Szabo, Aaron

From: Jeff R. Gabor <jrgabor@erineng.com>
Sent: Tuesday, August 13, 2013 12:16 PM
To: Szabo, Aaron
Cc: KRAFT, Steven
Subject: Industry Slides for Aug 14
Attachments: APET Results-Alternative 3A-for NRC.zip; APET Results-Base Case-for NRC.zip; CoreDamageET-for_NRC.zip

Aaron,
Attached are 3 zip files containing material for our discussions on Wednesday. This is considered preliminary draft and meant to help focus our discussion tomorrow. As hard copies of this material can be helpful, I will bring 10 copies with me tomorrow. Please confirm that you received this material. See you tomorrow morning at 9.
Jeff

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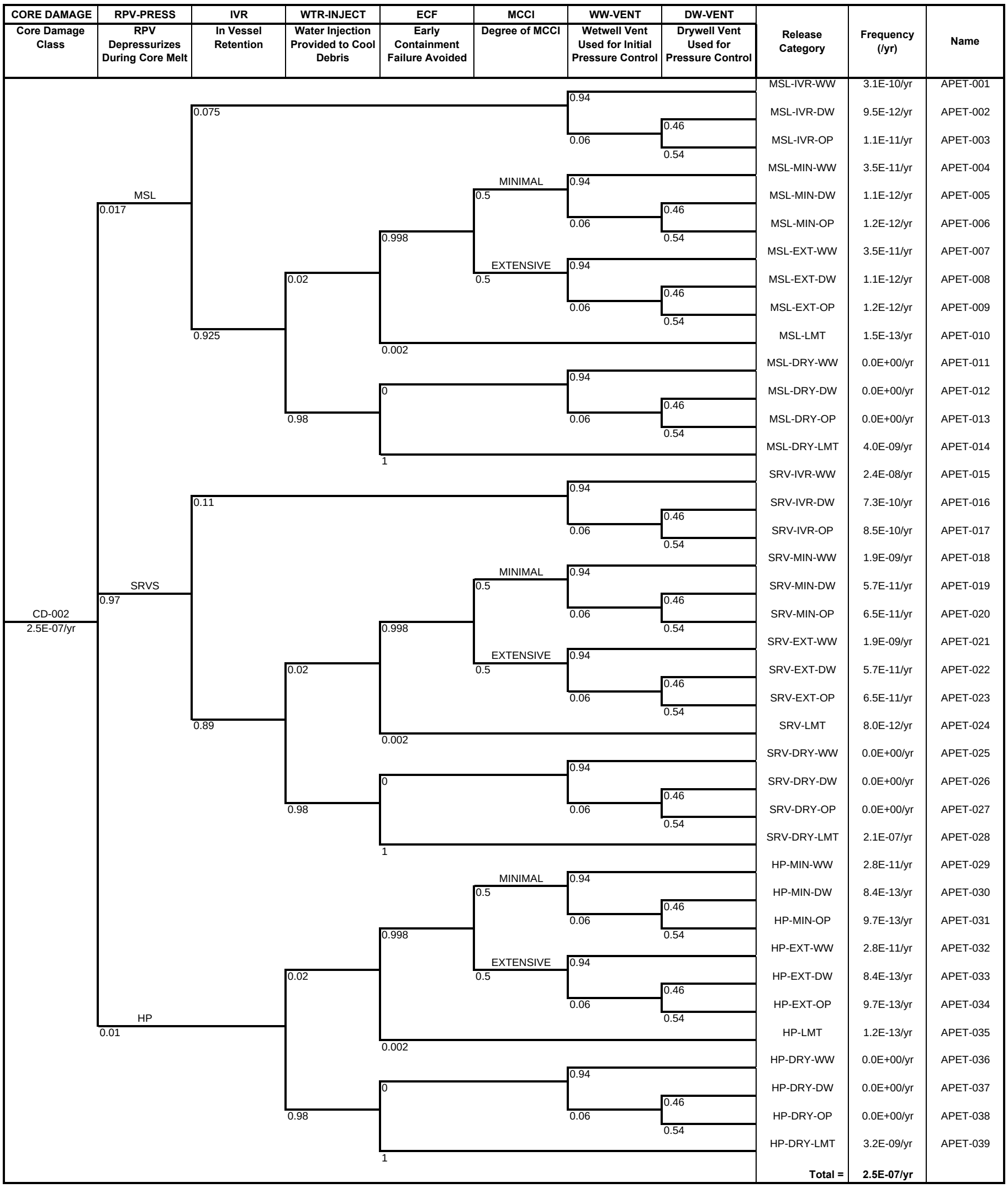
APET-Alternative 3A

BWR MARK I ACCIDENT PROGRESSION EVENT TREE FOR CD-002

(RCIC & Early Venting Succeed, FLEX fails late, Cont. Re-isolated)



CORE DAMAGE	RPV-PRESS	IVR	WTR-INJECT	ECF	MCCI	WW-VENT	DW-VENT	Release Category	Frequency (/yr)	Name
Core Damage Class	RPV Depressurizes During Core Melt	In Vessel Retention	Water Injection Provided to Cool Debris	Early Containment Failure Avoided	Degree of MCCI	Wetwell Vent Used for Initial Pressure Control	Drywell Vent Used for Pressure Control			
								MSL-IVR-WW	3.1E-10/yr	APET-001
								MSL-IVR-DW	9.5E-12/yr	APET-002
								MSL-IVR-OP	1.1E-11/yr	APET-003
								MSL-MIN-WW	3.5E-11/yr	APET-004
								MSL-MIN-DW	1.1E-12/yr	APET-005
								MSL-MIN-OP	1.2E-12/yr	APET-006
								MSL-EXT-WW	3.5E-11/yr	APET-007
								MSL-EXT-DW	1.1E-12/yr	APET-008
								MSL-EXT-OP	1.2E-12/yr	APET-009
								MSL-LMT	1.5E-13/yr	APET-010
								MSL-DRY-WW	0.0E+00/yr	APET-011
								MSL-DRY-DW	0.0E+00/yr	APET-012
								MSL-DRY-OP	0.0E+00/yr	APET-013
								MSL-DRY-LMT	4.0E-09/yr	APET-014
								SRV-IVR-WW	2.4E-08/yr	APET-015
								SRV-IVR-DW	7.3E-10/yr	APET-016
								SRV-IVR-OP	8.5E-10/yr	APET-017
								SRV-MIN-WW	1.9E-09/yr	APET-018
								SRV-MIN-DW	5.7E-11/yr	APET-019
								SRV-MIN-OP	6.5E-11/yr	APET-020
								SRV-EXT-WW	1.9E-09/yr	APET-021
								SRV-EXT-DW	5.7E-11/yr	APET-022
								SRV-EXT-OP	6.5E-11/yr	APET-023
								SRV-LMT	8.0E-12/yr	APET-024
								SRV-DRY-WW	0.0E+00/yr	APET-025
								SRV-DRY-DW	0.0E+00/yr	APET-026
								SRV-DRY-OP	0.0E+00/yr	APET-027
								SRV-DRY-LMT	2.1E-07/yr	APET-028
								HP-MIN-WW	2.8E-11/yr	APET-029
								HP-MIN-DW	8.4E-13/yr	APET-030
								HP-MIN-OP	9.7E-13/yr	APET-031
								HP-EXT-WW	2.8E-11/yr	APET-032
								HP-EXT-DW	8.4E-13/yr	APET-033
								HP-EXT-OP	9.7E-13/yr	APET-034
								HP-LMT	1.2E-13/yr	APET-035
								HP-DRY-WW	0.0E+00/yr	APET-036
								HP-DRY-DW	0.0E+00/yr	APET-037
								HP-DRY-OP	0.0E+00/yr	APET-038
								HP-DRY-LMT	3.2E-09/yr	APET-039
								Total =	**2.5E-07/yr**	

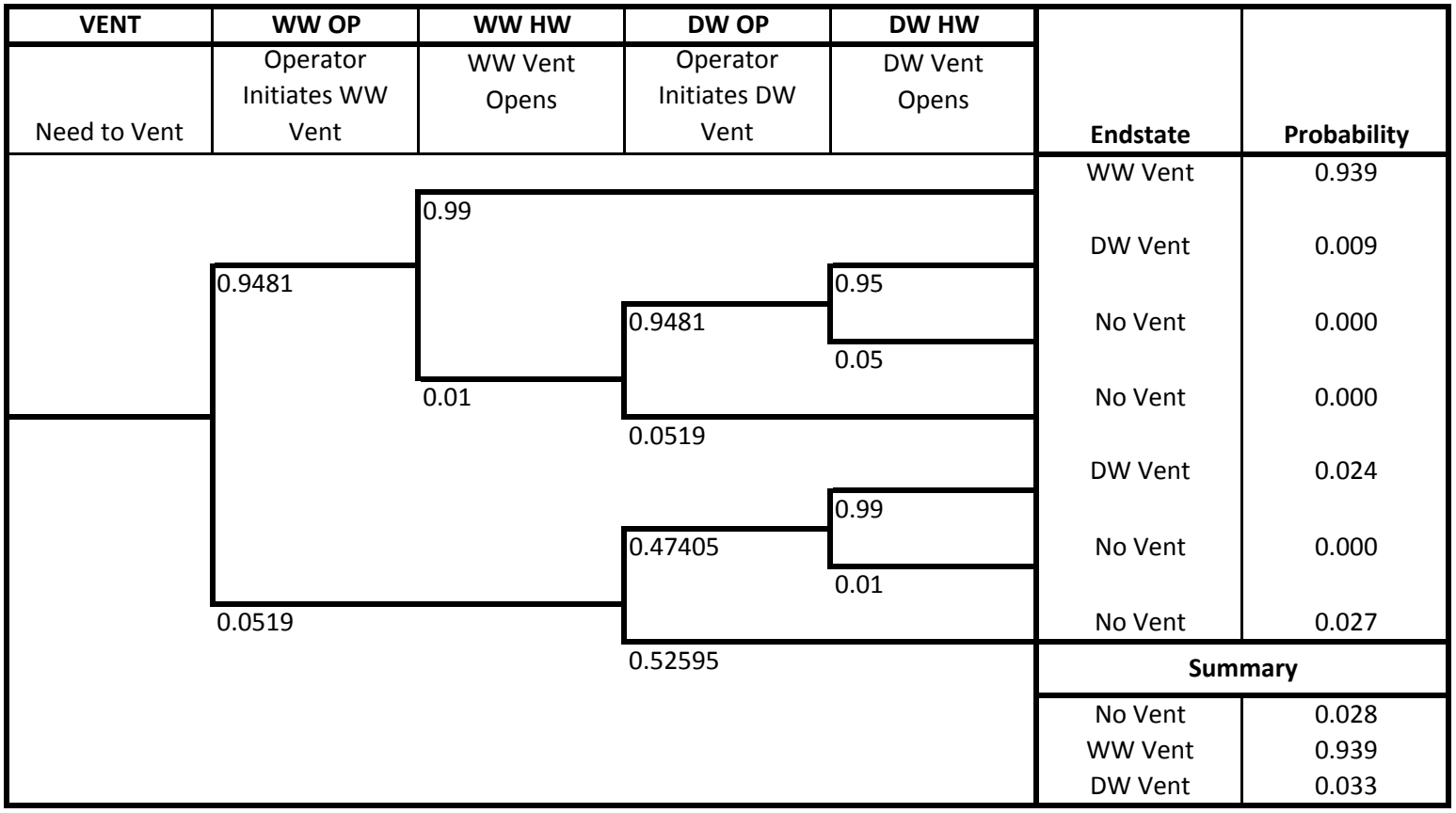
APET-Alternative 3A

BWR MARK I ACCIDENT PROGRESSION EVENT TREE FOR CD-002

Top Event	Description	Condition(s)	Probability	Inputs to the Assumed Failure Probability
CORE DAMAGE	Core Damage Class	CD-002	2.52E-07	RCIC & Early Venting Succeed, FLEX fails late, Cont. Re-isolated
RPV-PRESS	RPV Depressurizes During Core Melt	All	1.30E-01	Operator fails to depressurize RPV prior to vessel being compromised. High dependence on fraction of CD-002 with operator error. HEP from SPAR-H worksheet for fraction with FLEX equipment failures.
			0.15	HP RPV depressurizes via MSL
			0.85	HP RPV depressurizes via SRV seizure
			0.1	MSL & SRV Seizure do not occur
IVR	In Vessel Retention	All	8.50E-01	FLEX alignment for RPV injection would have occurred early in the scenario. Action only requires turning on the pump. However, cases with FLEX equipment failures are not recoverable.
		MSL Occurs	0.5	Core damage Not Arrested with water available
		SRV Depress Occurs	0.3	Core damage Not Arrested with water available
WTR-INJECT	Water Injection Provided to Cool Debris	All	9.81E-01	Fraction of IVR without water due to FLEX Hardware Failures
			0.05	Equipment failures (need basis)
ECF	Early Containment Failure Avoided	WTR-INJECT Fails	1	LMT without water
		WTR-INJECT Success	0.001	HPME w/ or w/o water
			0.001	LMT w/water
MCCI	Degree of MCCI	All	0.5	Extensive MCCI
WW-VENT	Wetwell Vent Used for Initial Pressure Control	All	5.2E-02	Operator fails to open WW vent
			0.01	Hardware failures (need basis)
DW-VENT	Drywell Vent Used for Pressure Control	All	0.53	Operator fails to open WW vent given failure to open WW (high dependence)
			5.2E-02	Operator failure given WW hardware failure
			0.05	DW hardware given WW hardware failure (need basis)
			0.01	DW failure (independent) - (need basis)

