

# Automatic Implementation of the KKL seismic PSA



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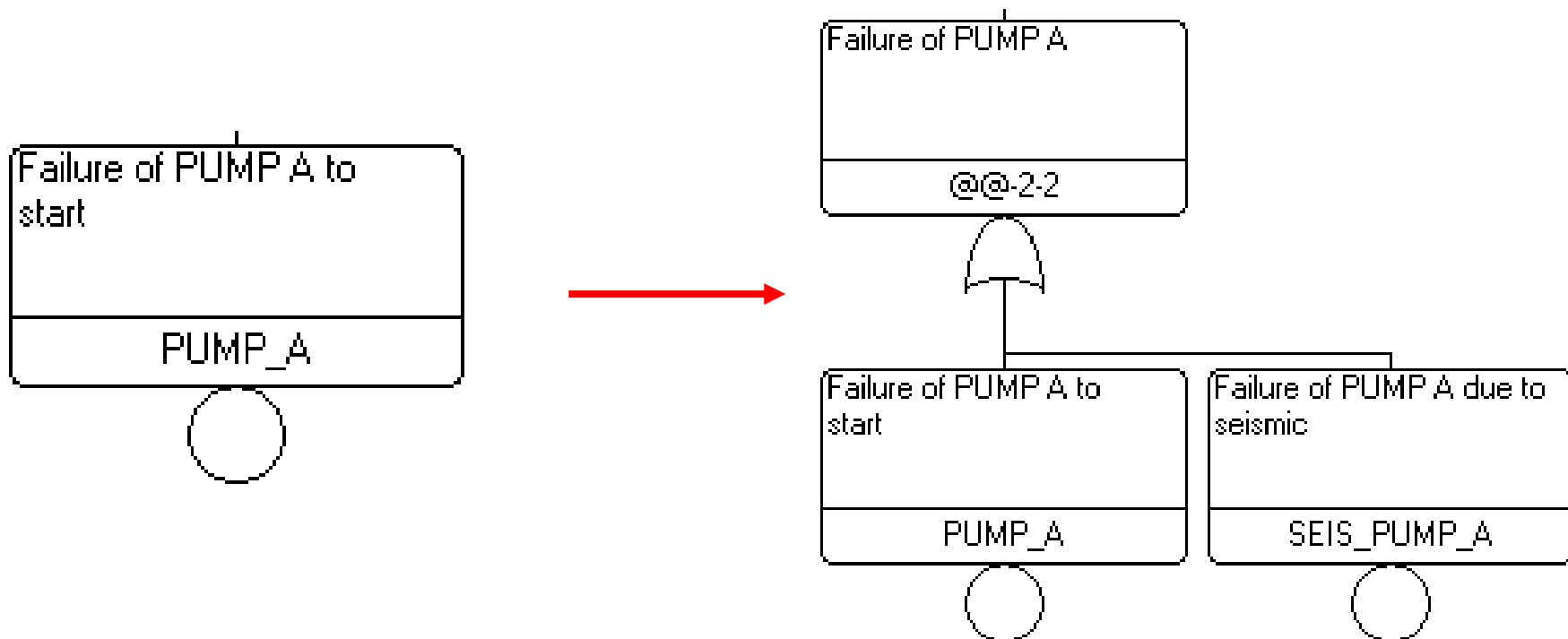


# Contents

- **Goal and processes of the KKL seismic PSA**
- **The challenges of the implementation**
- **Solutions developed**
- **Wink to PSA software developers**

