TYPES OF COMMON CAUSE FAILURES AND THEIR ASPECTS

	DEPENDENT	STRUCTURAL*	ENVIRONMENTAL	EXTERNAL*
Description of Failure Cause	Failure of an interfacing system, action or component	A common material or design flaw which simultaneously affects all components population	A change in the operational environment which affects all members of a component population simultaneously	An event originating outside the system which affects all members of a component population simultaneously
Hardware Examples	• Loss of electrical power • Loss of steam production in steam-driven feedwater system • A manufacturer provides defective replacement parts that are installed in all components of a given class	• Faulty materials • Aging • Fatigue • Improperly cured materials • Manufacturing flaw	• Dirty water in RCS with regard to pump seal • High pressure • High temperature • Vibration	• Weather: hurricanes, tornado, ice, heat, low cooling water flow • Earthquake (breaks pipe, disables cooling system, breaks containment) • Flooding→loss of electricity • Birds in engine of airplane
Human Examples	• Following a mistaken leader • An erroneous maintenance procedure is repeated for all components of a given class	• Incorrect training • Poor management • Poor motivation • Low pay	• Common cause psf's • New disease • Hunger • Fear • Noise • Radiation in control room	• Explosion • Toxic substance • Weather • Earthquake • Concern for families
Easy to Anticipate?:				
Component failure	High	Very Low	Medium	Medium
Human error	Medium	Very Low	Medium	Medium
Easy to Mitigate?:				
Component failure	High, if system designed for mitigation	Very Low, hard to design for mitigation	Low	Low
Human error	High, if feedback provided to identify the error promptly	Very Low, the factors making CCF likely also discourage being prepared for correction	Low	Low

* Usually there are no precursors

EXAMPLE OF COMMON CAUSE FAILURE SOURCES POTENTIALLY ABLE TO AFFECT DATA CENTERS SERIOUSLY

Support System	Environmental (Exceeding Allowable Envelope)	Structural	External
Fuel Quantity	Temperature	Manufacturing Flaw	Earthquake
Fuel Quality	Pressure	Faulty Maintenance Procedure	Hurricane
Cooling	Vibration	Component Design Error	Tornado
Lubrication	Noise		Flood
Ventilation	Air Quality		Explosion
Human Error	Electromagnetic Pulse		Labor Strike
Control Power			Terrorist Action
Interfacing Switchgear			

KEY CHARACTERISTICS OF THE PARAMETRIC MODELS

(After Mosleh, 1991)

Estimation Approach	Model	Model Parameters	General Form for Multiple Component Failure Frequency
Nonshock models Single parameter	Beta factor	Q_t, β	$Q_k = \begin{cases} (1-\beta)Q_t & k = 1 \\ 0 & 1 < k < m \\ \beta Q_t & k = m \end{cases}$
Nonshock models Multiparameter	Multiple Geek letters	$Q_t, \underbrace{\beta, \gamma, \delta}_{\text{m-1 parameters}}$	$Q_k = \frac{1}{\binom{m-1}{k-1}}(1-\rho_{k+1})(\prod_{i=1}^{k}\rho_i)Q_t$ $\rho_1 = 1, \rho_2 = \beta, \ldots, \rho_{m+1} = 0$
	Alpha factor	$Q_t, \alpha_1, \alpha_2, \ldots, \alpha_m$	$Q_k = \frac{k}{\binom{m-1}{k-1}} \frac{\alpha_k}{\alpha_t} Q_t, k = 1, \ldots, m$ $\alpha_t = \sum_{k=1}^{m} k\alpha_k$
Shock models	Binomial failure rate	Q_1, μ, ρ, ω	$Q_k = \begin{cases} \mu\rho_k(1-\rho)^{m-k} & k \neq m \\ \mu\rho^m + \omega & k = m \end{cases}$

Figure by MIT OCW.