APET-Alternative 3A

BWR MARK I WW/DW VENTING EVENT TREE FOR CD-002



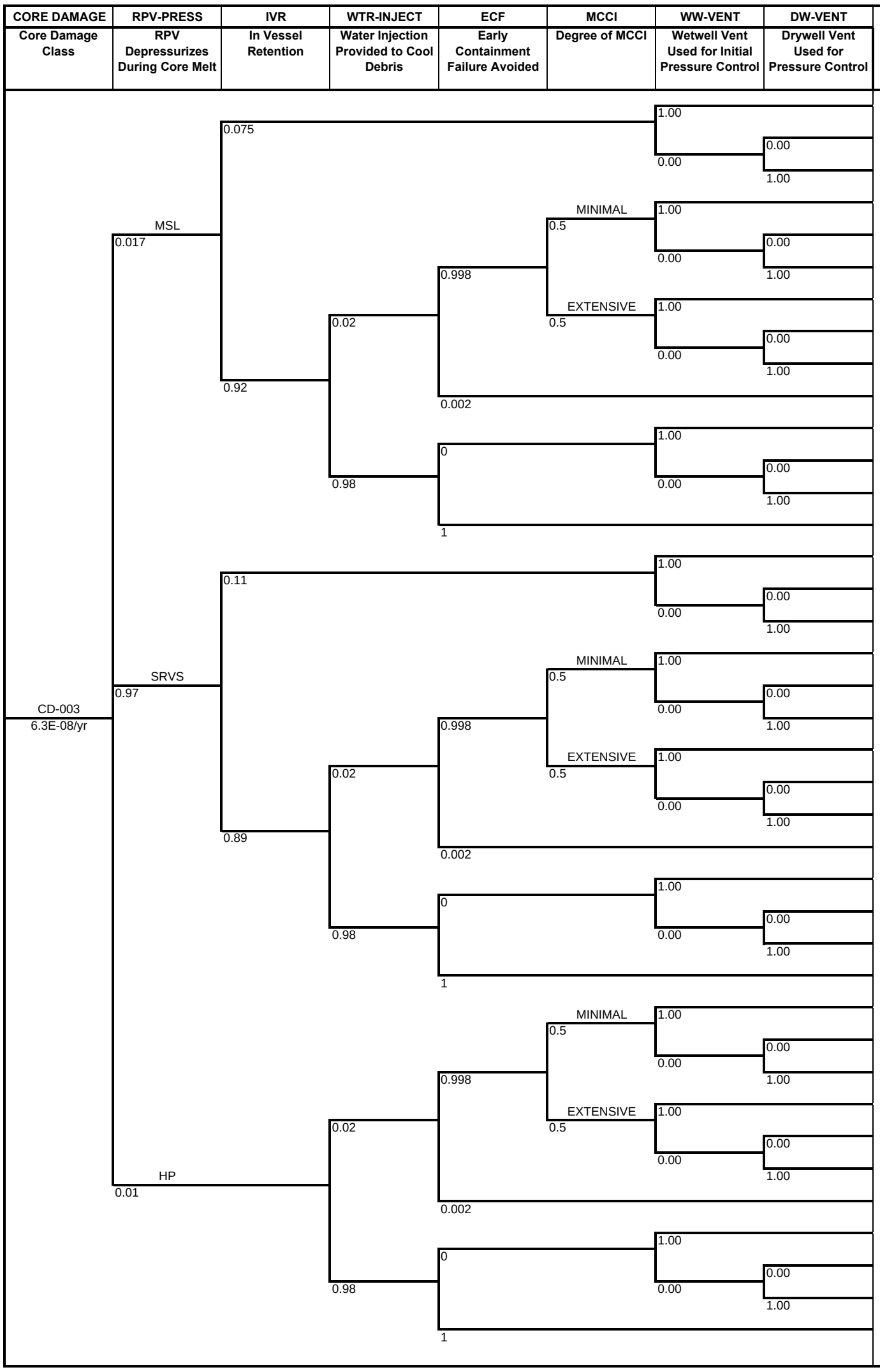
Endstate	Probability
WW Vent	0.939
DW Vent	0.009
No Vent	0.000
No Vent	0.000
DW Vent	0.024
No Vent	0.000
No Vent	0.027

Summary	
No Vent	0.028
WW Vent	0.939
DW Vent	0.033

APET-Alternative 3A

BWR MARK I ACCIDENT PROGRESSION EVENT TREE FOR CD-003

(RCIC & Early Venting Succeed, FLEX fails late, WW Vent Not Re-Isolated)



CORE DAMAGE	RPV-PRESS	IVR	WTR-INJECT	ECF	MCCI	WW-VENT	DW-VENT	Release Category	Frequency (/yr)	Name
Core Damage Class	RPV Depressurizes During Core Melt	In Vessel Retention	Water Injection Provided to Cool Debris	Early Containment Failure Avoided	Degree of MCCI	Wetwell Vent Used for Initial Pressure Control	Drywell Vent Used for Pressure Control			
								MSL-IVR-WW	8.3E-11/yr	APET-001
								MSL-IVR-DW	0.0E+00/yr	APET-002
								MSL-IVR-OP	0.0E+00/yr	APET-003
								MSL-MIN-WW	9.3E-12/yr	APET-004
								MSL-MIN-DW	0.0E+00/yr	APET-005
								MSL-MIN-OP	0.0E+00/yr	APET-006
								MSL-EXT-WW	9.3E-12/yr	APET-007
								MSL-EXT-DW	0.0E+00/yr	APET-008
								MSL-EXT-OP	0.0E+00/yr	APET-009
								MSL-LMT	3.7E-14/yr	APET-010
								MSL-DRY-WW	0.0E+00/yr	APET-011
								MSL-DRY-DW	0.0E+00/yr	APET-012
								MSL-DRY-OP	0.0E+00/yr	APET-013
								MSL-DRY-LMT	1.0E-09/yr	APET-014
								SRV-IVR-WW	6.4E-09/yr	APET-015
								SRV-IVR-DW	0.0E+00/yr	APET-016
								SRV-IVR-OP	0.0E+00/yr	APET-017
								SRV-MIN-WW	5.0E-10/yr	APET-018
								SRV-MIN-DW	0.0E+00/yr	APET-019
								SRV-MIN-OP	0.0E+00/yr	APET-020
								SRV-EXT-WW	5.0E-10/yr	APET-021
								SRV-EXT-DW	0.0E+00/yr	APET-022
								SRV-EXT-OP	0.0E+00/yr	APET-023
								SRV-LMT	2.0E-12/yr	APET-024
								SRV-DRY-WW	0.0E+00/yr	APET-025
								SRV-DRY-DW	0.0E+00/yr	APET-026
								SRV-DRY-OP	0.0E+00/yr	APET-027
								SRV-DRY-LMT	5.4E-08/yr	APET-028
								HP-MIN-WW	7.4E-12/yr	APET-029
								HP-MIN-DW	0.0E+00/yr	APET-030
								HP-MIN-OP	0.0E+00/yr	APET-031
								HP-EXT-WW	7.4E-12/yr	APET-032
								HP-EXT-DW	0.0E+00/yr	APET-033
								HP-EXT-OP	0.0E+00/yr	APET-034
								HP-LMT	3.0E-14/yr	APET-035
								HP-DRY-WW	0.0E+00/yr	APET-036
								HP-DRY-DW	0.0E+00/yr	APET-037
								HP-DRY-OP	0.0E+00/yr	APET-038
								HP-DRY-LMT	8.0E-10/yr	APET-039
								Total =	**6.3E-08/yr**	

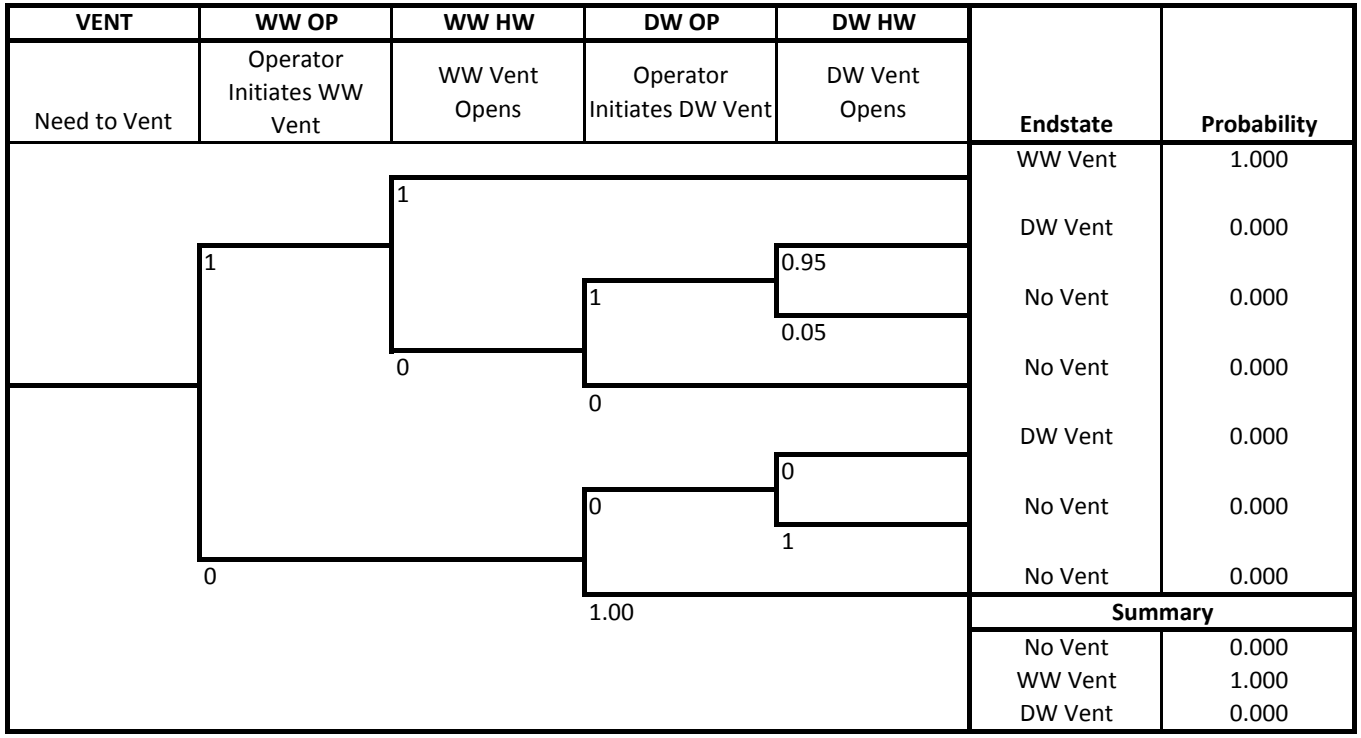
APET-Alternative 3A

BWR MARK I ACCIDENT PROGRESSION EVENT TREE FOR CD-003

Top Event	Description	Condition(s)	Probability	Inputs to the Assumed Failure Probability
CORE DAMAGE	Core Damage Class	CD-003	6.31E-08	RCIC & Early Venting Succeed, FLEX fails late, WW Vent Not Re-Isolated
RPV-PRESS	RPV Depressurizes During Core Melt	All	1.30E-01	Operator fails to depressurize RPV prior to vessel being compromised. High dependence on fraction of CD-003 with operator error. HEP from SPAR-H worksheet for fraction with FLEX equipment failures.
			0.15	HP RPV depressurizes via MSL
			0.85	HP RPV depressurizes via SRV seizure
			0.1	MSL & SRV Seizure do not occur
IVR	In Vessel Retention	All	8.50E-01	FLEX alignment for RPV injection would have occurred early in the scenario. Action only requires turning on the pump. However, cases with FLEX equipment failures are not recoverable.
		MSL Occurs	0.5	Core damage Not Arrested with water available
		SRV Depress Occurs	0.3	Core damage Not Arrested with water available
WTR-INJECT	Water Injection Provided to Cool Debris	All	9.81E-01	Fraction of IVR without water
			0.05	Equipment failures (need basis)
ECF	Early Containment Failure Avoided	WTR-INJECT Fails	1	LMT without water
		WTR-INJECT Success	0.001	HPME w/ or w/o water
			0.001	LMT w/water
MCCI	Degree of MCCI	All	0.5	Extensive MCCI
WW-VENT	Wetwell Vent Used for Initial Pressure Control	All	0.0E+00	Vent left open. No operator action required
			0	Hardware failures (need basis)
DW-VENT	Drywell Vent Used for Pressure Control	All	1.00	Operator fails to open WW vent given failure to open WW (high dependence)
			0.0E+00	Operator failure given WW hardware failure
			1	DW hardware given WW hardware failure (need basis)
			1	DW failure (independent) - (need basis)

APET-Alternative 3A

BWR MARK I WW/DW VENTING EVENT TREE FOR CD-003



Endstate	Probability
WW Vent	1.000
DW Vent	0.000
No Vent	0.000
No Vent	0.000
DW Vent	0.000
No Vent	0.000
No Vent	0.000

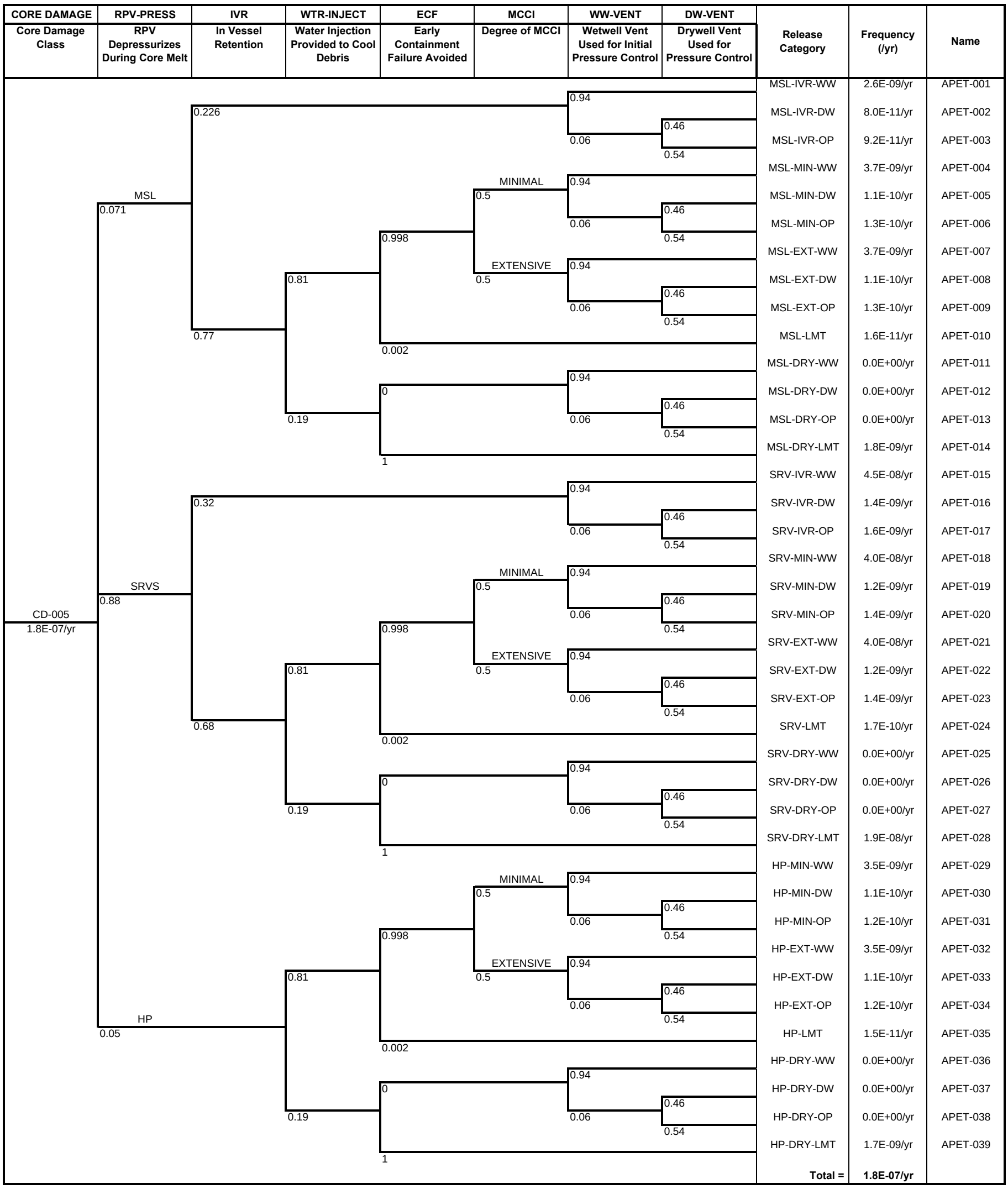
Summary	
No Vent	0.000
WW Vent	1.000
DW Vent	0.000

WW Fails	0.000	
DW Fails Given WW F	1.00	Assume operators not taking actions to vent
No Vent		

APET-Alternative 3A

BWR MARK I ACCIDENT PROGRESSION EVENT TREE FOR CD-005

(RCIC Lost on ED, FLEX Fails, Cont. Re-Isolated)



