



**RELCON SCANDPOWER**  
Risk Management



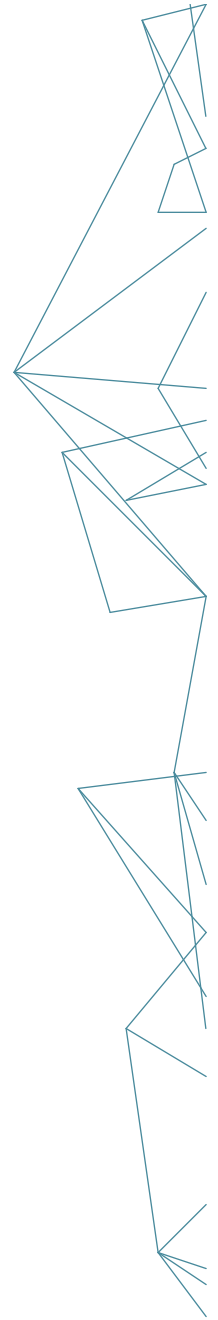


## NPSAG/NKS: Interpretation and Evaluation of the Technical Specification Criteria

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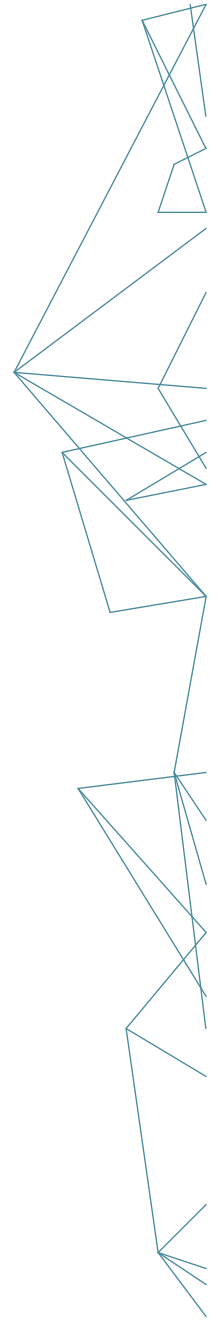
## Background to research project

- **Do we need PSA in the evaluation of TS?**
- **What is the situation?**
  - Requirement by STUK
  - SKI practice
  - US influence?
  - What is the option?
- **Is there a common acceptance on how and what to include in an evaluation?**
- **There are requirements, should there be a guideline?**



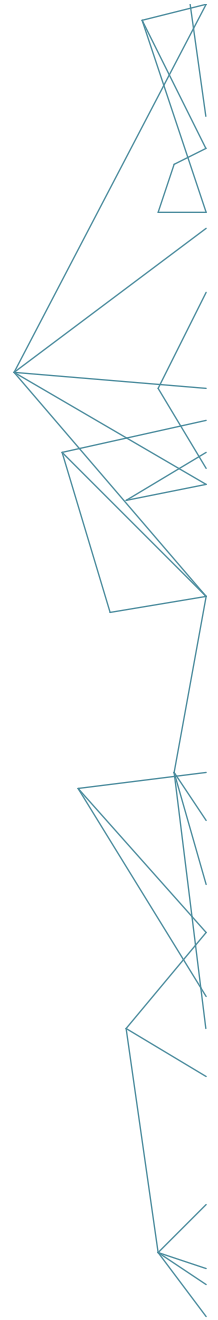
## Trends in the Industry

- **Risk informed methods have been applied on a case by case basis**
- **There are several ongoing projects at the NPPs**
  - Modernization
  - Power upgrade
  - These projects will require modification of the TS. The requirements on a risk analysis to verify exceptions will be a natural part of the TS update



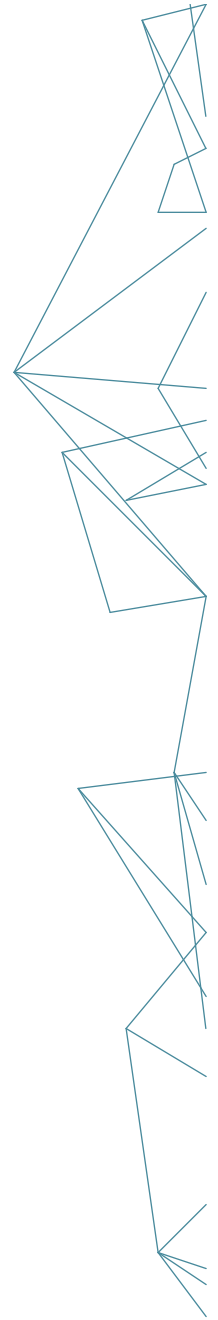
# The Project

- **Two Phases:**
  - **Phase 1:**
    - Information gathering, check of performed projects
    - Definition of aspects to be considered in a TS evaluation. Both positive and negative aspects shall be included.
    - Describe the background of the TS today. What was the intention when the TS was written. What would the NPP like the TS to define? What would the authority like the TS to define?
  - **Phase 2:**
    - Development of guidelines for evaluation of TS changes (with regard to the aspects defined in step 1).
    - If necessary, propose changes of the TS (or similar), to satisfy the needs.



