

Recent Insights from the International Common Cause Failure Data Exchange (ICDE) Project

PSAM 14

September 17-21, 2018, Los Angeles, California

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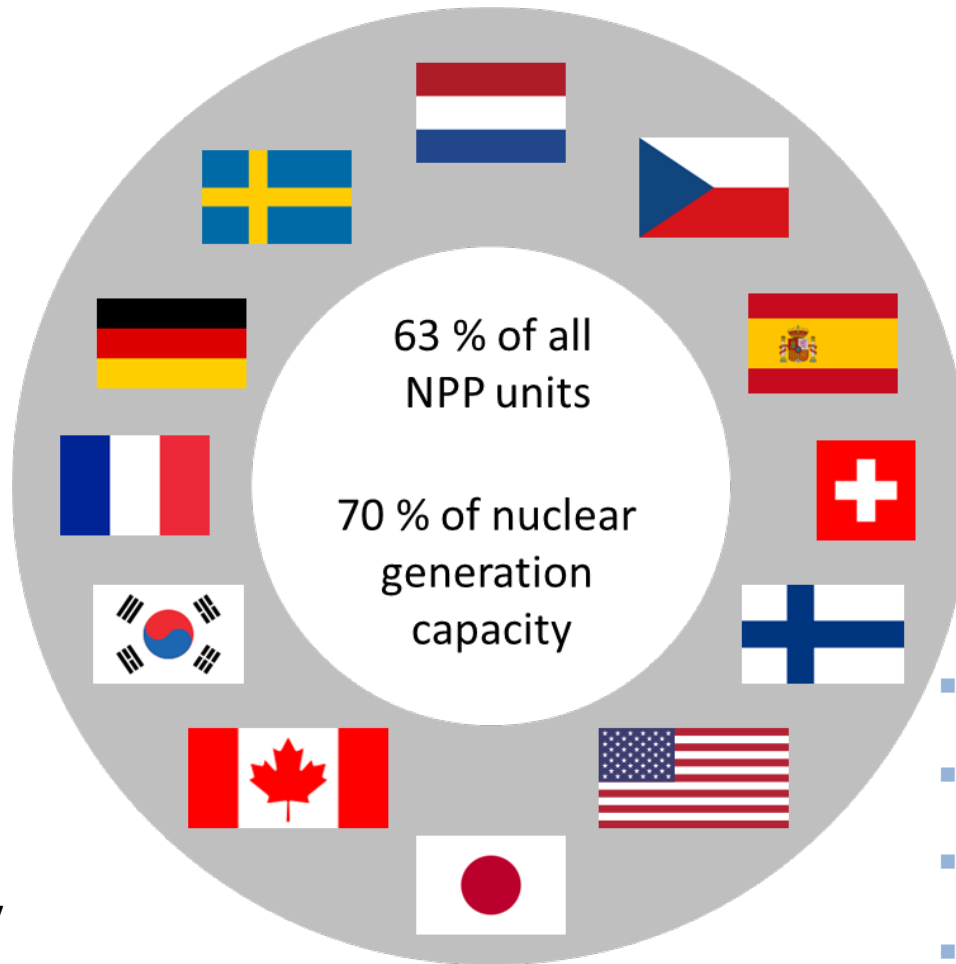
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International Common Cause Failure Data Exchange

- The ICDE project was initiated in August 1994.
- Since April 1998, the OECD/NEA has formally operated the project.
- ICDE defines the formats for collection of CCF events in order to arrive in a consistent database.
- The ICDE project phase VII covers the period 2015-2018
- Continuation of the project is planned, phase VIII is intended to start 2019

Participants in phase VII



- CNSC - Canada
- STUK - Finland
- IRSN - France
- GRS - Germany
- NRA - Japan
- KAERI - Republic of Korea

- ANVS - Netherlands
- SSM - Sweden
- ENSI - Switzerland
- NRC - United States
- UJV - Czech Republic
- CSN - Spain

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ICDE Objectives (1/2)

- To provide a framework for an international co-operation
- To collect and analyse CCF events on a long term basis
- To better understand CCF events, their causes and their prevention

ICDE Objectives (2/2)

- Experience feedback on CCF phenomena and on defence against CCF
 - To generate qualitative insights into the root causes and failure mechanisms of CCF events.
 - To be used to derive approaches for their prevention or for mitigating their consequences
- To record event attributes to facilitate quantification of CCF frequencies
 - When so decided by participants of the project.