CORE DAMAGE	RPV-PRESS	IVR	WTR-INJECT	ECF	MCCI	WW-VENT	DW-VENT	Release Category	Frequency (/yr)	Name
Core Damage Class	RPV Depressurizes During Core Melt	In Vessel Retention	Water Injection Provided to Cool Debris	Early Containment Failure Avoided	Degree of MCCI	Wetwell Vent Used for Initial Pressure Control	Drywell Vent Used for Pressure Control			
								MSL-IVR-WW	2.6E-09/yr	APET-001
								MSL-IVR-DW	8.0E-11/yr	APET-002
								MSL-IVR-OP	9.2E-11/yr	APET-003
								MSL-MIN-WW	3.7E-09/yr	APET-004
								MSL-MIN-DW	1.1E-10/yr	APET-005
								MSL-MIN-OP	1.3E-10/yr	APET-006
								MSL-EXT-WW	3.7E-09/yr	APET-007
								MSL-EXT-DW	1.1E-10/yr	APET-008
								MSL-EXT-OP	1.3E-10/yr	APET-009
								MSL-LMT	1.6E-11/yr	APET-010
								MSL-DRY-WW	0.0E+00/yr	APET-011
								MSL-DRY-DW	0.0E+00/yr	APET-012
								MSL-DRY-OP	0.0E+00/yr	APET-013
								MSL-DRY-LMT	1.8E-09/yr	APET-014
								SRV-IVR-WW	4.5E-08/yr	APET-015
								SRV-IVR-DW	1.4E-09/yr	APET-016
								SRV-IVR-OP	1.6E-09/yr	APET-017
								SRV-MIN-WW	4.0E-08/yr	APET-018
								SRV-MIN-DW	1.2E-09/yr	APET-019
								SRV-MIN-OP	1.4E-09/yr	APET-020
								SRV-EXT-WW	4.0E-08/yr	APET-021
								SRV-EXT-DW	1.2E-09/yr	APET-022
								SRV-EXT-OP	1.4E-09/yr	APET-023
								SRV-LMT	1.7E-10/yr	APET-024
								SRV-DRY-WW	0.0E+00/yr	APET-025
								SRV-DRY-DW	0.0E+00/yr	APET-026
								SRV-DRY-OP	0.0E+00/yr	APET-027
								SRV-DRY-LMT	1.9E-08/yr	APET-028
								HP-MIN-WW	3.5E-09/yr	APET-029
								HP-MIN-DW	1.1E-10/yr	APET-030
								HP-MIN-OP	1.2E-10/yr	APET-031
								HP-EXT-WW	3.5E-09/yr	APET-032
								HP-EXT-DW	1.1E-10/yr	APET-033
								HP-EXT-OP	1.2E-10/yr	APET-034
								HP-LMT	1.5E-11/yr	APET-035
								HP-DRY-WW	0.0E+00/yr	APET-036
								HP-DRY-DW	0.0E+00/yr	APET-037
								HP-DRY-OP	0.0E+00/yr	APET-038
								HP-DRY-LMT	1.7E-09/yr	APET-039
								Total =	**1.8E-07/yr**	

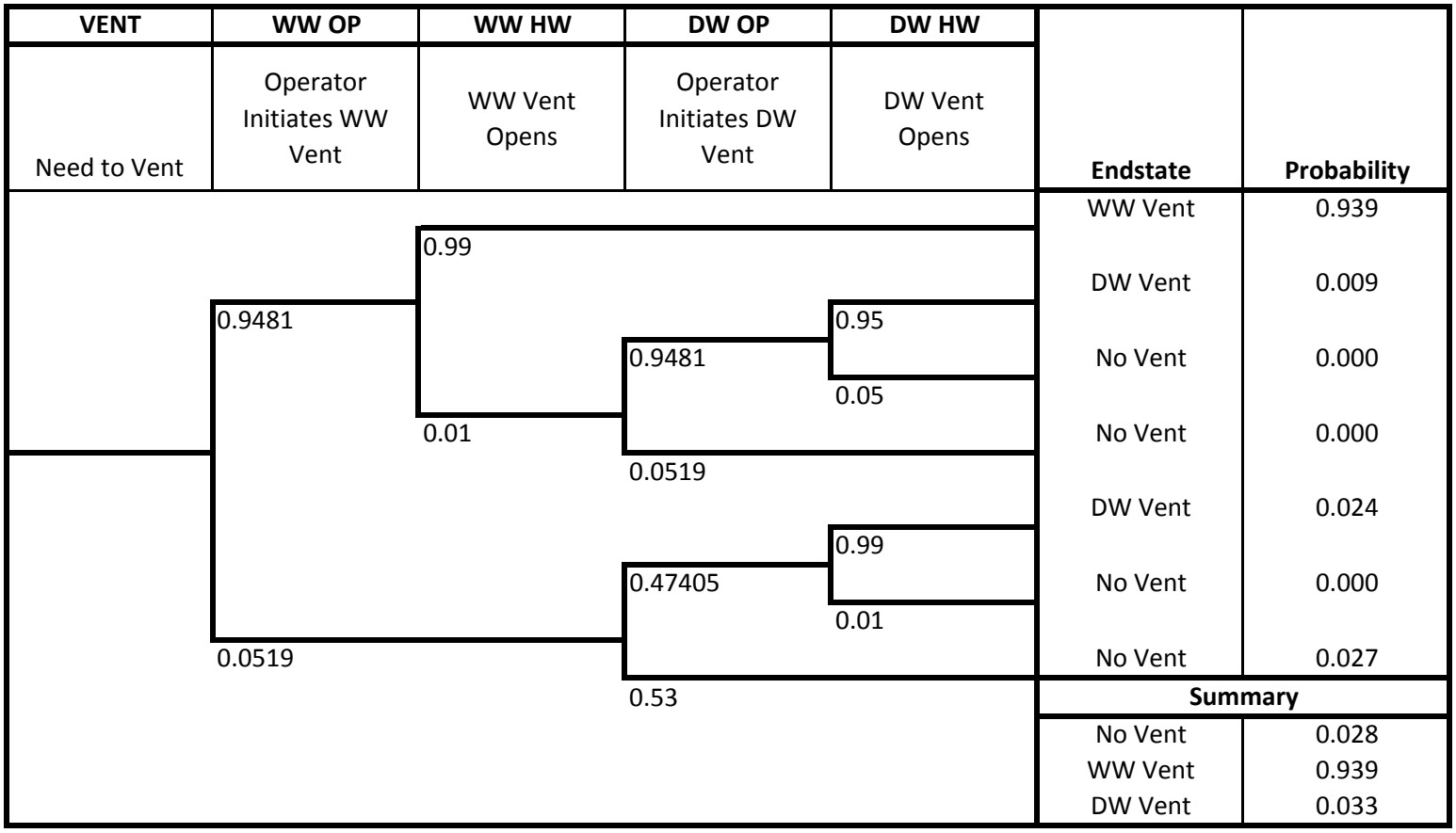
APET-Alternative 3A

BWR MARK I ACCIDENT PROGRESSION EVENT TREE FOR CD-005

Top Event	Description	Condition(s)	Probability	Inputs to the Assumed Failure Probability
CORE DAMAGE	Core Damage Class	CD-005	1.75E-07	RCIC Lost on ED, FLEX Fails, Cont. Re-Isolated
RPV-PRESS	RPV Depressurizes During Core Melt	All	5.25E-01	Operator fails to depressurize RPV prior to vessel being compromised. High dependence on fraction of CD-005 with operator error. HEP from SPAR-H worksheet for fraction with FLEX equipment failures.
			0.15	HP RPV depressurizes via MSL
			0.85	HP RPV depressurizes via SRV seizure
			0.1	MSL & SRV Seizure do not occur
IVR	In Vessel Retention	All	5.49E-01	FLEX alignment for RPV injection would have occurred early in the scenario. Action only requires turning on the pump. High dependence assumed since CD-005 is all human failures.
		MSL Occurs	0.5	Core damage Not Arrested with water available
		SRV Depress Occurs	0.3	Core damage Not Arrested with water available
WTR-INJECT	Water Injection Provided to Cool Debris	All	1.43E-01	Low dependence on vessel HFE due to additional crews, not close in time, same location, additional cues(needs development)
			0.05	Equipment failures (need basis)
ECF	Early Containment Failure Avoided	WTR-INJECT Fails	1	LMT without water
		WTR-INJECT Success	0.001	HPME w/ or w/o water
			0.001	LMT w/water
MCCI	Degree of MCCI	All	0.5	Extensive MCCI
WW-VENT	Wetwell Vent Used for Initial Pressure Control	All	5.2E-02	Operator fails to open WW vent
			0.01	Hardware failures (need basis)
DW-VENT	Drywell Vent Used for Pressure Control	All	0.53	Operator fails to open WW vent given failure to open WW (high dependence)
			5.2E-02	Operator failure given WW hardware failure
			0.05	DW hardware given WW hardware failure (need basis)
			0.01	DW failure (independent) - (need basis)

APET-Alternative 3A

BWR MARK I WW/DW VENTING EVENT TREE FOR CD-005



Endstate	Probability
WW Vent	0.939
DW Vent	0.009
No Vent	0.000
No Vent	0.000
DW Vent	0.024
No Vent	0.000
No Vent	0.027

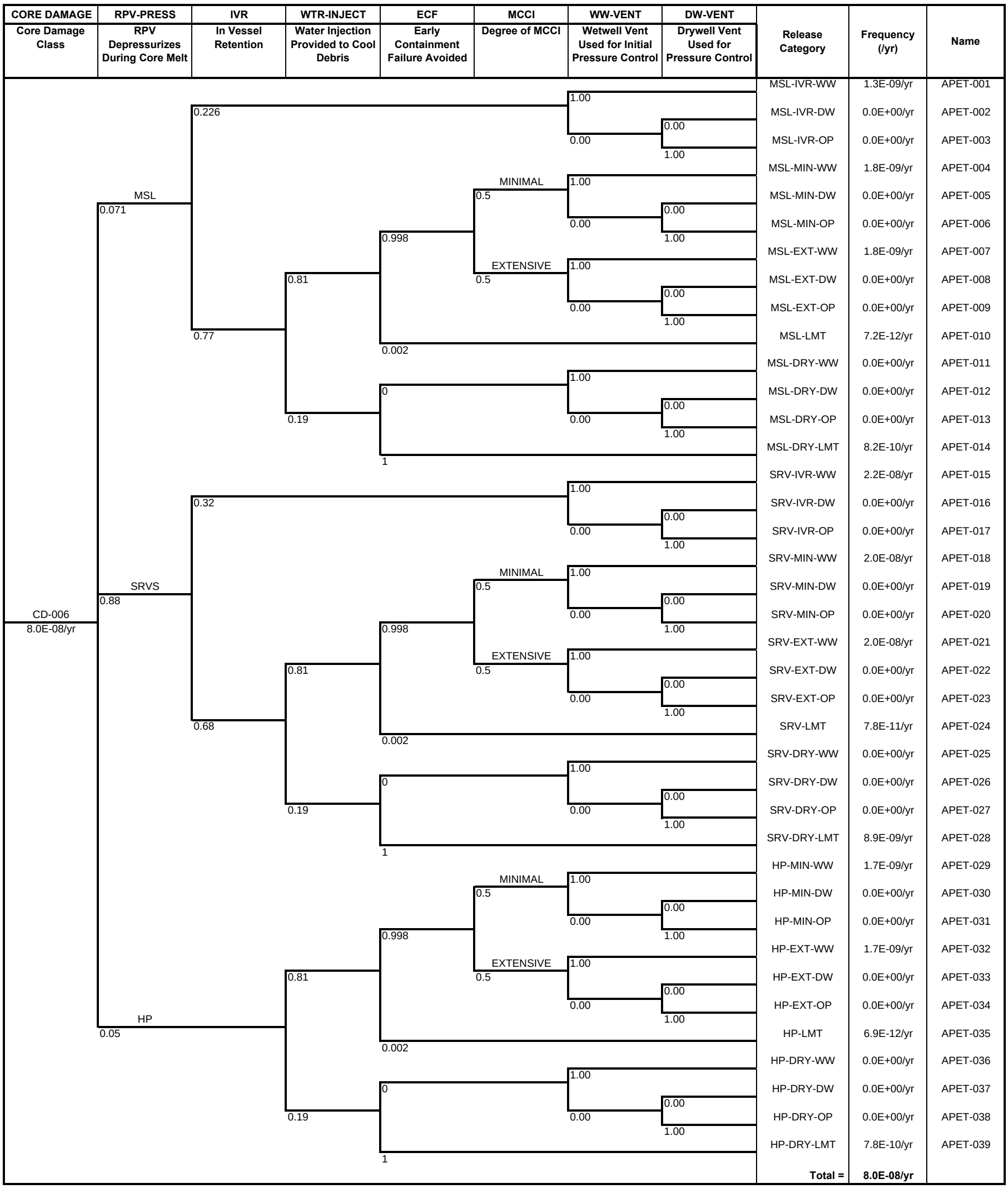
Summary	
No Vent	0.028
WW Vent	0.939
DW Vent	0.033

WW Fails	0.061
DW Fails Given WW F	0.54
No Vent	

APET-Alternative 3A

BWR MARK I ACCIDENT PROGRESSION EVENT TREE FOR CD-006

(RCIC Lost on ED, FLEX Fails, WW Vent Not Re-Isolated)



CORE DAMAGE	RPV-PRESS	IVR	WTR-INJECT	ECF	MCCI	WW-VENT	DW-VENT	Release Category	Frequency (/yr)	Name
Core Damage Class	RPV Depressurizes During Core Melt	In Vessel Retention	Water Injection Provided to Cool Debris	Early Containment Failure Avoided	Degree of MCCI	Wetwell Vent Used for Initial Pressure Control	Drywell Vent Used for Pressure Control			
								MSL-IVR-WW	1.3E-09/yr	APET-001
								MSL-IVR-DW	0.0E+00/yr	APET-002
								MSL-IVR-OP	0.0E+00/yr	APET-003
								MSL-MIN-WW	1.8E-09/yr	APET-004
								MSL-MIN-DW	0.0E+00/yr	APET-005
								MSL-MIN-OP	0.0E+00/yr	APET-006
								MSL-EXT-WW	1.8E-09/yr	APET-007
								MSL-EXT-DW	0.0E+00/yr	APET-008
								MSL-EXT-OP	0.0E+00/yr	APET-009
								MSL-LMT	7.2E-12/yr	APET-010
								MSL-DRY-WW	0.0E+00/yr	APET-011
								MSL-DRY-DW	0.0E+00/yr	APET-012
								MSL-DRY-OP	0.0E+00/yr	APET-013
								MSL-DRY-LMT	8.2E-10/yr	APET-014
								SRV-IVR-WW	2.2E-08/yr	APET-015
								SRV-IVR-DW	0.0E+00/yr	APET-016
								SRV-IVR-OP	0.0E+00/yr	APET-017
								SRV-MIN-WW	2.0E-08/yr	APET-018
								SRV-MIN-DW	0.0E+00/yr	APET-019
								SRV-MIN-OP	0.0E+00/yr	APET-020
								SRV-EXT-WW	2.0E-08/yr	APET-021
								SRV-EXT-DW	0.0E+00/yr	APET-022
								SRV-EXT-OP	0.0E+00/yr	APET-023
								SRV-LMT	7.8E-11/yr	APET-024
								SRV-DRY-WW	0.0E+00/yr	APET-025
								SRV-DRY-DW	0.0E+00/yr	APET-026
								SRV-DRY-OP	0.0E+00/yr	APET-027
								SRV-DRY-LMT	8.9E-09/yr	APET-028
								HP-MIN-WW	1.7E-09/yr	APET-029
								HP-MIN-DW	0.0E+00/yr	APET-030
								HP-MIN-OP	0.0E+00/yr	APET-031
								HP-EXT-WW	1.7E-09/yr	APET-032
								HP-EXT-DW	0.0E+00/yr	APET-033
								HP-EXT-OP	0.0E+00/yr	APET-034
								HP-LMT	6.9E-12/yr	APET-035
								HP-DRY-WW	0.0E+00/yr	APET-036
								HP-DRY-DW	0.0E+00/yr	APET-037
								HP-DRY-OP	0.0E+00/yr	APET-038
								HP-DRY-LMT	7.8E-10/yr	APET-039
								Total =	**8.0E-08/yr**	

