AGAPE-ET: An Advanced HRA Method Integrating EOOs and EOCs

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1. Introduction

In the area of human reliability analysis (HRA), two major researches and developments have been done in Korea. The first one is the development of the Korean standard HRA method [1], and the second one is of a method for assessing diagnosis failures (or misdiagnosis) and their consequent human events involving errors of commission (EOCs) [2]. This study aims to integrate both efforts for assessing EOCs and EOOs, under a single framework to be applicable to an event scenario. The integrated method is named AGAPE-ET (*A*dvanced *G*uidelines for *A*nalysing *P*rospective human *E*vents in performing *E*mergency *T*asks).

2. Method

The approach to an integrative HRA framework is divided two parts largely (see Figure 1). The first part is for analysing human unsafe actions that might occur from the diagnosis failures in an initial event diagnosis. The second part is to analyze possible unsafe actions during event responses after an initial event diagnosis.

2.1. Part 1: Assessment of diagnosis failures and their consequent human failure events

The potential for an initial event diagnosis can be applied to two cases: *case 1* - a single initiating event, and *case 2* - multiple events involving an initiating event and additional events that may occur before an initial event diagnosis. Both cases use the same approach for identifying and assessing the possible unsafe actions (UAs) or human failure events (HFEs).

- Assessment of the potential for a diagnosis failure

The misdiagnosis tree analysis (MDTA) framework was developed for the assessment of the potential for diagnosis failures [3]. Three causes for a diagnosis failure are considered, i.e. plant dynamics (PD), operator errors (OE), and instrumentation failures (IF), in performing MDTA and assessing the diagnosis failure probability.

The contribution of the PD factor for an event at a decision rule is evaluated by estimating the fraction of an event spectrum where the behaviour of the decision parameter does not match the established criteria of the decision rule at the operators' diagnosis time. In order to estimate that fraction in a reasonably acceptable level of detail, an event under analysis should be classified into sub-groups by considering plant dynamic behaviours from the viewpoint of the operators' event diagnosis. For an event group that shows the potential for a mismatch, a further T/H analysis is performed to decide the range of a mismatch.

The contribution of operator errors for taking a wrong path at a decision point is assessed by assigning an appropriate probability to the selected items according to a cognitive function. Operator errors are considered for two cognitive functions, i.e. information gathering and rule interpretation.

As for an instrumentation failure, the failure of multiple channels in a common mode during a normal operation is considered, since most of the instruments in NPPs have multiple channels (2 or 4 channels) and the operators can identify the failed state of an instrumentation when a single channel fails during a normal operation.

- Identification of human failure events (HFEs)

The HFEs can result from the unsafe actions related to both the required functions and the unrequired or unnecessary functions. The unsafe actions in view of both functions can be defined as follows:

- UAs related to the required functions
  - Failure to initiate the required functions
  - Failure to maintain the required functions
- UAs related to the unrequired functions
  - Manual operation of unrequired or unnecessary functions

The HFEs that might be induced from the diagnosis failures are identified by comparing the requisite functions for both the actual event and the misdiagnosed event.

- Quantification and modeling into PSA

A rough quantification scheme for the identified HFEs is provided in Equation (1).

- Prob. of a HFE = (Prob. of a diagnosis failure) * (Prob. of an UA under the diagnosis failure) * (Prob. of non-recovery) (1)

The key influencing factors and their contributions to performing unsafe actions and their recovery potential are provided.

2.2. Part 2: Assessment of post-diagnosis human failure events

The possible post-diagnosis human interactions (HIs) can be categorised into three cases largely: (1) *case 1* – the HIs related to the required functions subordinate to an initial event diagnosis, (2) *case 2* - the HIs related to the functions that are required when the requisite functions fail, and *case 3* - the HIs related to a new event that require new requisite functions.

The possible human contributions that may contribute to the failure of each HI for the above mentioned three cases can be classified again into three HFEs: (1) HFE-1: prior acts that make a requisite function unavailable, (2) HFE-2: failure to perform required actions adequately, and (3) HFE-3: failure to maintain a requisite function.

Firstly, for the HFE-1, three causes of a diagnosis failure, i.e. PD, OE, and IF, are applied to a procedural rule that is relevant to making a function unavailable. This is applicable for all three *cases* of HIs.

Secondly, for the HFE-2, the Korean standard HRA method [1] is used for all three *cases* of HIs.

Lastly, for the HFE-3, the potential for an inappropriate termination is assessed by applying three causes of a diagnosis failure to a termination rule for a function. In the case where an initially selected procedure provides a direct rule for diagnosing a new event, it is assumed that, a consistent (or long-term) inappropriate situation assessment should be made in order for a function to be inappropriately terminated. On the other hand, in the case where there is no direct rule for a new event, the possibility of a complete diagnosis failure is assumed, therefore, an assessment rule for an inappropriate termination under a diagnosis failure is used.

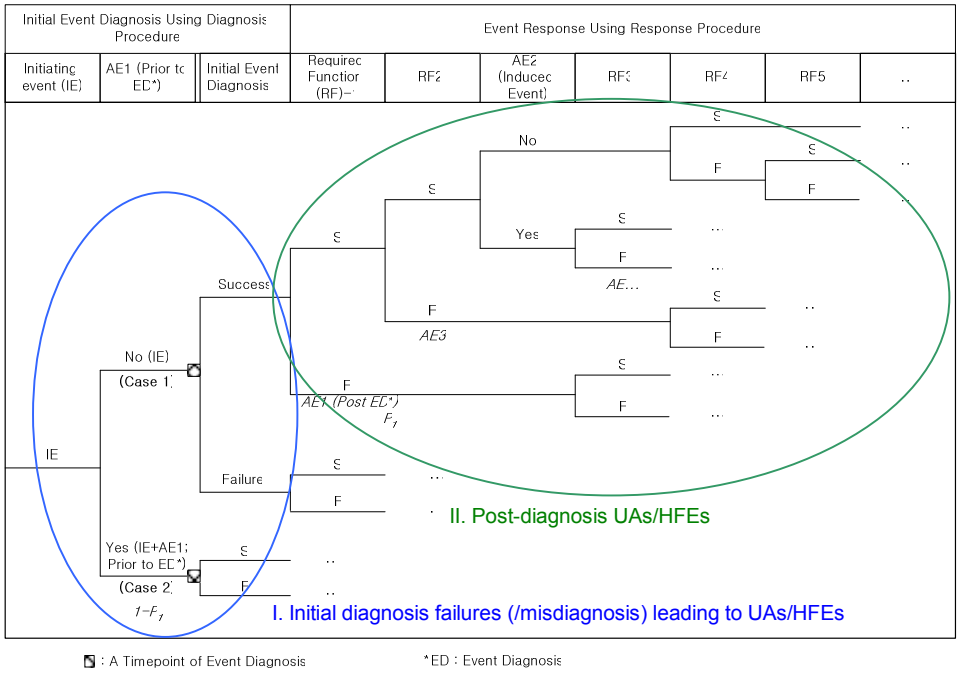

Figure 1. An integrated HRA framework for emergency situations

3. Conclusion

In this study, we introduced an advanced HRA method, AGAPE-ET, which integrates human errors of commission and omission events in a single framework. Compared with conventional HRA methods, AGAPE-ET has the capability not only to systematically analyze human errors of commission, but also to consistently identify and assess the possible human failure events (HFEs) that may contribute to plant safety.

REFERENCES

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