# Interviews

- **Following organizations have been interviewed:**
  - Sweden
    - FKA
    - OKG
    - RAB
    - SKI
  - Finland
    - FNS
    - STUK
    - TVO



## Methods for Evaluation of Surveillance Test Intervals (STIs)

- **Evaluation for a Specific STI**

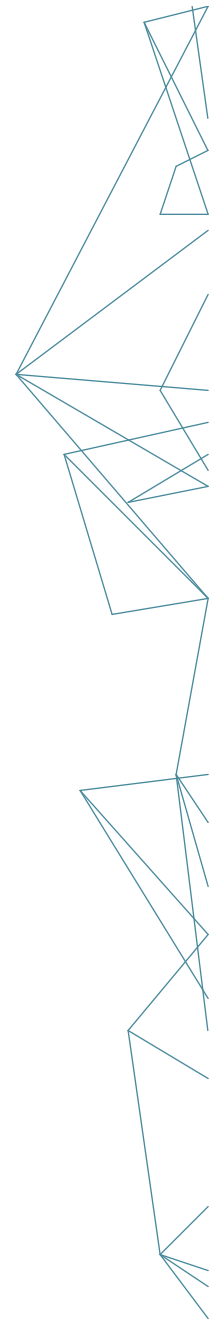
$$R_T = R_D + R_C$$

$R_T$  = Total risk for the test  
 $R_D$  = Risk contribution detected by the test  
 $R_C$  = Risk contribution caused by the test

- **Evaluation on Plant Level**

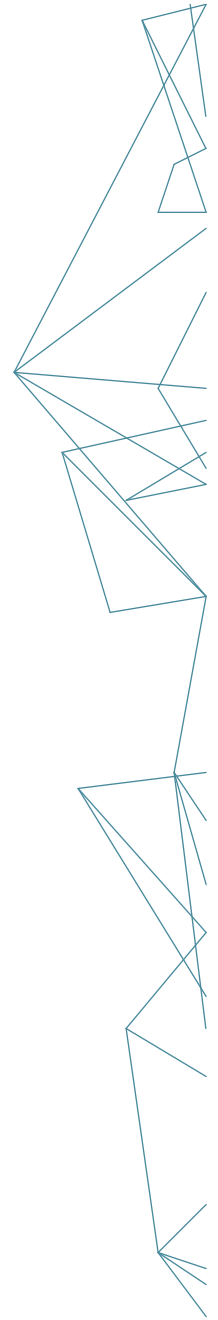
$$R_{Tot} = \sum_{j=1}^n R_{Dj}$$

$R_{Tot}$  = Total change in risk of a complete test program  
 $R_{Dj}$  = Change in risk due to change in one test interval



## Areas Discussed for STI Evaluation, Examples

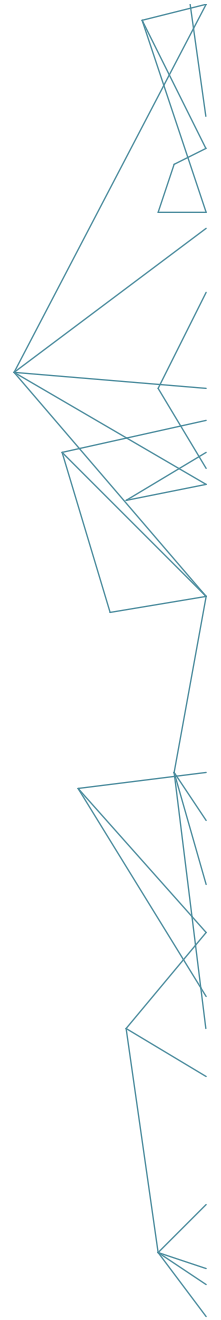
- **A test can result in adverse effects such as a test-caused trips, maintenance etc.**
- **How should different plant configurations be considered?**
- **Which risk measures should be studied; core damage, large early release frequency, large release frequency?**
- **Which initiating events should be considered? Area events, LOCA, etc?**
- **Is it acceptable to decrease the barrier against LOCA for example and instead increase the barrier against transients, i.e. can trade offs in the defense-in-depth functions be accepted?**
- **The effect on the CCF events by changed STIs should be considered.**
- **There are several different tests that affect the same component. How should this be considered?**