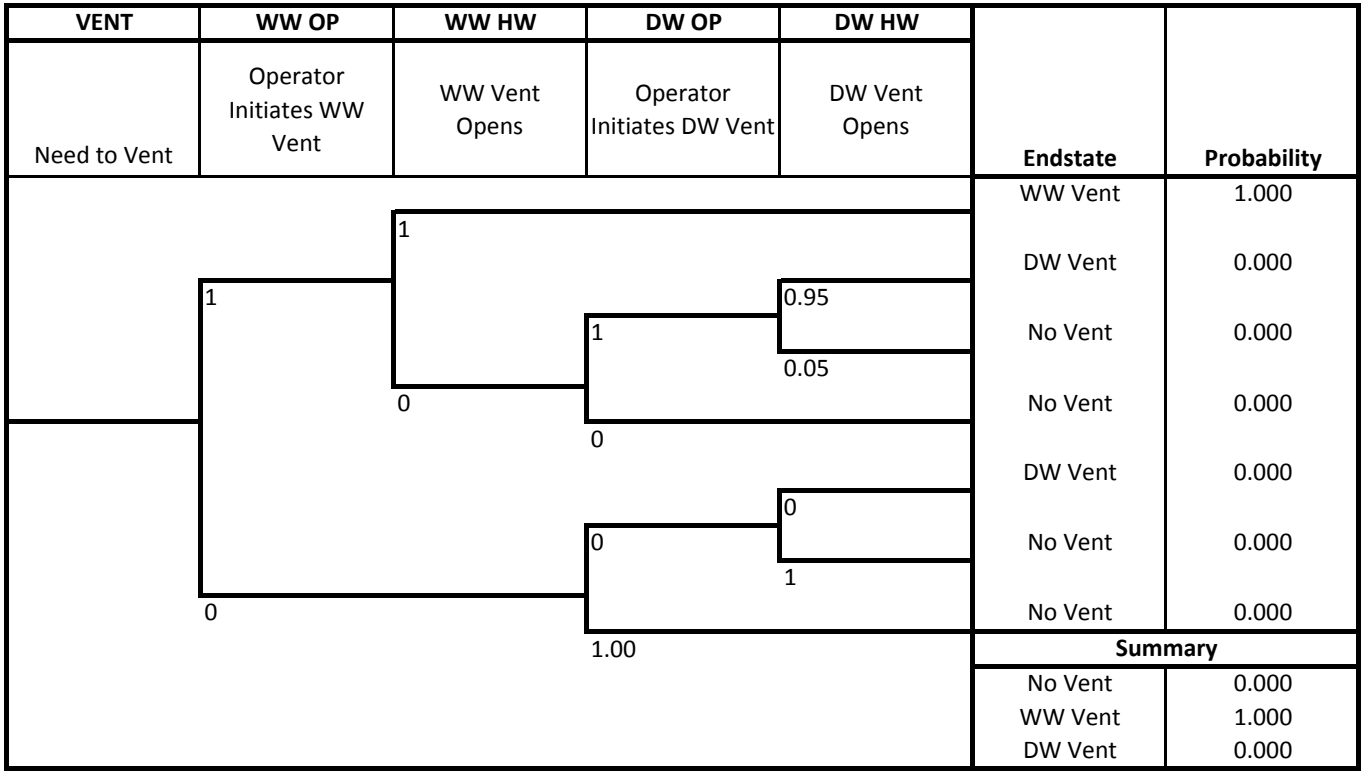
APET-Alternative 3A

BWR MARK I ACCIDENT PROGRESSION EVENT TREE FOR CD-006

Top Event	Description	Condition(s)	Probability	Inputs to the Assumed Failure Probability
CORE DAMAGE	Core Damage Class	CD-006	8.02E-08	RCIC Lost on ED, FLEX Fails, WW Vent Not Re-Isolated
RPV-PRESS	RPV Depressurizes During Core Melt	All	5.25E-01	Operator fails to depressurize RPV prior to vessel being compromised. High dependence on fraction of CD-005 with operator error. HEP from SPAR-H worksheet for fraction with FLEX equipment failures.
			0.15	HP RPV depressurizes via MSL
			0.85	HP RPV depressurizes via SRV seizure
			0.1	MSL & SRV Seizure do not occur
IVR	In Vessel Retention	All	5.49E-01	FLEX alignment for RPV injection would have occurred early in the scenario. Action only requires turning on the pump. High dependence assumed since CD-005 is all human failures.
		MSL Occurs	0.5	Core damage Not Arrested with water available
		SRV Depress Occurs	0.3	Core damage Not Arrested with water available
WTR-INJECT	Water Injection Provided to Cool Debris	All	1.43E-01	Low dependence on vessel HFE due to additional crews, not close in time, same location, additional cues(needs development)
			0.05	Equipment failures (need basis)
ECF	Early Containment Failure Avoided	WTR-INJECT Fails	1	LMT without water
		WTR-INJECT Success	0.001	HPME w/ or w/o water
			0.001	LMT w/water
MCCI	Degree of MCCI	All	0.5	Extensive MCCI
WW-VENT	Wetwell Vent Used for Initial Pressure Control	All	0.0E+00	Vent left open. No operator action required
			0	Hardware failures (need basis)
DW-VENT	Drywell Vent Used for Pressure Control	All	1.00	Operator fails to open WW vent given failure to open WW (high dependence)
			0.0E+00	Operator failure given WW hardware failure
			1	DW hardware given WW hardware failure (need basis)
			1	DW failure (independent) - (need basis)

APET-Alternative 3A

BWR MARK I WW/DW VENTING EVENT TREE FOR CD-006



Endstate	Probability
WW Vent	1.000
DW Vent	0.000
No Vent	0.000
No Vent	0.000
DW Vent	0.000
No Vent	0.000
No Vent	0.000

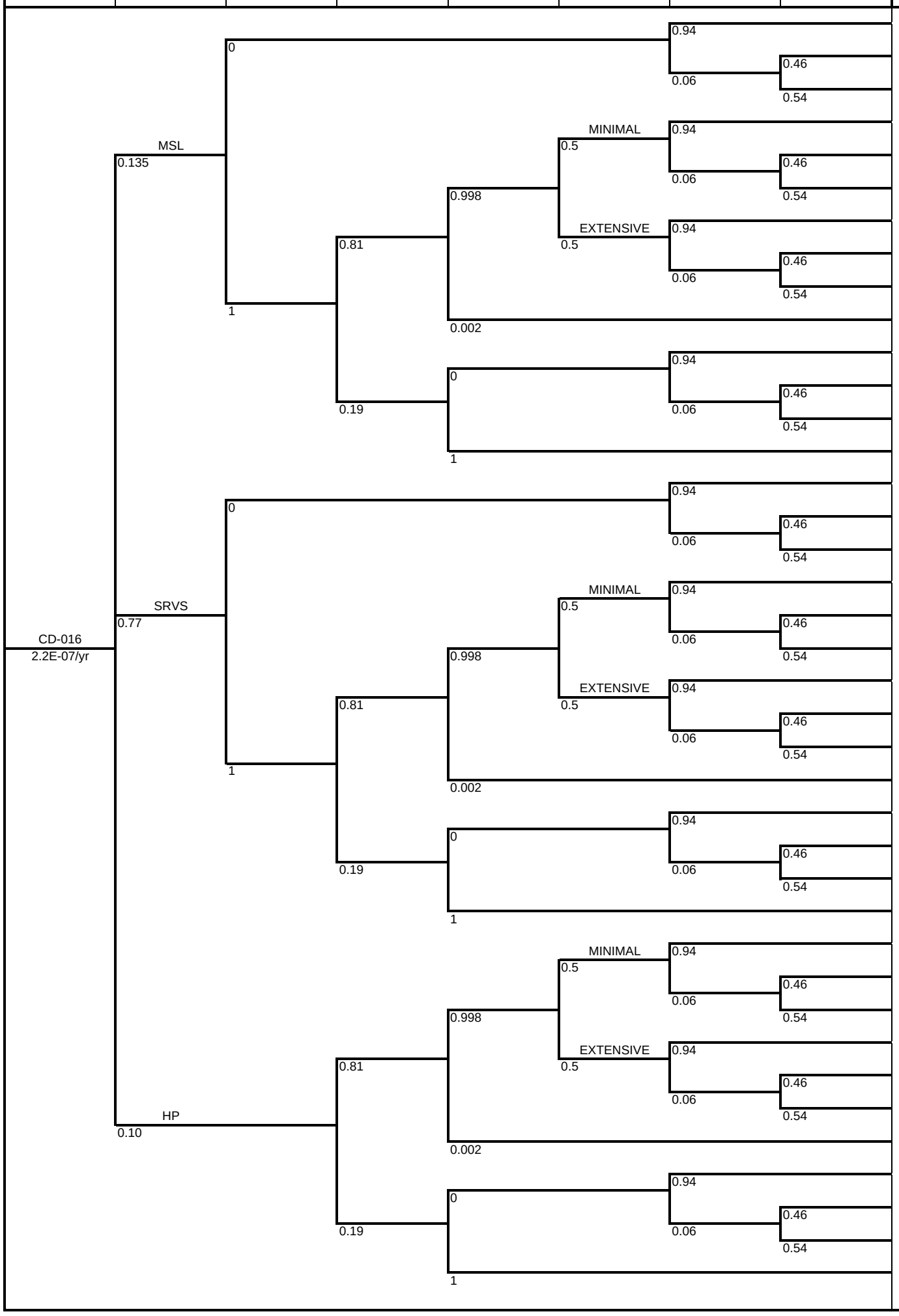
Summary	
No Vent	0.000
WW Vent	1.000
DW Vent	0.000

WW Fails	0.000	
DW Fails Given WW F	1.00	Assume operators not taking actions to vent
No Vent		

APET-Alternative 3A

BWR MARK I ACCIDENT PROGRESSION EVENT TREE FOR CD-016

(RCIC Succeeds Early (0-6 hrs), FLEX Succeeds, No Venting, ED)



CORE DAMAGE	RPV-PRESS	IVR	WTR-INJECT	ECF	MCCI	WW-VENT	DW-VENT	Release Category	Frequency (/yr)	Name
Core Damage Class	RPV Depressurizes During Core Melt	In Vessel Retention	Water Injection Provided to Cool Debris	Early Containment Failure Avoided	Degree of MCCI	Wetwell Vent Used for Initial Pressure Control	Drywell Vent Used for Pressure Control			
								MSL-IVR-WW	0.0E+00/yr	APET-001
								MSL-IVR-DW	0.0E+00/yr	APET-002
								MSL-IVR-OP	0.0E+00/yr	APET-003
								MSL-MIN-WW	1.1E-08/yr	APET-004
								MSL-MIN-DW	3.4E-10/yr	APET-005
								MSL-MIN-OP	3.9E-10/yr	APET-006
								MSL-EXT-WW	1.1E-08/yr	APET-007
								MSL-EXT-DW	3.4E-10/yr	APET-008
								MSL-EXT-OP	3.9E-10/yr	APET-009
								MSL-LMT	4.8E-11/yr	APET-010
								MSL-DRY-WW	0.0E+00/yr	APET-011
								MSL-DRY-DW	0.0E+00/yr	APET-012
								MSL-DRY-OP	0.0E+00/yr	APET-013
								MSL-DRY-LMT	5.4E-09/yr	APET-014
								SRV-IVR-WW	0.0E+00/yr	APET-015
								SRV-IVR-DW	0.0E+00/yr	APET-016
								SRV-IVR-OP	0.0E+00/yr	APET-017
								SRV-MIN-WW	6.3E-08/yr	APET-018
								SRV-MIN-DW	1.9E-09/yr	APET-019
								SRV-MIN-OP	2.2E-09/yr	APET-020
								SRV-EXT-WW	6.3E-08/yr	APET-021
								SRV-EXT-DW	1.9E-09/yr	APET-022
								SRV-EXT-OP	2.2E-09/yr	APET-023
								SRV-LMT	2.7E-10/yr	APET-024
								SRV-DRY-WW	0.0E+00/yr	APET-025
								SRV-DRY-DW	0.0E+00/yr	APET-026
								SRV-DRY-OP	0.0E+00/yr	APET-027
								SRV-DRY-LMT	3.1E-08/yr	APET-028
								HP-MIN-WW	8.2E-09/yr	APET-029
								HP-MIN-DW	2.5E-10/yr	APET-030
								HP-MIN-OP	2.9E-10/yr	APET-031
								HP-EXT-WW	8.2E-09/yr	APET-032
								HP-EXT-DW	2.5E-10/yr	APET-033
								HP-EXT-OP	2.9E-10/yr	APET-034
								HP-LMT	3.5E-11/yr	APET-035
								HP-DRY-WW	0.0E+00/yr	APET-036
								HP-DRY-DW	0.0E+00/yr	APET-037
								HP-DRY-OP	0.0E+00/yr	APET-038
								HP-DRY-LMT	4.0E-09/yr	APET-039
								Total =	**2.2E-07/yr**	