# Seismic integrated model

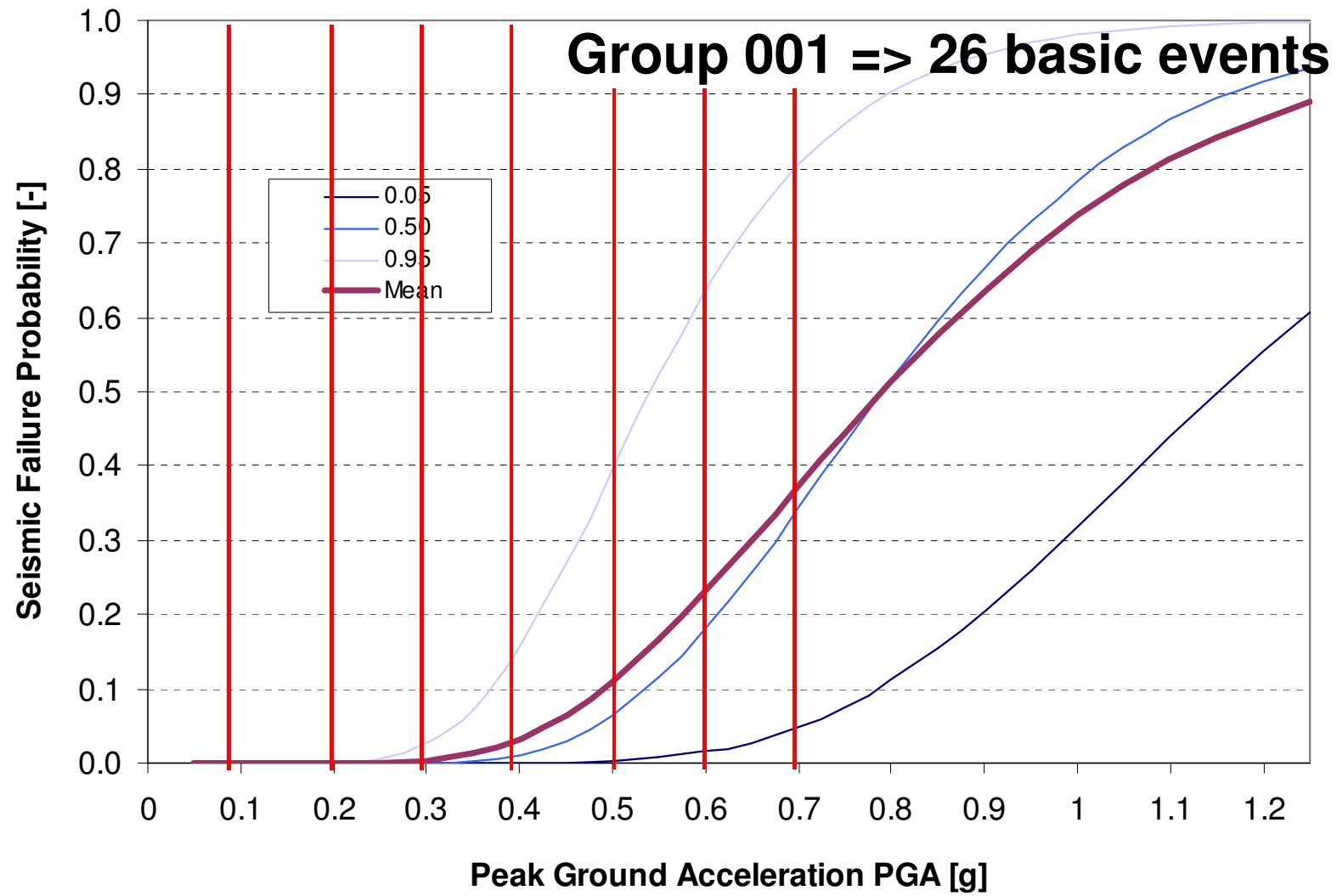
- Seismic fragility of components is considered in the system fault trees



# Process followed

- **Grouping of components (type and elevation)**
- **Walkdown**
- **Finite element modelling**
- **Simulation => median capacity**
- **Screening**

130 seismic groups retained



# Let's calculate...

- **130 groups ; 26 basic events per group:**
  - 3380 basic events**
  - + 3380 basic events descriptions**
  - + 3380 parameters**
  - + 3380 parameter descriptions**
  - = ... lots of work...**

1 per minute => 27 working days

# Two challenges

- 1) **How do we put all these objects in RiskSpectrum?**
- 2) **Once they are there, how do we put them in the Fault Trees? (3762 places)**