## Conclusions – STI Analysis

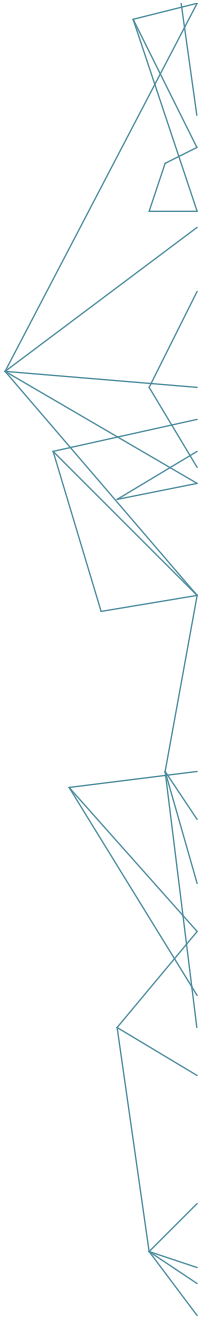
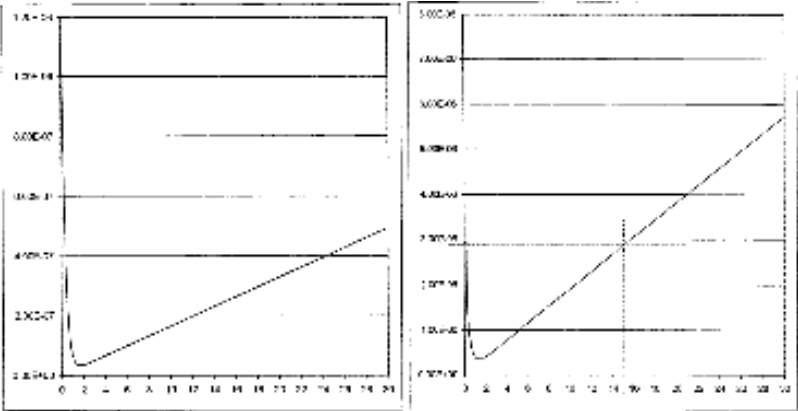
- **Seem to be a general acceptance for STI evaluation on plant level, i.e. making trade offs between different systems**
- **No consensus on which initiators to include and what risk measures to study**
- **Analysis of safety functions proposed (SKI, OKG)**
- **All utilities have performed some STI analysis**
- **Only FNS has performed an analysis that has resulted in a TS change**



# Methods for Analysis of AOTs

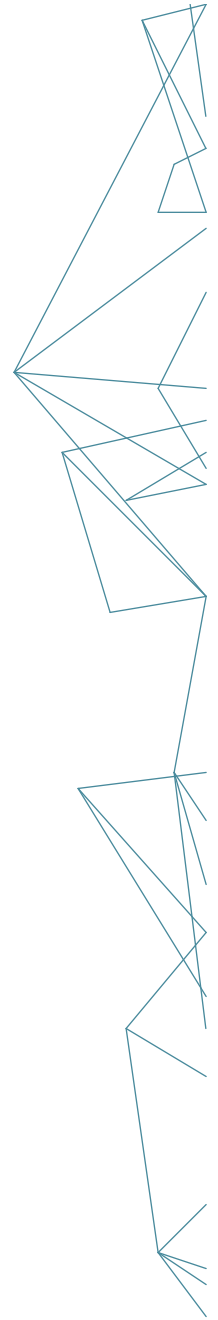
- **Three main methods are:**
  - Risk for continued operation with objects unavailable compared with an accepted frequency
  - Risk for continued operation with objects unavailable compared with an accepted probability (risk budget)
  - Risk for continued operation compared to plant shutdown (with objects unav.)
    - Risk Optimal solution (probability of repair taken into account)

$$\Delta CD_{AOT} = P_{>aot,x} \cdot (P_{SD,x} + P_{forcedoutage} + P_{startup}) + f_{power,x} \cdot AOT$$



