General Insights from Analysis of Common-Cause Failure Data at U.S. Nuclear Power Plants

1997–2009

The common-cause failure (CCF) study uses operating experience to characterize the frequency and nature of component failure data from operating U.S. commercial nuclear power plants. The evaluation is based on the operating experience from 1997 through 2009. The data sources for this report include:

- License Event Reports (LERs), 1997 to 2009
- Equipment Performance and Information Exchange (EPIX), 1997 to 2009

The CCF database is a rich source of information on various aspects of CCF. Exploring the full potential of the database merits a dedicated activity and is outside the scope of the current effort, which has focused on building the infrastructure for such analyses. Nevertheless, some general observations have been made on the character of CCF events, including their causes and shared cause factors, and frequency of occurrence. Some of these insights are summarized in this section.

Table 1 lists the systems and component types for which CCF events have been collected and entered into the database. The events are further classified by failure modes (e.g., pump fails to start, valve fails to open).

Basic information about the nature of CCF events is displayed in Figure 1 and Figure 2. These figures illustrate the distribution of CCF event proximate causes and coupling factors, respectively. This information provides a general picture of the types of events that may be expected to occur, and what design features might be most susceptible to CCF events. These figures also illustrate the different characteristics of partial CCF events and complete CCF events (events with timing factor, shared cause factor, and component degradation values for each component in the common-cause component group (CCCG) = 1.0). Figure 3 and Figure 4 display the number of CCF events by year of occurrence. Figure 5 and Figure 6 show the distribution of CCF events by system. Figure 7 and Figure 8 show the distribution of CCF events by component.

1.1 Database Modifications

The CCF and RADS databases have been modified to read data from a new set of tables stored in the SQL Server environment. The RADS program and the relief valve data will not have to be modified any further to continue calculations.

The CCF database has been modified to:

1. Conform with an updated component naming scheme,
2. Conform with the new failure mode naming and definition scheme:

   a. New failure modes include fail-to-run < 1 hour, fail-to-load-run, setpoint drift, fail-to-operate, and others being used to gather better strainer and traveling screen data including bypass, plug, and high Δp.

   b. The p-value guidance has been clarified to relate to the failure mode. Previously, when a relief valve failed its calibration, its failure mode was fail-to-open and the p-value was 0.1. Now the failure mode is setpoint drift and the p-value is 1.0. Similarly, leakage failure modes were coded with p-values of 0.1. These have been changed to use a p-value of 1.0.

   c. Unavailability; either due to maintenance or the state of another component are now allowed as failure modes, which replace fail-start, run, etc in those cases where the equipment problem was discovered before a demand and taken out of service for repair. The reevaluation of data to support the enhanced component performance studies (EDG, TDP, and MDP to date), the recent relief valve study, and the evaluation of the service water system components for the support system initiating events has updated the data to include homogeneous treatment for those entire data sets.

3. The data in the CCF database now begins in CY 1997. The original CCF database contained data from as early as 1980, and complete data from 1984. There are several reasons or implications of such a change:

   a. The CCF event count trend shows a significant decrease since 1984 (see Figure A-1 from the 2007 CCF insights on the web). For the 2007 CCF update, the INL staff and Dr. Dale Rasmuson recommend using CCF data from 1991 for the Parameter Estimation report and for use in SPAR.

   b. The most recent prior distribution created from the 2007 CCF release used data from 1995 to 2007. This was recommended by Dale Rasmuson based on the above-mentioned trend.

   c. EPIX data starts in 1997. Unfortunately, the NPRDS data (1980 to 1996 in the CCF database) used for CCF were not maintained with a unique link to the original data source. This precludes the efficient reevaluation of NPRDS data for the new CCF database guidelines.

   d. EPIX data is supported by detailed demand and run hour data, which is not available from NPRDS or LER reports.

   e. It is widely believed that the Maintenance Rule has positively affected component reliability and especially CCF rates since around 1994. Including the older data leads to overestimation of CCF probabilities.

   f. The complete original CCF data (through 2007) is accessible in the new version of the CCF database by selecting the ‘Old CCF’ study. This allows backward compatibility, but is not recommended for parameter estimation.

g. Due to the changes in the component and failure mode naming schemes, it will not be possible to provide backward compatibility to applications (the term for CCF search criteria). The original CCF database allowed the installation of the updated CCF program over the users existing CCF program. Any existing applications were preserved and the applications could be rerun using the new dataset. This will be a one-time incompatibility issue.

h. The total number of CCF events remaining in the CCF database is severely reduced in the 2009 version from the 2007 version. (The counts decreased from 1,759 CCF events with 19,411 independent events in the 2007 version to 321 CCF events with 5,689 independent events).

i. The number of independent events has decreased relative to the CCF event count. One of the CCF database modifications that were implemented in the 2009 version was to count independent events by weighting the failure count by the p-value. For example, two independent failures of the MDP to FR with the p-value of 0.1 counted as 2.0 for the independent element in the alpha factor calculation in the 2007 version. The 2009 version counts 2*0.1 = 0.2 for the independent element. The net result is a decreased count of independent events relative to the CCF event count that does not reflect a real increased CCF likelihood, but rather a more precise method to calculate the CCF parameters.

4. The CCF database contains an option to remove CCF events from the calculation. The INL staff position is that this feature results in inaccurate alpha factor estimates and recommends that users investigate other avenues for data refinement such as excluding plants with the incompatible equipment or procedures, which will reduce the independent event count proportionately to the CCF count. Rather than disabling this option, the Application Search Summary report now lists the CCF events that were removed from the application to provide an audit capability.

