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Human Reliability Analysis method-SPAR-H – A Review

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Abstract- **Human performance makes a considerable contribution to incidents and accidents in many industries. This human performance is estimated in terms of 'Human Reliability' which highly affects the maintenance activity performance, safety and cost efficiency of any production process. Improvement of Human Reliability relies on identification of human error causes and quantification of human error probability. The central thrust of this paper is to review the common Human Reliability Analysis technique – Standardized Plant Analysis Risk-Human reliability (SPAR-H). The paper also discusses the effectiveness of performance shaping factors (PSFs) influencing on the human performance with the consideration of its strength and limitations**

Key words- **Human error, Human reliability analysis, SPAR-H.**

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I. INTRODUCTION

Human Reliability is the key component of measurement of human performance which deepens the human error identification. HRA concerned with the identifying, modelling and quantifying human error probability. The HRA study was started in 1950 and it actually grew up from 1960. From 1965 the HRA methods have been started to develop generation wise with their timeline accordingly. Most of the method was found as the quantitative approach towards the estimation of HEP i.e. Human Error Probability except SPAR-H method.

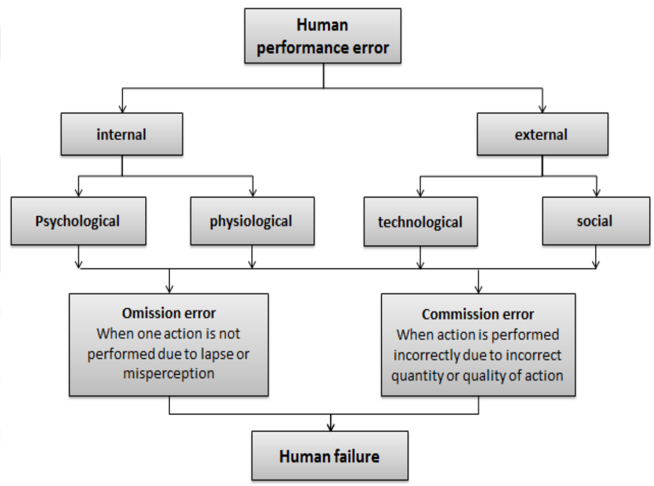
SPAR-H method estimates the HEP in both the ways qualitative and quantitative. The method uses 8 PSFs which impacts the human performance. The PSF are environmental factors, personal, or directed to activities that have the potential to affect performance positively or negatively; therefore, identifying and quantifying the effects of a PSF are key steps in the process of HRA..

II.HUMAN RELIABILITY ANALYSIS

A.Human error identification

First step of HRA is the human error identification or to find out the consequences. Human Error can be defined as the unwanted actions or inactions that result in deviations from expected standards or norms and that potentially place people, equipment, and systems at risk.

The human error can be of any type i.e. physiological, psychological, technical and social which leads to technical failure. Mainly Human performance error can be divided in two main types. This will be more cleared from the figure given below.



While performing any action by human, there can be the possibility of some physiological or psychological conditions affects his performance and which leads to some omission or commission error.These error can be rectified or improved by estimating human error probability

B.Human Error Probability

Human Error Probability is the component which shows the fashion of the human reliability for the specific activity. But first of all it is important to understand human context in system performance.

So the Human reliability is the probability of humans conducting specific tasks with satisfactory performance. That task can be a repairing, system operation, safety actions and analysis or any other kinds of human actions that influence system performance. Basically human error probability is described as:

$$P(HE) = \text{No. of errors} / \text{No. of error opportunities}$$

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As high is the HEP low is the Human Reliability and as low is the HEP high will be the human reliability.

Mainly questions HRA tries answer are:
1. What's go wrong?
2. Which are human failure consequences?
3. Which performance shaping factor influence Human reliability the most?
4. What is necessary to improve HR to avoid or prevent human error?

To answer these questions some appropriate method must be applied, which depends on some issues given below:

- HRA objectives, which are applied to investigate incidents, to improve maintenance procedure, and to improve operational steps.
- Availability of human error data for performance analysis. To perform HRA specialist opinion should be taken in consideration. It's necessary to verify the reliability of data from literature.
- Most critical issue in HRA is time to perform analysis. Time is always critical issue because human reliability analysis can last for hours or a few days.

C.Method Selection for HRA quantification

After identification and modelling, the step comes is that quantification. Many methods have been developed for HRA but talking about the qualitative and quantitative approach the SPAR-H method is considered as good method. As this method mainly focuses on performing shaping factors which influences the human performance that what we required in HRA. The SPAR-H method is described in brief further.