# Challenge 1

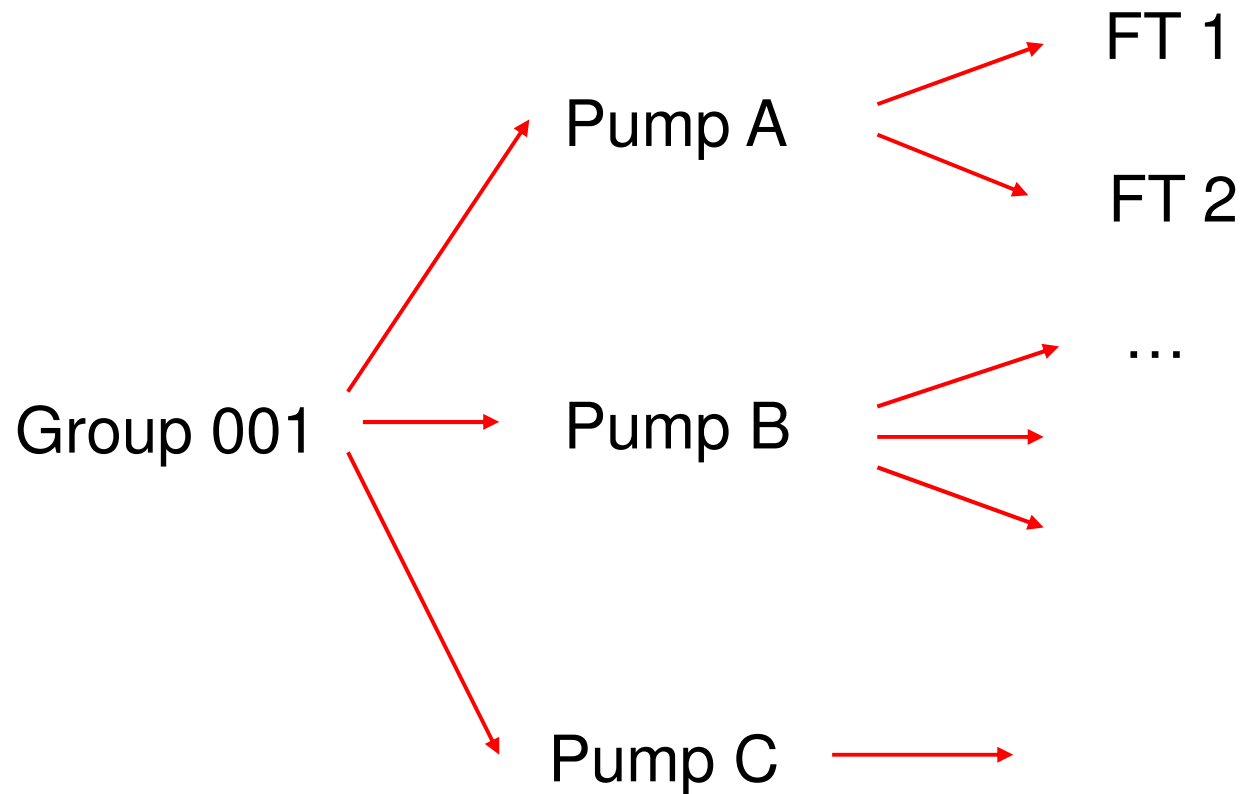
- **Solved using Excel Import**

Overview of the Excel document



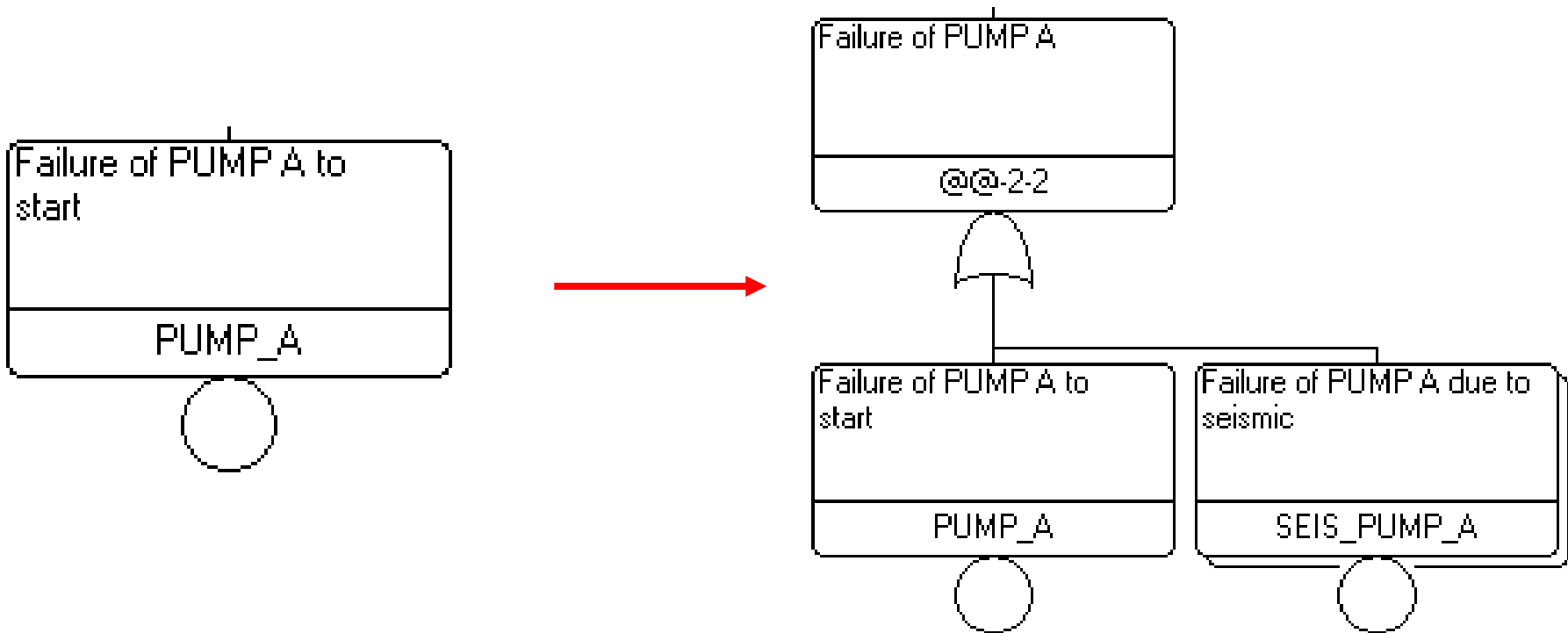
## Challenge 2

- How to prevent spending 2 months inserting basic events in fault tree pages?

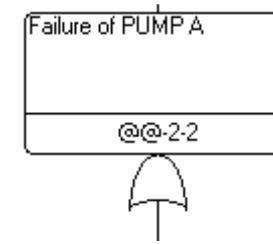


# Challenge 2

- In each Fault Tree:



## Challenge 2



- [001, 002, 003, ..., 0130]
- For each group *gr*
  - ☼ *Basic events = get\_basicevents\_associated(gr)*
  - ☼ For each basic events *be*