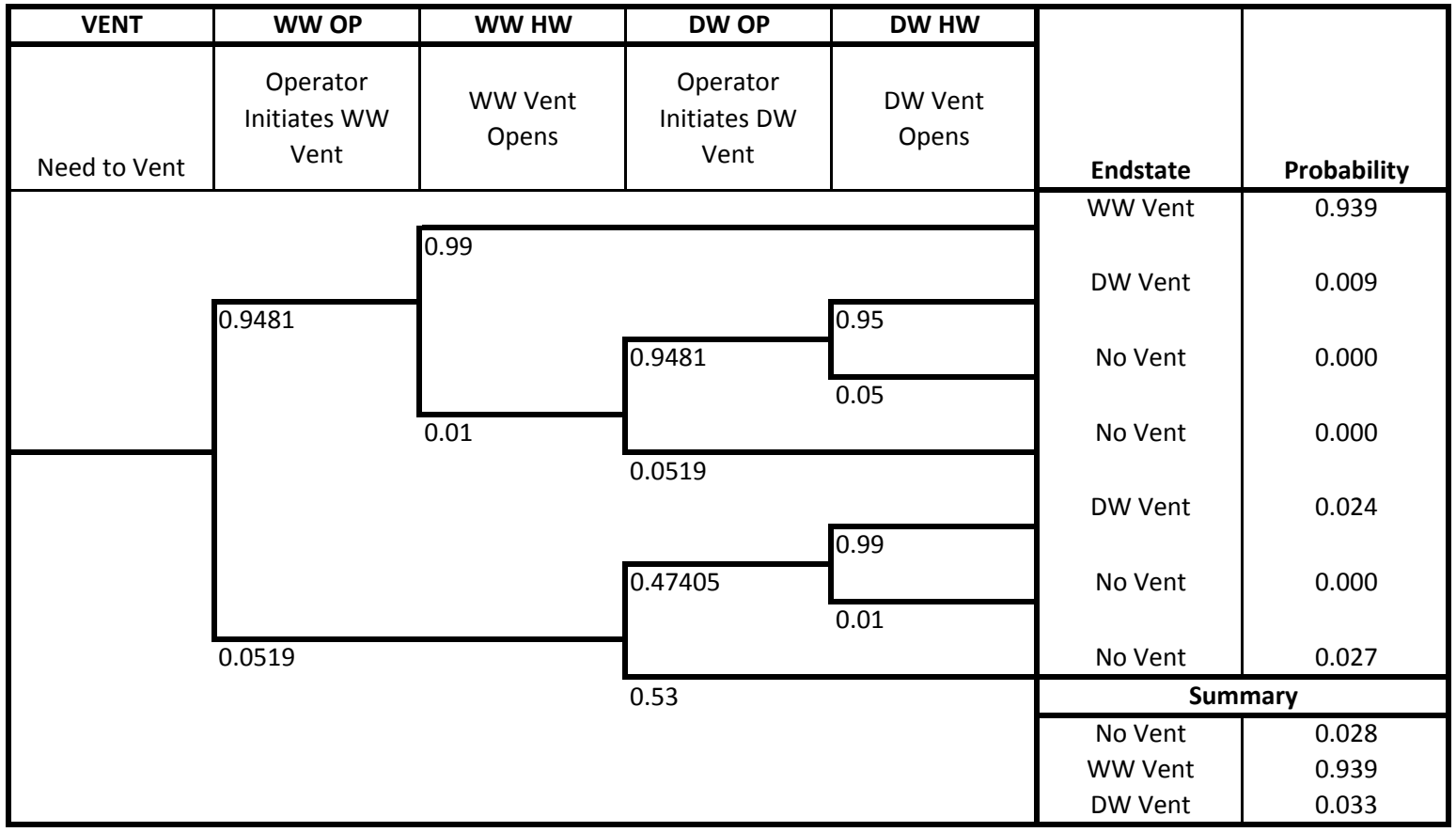
APET-Alternative 3A

BWR MARK I ACCIDENT PROGRESSION EVENT TREE FOR CD-016

Top Event	Description	Condition(s)	Probability	Inputs to the Assumed Failure Probability
CORE DAMAGE	Core Damage Class	CD-016	2.16E-07	RCIC Succeeds Early (0-6 hrs), FLEX Succeeds, No Venting, ED
RPV-PRESS	RPV Depressurizes During Core Melt	All	1	Operator fails to depressurize RPV prior to vessel being compromised
			0.15	HP RPV depressurizes via MSL
			0.85	HP RPV depressurizes via SRV seizure
			0.1	MSL & SRV Seizure do not occur
IVR	In Vessel Retention	All	1	RPV Injection Unavailable in a Timely Manner
		MSL Occurs	0.5	Core damage Not Arrested with water available
		SRV Depress Occurs	0.3	Core damage Not Arrested with water available
WTR-INJECT	Water Injection Provided to Cool Debris	All	1.43E-01	Low dependence on vessel HFE due to additional crews, not close in time, same location, additional cues(needs development)
			0.05	Equipment failures
ECF	Early Containment Failure Avoided	WTR-INJECT Fails	1	LMT without water
		WTR-INJECT Success	0.001	HPME w/ or w/o water
			0.001	LMT w/water
MCCI	Degree of MCCI	All	0.5	Extensive MCCI
WW-VENT	Wetwell Vent Used for Initial Pressure Control	All	5.2E-02	Operator fails to open WW vent
			0.01	Hardware failures (need basis)
DW-VENT	Drywell Vent Used for Pressure Control	All	0.53	Operator fails to open WW vent given failure to open WW (high dependence)
			5.2E-02	Operator failure given WW hardware failure
			0.05	DW hardware given WW hardware failure (need basis)
			0.01	DW failure (independent) - (need basis)

APET-Alternative 3A

BWR MARK I WW/DW VENTING EVENT TREE FOR CD-016



Endstate	Probability
WW Vent	0.939
DW Vent	0.009
No Vent	0.000
No Vent	0.000
DW Vent	0.024
No Vent	0.000
No Vent	0.027

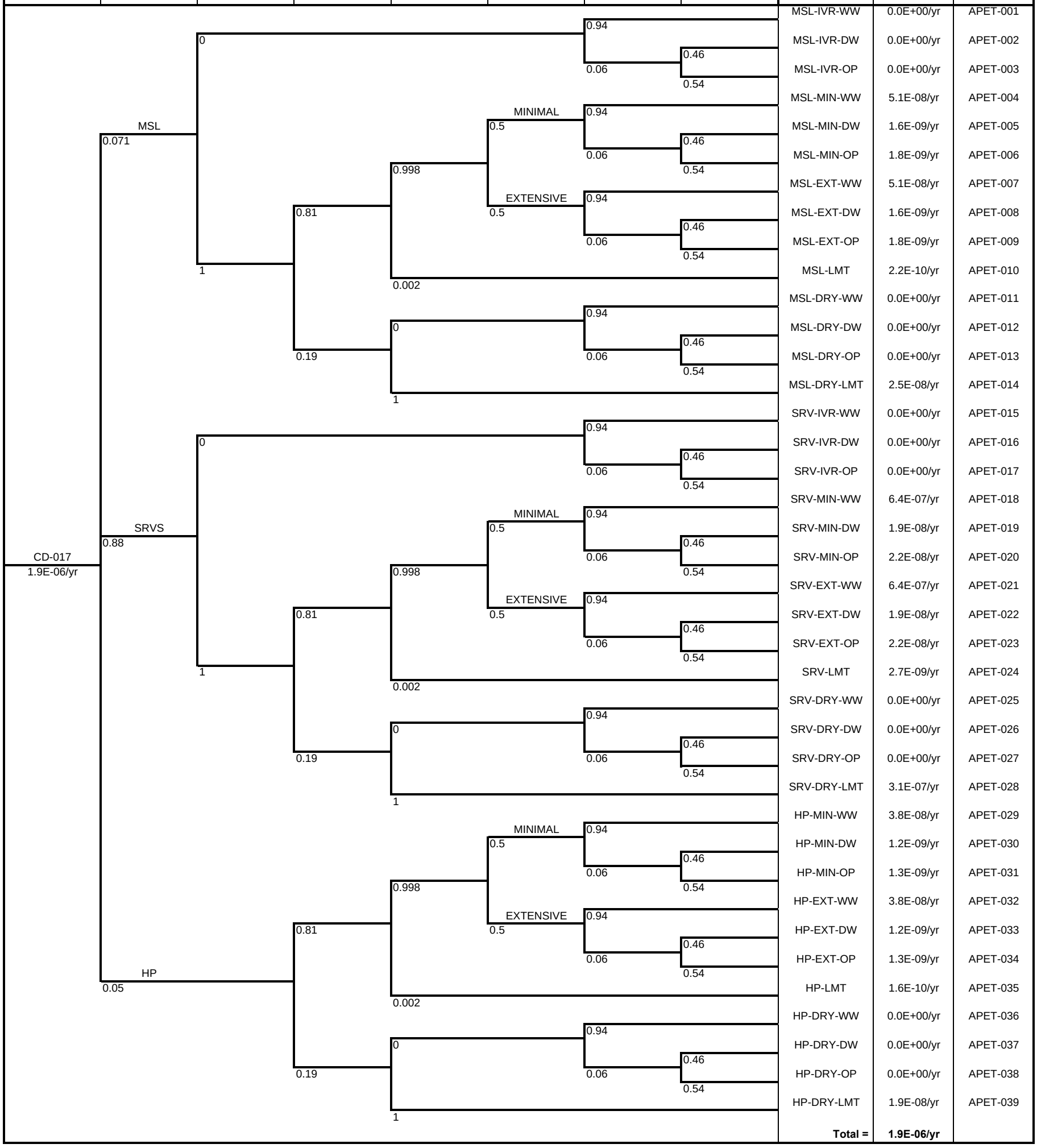
Summary	
No Vent	0.028
WW Vent	0.939
DW Vent	0.033

WW Fails	0.061
DW Fails Given WW F	0.54
No Vent	

APET-Alternative 3A

BWR MARK I ACCIDENT PROGRESSION EVENT TREE FOR CD-017

(Operators Fail to Deploy FLEX)



CORE DAMAGE	RPV-PRESS	IVR	WTR-INJECT	ECF	MCCI	WW-VENT	DW-VENT	Release Category	Frequency (/yr)	Name
Core Damage Class	RPV Depressurizes During Core Melt	In Vessel Retention	Water Injection Provided to Cool Debris	Early Containment Failure Avoided	Degree of MCCI	Wetwell Vent Used for Initial Pressure Control	Drywell Vent Used for Pressure Control			
								MSL-IVR-WW	0.0E+00/yr	APET-001
								MSL-IVR-DW	0.0E+00/yr	APET-002
								MSL-IVR-OP	0.0E+00/yr	APET-003
								MSL-MIN-WW	5.1E-08/yr	APET-004
								MSL-MIN-DW	1.6E-09/yr	APET-005
								MSL-MIN-OP	1.8E-09/yr	APET-006
								MSL-EXT-WW	5.1E-08/yr	APET-007
								MSL-EXT-DW	1.6E-09/yr	APET-008
								MSL-EXT-OP	1.8E-09/yr	APET-009
								MSL-LMT	2.2E-10/yr	APET-010
								MSL-DRY-WW	0.0E+00/yr	APET-011
								MSL-DRY-DW	0.0E+00/yr	APET-012
								MSL-DRY-OP	0.0E+00/yr	APET-013
								MSL-DRY-LMT	2.5E-08/yr	APET-014
								SRV-IVR-WW	0.0E+00/yr	APET-015
								SRV-IVR-DW	0.0E+00/yr	APET-016
								SRV-IVR-OP	0.0E+00/yr	APET-017
								SRV-MIN-WW	6.4E-07/yr	APET-018
								SRV-MIN-DW	1.9E-08/yr	APET-019
								SRV-MIN-OP	2.2E-08/yr	APET-020
								SRV-EXT-WW	6.4E-07/yr	APET-021
								SRV-EXT-DW	1.9E-08/yr	APET-022
								SRV-EXT-OP	2.2E-08/yr	APET-023
								SRV-LMT	2.7E-09/yr	APET-024
								SRV-DRY-WW	0.0E+00/yr	APET-025
								SRV-DRY-DW	0.0E+00/yr	APET-026
								SRV-DRY-OP	0.0E+00/yr	APET-027
								SRV-DRY-LMT	3.1E-07/yr	APET-028
								HP-MIN-WW	3.8E-08/yr	APET-029
								HP-MIN-DW	1.2E-09/yr	APET-030
								HP-MIN-OP	1.3E-09/yr	APET-031
								HP-EXT-WW	3.8E-08/yr	APET-032
								HP-EXT-DW	1.2E-09/yr	APET-033
								HP-EXT-OP	1.3E-09/yr	APET-034
								HP-LMT	1.6E-10/yr	APET-035
								HP-DRY-WW	0.0E+00/yr	APET-036
								HP-DRY-DW	0.0E+00/yr	APET-037
								HP-DRY-OP	0.0E+00/yr	APET-038
								HP-DRY-LMT	1.9E-08/yr	APET-039
								Total =	**1.9E-06/yr**	

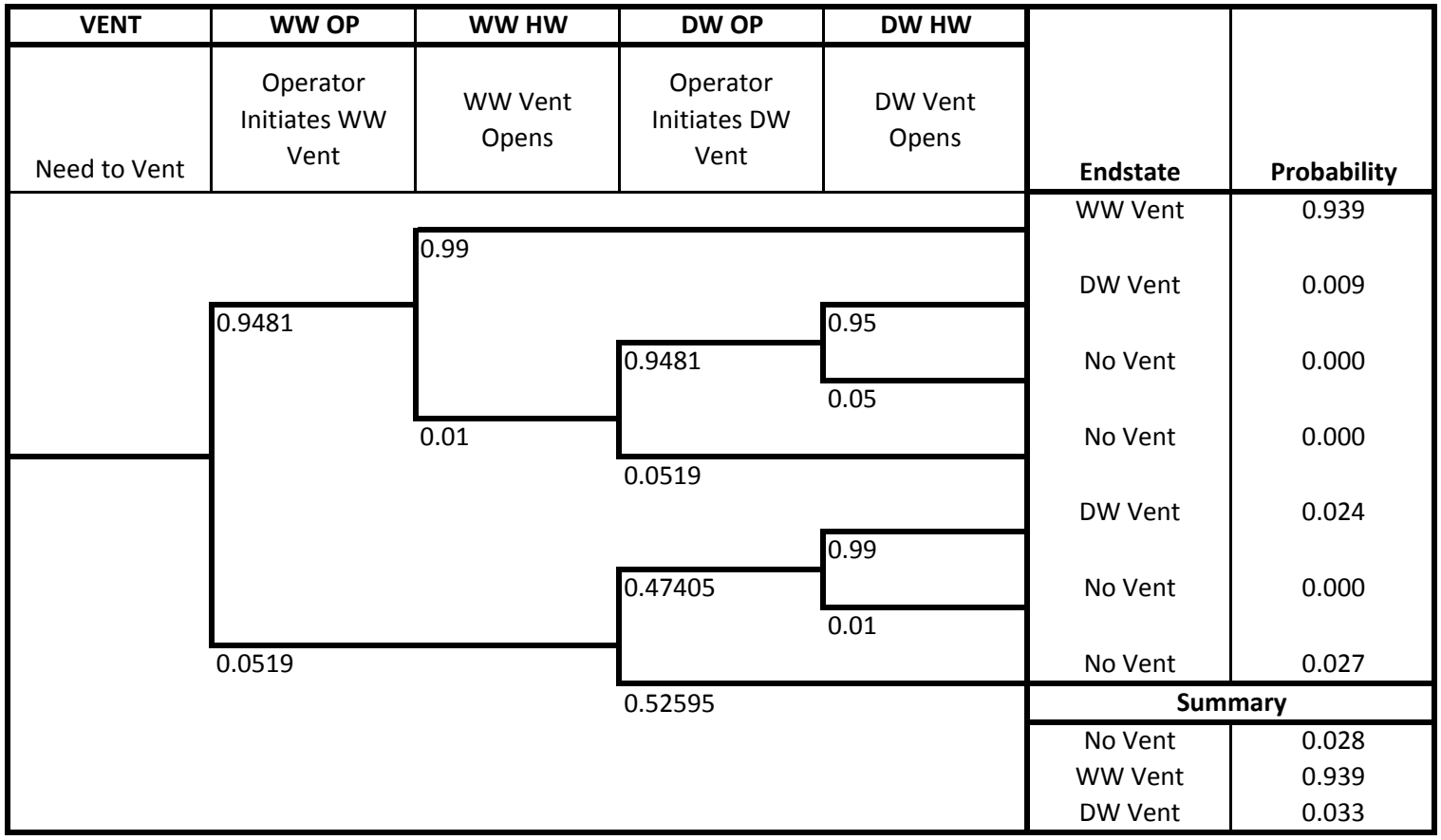
APET-Alternative 3A

BWR MARK I ACCIDENT PROGRESSION EVENT TREE FOR CD-017

Top Event	Description	Condition(s)	Probability	Inputs to the Assumed Failure Probability
CORE DAMAGE	Core Damage Class	CD-017	1.90E-06	Operators Fail to Deploy FLEX
RPV-PRESS	RPV Depressurizes During Core Melt	All	5.25E-01	Operator fails to depressurize RPV prior to vessel being compromised. High dependence on fraction of CD-017 with operator error. HEP from SPAR-H worksheet for fraction with FLEX equipment failures.
			0.15	HP RPV depressurizes via MSL
			0.85	HP RPV depressurizes via SRV seizure
			0.1	MSL & SRV Seizure do not occur
IVR	In Vessel Retention	All	1.00E+00	FLEX alignment for RPV injection precluded by core damage.
		MSL Occurs	0.5	Core damage Not Arrested with water available
		SRV Depress Occurs	0.3	Core damage Not Arrested with water available
WTR-INJECT	Water Injection Provided to Cool Debris	All	1.43E-01	Low dependence on vessel HFE due to additional crews, not close in time, same location, additional cues(needs development)
			0.05	Equipment failures
ECF	Early Containment Failure Avoided	WTR-INJECT Fails	1	LMT without water
		WTR-INJECT Success	0.001	HPME w/ or w/o water
			0.001	LMT w/water
MCCI	Degree of MCCI	All	0.5	Extensive MCCI
WW-VENT	Wetwell Vent Used for Initial Pressure Control	All	5.2E-02	Operator fails to open WW vent
			0.01	Hardware failures (need basis)
DW-VENT	Drywell Vent Used for Pressure Control	All	0.53	Operator fails to open WW vent given failure to open WW (high dependence)
			5.2E-02	Operator failure given WW hardware failure
			0.05	DW hardware given WW hardware failure (need basis)
			0.01	DW failure (independent) - (need basis)