5. The CCF search criteria now treats the independent and CCF searches equally for:

    a. Date
    b. Plant name
    c. System
    d. Component
    e. Component subtype
    f. Failure mode
    g. Proximate cause (new). Currently used to discriminate the extreme environmental events that affect the service water system from normal equipment failure.
    h. Subcomponent (new). Currently used to estimate the pump (volute) only CCF, which is used when the CCF spans multiple pump driver types.
    i. Plant type
    j. Plant vendor

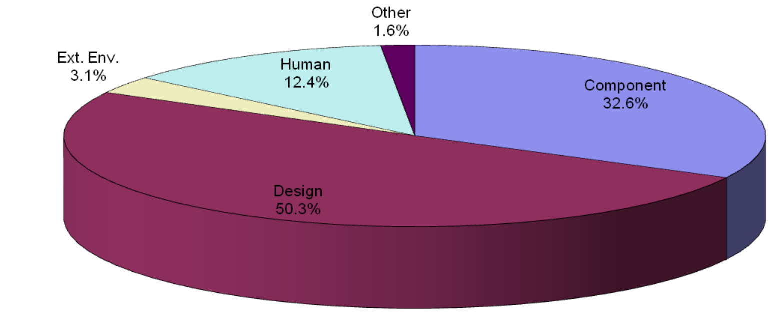
A general review of the actual events and the distributions provided in Figure 1 and Figure 2 reveals the following insights regarding CCF events:

- Human errors related to procedures caused a small percentage of the total events, but the impact of the individual events is usually greater, since human errors have overridden the programmatic controls. This is illustrated by comparing Figure 1, the All CCF events case with the Complete CCF events case, which shows that human error causes a larger portion of complete CCF events than all CCF events. The examples of events caused by human error are all EDG day tanks simultaneously drained for chemistry surveillance, and two pump breakers racked out as the plant changed modes from shutdown to power.
- A vast majority of All CCF events are not due to multiple failures in response to an operational demand, but result from a "condition of equipment." The most common is inspection or surveillance test of one component revealing a deficiency that prompts the licensee to inspect/test the redundant component, resulting in the discovery that the same defective condition exists on both components. This demonstrates that detection of failures during the testing and surveillance program prevents CCF events from occurring during actual demand situations.
- A major contributor to CCF events is programmatic maintenance practices. The frequency of scheduling has been a factor in the numerous wear-caused and aging-caused events. Additionally, the quality of the maintenance, both in the procedures and in performance of the maintenance activities, is an essential factor. Similar events have occurred at different plants—lubrication of circuit breakers (too much, too little, or too long between lubrications), improperly set torque and limit switches on MOVs that are reported as misadjustments and not setpoint drift. This indicates that there are maintenance practices that need to be reviewed to reduce CCF potential. However, the maintenance issue generally does not cause complete CCF events.
- Among complete CCF events, design problems are an important contributor. Many of the design-related events resulted from a design modification, indicating that perhaps the modification review processes were not rigorous and resulted in CCF susceptibilities.
- The CCF database contains several examples where both CCF and independent events recur at some, but not all, plants, perhaps indicating ineffective root cause analysis and corrective action. Examples of repeated events are water in compressed air systems, pump seal wear-out, and turbine governor misadjustments. Additionally, not all plants experience the same type of recurring event. This indicates that plant-to-plant variability exists in the CCF parameters that might cause the CCF parameter estimates for some plants to be higher than the industry average, for some component and system combinations. Thus, it is very important to perform plant-specific CCF parameter estimations for plant-specific PRAs and reliability studies.
- The trends show that All CCF events and Complete CCF events have been decreasing with time.

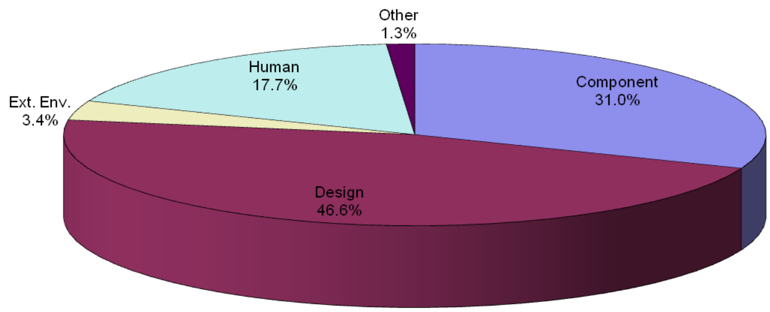
With respect to quantification of CCFs, the overall conclusion is that, based on the evaluation of over 20 years of operating experience data, CCF parameters for similar components vary among systems and failure modes. In addition, the CCF failure parameters have decreased over time.

Table 1. Component types and systems analyzed for CCF events (1997–2009).

Component Type	System
Air Operated Valve	Auxiliary feedwater
	High pressure injection
	Residual Heat Removal (LCI in BWRs, LPI in PWRs)
Battery Charger	dc power
Check Valve	Auxiliary feedwater
	Containment spray recirculation
	Normally operating service water
	Reactor core isolation
	Residual Heat Removal (LCI in BWRs, LPI in PWRs)
Circuit Breaker	Plant ac power
	Reactor protection
Generator	Emergency power supply
Heat Exchanger	Component cooling water
Hydraulic Operated Valve	Residual Heat Removal (LCI in BWRs, LPI in PWRs)
Main Steam Stop Valve	Main steam
Motor Driven Pump	Auxiliary feedwater
	Chemical and volume control
	Containment spray recirculation
	High pressure injection
	Main feedwater
	Normally operating service water
	Residual Heat Removal (LCI in BWRs, LPI in PWRs)
	Standby liquid control
	Standby service water
Motor Operated Valve	Auxiliary feedwater
	High pressure injection
	Low pressure core spray
	Reactor core isolation
	Residual Heat Removal (LCI in BWRs, LPI in PWRs)
Power Operated Relief Valve	Main steam
	Reactor coolant
Safety Relief Valve (Dual Actuation)	Main steam
Safety Valve (Single Acting)	Main steam
Strainer	Circulating water system
	Normally operating service water
	Standby service water
Turbine Driven Pump	Auxiliary feedwater
	High pressure coolant injection
Vacuum Breaker	Vapor suppression

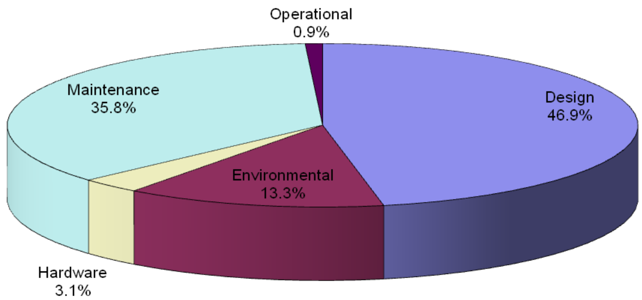


Distribution of causes of only the complete CCF events.