    - *Fault trees = get\_faulttrees\_associated(be)*
      - For each fault trees *ft*
        - *Create\_OR\_gate(name\_gate)*
        - *Populate\_gate(name\_gate, gr, be)*
        - *Replace\_be\_by\_gate(be, name\_gate)*

# Challenges 1&2

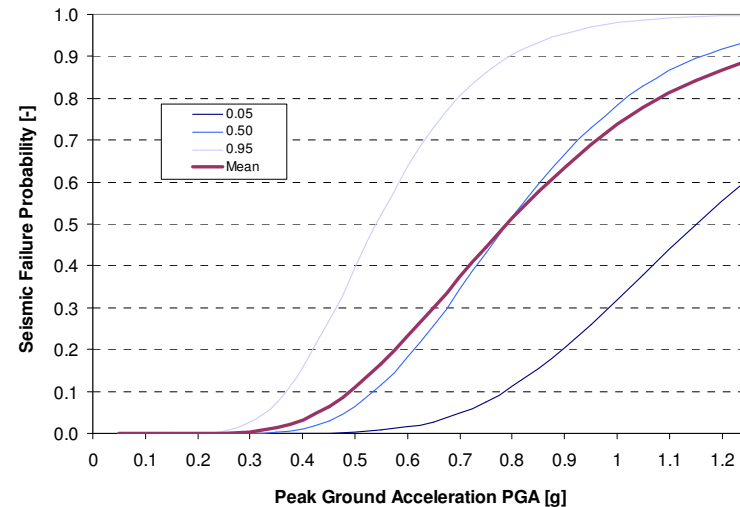
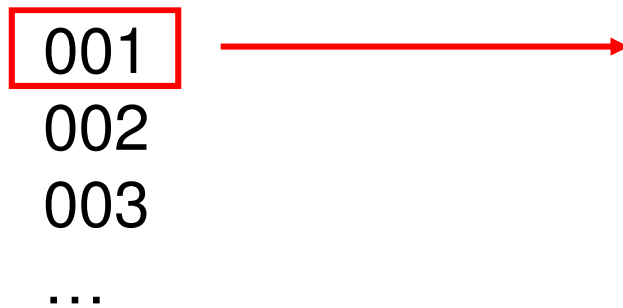
- **Challenge 1: cleared using VBA macro and the Excel Import functionality of RiskSpectrum**
- **Challenge 2: cleared using a script which automated the replacement of basic events by gates**