APET-Alternative 3A

BWR MARK I WW/DW VENTING EVENT TREE FOR CD-017



Endstate	Probability
WW Vent	0.939
DW Vent	0.009
No Vent	0.000
No Vent	0.000
DW Vent	0.024
No Vent	0.000
No Vent	0.027

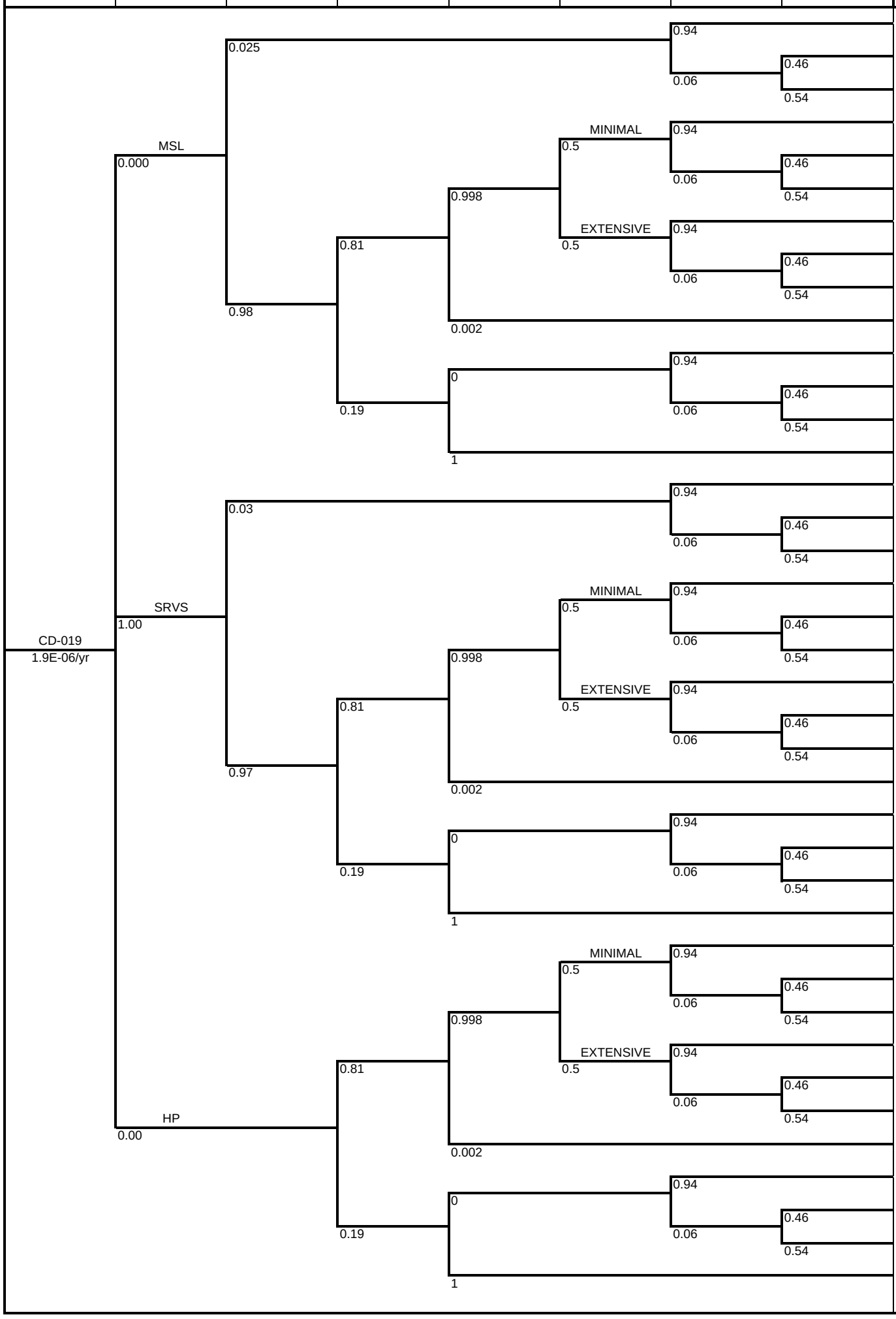
Summary	
No Vent	0.028
WW Vent	0.939
DW Vent	0.033

WW Fails	0.061
DW Fails Given WW F	0.54
No Vent	

APET-Alternative 3A

BWR MARK I ACCIDENT PROGRESSION EVENT TREE FOR CD-019

(RCIC Fails before FLEX can be deployed)



CORE DAMAGE	RPV-PRESS	IVR	WTR-INJECT	ECF	MCCI	WW-VENT	DW-VENT			
Core Damage Class	RPV Depressurizes During Core Melt	In Vessel Retention	Water Injection Provided to Cool Debris	Early Containment Failure Avoided	Degree of MCCI	Wetwell Vent Used for Initial Pressure Control	Drywell Vent Used for Pressure Control	Release Category	Frequency (/yr)	Name
								MSL-IVR-WW	0.0E+00/yr	APET-001
								MSL-IVR-DW	0.0E+00/yr	APET-002
								MSL-IVR-OP	0.0E+00/yr	APET-003
								MSL-MIN-WW	0.0E+00/yr	APET-004
								MSL-MIN-DW	0.0E+00/yr	APET-005
								MSL-MIN-OP	0.0E+00/yr	APET-006
								MSL-EXT-WW	0.0E+00/yr	APET-007
								MSL-EXT-DW	0.0E+00/yr	APET-008
								MSL-EXT-OP	0.0E+00/yr	APET-009
								MSL-LMT	0.0E+00/yr	APET-010
								MSL-DRY-WW	0.0E+00/yr	APET-011
								MSL-DRY-DW	0.0E+00/yr	APET-012
								MSL-DRY-OP	0.0E+00/yr	APET-013
								MSL-DRY-LMT	0.0E+00/yr	APET-014
								SRV-IVR-WW	6.3E-08/yr	APET-015
								SRV-IVR-DW	1.9E-09/yr	APET-016
								SRV-IVR-OP	2.2E-09/yr	APET-017
								SRV-MIN-WW	7.0E-07/yr	APET-018
								SRV-MIN-DW	2.1E-08/yr	APET-019
								SRV-MIN-OP	2.5E-08/yr	APET-020
								SRV-EXT-WW	7.0E-07/yr	APET-021
								SRV-EXT-DW	2.1E-08/yr	APET-022
								SRV-EXT-OP	2.5E-08/yr	APET-023
								SRV-LMT	3.0E-09/yr	APET-024
								SRV-DRY-WW	0.0E+00/yr	APET-025
								SRV-DRY-DW	0.0E+00/yr	APET-026
								SRV-DRY-OP	0.0E+00/yr	APET-027
								SRV-DRY-LMT	3.4E-07/yr	APET-028
								HP-MIN-WW	0.0E+00/yr	APET-029
								HP-MIN-DW	0.0E+00/yr	APET-030
								HP-MIN-OP	0.0E+00/yr	APET-031
								HP-EXT-WW	0.0E+00/yr	APET-032
								HP-EXT-DW	0.0E+00/yr	APET-033
								HP-EXT-OP	0.0E+00/yr	APET-034
								HP-LMT	0.0E+00/yr	APET-035
								HP-DRY-WW	0.0E+00/yr	APET-036
								HP-DRY-DW	0.0E+00/yr	APET-037
								HP-DRY-OP	0.0E+00/yr	APET-038
								HP-DRY-LMT	0.0E+00/yr	APET-039
								Total =	**1.9E-06/yr**	

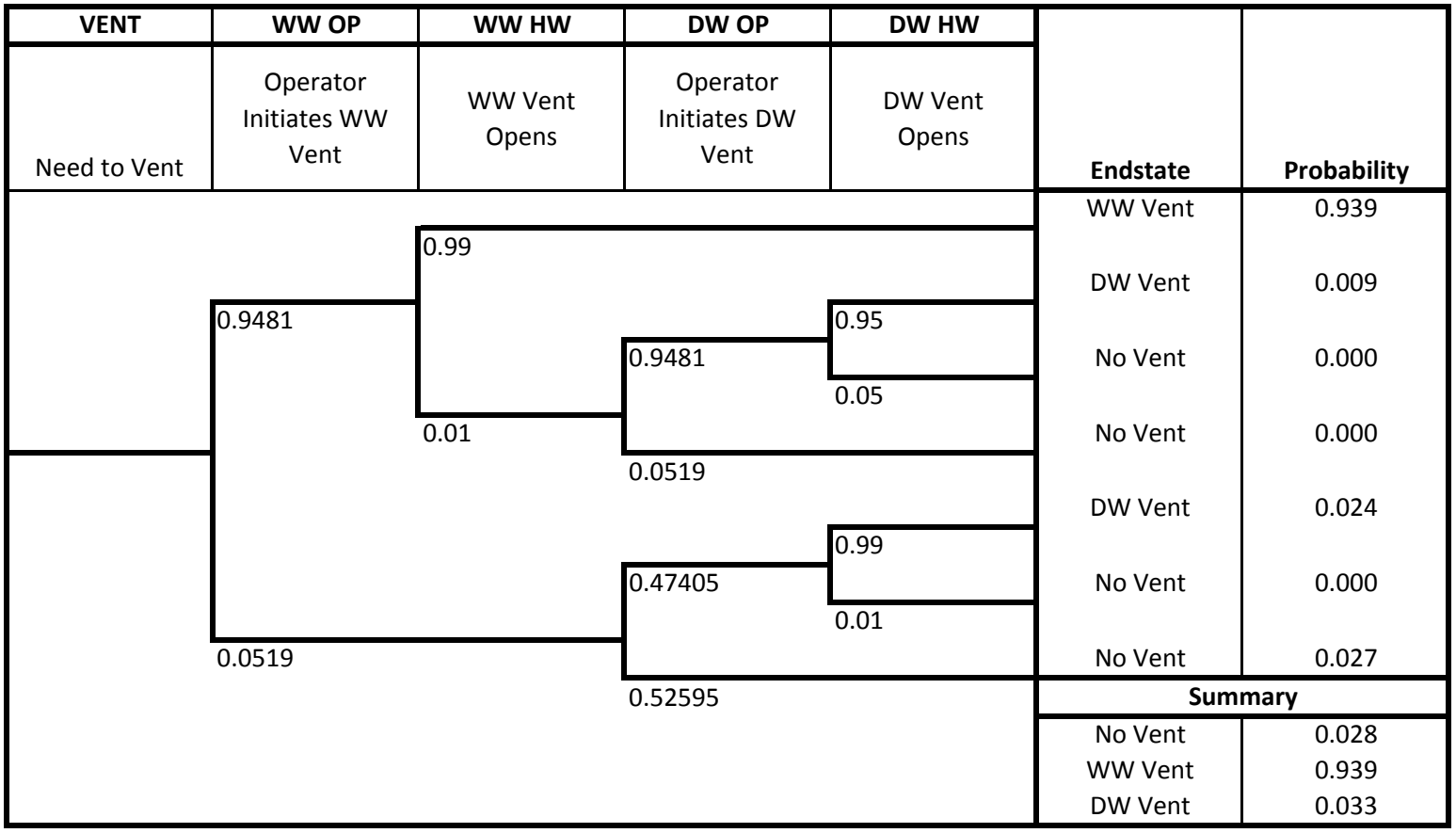
APET-Alternative 3A

BWR MARK I ACCIDENT PROGRESSION EVENT TREE FOR CD-019

Top Event	Description	Condition(s)	Probability	Inputs to the Assumed Failure Probability
CORE DAMAGE	Core Damage Class	CD-019	1.91E-06	RCIC Fails before FLEX can be deployed
RPV-PRESS	RPV Depressurizes During Core Melt	All	0.00E+00	RPV already at low pressure.
			0.15	HP RPV depressurizes via MSL
			0.85	HP RPV depressurizes via SRV seizure
			0.1	MSL & SRV Seizure do not occur
IVR	In Vessel Retention	All	9.50E-01	FLEX alignment for RPV injection would be impeded by early onset of core damage. (need basis)
		MSL Occurs	0.5	Core damage Not Arrested with water available
		SRV Depress Occurs	0.3	Core damage Not Arrested with water available
WTR-INJECT	Water Injection Provided to Cool Debris	All	1.43E-01	Low dependence on vessel HFE due to additional crews, not close in time, same location, additional cues(needs development)
			0.05	Equipment failures
ECF	Early Containment Failure Avoided	WTR-INJECT Fails	1	LMT without water
		WTR-INJECT Success	0.001	HPME w/ or w/o water
			0.001	LMT w/water
MCCI	Degree of MCCI	All	0.5	Extensive MCCI
WW-VENT	Wetwell Vent Used for Initial Pressure Control	All	5.2E-02	Operator fails to open WW vent
			0.01	Hardware failures (need basis)
DW-VENT	Drywell Vent Used for Pressure Control	All	0.53	Operator fails to open WW vent given failure to open WW (high dependence)
			5.2E-02	Operator failure given WW hardware failure
			0.05	DW hardware given WW hardware failure (need basis)
			0.01	DW failure (independent) - (need basis)

APET-Alternative 3A

BWR MARK I WW/DW VENTING EVENT TREE FOR CD-019



Endstate	Probability
WW Vent	0.939
DW Vent	0.009
No Vent	0.000
No Vent	0.000
DW Vent	0.024
No Vent	0.000
No Vent	0.027