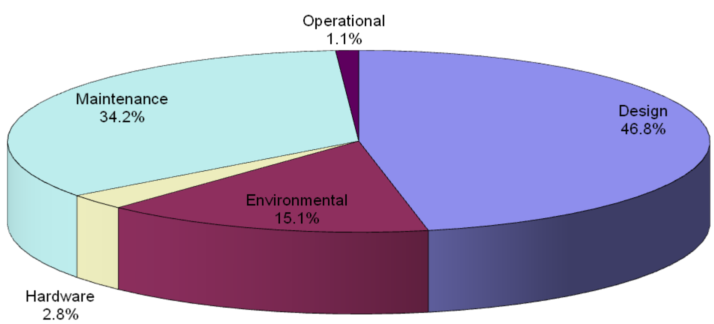


Distribution of causes of complete and partial CCF events

Figure 1. Distribution of CCF events by proximate cause.



Distribution of coupling factors for only the complete CCF events.



Distribution of coupling factors for both complete and partial events.

Figure 2 Distribution of CCF events by coupling factor.

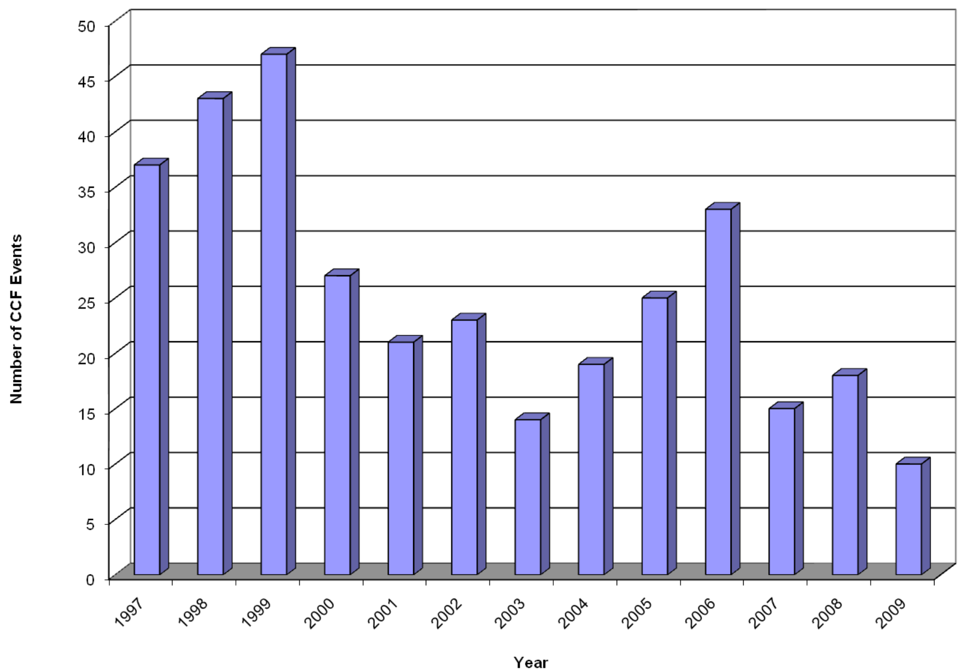


Figure 3 Distribution of all CCF events by year.

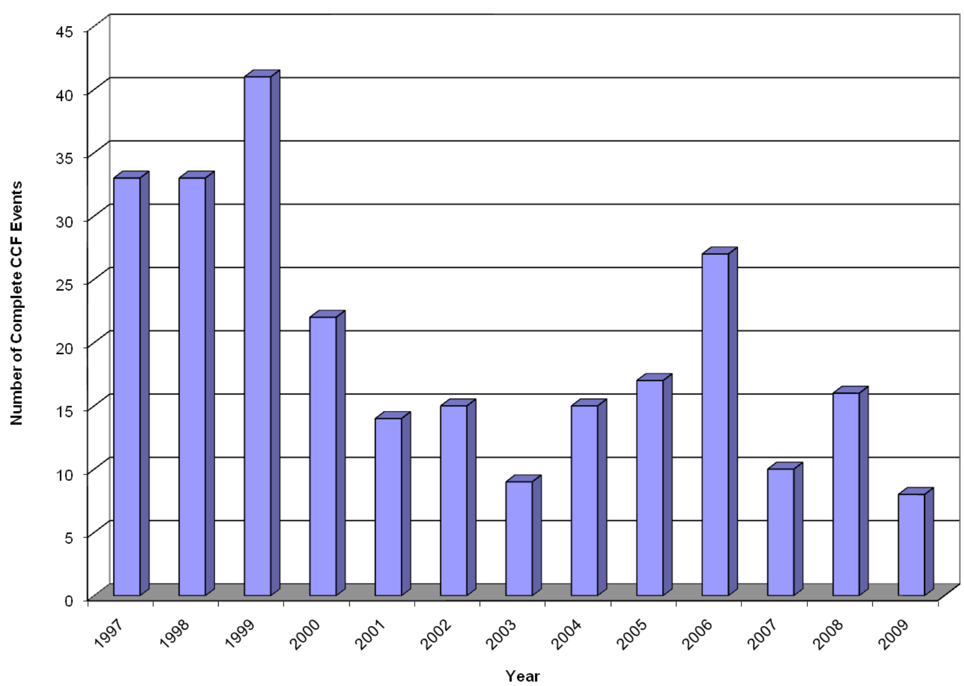


Figure 4. Distribution of complete CCF events by year.

