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# 원자력에서 성취한 안전과 사회적 수용성 개선을 위한 확장 가능한 안전 기초조사연구
# A Preliminary Study on the Achieved and Extendable Concepts of Nuclear Safety to Improve the Social Acceptance in Korea

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## 1. Introduction and Background : Changes of Safety

**Benefits and Economics of Nuclear technology => Controversy over Acceptance in Korea**
- Acceptance of Nuclear technology is mainly about the safety. => Controversy is still expanding /Demanding for Gen IV NPPs such as SMR
- Change of Safety Concept ~ advanced technology and social change.

**Safety necessary to improve the Social Acceptance of next-generation nuclear power.**
- Unique Characteristics of Nuclear safety & conceptual scopes of safety achieved in the field of nuclear
- Survey on scope of safety necessary to improve the social acceptance of nuclear
  - current awareness on status and demand of Nuclear safety
  - Q-survey and interview with residents around a nuclear facility.
  - conceptual areas of safety necessary for future nuclear power => ratings and priorities

**원자력 =기술에너지/무탄소에너지**
**안전의 개념적 변화 = 확장/신기술**
**사회적 수용성 4세대 원자로 = SMR**

**[동기] 원자력 안전의 진정성을 이해 받고 싶다!**
Q.고장/사고가 나지 않으면 안전한 것인가?
Q. 손실 발생 확률이 낮으면 안전한 것인가?
**=> 무엇을 더 노력해야 안전을 인정받을까?**

## 2. Safety Characteristics *of Nuclear & Pioneering Achieves*

**Safety Characteristics of Nuclear**
- *Intrinsic Hazards ~ Large Amount of Energy and Drastic Drop -> social and political matter*
- *Unfamiliar ~ not-experienced in everyday life, complex*
- *Disastrous ~ Impact of Unknown & Shock w.r.t. big benefits*
- *Irreversible ~ Medical Restoration? Long-term(Genetic)*
- *Un-learnable ~ rare date, doubt to maturity*

**Different Dimensions of Safety : Various Values of human, system, economy, society, etc.**
- **Safety ~ Freedom From Hazards (Negatives, Undesirables, Unacceptables, etc)**
- Death & Injury, Quality/Functional Fail -> Engineering Safety
- Environment -> Ecological, Economics -> Social/Global Safety

**Various Safety Aspects ~ Achieves & Pioneered by Nuclear**
- Economic
- Quality based Safety :
- Reliability based Safety
- Functional safety and safety objectives and designs :
- Human (and Organizational) Factors Safety
- Organizational and Cultural Safety
- Environmental
- Social

**Safety ~ Freedom From Hazards**
**(Negatives, Undesirables, Unacceptables, etc)**

***Variety of Concepts of Safety and Risk***
- *Risk Society Paradigm*
- *Normal Accident Paradigm*
- *X-event and Big-One Paradigm*
- *Man-Technology-Organization Paradigm*
- *House of Cards Paradigm*
- *Safety II and Resilience*
- *Human Error 3.0 Paradigm*

**New Conceptual Scope of Safety**
- *Sustainability*
- *Resilience*
- *Restorability*
- *Shock Impact to daily life*
- *Disgusting or Reluctance*
- *Self-management or self-control*
- *Environmental and health impacts*
- *Compliance with pre-appointments*

## 3. Further Scopes for Safety and Behavioral Scientific Approach to Safety

**Variety of Concepts of Safety and Risk ≠ Reliability and Probability**
- Environmental Safety ~ radiation impact -> Long-term, genetic, unknown
- Global Safety ~ Climate Crisis and Carbon Neutrality
- Social Safety ~ acceptability/ dependability ~ Disaster Safety

  *Cf. Safety II*
  - *Positive(Real) Perspective on Safety over Reliability*
  - *Resilience*

