위반 및 대책을 보다 효과적으로 포함하는 인적 오류 조사분석의 세밀화 단계 제안

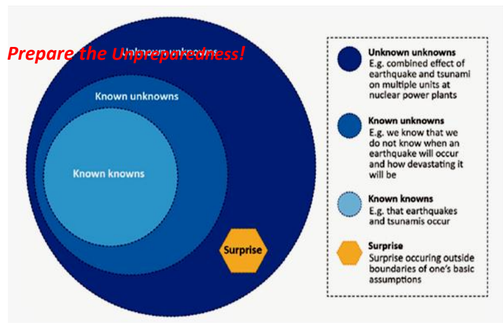
A Scrutinized Step Proposed to More Effective Human Error Investigations for including Violations and their Countermeasures

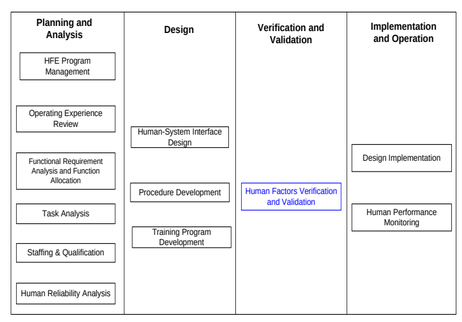
이용희(Lee Yong Hee; yhlee@kaeri.re.kr) , 한국원자력연구원(KAERI)/사고감시대처연구실

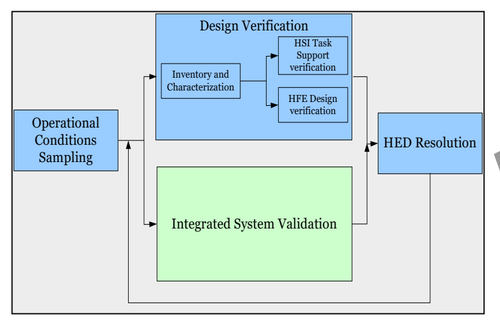
KAERI 한국원자력연구원 Korea Atomic Energy Research Institute

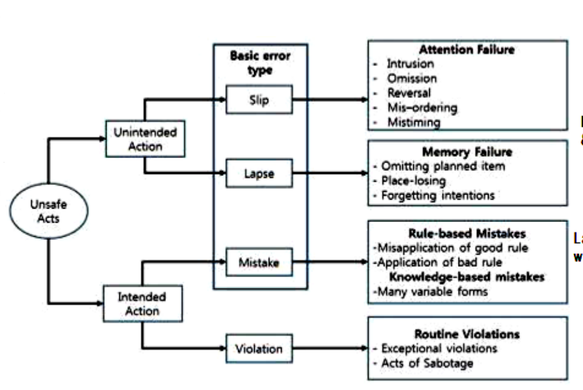
1. Background and Introduction

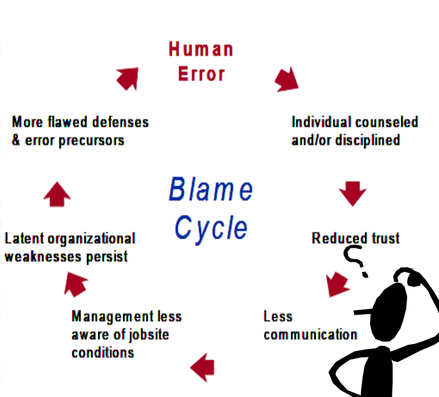
- Revisit and Redefine Human Error Risk After Fukushima => **HOF (OECD, IAEA)**
  - ◆ **Human Errors : Error of Human vs. Errors related Human**
  - ◆ **Potential Defects related to Person/Team/Org.(including Gov. & Society)**
- Extended Scope of Efforts to Human Errors : **Quarrelsome**
  - ◆ **Human Errors in HFE V&V, PSR, stress Test, PSA/ HRA, and Investigations**
  - ◆ **including Human Error potential of Person/Team/Org.**
  - ◆ **Abnormal/emergency -> unexpected/unprepared**
- Characteristics of Nuclear System (**NPP =** Unique Complexity and Uncertain 2015, 2016 Lee)
  - ➢ large and complex system into a **social disaster**
  - ➢ **non-injury** but irreversible system loss with low self-motives
  - ➢ **latent** hazards by multiple barriers and DID
  - ➢ **rare** data for learning from errors
  - ➢ **tightly-coupled but delayed** risk
  - ➢ **Segmented and out-of-loop** by the partial automation/integration
- **Revisit to Violation due to Impacts (2015/2019 Lee)** => **more vulnerable & quarrelsome issue**
  - ➢ 예외성(exceptionality) : 설계/예상된 범위 밖의 조치
  - ➢ 책임성(responsibility) : 관련자/이해관계자 **cf. Sharp-End/Organized Irresponsibility Issue**
  - ➢ 파급성(propagatory) : 안전 기능의 무력화 파급 + 사후 논란의 파급성 **cf. 등급평가 문제**

