

Summary of Parametric Study

τ (time to reach peak heat release rate)[Minutes]	Qpeak (peak heat release rate)[kW]	Time [Minutes]	Heat Release Rate [kW]
12	464	0.1	0.032
		0.2	0.129
	400	0.3	0.290
	200	0.4	0.516
		0.5	0.806
		0.6	1.160
		0.7	1.579
		0.8	2.062
		0.9	2.610
		1	3.222
		1.1	3.899
		1.2	4.640
		1.3	5.446
		1.4	6.316
		1.5	7.250
		1.6	8.249
		1.7	9.312
		1.8	10.440
		1.9	11.632
		2	12.889
		2.1	14.210
		2.2	15.596
		2.3	17.046
		2.4	18.560
		2.5	20.139
		2.6	21.782
		2.7	23.490
		2.8	25.262
		2.9	27.099
		3	29.000
		3.1	30.966
		3.2	32.996
		3.3	35.090
		3.4	37.249
		3.5	39.472
		3.6	41.760
		3.7	44.112
		3.8	46.529
		3.9	49.010
		4	51.556
		4.1	54.166
		4.2	56.840
		4.3	59.579
		4.4	62.382
		4.5	65.250
		4.6	68.182
		4.7	71.179
		4.8	74.240
		4.9	77.366
		5	80.556
		5.1	83.810
		5.2	87.129
		5.3	90.512
		5.4	93.960
		5.5	97.472
		5.6	101.049
		5.7	104.690
		5.8	108.396
		5.9	112.166
		6	116.000
		6.1	119.899
		6.2	123.862
		6.3	127.890
		6.4	131.982
		6.5	136.139
		6.6	140.360
		6.7	144.646
		6.8	148.996
		6.9	153.410
		7	157.889
		7.1	162.432
		7.2	167.040
		7.3	171.712
		7.4	176.449
		7.5	181.250
		7.6	186.116
		7.7	191.046
		7.8	196.040
		7.9	201.099
		8	206.222
		8.1	211.410
		8.2	216.662
		8.3	221.979
		8.4	227.360
		8.5	232.806
		8.6	238.316
		8.7	243.890
		8.8	249.529
		8.9	255.232
		9	261.000
		9.1	266.832
		9.2	272.729
		9.3	278.690
		9.4	284.716
		9.5	290.806
		9.6	296.960
		9.7	303.179
		9.8	309.462
		9.9	315.810
		10	322.222
6850 C4 Peak HRR, 1ft Distance, TP Damage Temp.	Goal Seek for 32.57kW	3.179297293	32.570
6850 C4 Peak HRR, 2ft Distance, TP Damage Temp.	Goal Seek for 53.06kW	4.057943614	53.060
2178 4AC Peak HRR, 1ft Distance, TP Damage Temp.	Goal Seek for 32.57kW	3.42420804	32.570
2178 4AC Peak HRR, 2ft Distance, TP Damage Temp.	Goal Seek for 53.06kW	4.37053757	53.060
2178 4BC Peak HRR, 1ft Distance, TP Damage Temp.	Goal Seek for 32.57kW	4.842559353	32.570
2178 4BC Peak HRR, 2ft Distance, TP Damage Temp.	Goal Seek for 53.06kW	6.180875217	53.060