# What we have learnt from this

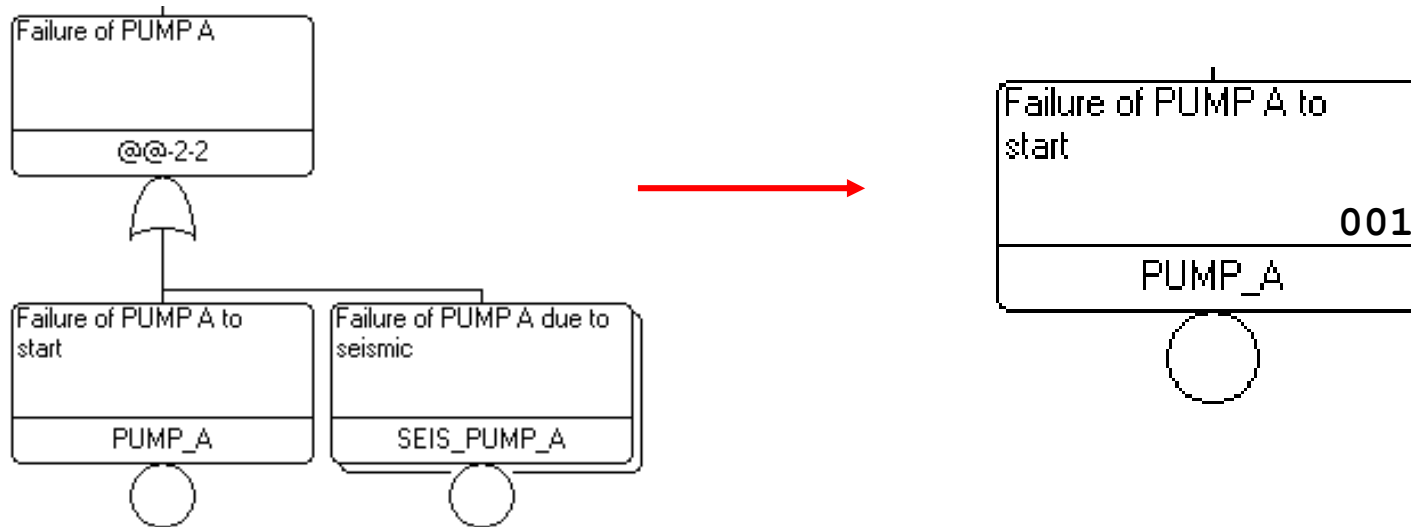
- **It works, but...**
  - ⊗ There is a lot of duplications
  - ⊗ The use of an external program was necessary
  - ⊗ Fault trees are more loaded
- **A more optimal solution should be available.**

# Attribute related fragilities

- This feature does not exist in RiskSpectrum
- This feature is just an idea...

