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원자력 사건에서 위반 오류의 효과적 분석을 위한 착수 원칙 및 비난성 논리 개발

Development of Starting Principles and a Culpability Logic Suggested for more Effective Analysis on Violations in Nuclear Events

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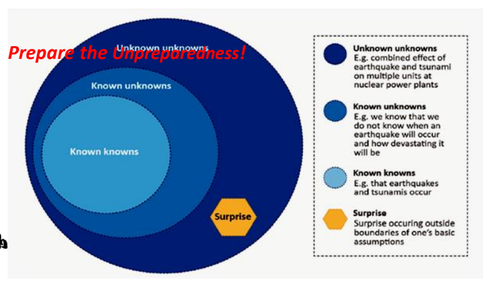
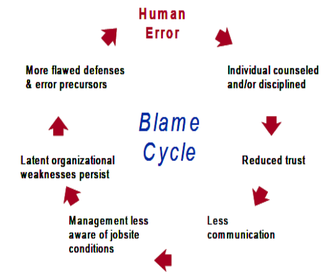
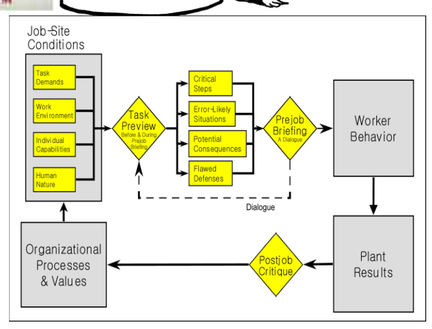
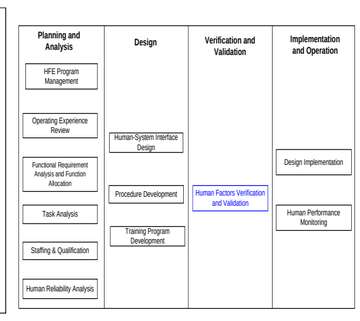
1. Introduction : 인적오류 재부각

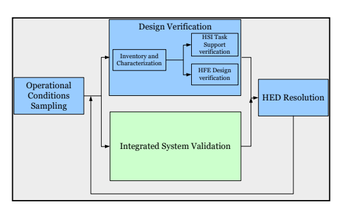
- 인적오류 재부각 : 중대사고 (TMI => 체르노빌 => JCO => 후쿠시마)
  - 불확실성 **현실화=요구 확대 : Unprepared/Unknown/Unexpected Risk**
  - 인적오류 범위의 확대 : **HOF** ***인적오류 안전 한계= 위반 무한책임***
  - ◆ **설계 검증 V&V , PSA/ HRA ,**
  - ◆ **PSR, Stress Test 인적오류의 범위**
  - ◆ **사고고장 사건의 조사분석 : 빈번한 논란(후견지명/사후약방문+책임)**
- 원자력 시스템 특성 (**NPP 기준)** unique & hard-to-overcome . (2015, 2016 Lee)
  - ➢ *large and complex system into a social disaster*
  - ➢ *non-injury system loss with low self-motives*
  - ➢ *latent hazards by multiple barriers and DID*
  - ➢ *rare data for learning from errors*
  - ➢ *tightly-coupled but delayed risk*
  - ➢ *out-of-loop by the partial automation/integration*
- **위반(violation)** => **more vulnerable & quarrelsome issue(2015/2019 이용희)**
  - ➢ 예외성(exceptionality) : 설계/예상된 범위 밖의 조치
  - ➢ 책임성(responsibility) : 관련자/이해관계자 **cf. Sharp-End/Organized Irresponsibility Issue**
  - ➢ 파급성(propagation) : 안전 기능의 무력화 파급 + 사후 논란의 파급성 **cf. 등급평가 문제**