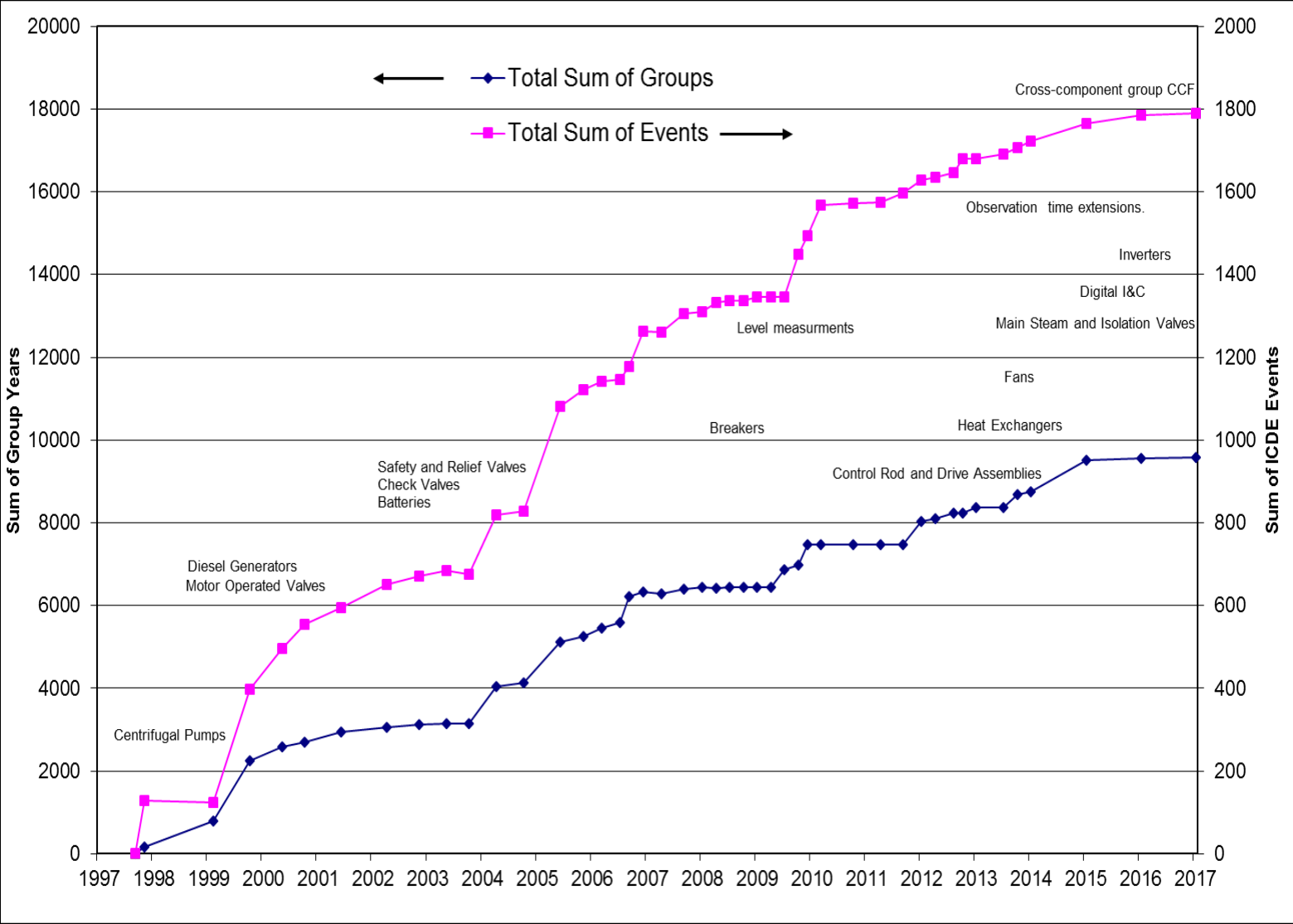
Operating Structure

- The in-kind principle is followed
 - Data exchange means that each participant gets the dataset corresponding to its own data sent to ICDE.
- Data collection and analysis has to be organized on national levels.
- ICDE data is restricted by proprietary rights.

Definitions

- Common Cause Failure Event:
 - A dependent failure in which two or more component fault states exist simultaneously, or within a short time interval, and are a direct result of a shared cause.
 - ICDE data collection includes also potential CCF events
- ICDE Event
 - Impairment of two or more components (with respect to performing a specific function), which exists over a relevant time interval and is the direct result of a shared cause.

ICDE - Progress



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Data Collection Overview (November, 2017)

Component Type	CCF Events	Percentage	Complete CCF	Partial CCF
Centrifugal Pumps	399	22,0%	51	39
Safety and Relief Valves	271	15,0%	26	36
Diesels	236	13,0%	26	18
Control Rod Drive Assembly	173	9,6%	3	24
Motor Operated Valves	172	9,5%	9	33
Level measurement	154	8,5%	7	27
Check valves	117	6,5%	14	24
Breakers	110	6,1%	8	25
Breakers	110	6,1%	8	25
Battery	77	4,3%	5	2
Heat Exchanger	55	3,0%	4	1
Fans	32	1,8%	3	0
Main Steam Isolation Valves	10	0,6%	3	0
Digital I&C	4	0,2%	2	0
Cross-component CCF	0	0,0%	0	0
Total	1810	100%	161	229

Technical Scope, Current Status (1/3)

- The ICDE Steering Group prepares publicly available reports
 - Containing insights and conclusions from the analysis performed whenever
- Major steps of the project have been completed, e. g.
 - analysis of a dataset for a certain component type or
 - a certain topic

Technical Scope, Current Status (2/3)