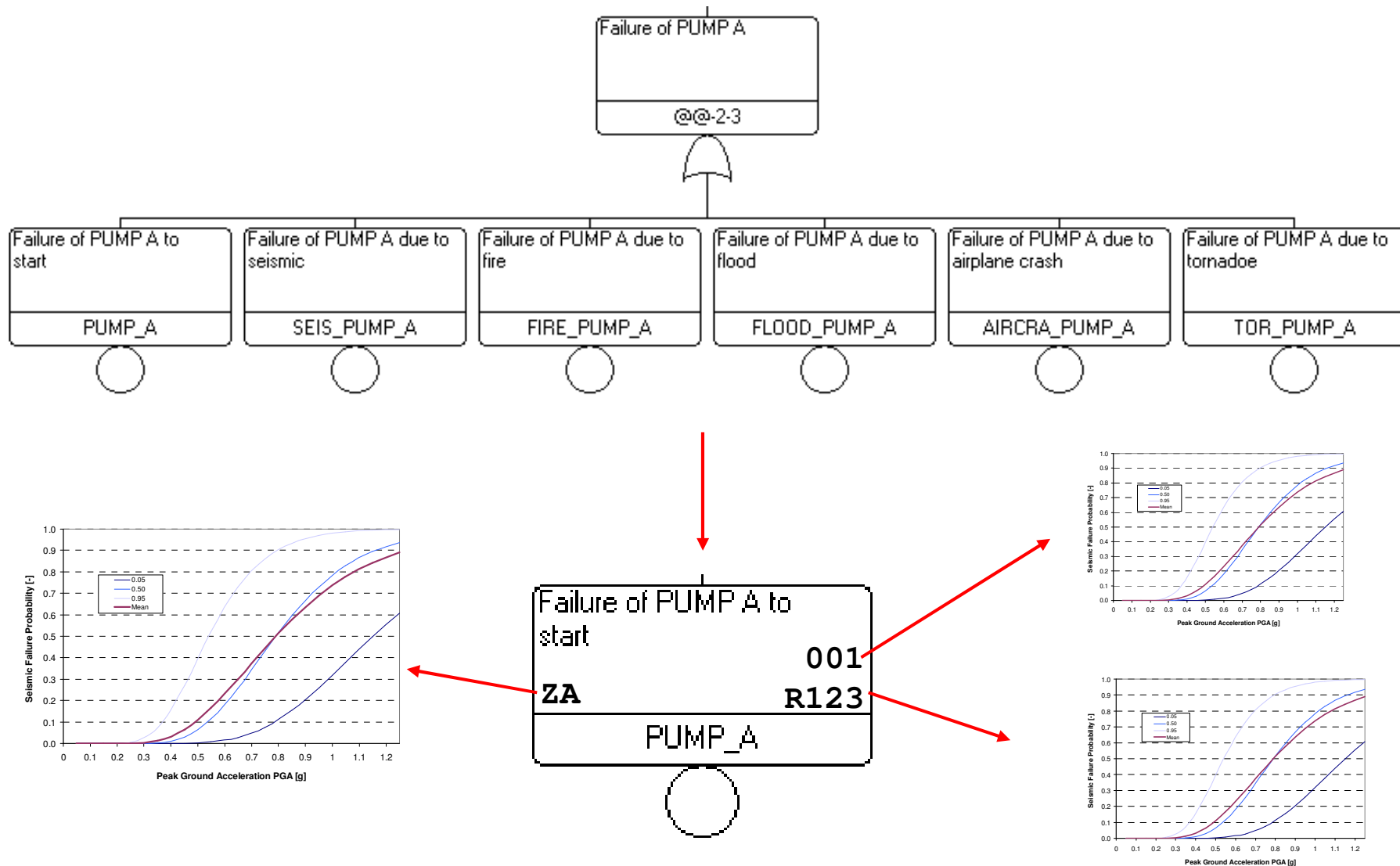


# Explicit => Implicit



- Replacement performed in the background
- Less implementation work (Attribute  $\leftrightarrow$  Basic Event)
- Lighter Fault Trees, more « System focused »

# Multiple applications





# Multiple applications

- **Very similar to Exchange Events except that:**
  - ⊗ It is not necessary to define the exchanges for each basic event individually
  - ⊗ It does not replace a basic event, it « adds » a contribution (equivalent to an OR gate)

# Conclusions

- **KKL seismic PSA has been efficiently implemented**
- **The model is easy to maintain (Excel Import)**
- **Improvements are possible in PSA softwares as requirements move more and more to integrated models**