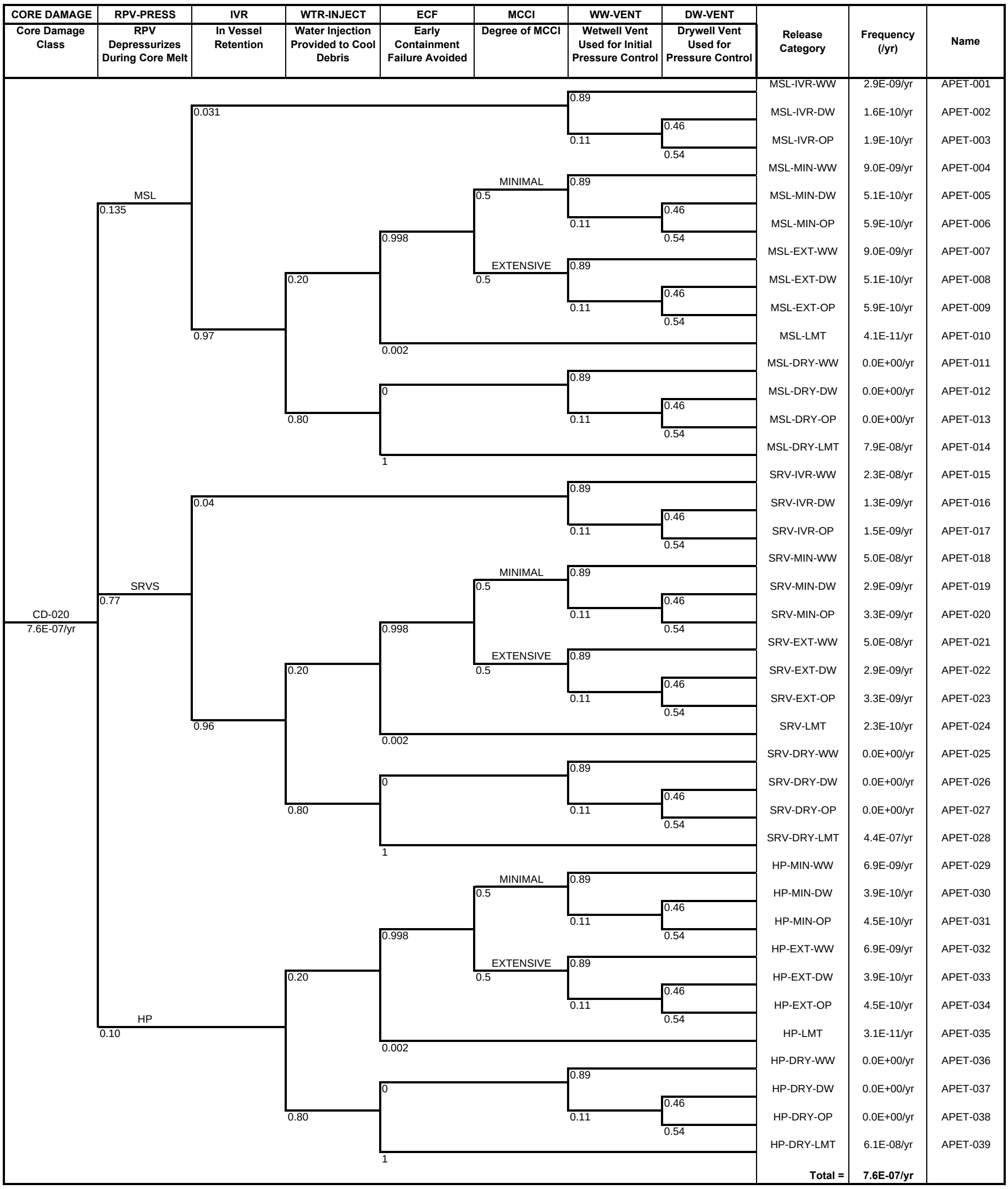
Summary	
No Vent	0.028
WW Vent	0.939
DW Vent	0.033

WW Fails	0.061
DW Fails Given WW F	0.54
No Vent	

APET-Alternative 3A

BWR MARK I ACCIDENT PROGRESSION EVENT TREE FOR CD-020

(RCIC Hardware Failures, Operator fails to ED)



CORE DAMAGE	RPV-PRESS	IVR	WTR-INJECT	ECF	MCCI	WW-VENT	DW-VENT	Release Category	Frequency (/yr)	Name
Core Damage Class	RPV Depressurizes During Core Melt	In Vessel Retention	Water Injection Provided to Cool Debris	Early Containment Failure Avoided	Degree of MCCI	Wetwell Vent Used for Initial Pressure Control	Drywell Vent Used for Pressure Control			
								MSL-IVR-WW	2.9E-09/yr	APET-001
								MSL-IVR-DW	1.6E-10/yr	APET-002
								MSL-IVR-OP	1.9E-10/yr	APET-003
								MSL-MIN-WW	9.0E-09/yr	APET-004
								MSL-MIN-DW	5.1E-10/yr	APET-005
								MSL-MIN-OP	5.9E-10/yr	APET-006
								MSL-EXT-WW	9.0E-09/yr	APET-007
								MSL-EXT-DW	5.1E-10/yr	APET-008
								MSL-EXT-OP	5.9E-10/yr	APET-009
								MSL-LMT	4.1E-11/yr	APET-010
								MSL-DRY-WW	0.0E+00/yr	APET-011
								MSL-DRY-DW	0.0E+00/yr	APET-012
								MSL-DRY-OP	0.0E+00/yr	APET-013
								MSL-DRY-LMT	7.9E-08/yr	APET-014
								SRV-IVR-WW	2.3E-08/yr	APET-015
								SRV-IVR-DW	1.3E-09/yr	APET-016
								SRV-IVR-OP	1.5E-09/yr	APET-017
								SRV-MIN-WW	5.0E-08/yr	APET-018
								SRV-MIN-DW	2.9E-09/yr	APET-019
								SRV-MIN-OP	3.3E-09/yr	APET-020
								SRV-EXT-WW	5.0E-08/yr	APET-021
								SRV-EXT-DW	2.9E-09/yr	APET-022
								SRV-EXT-OP	3.3E-09/yr	APET-023
								SRV-LMT	2.3E-10/yr	APET-024
								SRV-DRY-WW	0.0E+00/yr	APET-025
								SRV-DRY-DW	0.0E+00/yr	APET-026
								SRV-DRY-OP	0.0E+00/yr	APET-027
								SRV-DRY-LMT	4.4E-07/yr	APET-028
								HP-MIN-WW	6.9E-09/yr	APET-029
								HP-MIN-DW	3.9E-10/yr	APET-030
								HP-MIN-OP	4.5E-10/yr	APET-031
								HP-EXT-WW	6.9E-09/yr	APET-032
								HP-EXT-DW	3.9E-10/yr	APET-033
								HP-EXT-OP	4.5E-10/yr	APET-034
								HP-LMT	3.1E-11/yr	APET-035
								HP-DRY-WW	0.0E+00/yr	APET-036
								HP-DRY-DW	0.0E+00/yr	APET-037
								HP-DRY-OP	0.0E+00/yr	APET-038
								HP-DRY-LMT	6.1E-08/yr	APET-039
								Total =	**7.6E-07/yr**	

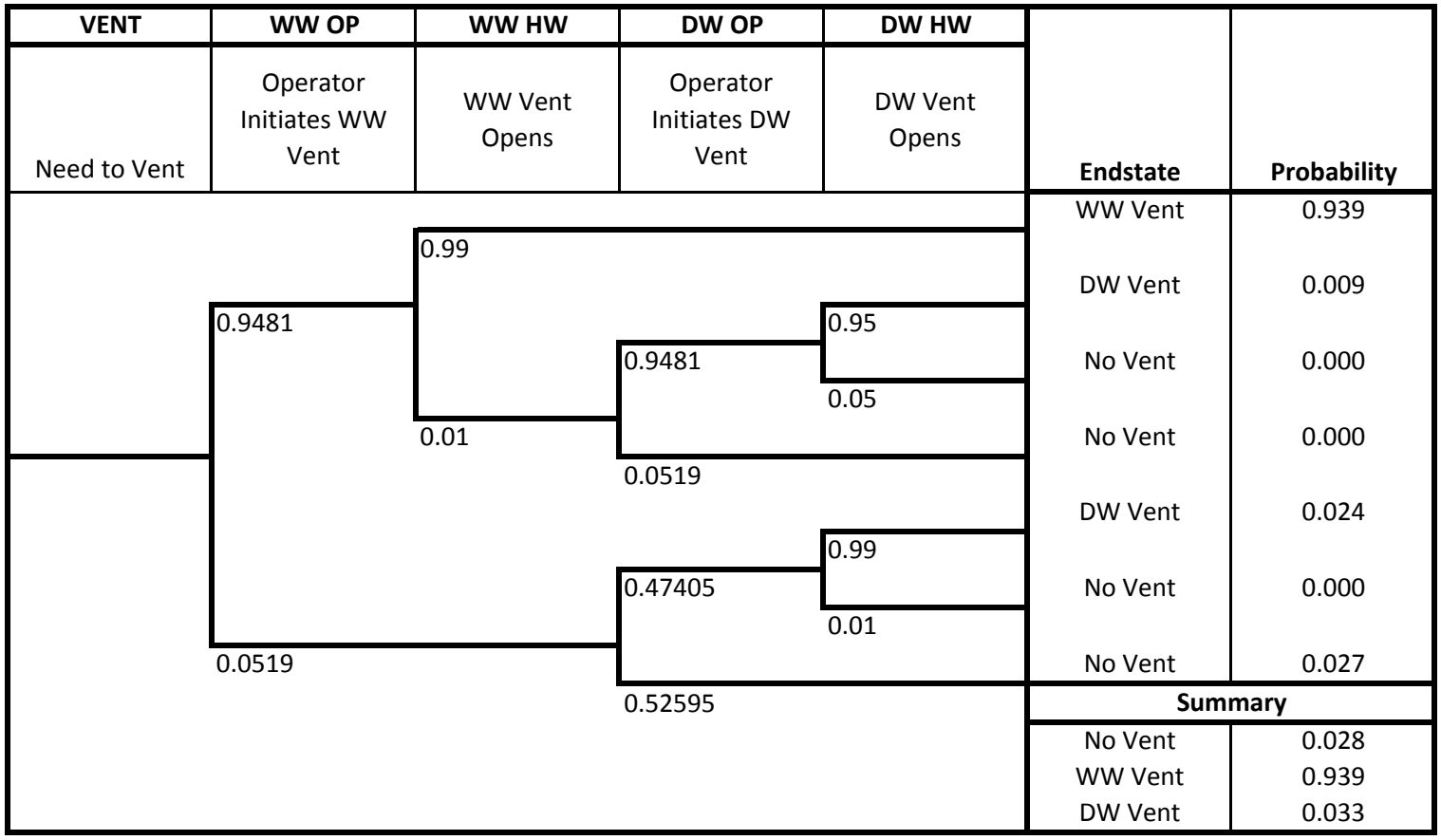
APET-Alternative 3A

Bases for APET - CD-020

Top Event	Description	Condition(s)	Probability	Inputs to the Assumed Failure Probability
CORE DAMAGE	Core Damage Class	CD-020	7.61E-07	RCIC Hardware Failures, Operator fails to ED
RPV-PRESS	RPV Depressurizes During Core Melt	All	1	Assume complete dependence. Operator has already failed to depressurize RPV prior to core damage
			0.15	HP RPV depressurizes via MSL
			0.85	HP RPV depressurizes via SRV seizure
			0.1	MSL & SRV Seizure do not occur
IVR	In Vessel Retention	All	9.38E-01	RPV Injection Unavailable in a Timely Manner
		MSL Occurs	0.5	Core damage Not Arrested with water available
		SRV Depress Occurs	0.3	Core damage Not Arrested with water available
WTR-INJECT	Water Injection Provided to Cool Debris	All	7.86E-01	Substantial fraction involve loss of DC. Remainder treated as low HFE dependence on vessel HFE due to additional crews, not close in time, same location, additional cues(needs development)
			0.05	Equipment failures
ECF	Early Containment Failure Avoided	WTR-INJECT Fails	1	LMT without water
		WTR-INJECT Success	0.001	HPME w/ or w/o water
			0.001	MLMT w/water
MCCI	Degree of MCCI	All	0.5	Extensive MCCI
WW-VENT	Wetwell Vent Used for Initial Pressure Control	All	0.1	Operator fails to open WW vent
			0.01	Hardware failures
DW-VENT	Drywell Vent Used for Pressure Control	All	0.55	Operator fails to open WW vent given failure to open WW (high dependence)
			0.1	Operator failure given WW hardware failure
			0.05	DW hardware given WW hardware failure
			0.01	DW failure (independent)

APET-Alternative 3A

BWR MARK I WW/DW VENTING EVENT TREE FOR CD-020



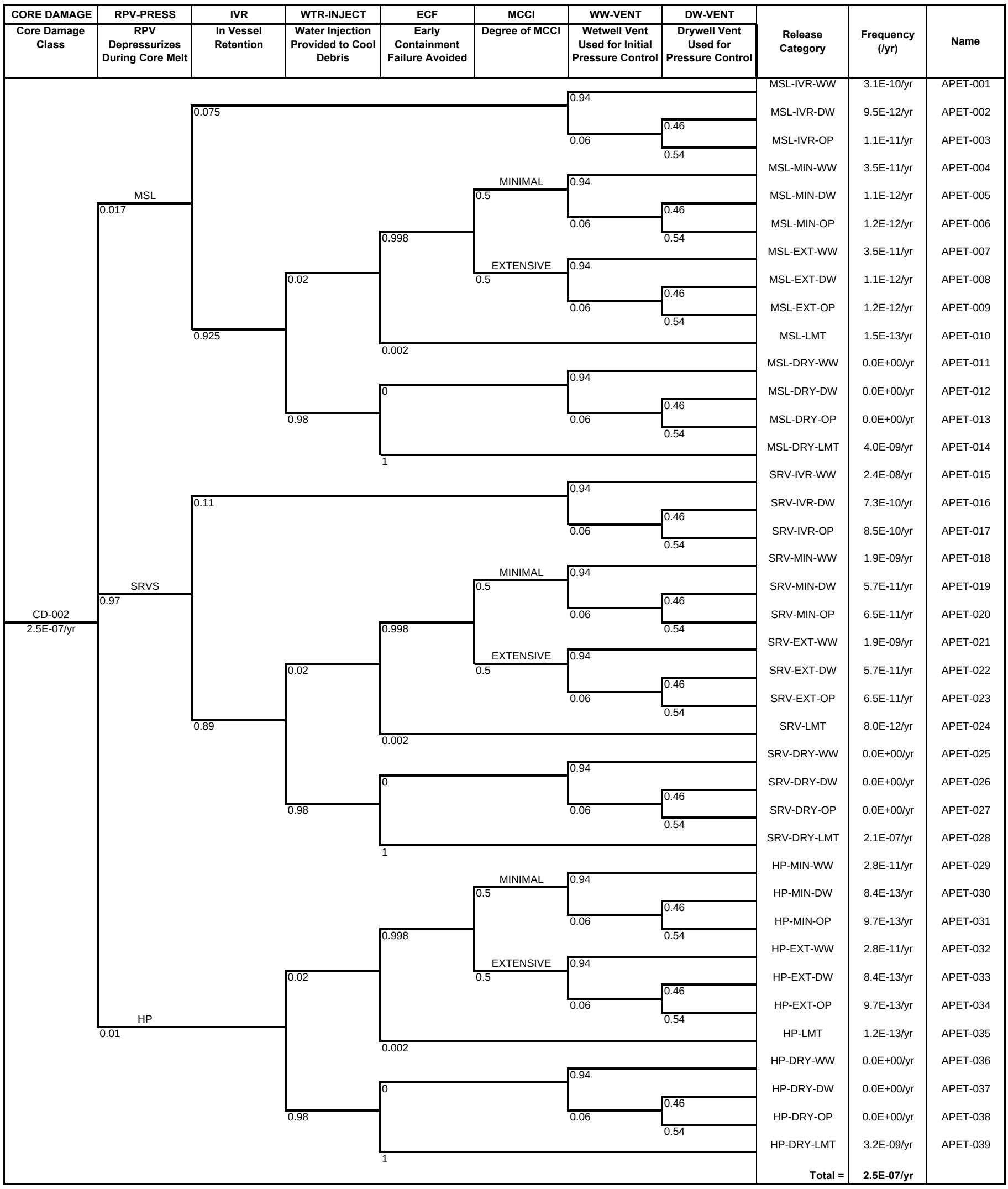
Endstate	Probability
WW Vent	0.939
DW Vent	0.009
No Vent	0.000
No Vent	0.000
DW Vent	0.024
No Vent	0.000
No Vent	0.027

Summary	
No Vent	0.028
WW Vent	0.939
DW Vent	0.033

WW Fails	0.061
DW Fails Given WW F	0.54
No Vent	

BWR MARK I ACCIDENT PROGRESSION EVENT TREE FOR CD-002

(RCIC & Early Venting Succeed, FLEX fails late, Cont. Re-isolated)