III.SPAR-H – STANDARDIZED PLANT ANALYSIS RISK HUMAN PROBABILITY

The SPAR-H method addresses the failures and its HRA based upon their type of failure. The failure is about a) Diagnostic Failure b) Action Failure.

The basic SPAR-H framework is:

- Decomposition of task into Diagnostic and Action
- Assigning base case HEP according to failure
- Use of pre-defined PSFs with its appropriate value.

Mainly this method derives the explicit information processing model of human performance. It also has been researched that eight PSFs capable of influencing human performance. These factors include:

1. Available Time
2. Stress and stressor
3. Experience and training
4. Complexity
5. Ergonomics
6. Procedures
7. Fitness for duty
8. Work processes

IV.SPAR-H FLOWCHART

The flowchart given describes the method and steps followed in estimation of HRA.

The Nominal HEP or base case HEP rates are mentioned in the flowchart according to type of failures occurred during the operation.

For diagnostic failure HEP rates at 1.0E-2 and that for action failure it rates at 1.0E-3.

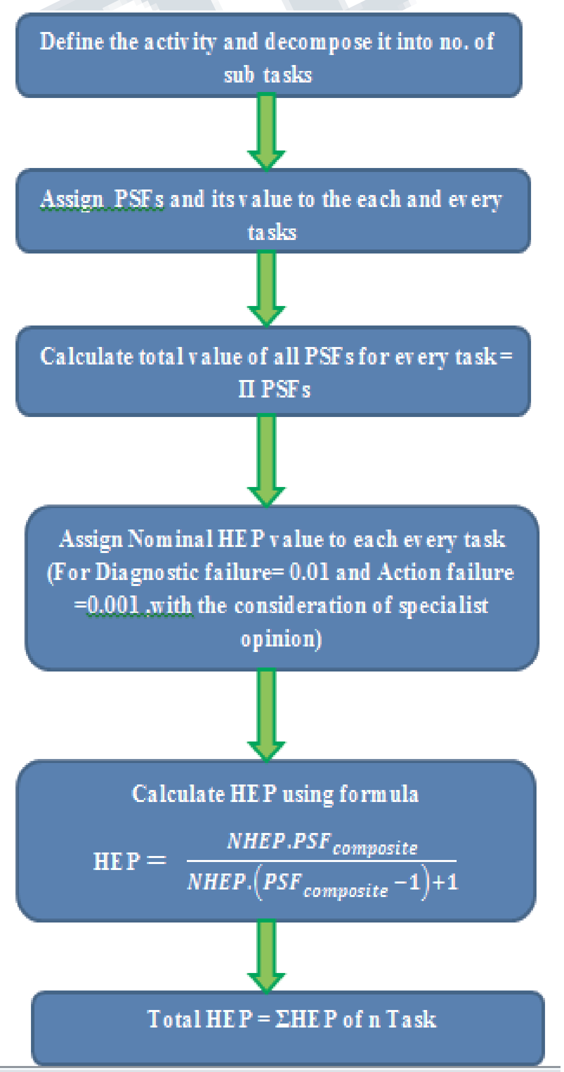

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Figure 1

A. PSFs table with its values

PSFs	PSF Levels	HEP for Diagnosis[1]	HEP for Action[1]
Available Time	Inadequate time	1.0 (no multiplier)	1.0 (no multiplier)
	Barely adequate time	0.1 (10)	0.01 (10)
	Nominal time	0.01 (1)	0.001 (1)
	Extra time	0.001 (0.1)	0.0001 (0.1)
	Expansive time	0.0001 (0.1-0.01)	0.00001 (0.01)
Stress/ Stressors	Extreme	0.05 (5)	0.005 (5)
	High	0.02 (2)	0.002 (2)
	Nominal	0.01 (1)	0.001 (1)
Complexity	Highly complex	0.05 (5)	0.005 (5)
	Moderately complex	0.02 (2)	0.002 (2)
	Nominal	0.01 (1)	0.001 (1)
	Obvious diagnosis	0.001 (0.1)	N/A
Experience/ Training	Low	0.1 (10)	0.003 (3)
	Nominal	0.01 (1)	0.001 (1)
	High	0.05 (0.5)	0.0005 (0.5)
Procedures	Not available	0.5 (50)	0.05 (50)
	Incomplete	0.2 (20)	0.02 (20)
	Available, but poor	0.05 (5)	0.005 (5)
	Nominal	0.01 (1)	0.001 (1)
	Diagnostic/symptom oriented	0.005 (0.5)	N/A
Ergonomics / HMI	Missing/Misleading	0.5 (50)	0.05 (50)
	Poor	0.1 (10)	0.01 (10)
	Nominal	0.01 (1)	0.001 (1)
	Good	0.005 (0.5)	0.0005 (0.5)
Fitness for Duty	Unfit	1.0 (no multiplier)	1.0 (no multiplier)
	Degraded Fitness	0.05 (5)	0.005 (5)
	Nominal	0.01 (1)	0.001 (1)
Work Processes	Poor	0.02 (2)	0.005 (5)
	Nominal	0.01 (1)	0.001 (1)
	Good	0.008 (0.8)	0.0005 (0.5)

