering Dependencies

- For failure sequences which include multiple operator actions, dependencies must be considered
- Three approaches compatible with NARA
  - Dependency Modelling
  - Dependency Specific Limits
  - Human Performance Limiting Values

Recording the Information Used

- Records are needed to bring together all the information used in the final assessment
- This information should provide the rationale for choosing the GTTs, EPCs, APOAs, ETFs and any Dependency Factors which help determine the calculated HEPs

Overview of the Human Error Quantification Process



Strengths of NARA

- Derivation of GTTs and EPCs fully open to scrutiny - a first for a data-based HRA approach
- This also means that NARA can evolve as additional data become available
- Particularly adapted to the needs of UK NPP PSAs
- Remains flexible and relatively rapid
- Additional functionality (dependency and long time-scales) make the HRA process more coherent
- More guidance for the assessor

Limitations of NARA

- **Validation - NARA's validity linked to HEART's, but may ultimately require proof - validations not cheap**
- **Data limitations in certain areas - some GTTs under-pinned by fewer than 10 data points**
- **Errors of commission - not yet 'operational'**

Future Developments

- Response to 2nd Peer Review
- Regulator approval
- Promotion of technique
- Application to different industries
- Gaining acceptance of the theoretical basis
- Validation
- Automation

DEVELOPING NARA FROM HEART

Thank you for listening
Any questions?