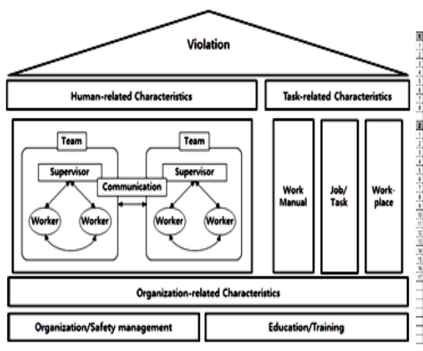


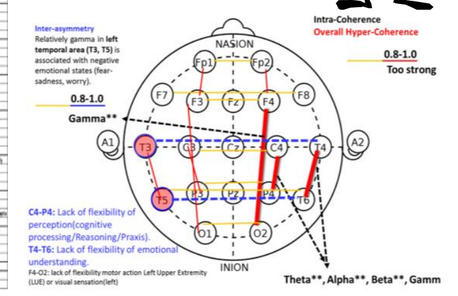


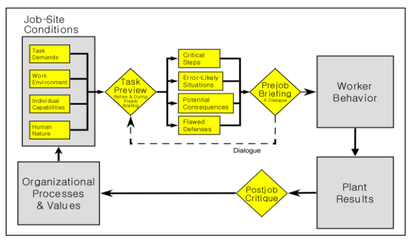


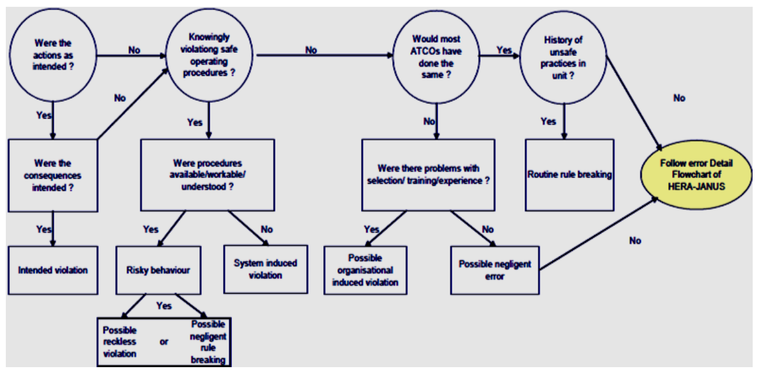












A Substitution Test Logic to Violations(2006 EAM, Reason)

2. Violation as a Safety Culture or HF?

- ➢ **Safety Culture Issue after** Human Error including Violations? => ***Attribution Error '답정너'***
  - 당연성 Triviality ; self-evident factor to all Events negative or positive
  - 종결간편성 : Convenient Termination Criteria to Event Investigations
  - 임의성 : Arbituality to Countermeasures
- ➢ **Prior Studies on Violations : blaming perspective**
  - ➢ Types of Violations (2016/2019 이용희)
    - *routine/permitted violation,*
    - *mannerism, negligence, avoidance, by-standing… **복지부동**, 매너리즘*
    - *Optimized and convenience violation…*
    - *temporal and exceptional violation…*
    - *test violation, curiosity violation, learning violation, asked/induced violations…*
    - ➢ *after-event violation…*
  - ➢ Influencing & causal factors to characterize violations. :
    - ➢ House Model of Violations :10 keys/152 factors (2015/2016 한성호, 강보라 외)
  - ➢ Violations in Safety Culture Management (2015 이용희, 2015 박기찬)
  - ➢ Just Culture (2019 NSSC, 2020 정윤형) -> *Validity of Responsibility*
  - ➢ EOC(error of commission) and EOO(error of omission) (2019 Kim)
  - ➢ Security Error & Fitness-For-Duty (2018 서영아 외, 2019 임만성 외, 2020김정환 외)

3. Study on Culpability of Violation in HE Investigations

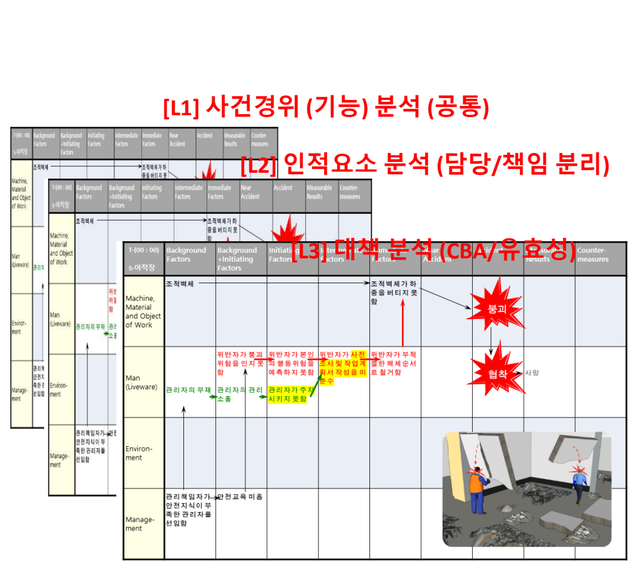
- Three Technical Approaches focused to Countermeasures : ***Human Error 1.0~3.0 (2015 Lee)***
- **Hyper-sensitive to Safety** => Blame Perspective => Issue of Culpability of Human Error
  - ➢ Responsibility Allocation => **Sharp-End/Organized Irresponsibility Issue** (2016/2019 이용희)
  - ➢ Safety Validity with Objectivity for Social Acceptance
  - ➢ new perspective to human errors separated/layered analysis - during event investigations
- Two Separated Dimensions of Culpability
  - ➢ **Validity to Blame** the (Personal/Org.) *Responsibility to Blame ability*
  - ➢ **Worthiness to Ask** (Personal/Org.) *Responsibility for Remedial Countermeasures*