Figure 2

The above tables explains how much HEP is assigned for the perticular PSF and which multiplier is used according to level of the PSF.

B. Ideal mean HEP as a function of influence of performance shaping factor

Figure shows the relationship between the human performance and the human error probability which is influenced by PSFs. The positive influence of PSFs can operate to reduce failure rates.

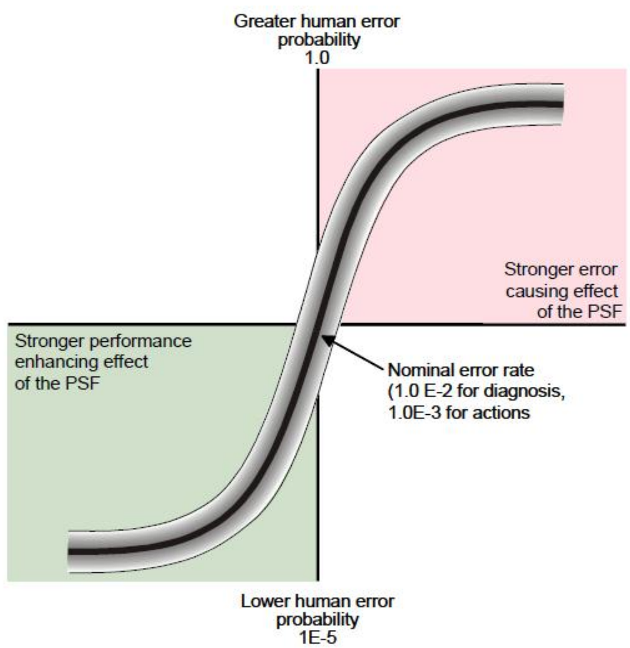

Figure 3The figure also explains that lower bound cut of is 1.0E-5

V.DISCUSSION

The SPAR-H method is straightforward, orthogonal and easy to apply, and is based on a human information-processing model of human performance and results from studies available in the behavioural sciences literature (Newell and Simon, 1972).

It is thought that the same PSFs and base failure rates are applicable to either type of error. The base error rates contained in the consideration of actions and diagnosis by including omission and commission types of errors; the explicit representation of omission versus commission is an issue left to the analyst and is part of the error identification and modelling process constituting HRA. In instances where the work process PSF is thought to influence performance, it is often difficult to determine its effects.

Traditionally, taking into account for the influence of multiple shaping factors with multiple levels of influence without imposing a high degree of expert consensus judgment on the HRA process has proven difficult for HRA. SPAR-H attempts to help make the assignment of human error probability a more repeatable and transparent function and less a function of the individual analyst who is performing the HRA. We believe that the analyst's expertise comes into play in discovery of the appropriate error and in assigning the correct level of influence (i.e., multiplier for the HEP). The HRA search process for determining unsafe acts given a particular context still remains a challenging task for the HRA analyst, but this is the information that is brought to SPAR-H for quantification. The need to provide sound qualitative assessments of factors is amplified as SPAR-H applications expand beyond basic plant PRA model development to include HRA for event analysis and the evaluation of specific plant performance issues.

VI. SUGGESTION

After discussing about the SPAR-H method the one thing is cleared that this method is easy to apply and transparent towards the qualitative approach. The one thing that is being suggested that while calculation of the HEP, if three of PSFs having value greater than 1 or nominal level then only the formula should be used shown in the flowchart.

Otherwise just multiplication of all PSFs along with its Nominal HEP is most preferred rather than always using the formula.

VII.CONCLUSION

Reaching to the conclusion it is concluded that SPAR-H method is best HRA methods with appreciating the quantitative as well as qualitative approach of HRA.

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