# Automation of the KKL PSA 'Results&Insights' Documentation



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# Requirements of ENSI-A05

- **CDF/FDF contributions by groups of initiating events**

| Group | Initiating Event Category | CDF/FDF | | | | % of Grand Total (Mean) |
|---|---|---|---|---|---|---|
| | | Mean | 5 % | 50 % | 95 % | |
| | Transient | | | | | |
| | LOCA | | | | | |
| Internal Events (Total) | | | | | | |
| | Fires | | | | | |
| | Internal floods | | | | | |
| | Other internal hazards | | | | | |
| Internal Plant Hazards (Total) | | | | | | |
| | Earthquakes | | | | | |
| | Extreme winds & tornadoes | | | | | |
| | External floods | | | | | |
| | Aircraft crash | | | | | |
| | Other external hazards | | | | | |
| External Plant Hazards (Total) | | | | | | |
| CDF/FDF (Grand Total) | | | | | | |

# Requirements of ENSI-A05

- **CDF/FDF contributions of all initiating events**

| Initiating Event | | | |
|---|---|---|---|
| ID | Description | Frequency | Mean *CDF/FDF* |
| *Seismic1* | | | |
| *Fire1* | | | |
| … | | | |

- **FDF contributions of each plant outage state**

| Operating State | | Reactor Cooling System | | | | Contain-ment | Initiation of Safety Systems | Dura-tion [h] | *FDF* [%] |
|---|---|---|---|---|---|---|---|---|---|
| Abbr. | Description | $P_{abs.}$ [bar] | $T$ [°C] | Level Pressurizer (PWR), [%] | Cond. RPV | | | | |
| A1 | Cooling down | 150-20 | 300-150 | 60 | closed | closed | automatic | 20 | 6.3 |
| A2 | Remove fuel | | | | | | | | |
| … | | | | | | | | | |

# Requirements of ENSI-A05

- **Importance of:**

  ✿ Basic events

  ✿ Components

  ✿ Personnel actions

  ✿ Systems

- **Most important minimal cutsets**

| | CDF (FDF) | % | Minimal Cutset | |
|---|---|---|---|---|
| | | | **Name** | **Description** |
| 1 | 1.63E-06 | 6.00 | IEXZ1 | Initiating Event XZ1 |
| | | | XY111ABC | Diesel 111 fails to start |
| | | | AXYZNCC | CCF of components XYZ |
| 2 | | | | |
| | | | | |

# Requirements of ENSI-A05

● **Most important accident sequences**

| | |
|---|---|
| Sequence Number | |
| Sequence Frequency | |
| Percent of Total *CDF* | |
| Initiating Event | |
| Unavailability due to Initiating Event<br>– Direct, Guaranteed Failure<br>– Dependent Failure (e.g., Fragility) | |
| Support Systems Failed | |
| Front-Line Systems Failed | |
| Personnel Action Failed | |
| Description | |

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# How do we get the information?

- **Define Consequence Analysis Cases**

| | |
|---|---|
| 00/EPH/SWS/01 | Fullpower - EPH - SWS inlet plugged |
| 00/EPH/TOR/01 | Fullpower - EPH - Tornado 01 |
| 00/EPH/TOR/02 | Fullpower - EPH - Tornado 02 |
| 00/EPH/TOR/03 | Fullpower - EPH - Tornado 03 |
| 00/EPH/WEI/01 | Fullpower - EPH - River diversion (weir failure) |
| 00/EPH/WIN/01 | Fullpower - EPH - Wind 01 |
| 00/EPH/WIN/02 | Fullpower - EPH - Wind 02 |
| 00/EPH/WIN/03 | Fullpower - EPH - Wind 03 |
| 00/INT/LOC/DW-EL | Fullpower - INT - Extreme Liquid LOCA inside Drywell |
| 00/INT/LOC/DW-I | Fullpower - INT - Intermediate LOCA inside Drywell |
| 00/INT/LOC/DW-LL | Fullpower - INT - Large liquid LOCA inside Drywell |
| 00/INT/LOC/DW-S | Fullpower - INT - Small LOCA inside Drywell |