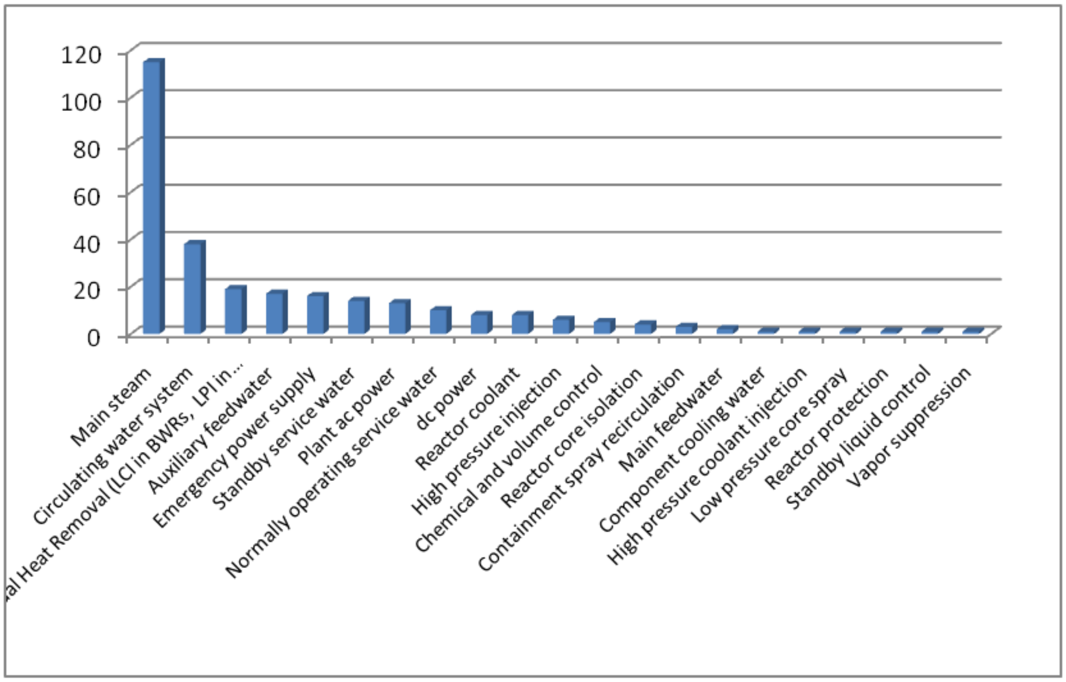


Figure 5. Distribution of all CCF events by system.

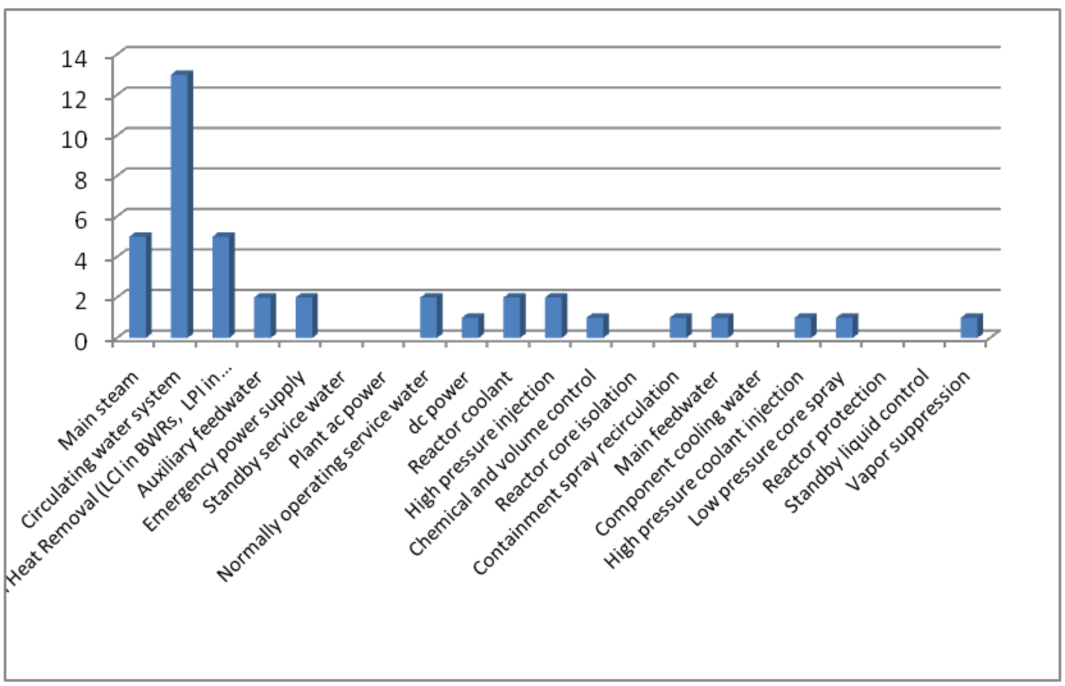


Figure 6. Distribution of complete CCF events by system.

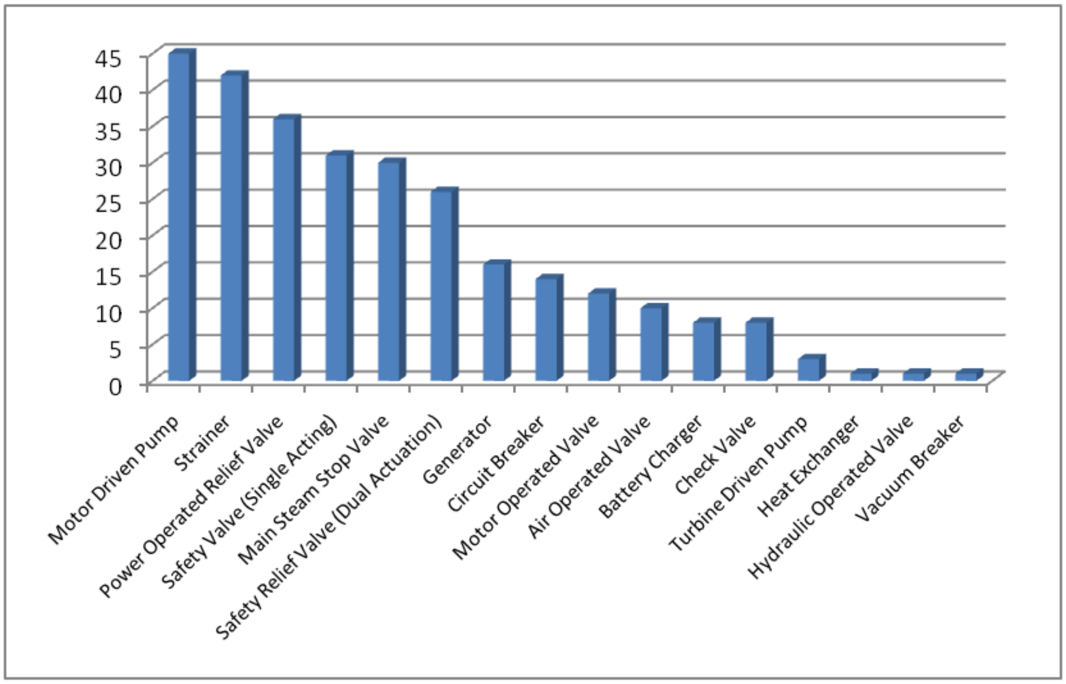


Figure 7. Distribution of all CCF events by component type.