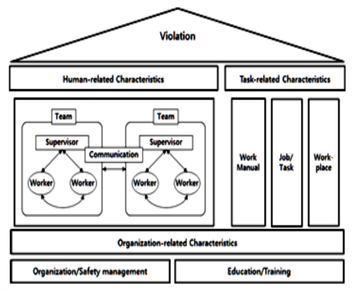


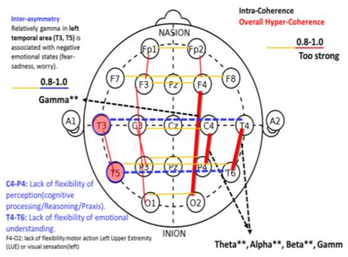


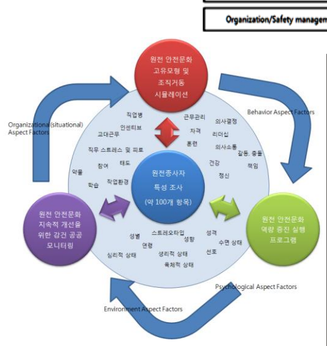


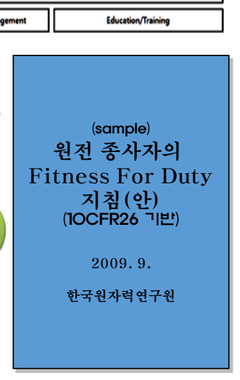
2. Previous Studies on Violation

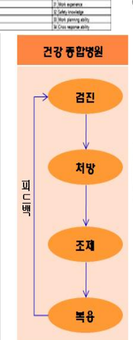
- ➢ * ***Safety Culture Attribution Problem !!! 답정너 현상***
  - 당연성 : Triviality, self-evident to all Events negative or positive
  - 편의성 : Convenient Termination Criteria to Event Investigations
  - 임의성 : Artificiality to Countermeasures
- ➢ Violations in Safety Culture Management (2015 Lee, 2015 Park)
- ➢ Types of Violations (2016/2019 Lee)
  - ➢ routine/permitted violation, mannerism, negligence, avoidance, by-standing…
  - ➢ 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 Kang, 2016 Han et al)
- ➢ Just Culture (2019 NSSC, 2020 Jung) -> *Validity of Responsibility*
- ➢ EOC(error of commission) and EOO(error of omission) (2019 Kim)
- ➢ Security Error & Fitness-For-Duty (2018 Suh, 2019 LIm, 2020 Kim et al)
- ➢ *Human Error 3.0* changes the main focus of investigations from the factual causes to the practical countermeasures (2016, 2018, 2019 Lee).

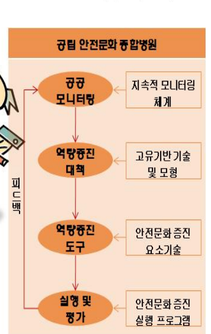






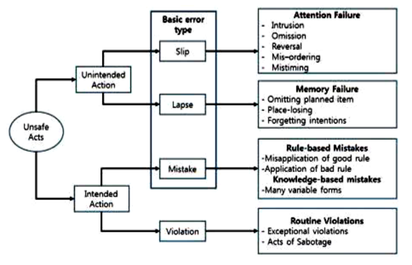


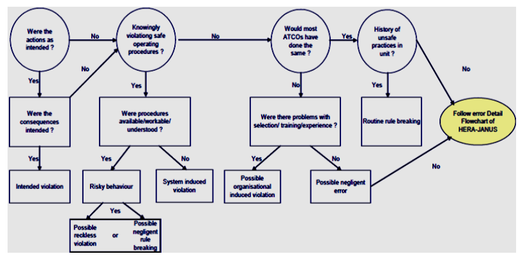




3. Starting Principles for Violations Investigation

- **5 Principles expected for HE Investigation Process**
  - ***Principle of no-intention and goodness***
  - ***Principle of objective evidence by controllable element***
  - ***Principle of independence of measures to causes***
  - ***Principle of practicality over causality***
  - ***Principle of responsibility limit and proportionality***
- Culpability of Human Error by Responsibility (Attorney's) Perspective
  - ➢ Validity with Objectivity for Blaming based on R&R and Limit of Task Competence
  - ➢ Responsibility Allocation => **Sharp-End/Organized Irresponsibility Issue** (2016/2019 이용희)