**** Extended Scope of Safety***

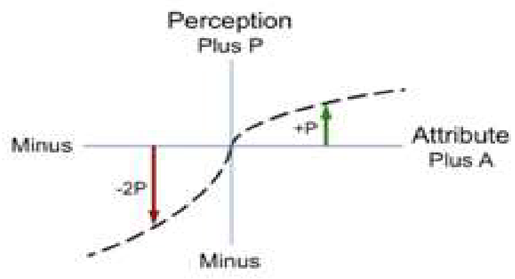
**Alternative Approach to Risk and Safety based on Behavioral Science Perspective** (2018/2020/2024 Lee).
Practical process of factors included in Risk Calculation and Safety Estimation

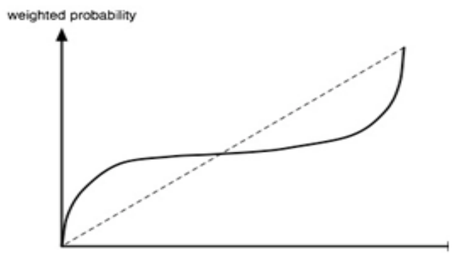
***Safety & Risk***
**≠ Reliability & Probability**
**안전 ≠ -(위험)**
**안전 ≠ 1- 고장**
**안전>>신뢰도**

**Suggested Dimensions of Real Safety**
- S0 Primitive Safety : No Fault & No Loss
- S1 Static Safety : Surplus, Excess, Margin *
- S2 Effort Safety : Tolerance & Resilience
- S3 Additive Safety : Emerging Challenges

**System Risk (R′) ≠ Σ (Loss x Prob.)**
Risk: Expected Loss = Loss x Prob.
System Risk (R) = Σ (Loss x Prob.)

*Risk(i): Expected Loss(i) = Loss(i) x Prob.(i)*
☞ ***Alternative Risk (R' or R*) = Σ R(i)***




**Perceived Risk (R′) = $f$ ( {u(Loss)$_i$ x π(Pro.)$_j$ } $_k$ )**
- ✓u(Loss) $_i$ = utility value of Loss $_i$
- ✓π(Prob.) $_j$ = weighted prob. of Pro$_j$
- ✓$f$(Risk$_k$) = integration of Risk$_k$

- **'u' means utility function that might be convex for gain and concave for loss along the reference point selected by people in risk perceptions and decisions.**
- **'π' means decision weight that may be a typical s-shape curve of conservatism**
- **∫ means the integral of risks rather than simple additive calculation.**

## 4. A Survey on Public Perception of Nuclear Safety :

- Method : Q-survey (rating) and Interview (FGI)
- Groups of Residences ~ near a Nuclear Facility ~ relatively familiar with concerns of nuclear
- Topics : current status on Safety Perception ~ rating & comparisons ~ ***other E-tech(Solar) & Public-tech(KTX)***
- **Preliminary Results (based on Rating statistics)**
  - ✓ ***Fatality and Injury Safety: no big Concern***
  - ✓ ***Investment Safety: no big Concern (Split*)***
  - ✓ ***Functional Safety: Acceptable***
  - ✓ ***Environment/Radiation Safety: Moderate/Split ****
  - ✓ ***Societal Safety: very limited and Demanding ~ Uncertainty /Long-term /Genetic***

**Mental Accounts of Safety/Risk**
- **Achieved Safety Dimensions**
- **Demanding Safety Dimensions**

*** No additive/accumulative value!**

## 5. Discussions and Conclusions

- **A Study on Nuclear Safety Status/Demands based on Public Perceptions**
- Safety is not fixed, and risk cannot be obtained objectively any more. => different perspectives and kinds of risk perceptions
- Alternative perspective on safety/risk and the Quantification approach based on Behavioral Science
- **Application ~ Social decision-making on Nuclear Facility : multi-unit NPP, radioactive-waste disposal, SMR**

**A Preliminary Survey on**
***Achieved vs. Required SAFETY***
***Of Nuclear in Korea***

## 6. References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