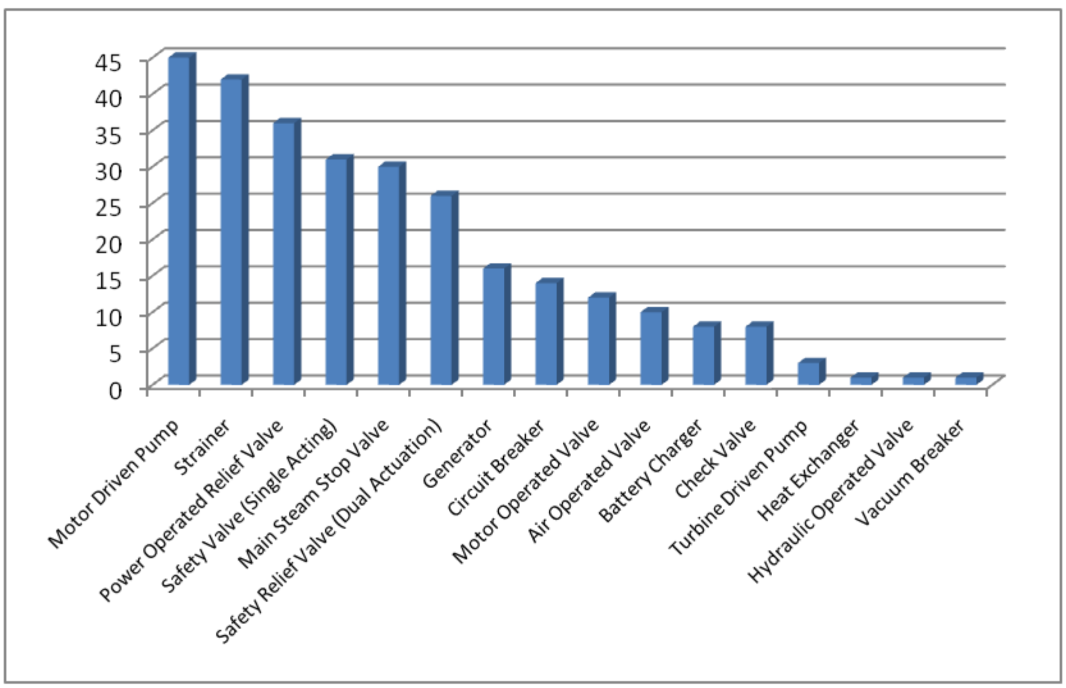


Figure 8. Distribution of complete CCF events by component type.

Appendix A

Evaluation of the Effects of the CCF Database Modifications

Evaluation of CCF Database Enhancements

The INL staff has loaded new data into the CCF database and performed alpha factor analyses on the results. The new data includes the CCF events currently at the WOG for external review and the results of the consolidation of CCF and Component Performance data collection at the INL. This evaluation will compare alpha factor calculations between the 2007 parameter estimation report and the results in the 2009 CCF database.

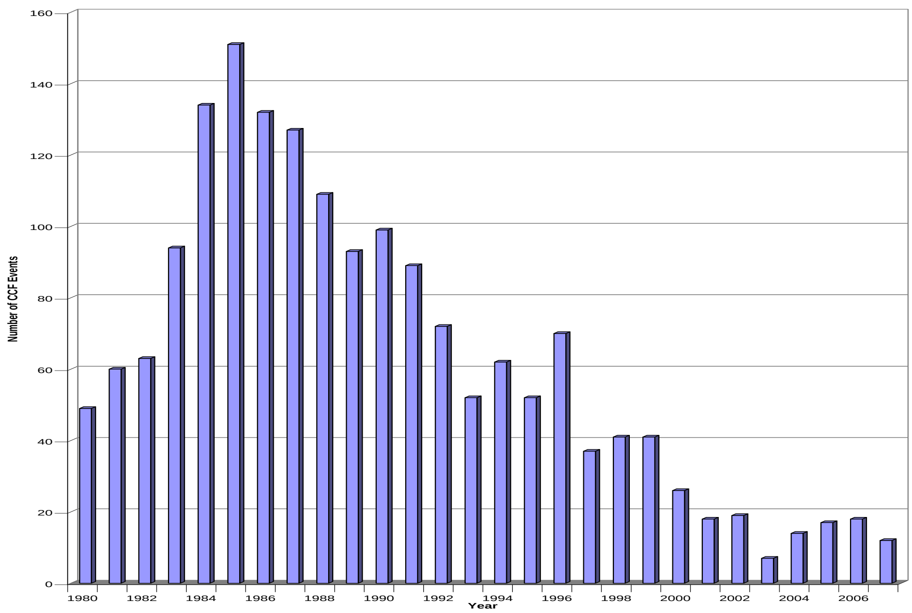


Figure A-1 Distribution of all CCF events by year (1980 to 2007).

Evaluation of Results

The 2007 and 2009 CCF databases were evaluated for equivalent application search criteria and the alpha 2 in a CCCG of 2 are compared between the two databases. Table A-1 shows the application name and the MLE and Mean of the alpha factor calculation. The percent differences between the two values are shown in the columns to the right (a positive percent difference means that the alpha 2 has increased in the 2009 CCF database).

Table A-1. Alpha factor results.