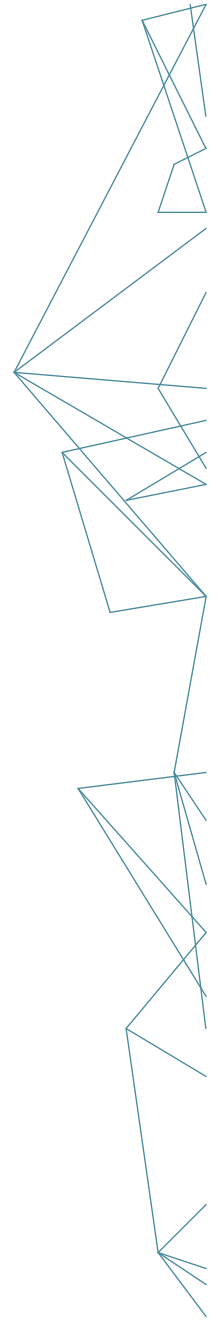
## Areas Discussed for AOT Analyses

- **What types of initiating events shall be studied?**
- **What is the measure (CDF, LERF)?**
- **What method shall be used for evaluating singular AOTs?**
  - Is it necessary to evaluate the singular AOTs?
  - How shall CCFs be treated (potential simultaneous failures)?
  - How shall mitigating/preventive actions be considered?
  - How shall different configurations be considered?
  - How shall several simultaneous maintenances be analyzed?
- **How shall the average PSA be adapted?**
  - Is it necessary to evaluate the complete PSA?
  - How shall several simultaneous maintenances be analyzed?



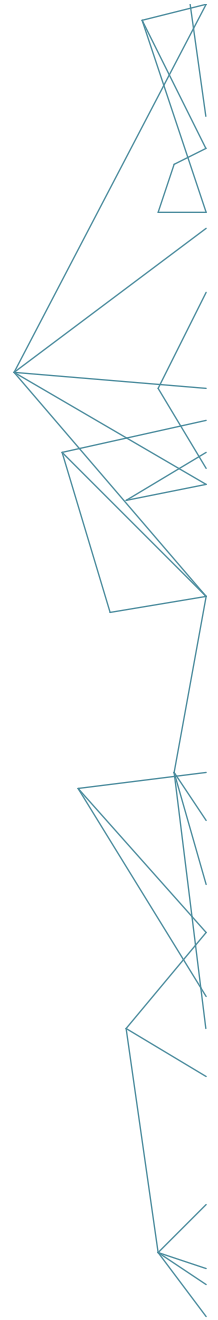
## Conclusions AOT Analysis

- **Common point of view is that the basis for AOTs is a thorough systems analysis, in which PSA is one input.**
- **There are different methods, and the methods may give very different results**
  - It does not seem like there is a general agreement on what method to be used, which initiators to be considered, or what type of result that should be studied
    - In Finland there seems to be an agreement
  - Since the methods may result in quite drastically different results, it is probably reasonable that several methods are used and the results compared.
- **The amount of performed sensitivity studies is fairly small.**
  - The results in the methods are stated to be fairly stable and the necessity of sensitivity analyses is therefore reasonably low (this must however be very case and method dependent).



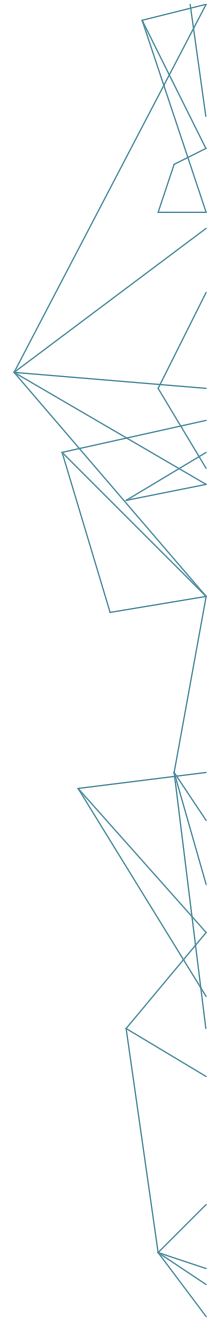
## Conclusions, Using PSA for TS Changes

- **On a general level, it seems that there is a reasonable agreement on what type of methods that are existing and what they represent.**
  - The application of STI analyses are also fairly converging.
  - However, the convergence is not that clear for AOT analyses
- **There is not a common agreement on the basis for the analyses**
  - Initiating events
  - Risk measures
  - In Finland the general agreement is to include all initiators and to study both PSA level 1 and 2.



## Next Phase

- **The Purpose: Develop Guideline**
  - Discuss the requirements on the process
    - What shall the guideline comprise?
  - Define what the TS requirements really mean
  - Define what methods that are appropriate
    - Not on a detailed level, but general scope
    - Is both "singular" and "average" analyses necessary?
    - How to address situations where:
      - Components are not part of the PSA
      - Shall consequence mitigation systems be included?
      - Shall systems not included in the SAR be included in the PSA?
  - Provide check list
    - Areas of importance shall be listed and described – and these shall be addressed in some way
  - Discuss areas quality requirements on PSA
    - Not the main target



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