4. A Logic for Testing Culpability of Violations

- Technical Approach : Human Error 1.0~3.0
  - ➢ Separated/layered analysis – new type of human errors during event investigations
- **Two Separated Dimensions of Culpability Test**
  - ➢ **Validity to Blame (Personal/Org.) Responsibility by 9 Violation Elements**
  - ➢ **Worthiness to ask (Personal/Org.) Responsibility for Remedial Countermeasures**

=> New Framework proposed for Violation Investigations

- Multi-layered Analysis with three additive layers of analysis on events.
  - ➢ L1 : functional level of events (event sequence)
  - ➢ L2 : behavioral level of human assignments : R&R
  - ➢ L3 : culpability level with two separated test logics
- **Simplified Haddon-Matrix 다계층/다관점 분석** : L3에서 책임성과 별도 분석

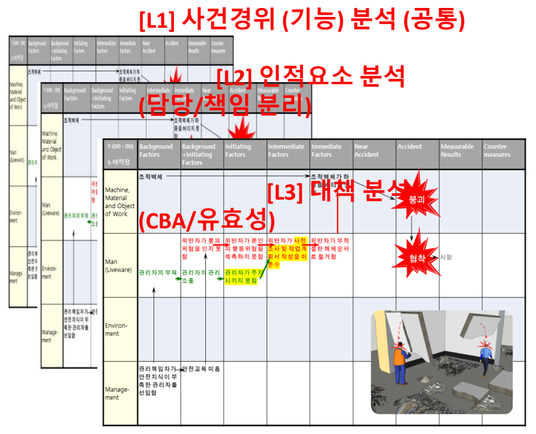
5. Conclusion and Discussion

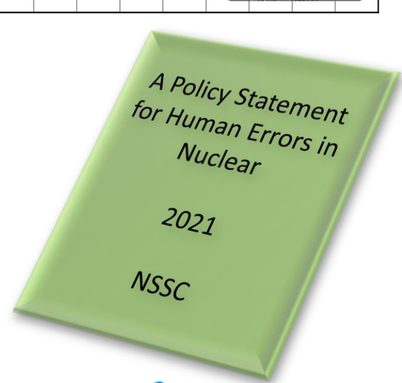
- **Policy Statement for Human Errors in Nuclear**
  - How to Treat Violations : Safety Culture? (Personal/Org.) Responsibility? => Remedial Countermeasures
  - Lessons Learned for Nuclear Safety : Retrospective to Proactive by Controllable Features
  - Practically Accept Subjective Importance of Events by People Analytics with Big-Data

- ➢ 기본 5원칙 : **Five Starting Principles for Human Error Policy in Nuclear**
  - **(1) 선의성의 원칙 : 이해관계자의 무과실/무의도 추정**
  - **(2) 객관적 제어가능 증거의 원칙 : 제어가능한 객관적 요소 기반 분석**
  - **(3) 원인/대책 독립의 원칙 : 원인(cause) < 대책 (countermeasure)**
  - **(4) 실효성의 원칙 : 원인 인과성보다 대책 실효성 우선**
  - **(5) 책임의 비례/한계 원칙 : 책임(respo.) < 권한/능력 (capability)**

- ➢ 비난성 검토 2단계 논리 **Two Separated Dimensions of Culpability Test**
  - **(1) 위반 요건 검토 (2020/2021 Lee) 9요소 검토 + 책임의 비례/한계 원칙**
  - **(2) 실효성 검토 : 비난의 대책 (countermeasure) 효과 (capability)**

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)





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