Application Name	MLE		Mean		Diff MLE	Diff Mean
	2007	2009	2007	2009		
ACP-CRB-4160-CC	0.0081	0.0175	0.0171	0.0364	115%	113%
ACP-CRB-4160-OO	0.0021	0.0000	0.0094	0.0074	-100%	-21%
ACP-CRB-4160-SA	0.0768	0.0187	0.0581	0.0332	-76%	-43%
ACP-CRB-480-CC	0.0216	0.0165	0.0236	0.0373	-24%	58%
ACP-CRB-480-OO	0.0325	0.0041	0.0310	0.0274	-87%	-12%
ACP-CRB-480-SA	0.0211	0.0000	0.0224	0.0088	-100%	-61%
AFW-AOV-CC	0.0314	0.0314	0.0293	0.0359	0%	23%
AFW-AOV-OO	0.0180	0.0178	0.0216	0.0299	-1%	38%
AFW-CKV-CC	0.0000	0.0000	0.0165	0.0343	-	108%
AFW-CKV-OO	0.0129	0.0161	0.0213	0.0393	25%	85%
AFW-MDP-FR	0.0016	0.0086	0.0073	0.0239	428%	226%
AFW-MDP-FS	0.0601	0.0149	0.0550	0.0211	-75%	-62%
AFW-MOV-CC	0.0043	0.0254	0.0143	0.0342	495%	139%
AFW-MOV-FTO	0.0092	0.0223	0.0138	0.0288	143%	109%

Application Name	MLE		Mean		Diff MLE	Diff Mean
	2007	2009	2007	2009		
AFW-MOV-OO	0.0137	0.0223	0.0188	0.0316	63%	68%
AFW-PMP-FR	0.0011	0.0052	0.0039	0.0179	360%	365%
AFW-TDP-FR	0.0009	0.0000	0.0054	0.0143	-100%	166%
AFW-TDP-FS	0.0000	0.0000	0.0025	0.0058	-	130%
ALL-AOV-CC	0.0207	0.0162	0.0219	0.0232	-22%	6%
ALL-AOV-FTO	0.0177	0.0151	0.0190	0.0199	-15%	5%
ALL-AOV-OO	0.0163	0.0154	0.0200	0.0250	-6%	25%
ALL-CKV-CC	0.0085	0.0000	0.0138	0.0246	-100%	78%
ALL-CKV-OO	0.0476	0.0668	0.0427	0.0560	40%	31%
ALL-HTX-HT	0.1260	0.0008	0.0935	0.0281	-99%	-70%
ALL-MDP-FR	0.0203	0.0297	0.0205	0.0302	46%	47%
ALL-MDP-FS	0.0346	0.0247	0.0343	0.0252	-29%	-27%
ALL-MOV-CC	0.0226	0.0174	0.0228	0.0205	-23%	-10%
ALL-MOV-CO	0.0267	0.0378	0.0264	0.0397	42%	50%
ALL-MOV-FTO	0.0154	0.0089	0.0158	0.0108	-42%	-32%
ALL-MOV-OO	0.0060	0.0025	0.0076	0.0064	-58%	-15%
ALL-NON-ESW-STR	0.0526	0.0000	0.0314	0.0407	-100%	30%
ALL-PMP-FR	0.0150	0.0146	0.0155	0.0178	-3%	15%
ALL-PORV-CC	0.0719	0.0233	0.0669	0.0271	-68%	-59%
ALL-PORV-OO	0.0354	0.0001	0.0317	0.0180	-100%	-43%
ALL-SMP-PG	0.0526	0.0000	0.0314	0.0357	-100%	14%
ALL-SVV-CC	0.0068	0.0110	0.0159	0.0387	62%	143%
ALL-SVV-OO	0.0000	0.0084	0.0078	0.0379	-	385%
ALL-TDP-FR	0.0004	0.0000	0.0029	0.0043	-100%	51%
ALL-TDP-FS	0.0028	0.0000	0.0039	0.0025	-100%	-36%
BWR-MSS-MSV-CC	0.0062	0.0000	0.0210	0.0382	-100%	82%
BWR-MSS-MSV-OO	0.0143	0.0182	0.0200	0.0365	27%	83%
BWR-MSS-SRV-CC	0.0550	0.0101	0.0453	0.0322	-82%	-29%
BWR-MSS-SRV-OO	0.0043	0.0000	0.0197	0.0260	-100%	32%
BWR-RHR-CKV-CC	0.0527	0.0000	0.0328	0.0343	-100%	5%
BWR-RHR-CKV-OO	0.0126	0.0000	0.0201	0.0260	-100%	29%
BWR-RHR-HTX-HT	0.1910	0.0000	0.0915	0.0343	-100%	-63%
BWR-RHR-MDP-FR	0.0056	0.0000	0.0166	0.0260	-100%	57%
BWR-RHR-MDP-FS	0.0706	0.0200	0.0557	0.0281	-72%	-50%
BWR-RHR-MOV-CC	0.0171	0.0139	0.0189	0.0174	-19%	-8%
BWR-RHR-MOV-OO	0.0066	0.0000	0.0126	0.0130	-100%	3%
BWR-RHR-STR-PG	0.0909	0.0000	0.0344	0.0407	-100%	18%
CCF-DEM	0.0353	0.0302	0.0352	0.0303	-14%	-14%
CCF-RATE	0.0279	0.0389	0.0278	0.0389	39%	40%
CCW-HTX-HT	0.0108	0.0062	0.0216	0.0266	-43%	23%
CCW-MDP-FR	0.0000	0.0355	0.0084	0.0369	-	340%
CCW-MDP-FS	0.0000	0.0000	0.0055	0.0051	-	-7%
CLN-MDP-FR	0.0190	0.0285	0.0194	0.0294	50%	52%
CLN-MDP-FS	0.0430	0.0271	0.0421	0.0276	-37%	-34%
CSS-HTX-HT	0.2400	0.0000	0.0775	0.0407	-100%	-47%
CSS-MDP-FR	0.0000	0.0000	0.0125	0.0243	-	94%
CSS-MDP-FS	0.0478	0.0553	0.0417	0.0521	16%	25%
CSS-MOV-CC	0.0035	0.0000	0.0173	0.0187	-100%	8%
CSS-MOV-OO	0.0002	0.0000	0.0176	0.0277	-100%	57%
CSS-STR-PG	0.0000	0.0000	0.0257	0.0407	-	58%
CVR-VAC-CC	0.1260	0.0408	0.0566	0.0407	-68%	-28%
DCP-BAT-NO	0.0076	0.0000	0.0106	0.0138	-100%	30%
DCP-BCH-FC	0.0080	0.0126	0.0091	0.0146	58%	61%
DCP-BCH-NO	0.0080	0.0146	0.0092	0.0168	82%	83%
DCP-CRB-CC	0.0734	0.0000	0.0498	0.0357	-100%	-28%
DCP-CRB-OO	0.0072	0.0000	0.0188	0.0246	-100%	31%
DCP-CRB-SA	0.0000	0.0000	0.0092	0.0196	-	113%
EPS-EDG-FR	0.0152	0.0080	0.0155	0.0105	-47%	-32%
EPS-EDG-FS	0.0110	0.0108	0.0115	0.0124	-2%	8%
ESW-MDP-FR	0.0117	0.0319	0.0126	0.0331	173%	163%
ESW-MDP-FS	0.0142	0.0135	0.0155	0.0168	-5%	8%
ESW-STR-PG	0.0738	0.0000	0.0670	0.0142	-100%	-79%
ESW-TSA-PG	0.0225	0.0000	0.0239	0.0407	-100%	70%
HCI-RCI-AOV-CC	0.0000	0.0000	0.0185	0.0296	-	60%