4. A Step proposed for HE/VIOLATION Investigations

- Adopt Perspective of Human Error 3.0 during HE Investigations :
  - Focus of investigations moves Science to Engineering
  - From factual causes to practical countermeasures (2016, 2018, 2019 Lee).
- **Multi-layered Analysis with three additive layers of *Culpability Test*.**
  - ➢ 기본 3 원칙 : three basic principles proposed for an enhanced HE Investigations
  - (1) 규칙(수준) 비례 원칙
  - (2) 책임(responsibility) < 권한/능력 (capability)
  - (3) 원인(cause) < 대책 (countermeasure)
- Multi-layered Analysis with three additive layers of analysis on events. (2020 Lee)
  - ➢ **L1 : functional level of events (event sequence)**
  - ➢ **L2 : behavioral level of human assignments : R&R**
  - ➢ **L3 : culpability level**
  - *** Simplified Haddon-Matrix 다계층/다관점 분석** : L3에서 책임성과 별도 분석

A Detailed Set of Criteria to Test Violations

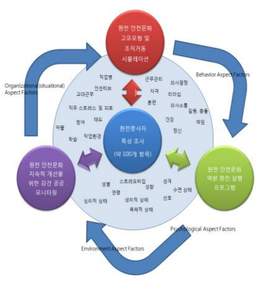
keys		sub-factors
intention	consequence (negatives)	loss/damage punishment
	value gain (positives)	gain interest, fun etc. personal value convenience others
	mis-captured	(selected in domain tasks)
perception	rule	rule itself/details rule purpose intended rule-breaking meaning of rule-breaking
	availability	physical informational
management	intervention	self peer supervisory
	E&T	education-class, case, mt'l training –OJT and etc. PJB etc.
	experiences	job-related personal others
	organization	(selected in domain org.)
	others	(selected on purpose)

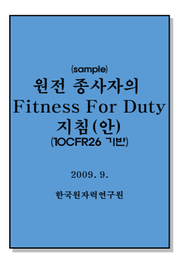


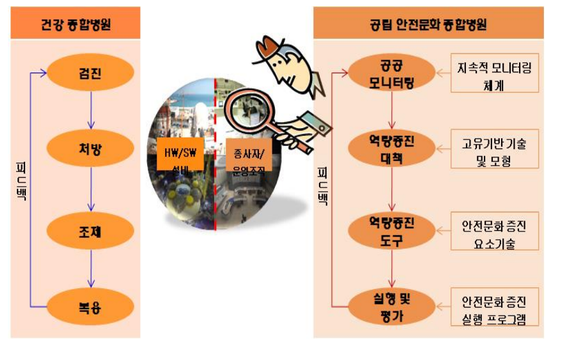
A Proposed Scheme of Violation Investigations

5. Conclusion and Discussions

- ***How to Treat Violations*** in Nuclear Events?
  - ➢ Primary Purpose and Theme of HE Investigations : CM Technical/Remedial Eng.
  - ➢ (Personal/Org.) Responsibility? By **a set of scrutinized criteria** (=> See Table)
  - ➢ Remedial Countermeasures to Enhance Safety : priority to Technical CMs
- INVALUABLE Lessons Learned for Nuclear Safety and Safety Culture?
  - ➢ Retrospective to Proactive by Feedback Loop of ***Learning Organization*** Paradigm
  - ➢ Subjective/Social Importance of Events/Factors selected
- Further Researches : Proposed Activities to Violations by Human Error 3.0
  - Near-term : **Revised Regulation Policy and Strategy to HEs**
  - ***People Analytics*** with ***Big-Data*** on Org. Safety and Socio-Technical System of NPPs







6. References

*** 선행발표논문 :** ***A Preliminary Study on the Culpability of Violation Errors in Nuclear Events and their Investigations,*** **KNS 2020 Autumn**

- Acknowledgement : 본 연구는 원안위 원자력 안전연구개발 사업 "**원자력 종사자 위반형 오류의 대처 규제 요건 및 정책 개발(200300)**" 과제의 일환으로 수행되었습니다.
- **ACKNOWLEDGMENT** This paper is supported by the Nuclear Safety Research Program grant funded by Nuclear Security and Safety Commission (NSSC) and KOFONS (Grant *No. 2003010*).

KAERI 한국원자력연구원 Korea Atomic Energy Research Institute