- Data and publicly available component reports for
 - Centrifugal Pumps, Diesel Generators, Motor-Operated Valves, Safety Relief Valves, Check Valves, Batteries, Level Measurement, Breakers Control Rod Drive Assemblies, Heat Exchangers
- Topical reports on CCF events
 - External factors (2015, 43 events)
 - Emergency Diesel Generators with all redundant diesels affected (completed, to be published)
 - Plant Modifications (2017, 54 events)
 - Improving Testing (Drafted, 59 events)
 - Multi-unit events, (Drafted, 87 multi-unit events)

Technical Scope, Current Status (3/3)

- Ongoing data exchange
 - Fans
 - Digital I&C
 - Inverters (in preparation)
 - Cross component CCF: multiple component group CCF due to asymmetric electrical faults (in preparation)
- Ongoing topical analyses
 - CCF due to plant modifications
 - Inter-system dependencies
 - Pre-initiator human failure ICDE events.
- Ongoing development of guidelines
 - Failure analysis guideline

Example: Topical report on Improving Testing

- Identify testing inadequacies that contributed to CCF events
- Identify ways to improve testing to reduce risk of events occurring
- 59 events identified related to this topic
 - An event could be assigned to more than one category

Test inadequacy categories	Category description	Number of events
Extent of test	Testing did not cover all aspects that could prevent failure	16
QA of test / maintenance / modification	QA and/or adequacy of testing were the most common issues	33
Performance of test	Errors during testing with focus on instructions, use of equipment, staff training and work control	9
Verification of operability	Inadequacy in the verification of operability after test, maintenance or modification	18
Unknown	Related to testing, but specific inadequacy was not determined	2

Lessons Learned from Improving Testing

- A process for quality assurance of procedures to ensure completeness, adequacy and validity of test is shown to be of high importance.
- When performing the test, it is important:
 - To verify the testing equipment
 - To ensure a high degree of training of the personnel performing tests
 - To have a safety culture to adhere to procedure steps and verify the work
- Verification of operability after test, maintenance activities and modifications are essential.
- The actual observed defences that prevented events from becoming complete CCFs shows that experience feedback from other units and previous events can be a successful way to detect latent failures.

Example: Topical report on Multi-Unit CCFs

- A multi-unit event consists of individual ICDE events of the same type that share a multi-unit dependency.
- The analysis covers 87 multi-unit events, which includes a total of 192 ICDE events.

Multi-Unit CCF Event Classification:

- **Internal factors** – Shared cause – Dependent multiple CCF events at a site
 - The same CCF failure mechanism is present and existing on multiple units at the site
- **External factors** – Shared environment or physical connection – Dependent multiple CCF events at a site
 - There exists a physical connection, an external connection, or a shared external environment between the affected systems and components.
- **Fleet CCF events** – Multiple CCF events occurring at multiple sites
 - Same or similar types of CCF events occurring at different sites.

Multi-Unit CCF Event Categories

Component type	Multi-unit event category			Total	Percent
	1. Internal factors (Shared cause)	2. External factors (Shared environment or physical connection)	3. Fleet CCF events		
Battery	7		2	9	10%
Breakers		1	1	2	2%
Centrifugal Pumps	16	4	2	22	25%
Check valves	4		1	5	6%
Control Rod Drive Assembly		1		1	1%
Diesels	16	7	3	26	30%
Heat Exchanger	2			2	2%
Level measurement	1		3	4	5%
Motor Operated Valves	4	1	1	6	7%
Safety and Relief Valves	7		3	10	11%
Total	57	14	16	87	100%

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Lessons Learned from Multi-Unit CCF Events

- Multi-unit events were observed for a wide range of component types.
 - Diesels and Centrifugal pumps were most common, i.e., more than 50% of events involved these types.
- The most common root cause for multi-unit CCF events is deficiency in the design of components and systems.
 - Events with design as predominant root cause and environment as contribution cause are significantly overrepresented.
 - Multi-unit events which involve environment effects usually require design improvements to prevent reoccurrence.
 - Events with observed environmental deficiencies were caused by harsh environmental conditions, such as severe weather or abnormal debris in a raw water source.
- About 10% of the events were complete multi-unit CCF events
 - Meaning that all the impacted components at all the impact units were completely failed.

Conclusion

- ICDE has changed the views to CCFs a great deal.
 - CCFs exist, 160 complete CCFs
 - Deep plant data collection and combining information from many sources, of which a major deal from NPP maintenance databases, needed.
- It is worth forming specialized data exchange projects like ICDE since they can be made to produce useful reports and insights.
- This, however requires,
 - the will of participants from several countries to form a critical mass
 - national efforts to collect lower level data
 - forming of a legal framework to protect proprietary data
 - a long term commitment to consistently continue and develop the activity.
- National efforts are the key to the success of any project relying on operating experience.

Further Conclusion

- ICDE has given a birth to several similar types of projects.
 - OPDE for pipe failure events (on-going under CODAP project)
 - OECD-FIRE for NPP fire events.

More information:

Publicly available reports

- <http://home.nea.fr/html/nsd/docs/indexcsni.html>
- <https://projectportal.afconsult.com/ProjectPortal/icde>

Thank you for your attention!