Application Name	MLE		Mean		Diff MLE	Diff Mean
	2007	2009	2007	2009		
HCI-RCI-AOV-OO	0.0000	0.0000	0.0231	0.0407	-	76%
HCI-RCI-CKV-CC	0.0016	0.0000	0.0195	0.0407	-100%	109%
HCI-RCI-CKV-OO	0.0000	0.0000	0.0118	0.0318	-	169%
HCI-RCI-MOV-CC	0.0001	0.0002	0.0102	0.0203	154%	99%
HCI-RCI-MOV-OO	0.0000	0.0000	0.0141	0.0098	-100%	-31%
HCI-RCI-TDP-FR	0.0000	0.0000	0.0031	0.0137	-	338%
HCI-RCI-TDP-FS	0.0052	0.0000	0.0070	0.0045	-100%	-35%
HPI-CKV-CC	0.0000	0.0000	0.0128	0.0318	-	148%
HPI-CKV-OO	0.0417	0.0000	0.0349	0.0227	-100%	-35%
HPI-MDP-FR	0.0314	0.0232	0.0307	0.0257	-26%	-16%
HPI-MDP-FS	0.0172	0.0232	0.0186	0.0257	35%	38%
HPI-MOV-CC	0.0295	0.0000	0.0283	0.0114	-100%	-60%
HPI-MOV-OO	0.0077	0.0000	0.0150	0.0114	-100%	-24%
ISO-AOV-CC	0.0000	0.0000	0.0231	0.0372	-	61%
ISO-AOV-OO	0.0000	0.0000	0.0244	0.0407	-	67%
ISO-HTX-HT	0.0000	0.0000	0.0244	0.0407	-	67%
ISO-MOV-CC	0.0000	0.0000	0.0149	0.0260	-	74%
ISO-MOV-OO	0.0000	0.0000	0.0193	0.0343	-	78%
PWR-MSS-MSV-CC	0.0667	0.0172	0.0444	0.0271	-74%	-39%
PWR-MSS-MSV-OO	0.1120	0.0510	0.0890	0.0462	-54%	-48%
PWR-MSS-PRV-CC	0.0268	0.0330	0.0266	0.0353	23%	33%
PWR-MSS-PRV-OO	0.0238	0.0002	0.0244	0.0200	-99%	-18%
PWR-MSS-SVV-CC	0.0076	0.0163	0.0174	0.0396	114%	128%
PWR-MSS-SVV-OO	0.0000	0.0095	0.0087	0.0383	-	340%
PWR-RCS-MOV-CC	0.0000	0.0000	0.0096	0.0296	-	208%
PWR-RCS-MOV-OO	0.0001	0.0000	0.0070	0.0296	-100%	320%
PWR-RCS-PORV-CC	0.0680	0.0012	0.0604	0.0167	-98%	-72%
PWR-RCS-PORV-OO	0.0000	0.0000	0.0107	0.0296	-	177%
PWR-RCS-SVV-CC	0.0000	0.0000	0.0159	0.0343	-	116%
PWR-RCS-SVV-OO	0.0000	0.0000	0.0220	0.0343	-	56%
PWR-RHR-CKV-CC	0.0000	0.0000	0.0220	0.0407	-	85%
PWR-RHR-CKV-OO	0.0312	0.0000	0.0283	0.0269	-100%	-5%
PWR-RHR-HTX-HT	0.0909	0.0000	0.0506	0.0343	-100%	-32%
PWR-RHR-MDP-FR	0.0112	0.0000	0.0137	0.0210	-100%	53%
PWR-RHR-MDP-FS	0.0331	0.0362	0.0315	0.0373	9%	18%
PWR-RHR-MOV-CC	0.0318	0.0012	0.0305	0.0255	-96%	-16%
PWR-RHR-MOV-OO	0.0049	0.0000	0.0112	0.0129	-100%	15%
RPS-RTB-CC	0.0000	0.0000	0.0081	0.0306	-	278%
SLC-MDP-FR	0.0555	0.0000	0.0457	0.0292	-100%	-36%
SLC-MDP-FS	0.0130	0.0008	0.0190	0.0198	-93%	4%
SWS-MDP-FR	0.1140	0.0310	0.0475	0.0337	-73%	-29%
SWS-MDP-FS	0.0000	0.0149	0.0185	0.0211	-	14%

Figure A-2 shows a scatter plot of the MLE columns in Table A-1 (excluding the zero entries) with a linear trend line fitted to the data. A line with y=x is also shown for information. Of the 58 plotted points, 43 lie above the y=0.3825x line, which means that when the 2009 estimate is higher than the 2007 estimate, the increase is smaller than when the opposite occurs. Importantly, there are several instances of much larger MLEs in the 2009 database. There are three CCF estimates that are approximately four times larger than the 2007 version: AFW-MOV-CC, AFW-MDP-FR, and AFW-PMP-FR. Each one of these is based on a single CCF event in the 2009 version and three or 4 CCF events in the 2007 version. The largest difference is the reduction in independent events. The independent count has been knocked down due to the p-value implementation and the implementation of the unavailability failure mode. It is also noticed that these events were evaluating to better than the average CCF estimate in the 2007 version and still evaluate to better than average in the 2009 version. Therefore, the INL staff does not see any cause for concern that the CCF database modifications have caused an inappropriate inflation of the parameter estimates.