Summary of Parametric Study					
Detection System Unavailability/Unreliability Probability (β)	ASD Very Early Warning (3.60E-03)	ASD Very Early Warning (3.60E-03)	ASD Very Early Warning (3.60E-03)	Spot (5.00E-02)	
Fraction of Fires that DO NOT have an Incipient Stage (α)	Low Voltage Control Cabinet (2.80E-01)	Low Voltage Control Cabinet (2.80E-01)	Low Voltage Control Cabinet (2.80E-01)	Low Voltage Control Cabinet (2.80E-01)	
System In-Effectiveness (τ)	Natural or Forced Ventilation up to 100 Cabinet ACH (2.70E-01)	Natural or Forced Ventilation up to 100 Cabinet ACH (5.30E-01)	Natural or Forced Ventilation up to 100 Cabinet ACH (1.90E-01)	Natural or Forced Ventilation up to 100 Cabinet ACH (1.00E-01)	
System Type	<u>ASD VEWFD Cloud Chamber</u>	<u>ASD VEWFD Light Scattering 1 (LS1)</u>	<u>ASD VEWFD Light Scattering 2 (LS2)</u>	<u>Ionization Spot (ION)</u>	
Human Error Probability for MCR Operator Response (μ)	Default MCR HEP (1.00E-04)	Default MCR HEP (1.00E-04)	Default MCR HEP (1.00E-04)	Default MCR HEP (1.00E-04)	
Human Error Probability for 1st Level Field Response (κ)	Default Field Operator HEP (4.60E-04)	Default Field Operator HEP (4.58E-02)	Default Field Operator HEP (4.58E-02)	Default Field Operator HEP (1.72E-02)	
Electrical non-suppression rate parameter (λ-Electrical)	0.098	0.098	0.098	0.098	
MCR non-suppression rate parameter (λ-MCR)	0.324	0.324	0.324	0.324	
Time to Target Damage (minutes)	4.057	4.057	4.057	4.057	
Redundant Automatic Fire Detection	[YES] Other conventional spot-type detector system (5.00E-02)	[YES] Other conventional spot-type detector system (5.00E-02)	[YES] Other conventional spot-type detector system (5.00E-02)	[YES] Other conventional spot-type detector system (5.00E-02)	
Time to Detection for Automatic Fire Detection Response (minutes)	1	1	1	1	
Automatic Fire Suppression System	[YES] Halon System (5.0E-02)	[YES] Halon System (5.0E-02)	[YES] Halon System (5.0E-02)	[YES] Halon System (5.0E-02)	
Automatic Fire Suppression System Dependency	Yes	Yes	Yes	Yes	
Manual Fixed Suppression	No (1.0E+00)	No (1.0E+00)	No (1.0E+00)	No (1.0E+00)	NOTES
Total Non-Suppression Probability	0.028	0.031	0.030	0.032	Changing the redundant automatic fire detection system does nothing to the overall NSP
Detection System Unavailability/Unreliability Probability (β)	ASD Very Early Warning (3.60E-03)	ASD Very Early Warning (3.60E-03)	ASD Very Early Warning (3.60E-03)	Spot (5.00E-02)	
Fraction of Fires that DO NOT have an Incipient Stage (α)	Low Voltage Control Cabinet (2.80E-01)	Low Voltage Control Cabinet (2.80E-01)	Low Voltage Control Cabinet (2.80E-01)	Low Voltage Control Cabinet (2.80E-01)	
System In-Effectiveness (τ)	Natural or Forced Ventilation up to 100 Cabinet ACH (2.70E-01)	Natural or Forced Ventilation up to 100 Cabinet ACH (5.30E-01)	Natural or Forced Ventilation up to 100 Cabinet ACH (1.90E-01)	Natural or Forced Ventilation up to 100 Cabinet ACH (1.00E-01)	
System Type	<u>ASD VEWFD Cloud Chamber</u>	<u>ASD VEWFD Light Scattering 1 (LS1)</u>	<u>ASD VEWFD Light Scattering 2 (LS2)</u>	<u>Ionization Spot (ION)</u>	
Human Error Probability for MCR Operator Response (μ)	Default MCR HEP (1.00E-04)	Default MCR HEP (1.00E-04)	Default MCR HEP (1.00E-04)	Default MCR HEP (1.00E-04)	
Human Error Probability for 1st Level Field Response (κ)	Default Field Operator HEP (4.60E-04)	Default Field Operator HEP (4.58E-02)	Default Field Operator HEP (4.58E-02)	Default Field Operator HEP (1.72E-02)	
Electrical non-suppression rate parameter (λ-Electrical)	0.098	0.098	0.098	0.098	
MCR non-suppression rate parameter (λ-MCR)	0.324	0.324	0.324	0.324	
Time to Target Damage (minutes)	4.057	4.057	4.057	4.057	
Redundant Automatic Fire Detection	[YES] Other conventional spot-type detector system (5.00E-02)	[YES] Other conventional spot-type detector system (5.00E-02)	[YES] Other conventional spot-type detector system (5.00E-02)	[YES] Other conventional spot-type detector system (5.00E-02)	
Time to Detection for Automatic Fire Detection Response (minutes)	1	1	1	1	
Automatic Fire Suppression System	[No] (1)	[No] (1)	[No] (1)	[No] (1)	
Automatic Fire Suppression System Dependency	No	No	No	No	
Manual Fixed Suppression	No (1.0E+00)	No (1.0E+00)	No (1.0E+00)	No (1.0E+00)	
Total Non-Suppression Probability	0.380	0.540	0.450	0.430	

Nominal Case (with Halon)		Parameter Varied																			
		System Type		β		α			τ & ξ			μ		Time to Damage							
Detection System Unavailability/Unreliability Probability (β)	ASD Very Early Warning (3.60E-03)				3.60E-02	3.60E-04															
Fraction of Fires that DO NOT have an Incipient Stage (α)	Low Voltage Control Cabinet (2.80E-01)						2.80E-02			2.80E-03											
System In-Effectiveness (τ)	Natural or Forced Ventilation up to 100 Cabinet ACH (5.30E-01)									5.30E-02	5.30E-03	5.30E-03									
System Type	LS1	CC	LS2	Ion Spot																	
Human Error Probability for MCR Operator Response (μ)	Default MCR HEP (1.00E-04)												1.00E-03	1.00E-05							
Human Error Probability for 1st Level Field Response (ξ)	Default Field Operator HEP (4.58E-04)									4.58E-04	4.58E-04	4.58E-05									
Electrical non-suppression rate parameter (λ-Electrical)	0.098																				
MCR non-suppression rate parameter (λ-MCR)	0.324																				
Time to Target Damage (minutes)	4.057														1	1.5	2	6	10	20	40
Redundant Automatic Fire Detection	[YES] Other conventional spot-type detector system (5.00E-02)																				
Time to Detection for Automatic Fire Detection Response (minutes)	1																				
Automatic Fire Suppression System	[YES] Halon System (5.0E-02)																				
Automatic Fire Suppression System Dependency	Yes																				
Manual Fixed Suppression	No (1.0E+00)																				
Total Non-Suppression Probability	0.031	0.028	0.030	0.032	3.30E-02	3.10E-02	3.10E-02		3.00E-02	2.90E-02	2.90E-02	2.90E-02	3.10E-02	3.10E-02	5.40E-02	4.90E-02	4.40E-02	2.40E-02	1.40E-02	4.90E-03	1.00E-03
Percent change in Nominal NSP		-10%	-3%	3%	6%	0%	0%		-3%	-6%	-6%	-6%	0%	0%	74%	58%	42%	-23%	-55%	-84%	-97%
Equivalent Manual Non-Suppression NSP, without any in-panel or incip detection															-0.8	0.2	1.3	7.5	13.0	23.7	39.9
Delta time for manual non-suppression (equivalent incipient stage duration)															-1.8	-1.3	-0.7	1.5	3.0	3.7	-0.1

Parameter Varied					
System Type	β	α	τ & ξ	μ	Time to Damage