- **Run MCS and Importance analysis case with text results**

| Setup type | Setup ID    Char #:1 | Run |
|---|---|---|
| MCS Analysis Specification | DEFAULT | Yes |
| Uncertainty Analysis Specification | DEFAULT | Yes |
| Importance/Sensitivity Analysis Specification | DEFAULT | Yes |

# Overview of the document

# Living PSA = Changing PSA

- **New parameter values (Bayesian update)**

- **New systems (support systems)**

- **New SAMG actions**

- **Debugging**


The model is constantly changing

# Maintenance is time-consuming

- **Find the information (it takes time to remember…)**

- **Copy/paste**

- **Formating**

- **Every single changes requires a complete new set of tables**

+ it is easy to make mistakes…

# Approach used at KKL



Automatic production of the documentation through
the use of databases and script language

- **Repetitive tasks can be programmed and performed by a computer**

- **Structure can be defined once and used whatever the data**
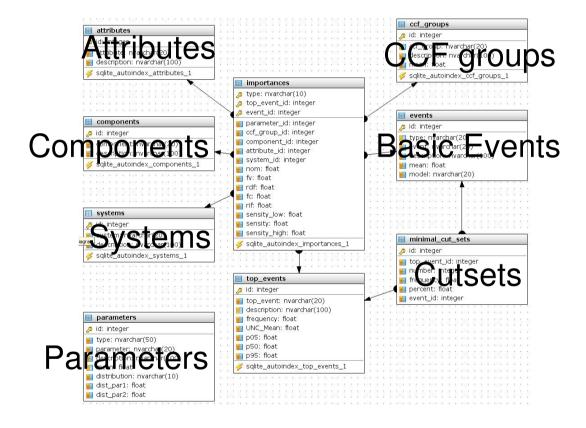
- **Layout, tables, graphs are defined only once**

# Steps

- **Run the model => text files (.MCS, .IMP, .UNC)**

```
=============================================================================
RiskSpectrum Analysis Tools - MCS, Version 3.2.0.7
=============================================================================
Project    : KKLPSA_1-3-0
Version    : 88
Top event  : 00/RP/DIV11
=============================================================================

Frequency = 4.377E-006

=============================================================================
No.    Frequency       %   Minimal Cutset Events
=============================================================================
1      1.000E-007     2.3   L-DW-XL
2      9.043E-008     2.1   IE/AOO3.9              __YVXXSCC8AMQ01=ZFC
3      7.886E-008     1.8   IE/E_WIND02           BN_ALL---_EG01ZFS
4      6.224E-008     1.4   IE/E_AIRCOM           __ZC1-E_AIRCOM
5      6.032E-008     1.4   IE/AOO8.4             T---SINJ_MQ-CZFC-ALL
                            __UJ--HINT_----=HFS
6      5.340E-008     1.2   IE/E_SUNSTORM         BN_ALL---_EG01ZFS
7      4.746E-008     1.1   IE/AOO7.1             T---SINJ_MQ-CZFC-ALL
```

- **Parse the text files with a script**

# Steps

● **Populate a database with a script**

# Steps

- **Query the database for the information you want (with a script)**

```
db.execute('SELECT    top_event, description, frequency, [% FDF]
            FROM      [ENSI_A05_Tab_02_FDF]
            ORDER BY frequency DESC')
```

- **Write the information in a LaTeX document**

```
puts "Creating Table 2 (CDF/contributions of all initiating events) regarding to ENSI A05 chapter 4.7.1 ..."
File.open(File.join(DIR_LATEX_PROJECT, 'chapter', 'ENSI_A05_Tab002a.tex'), 'w:utf-8') do |f|
  f.puts "\\begin{center}"
  f.puts "\\tiny"
  f.puts ensi_a05_table_2(@db)
  f.puts "\\end{center}\n\n"
```

# Steps

- **Compile the LaTeX document to produce a PDF**

```
G:\PSA>pdflatex Results&Insights.tex
```

- **Impress your manager 8-)**

# Pros & Cons

- **Report generated in a mouse-click**

- **Results always up to date**

- **Copy/paste error free**

- **Flexible and adaptable**

- **Knowledge of databases and script language required**

# Conclusions

- **Tools were developed to automatically generate the 'Results&Insights' documentation**

- **Many men-hours will be saved in the future**

- **Coherent with the Living PSA concept**