Figure A-3 shows the comparison of the Mean of the alpha 2 of 2 distributions after update using the current (2007) prior. Of the 120 plotted points, 91 lie above the y=0.7838x line, which means that when the 2009 estimate is higher than the 2007 estimate, the increase is smaller than when the opposite occurs.

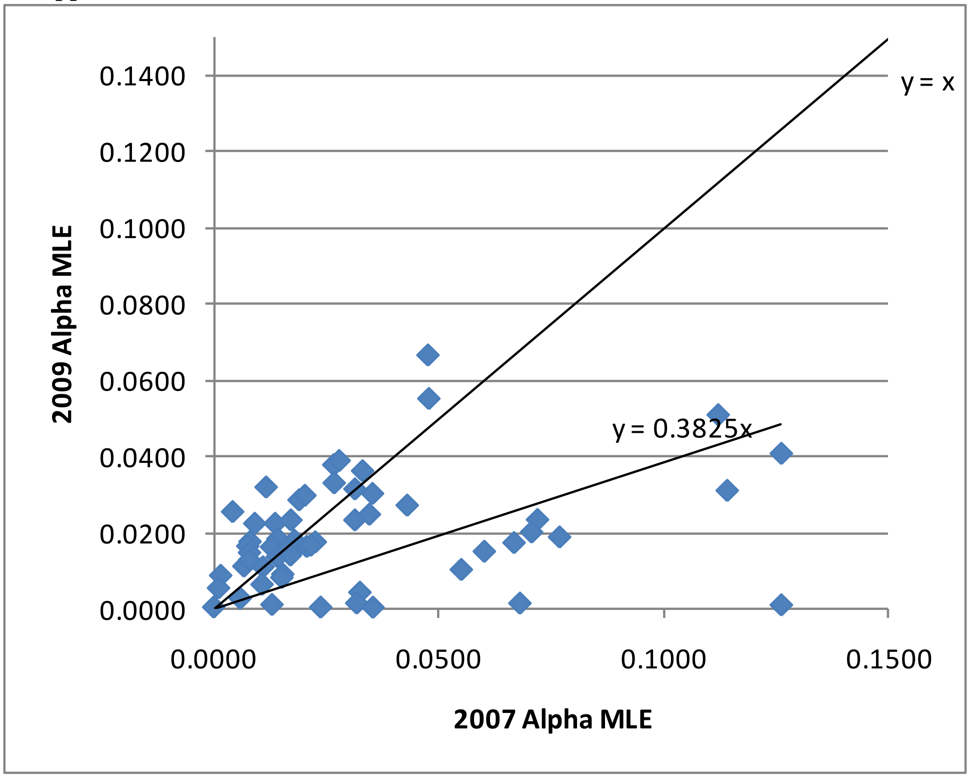


Figure A-2. Plot of the alpha 2 of 2 MLE between 2007 and 2009 CCF databases.

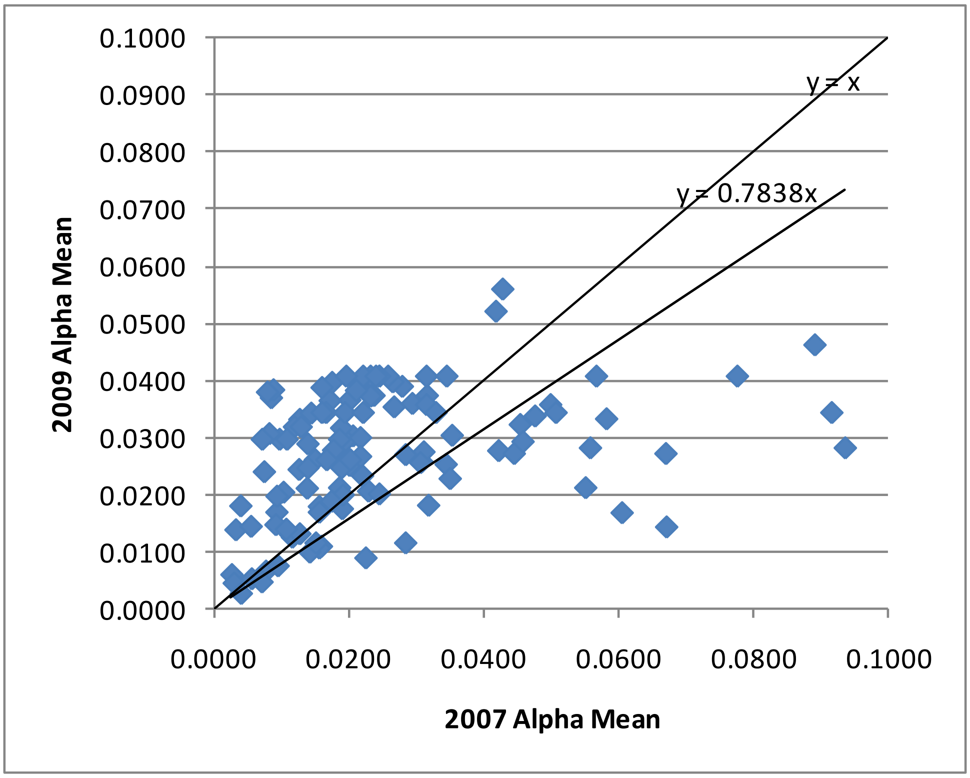


Figure A-3. Plot of the alpha 2 of 2 mean between 2007 and 2009 CCF databases.