CORE DAMAGE Core Damage Class	RPV-PRESS RPV Depressurizes During Core Melt	IVR In Vessel Retention	WTR-INJECT Water Injection Provided to Cool Debris	ECF Early Containment Failure Avoided	MCCI Degree of MCCI	WW-VENT Wetwell Vent Used for Initial Pressure Control	DW-VENT Drywell Vent Used for Pressure Control	Release Category	Frequency (/yr)	Name
								MSL-IVR-WW	3.1E-10/yr	APET-001
								MSL-IVR-DW	9.5E-12/yr	APET-002
								MSL-IVR-OP	1.1E-11/yr	APET-003
								MSL-MIN-WW	3.5E-11/yr	APET-004
								MSL-MIN-DW	1.1E-12/yr	APET-005
								MSL-MIN-OP	1.2E-12/yr	APET-006
								MSL-EXT-WW	3.5E-11/yr	APET-007
								MSL-EXT-DW	1.1E-12/yr	APET-008
								MSL-EXT-OP	1.2E-12/yr	APET-009
								MSL-LMT	1.5E-13/yr	APET-010
								MSL-DRY-WW	0.0E+00/yr	APET-011
								MSL-DRY-DW	0.0E+00/yr	APET-012
								MSL-DRY-OP	0.0E+00/yr	APET-013
								MSL-DRY-LMT	4.0E-09/yr	APET-014
								SRV-IVR-WW	2.4E-08/yr	APET-015
								SRV-IVR-DW	7.3E-10/yr	APET-016
								SRV-IVR-OP	8.5E-10/yr	APET-017
								SRV-MIN-WW	1.9E-09/yr	APET-018
								SRV-MIN-DW	5.7E-11/yr	APET-019
								SRV-MIN-OP	6.5E-11/yr	APET-020
								SRV-EXT-WW	1.9E-09/yr	APET-021
								SRV-EXT-DW	5.7E-11/yr	APET-022
								SRV-EXT-OP	6.5E-11/yr	APET-023
								SRV-LMT	8.0E-12/yr	APET-024
								SRV-DRY-WW	0.0E+00/yr	APET-025
								SRV-DRY-DW	0.0E+00/yr	APET-026
								SRV-DRY-OP	0.0E+00/yr	APET-027
								SRV-DRY-LMT	2.1E-07/yr	APET-028
								HP-MIN-WW	2.8E-11/yr	APET-029
								HP-MIN-DW	8.4E-13/yr	APET-030
								HP-MIN-OP	9.7E-13/yr	APET-031
								HP-EXT-WW	2.8E-11/yr	APET-032
								HP-EXT-DW	8.4E-13/yr	APET-033
								HP-EXT-OP	9.7E-13/yr	APET-034
								HP-LMT	1.2E-13/yr	APET-035
								HP-DRY-WW	0.0E+00/yr	APET-036
								HP-DRY-DW	0.0E+00/yr	APET-037
								HP-DRY-OP	0.0E+00/yr	APET-038
								HP-DRY-LMT	3.2E-09/yr	APET-039
								Total =	**2.5E-07/yr**	

APET-Base Case

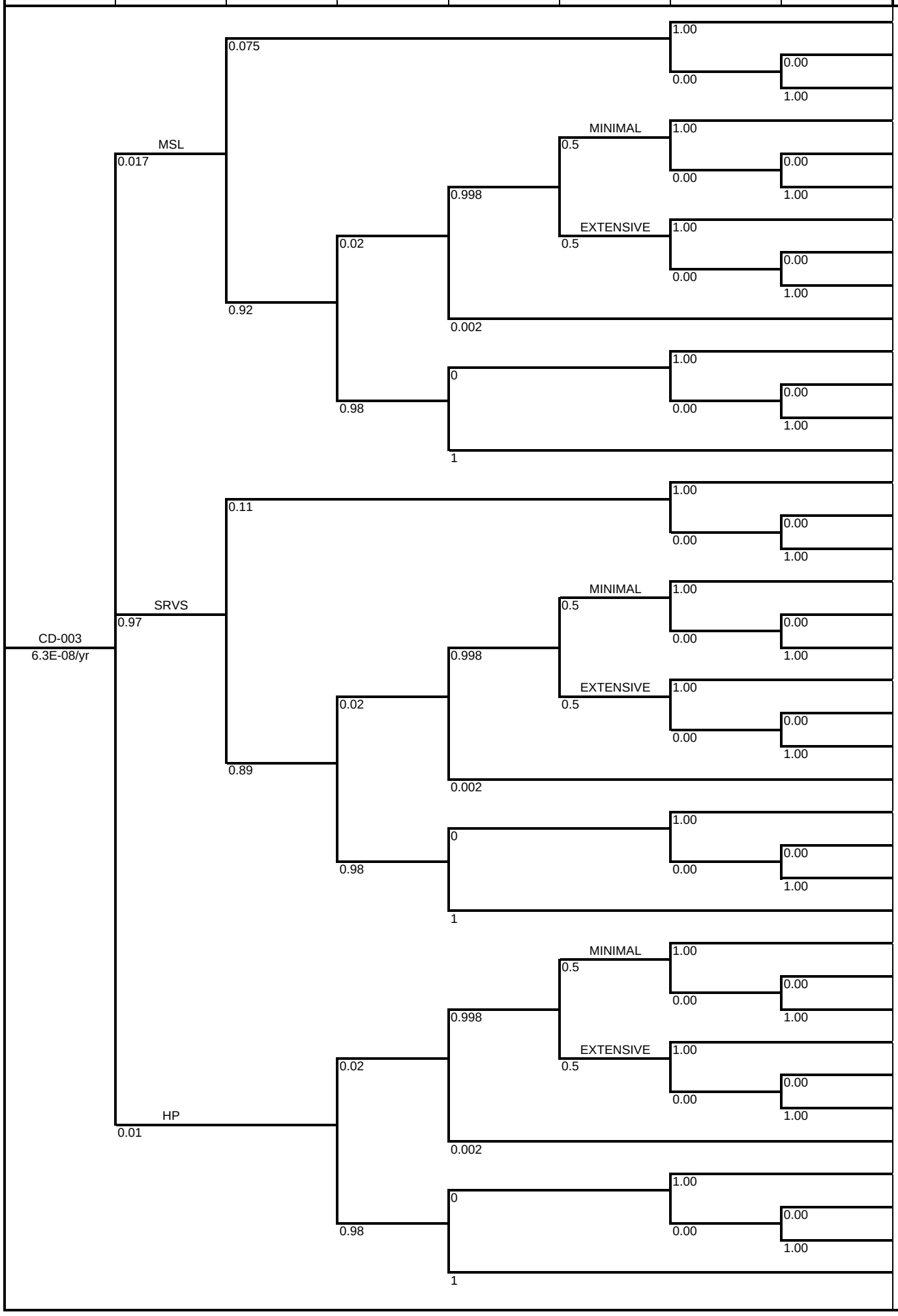
BWR MARK I ACCIDENT PROGRESSION EVENT TREE FOR CD-002

Top Event	Description	Condition(s)	Probability	Inputs to the Assumed Failure Probability
CORE DAMAGE	Core Damage Class	CD-002	2.52E-07	RCIC & Early Venting Succeed, FLEX fails late, Cont. Re-isolated
RPV-PRESS	RPV Depressurizes During Core Melt	All	1.30E-01	Operator fails to depressurize RPV prior to vessel being compromised. High dependence on fraction of CD-002 with operator error. HEP from SPAR-H worksheet for fraction with FLEX equipment failures.
			0.15	HP RPV depressurizes via MSL
			0.85	HP RPV depressurizes via SRV seizure
			0.1	MSL & SRV Seizure do not occur
IVR	In Vessel Retention	All	8.50E-01	FLEX alignment for RPV injection would have occurred early in the scenario. Action only requires turning on the pump. However, cases with FLEX equipment failures are not recoverable.
		MSL Occurs	0.5	Core damage Not Arrested with water available
		SRV Depress Occurs	0.3	Core damage Not Arrested with water available
WTR-INJECT	Water Injection Provided to Cool Debris	All	9.81E-01	Fraction of IVR without water
			0.05	Equipment failures (need basis)
ECF	Early Containment Failure Avoided	WTR-INJECT Fails	1	LMT without water
		WTR-INJECT Success	0.001	HPME w/ or w/o water
			0.001	LMT w/water
MCCI	Degree of MCCI	All	0.5	Extensive MCCI
WW-VENT	Wetwell Vent Used for Initial Pressure Control	All	5.2E-02	Operator fails to open WW vent
			0.01	Hardware failures (need basis)
DW-VENT	Drywell Vent Used for Pressure Control	All	0.53	Operator fails to open WW vent given failure to open WW (high dependence)
			5.2E-02	Operator failure given WW hardware failure
			0.05	DW hardware given WW hardware failure (need basis)
			0.01	DW failure (independent) - (need basis)

APET-Base Case

BWR MARK I ACCIDENT PROGRESSION EVENT TREE FOR CD-003

(RCIC & Early Venting Succeed, FLEX fails late, WW Vent Not Re-Isolated)



CORE DAMAGE	RPV-PRESS	IVR	WTR-INJECT	ECF	MCCI	WW-VENT	DW-VENT	Release Category	Frequency (/yr)	Name
Core Damage Class	RPV Depressurizes During Core Melt	In Vessel Retention	Water Injection Provided to Cool Debris	Early Containment Failure Avoided	Degree of MCCI	Wetwell Vent Used for Initial Pressure Control	Drywell Vent Used for Pressure Control			
								MSL-IVR-WW	8.3E-11/yr	APET-001
								MSL-IVR-DW	0.0E+00/yr	APET-002
								MSL-IVR-OP	0.0E+00/yr	APET-003
								MSL-MIN-WW	9.3E-12/yr	APET-004
								MSL-MIN-DW	0.0E+00/yr	APET-005
								MSL-MIN-OP	0.0E+00/yr	APET-006
								MSL-EXT-WW	9.3E-12/yr	APET-007
								MSL-EXT-DW	0.0E+00/yr	APET-008
								MSL-EXT-OP	0.0E+00/yr	APET-009
								MSL-LMT	3.7E-14/yr	APET-010
								MSL-DRY-WW	0.0E+00/yr	APET-011
								MSL-DRY-DW	0.0E+00/yr	APET-012
								MSL-DRY-OP	0.0E+00/yr	APET-013
								MSL-DRY-LMT	1.0E-09/yr	APET-014
								SRV-IVR-WW	6.4E-09/yr	APET-015
								SRV-IVR-DW	0.0E+00/yr	APET-016
								SRV-IVR-OP	0.0E+00/yr	APET-017
								SRV-MIN-WW	5.0E-10/yr	APET-018
								SRV-MIN-DW	0.0E+00/yr	APET-019
								SRV-MIN-OP	0.0E+00/yr	APET-020
								SRV-EXT-WW	5.0E-10/yr	APET-021
								SRV-EXT-DW	0.0E+00/yr	APET-022
								SRV-EXT-OP	0.0E+00/yr	APET-023
								SRV-LMT	2.0E-12/yr	APET-024
								SRV-DRY-WW	0.0E+00/yr	APET-025
								SRV-DRY-DW	0.0E+00/yr	APET-026
								SRV-DRY-OP	0.0E+00/yr	APET-027
								SRV-DRY-LMT	5.4E-08/yr	APET-028
								HP-MIN-WW	7.4E-12/yr	APET-029
								HP-MIN-DW	0.0E+00/yr	APET-030
								HP-MIN-OP	0.0E+00/yr	APET-031
								HP-EXT-WW	7.4E-12/yr	APET-032
								HP-EXT-DW	0.0E+00/yr	APET-033
								HP-EXT-OP	0.0E+00/yr	APET-034
								HP-LMT	3.0E-14/yr	APET-035
								HP-DRY-WW	0.0E+00/yr	APET-036
								HP-DRY-DW	0.0E+00/yr	APET-037
								HP-DRY-OP	0.0E+00/yr	APET-038
								HP-DRY-LMT	8.0E-10/yr	APET-039
								Total =	**6.3E-08/yr**	

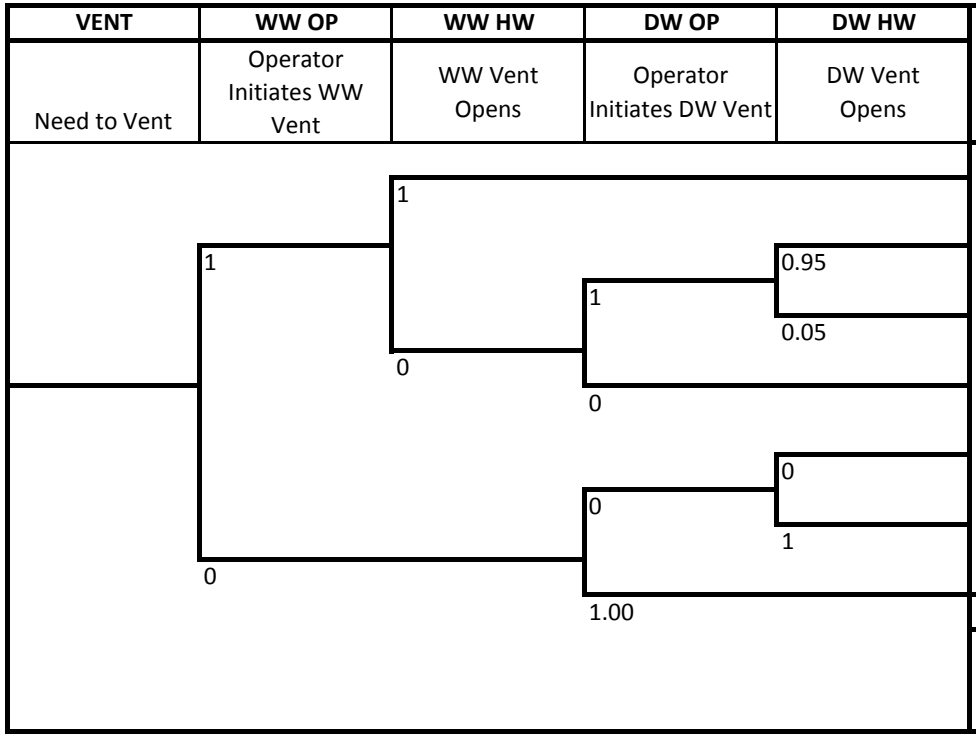
APET-Base Case

BWR MARK I ACCIDENT PROGRESSION EVENT TREE FOR CD-003

Top Event	Description	Condition(s)	Probability	Inputs to the Assumed Failure Probability
CORE DAMAGE	Core Damage Class	CD-003	6.31E-08	RCIC & Early Venting Succeed, FLEX fails late, WW Vent Not Re-Isolated
RPV-PRESS	RPV Depressurizes During Core Melt	All	1.30E-01	Operator fails to depressurize RPV prior to vessel being compromised. High dependence on fraction of CD-003 with operator error. HEP from SPAR-H worksheet for fraction with FLEX equipment failures.
			0.15	HP RPV depressurizes via MSL
			0.85	HP RPV depressurizes via SRV seizure
			0.1	MSL & SRV Seizure do not occur
IVR	In Vessel Retention	All	8.50E-01	FLEX alignment for RPV injection would have occurred early in the scenario. Action only requires turning on the pump. However, cases with FLEX equipment failures are not recoverable.
		MSL Occurs	0.5	Core damage Not Arrested with water available
		SRV Depress Occurs	0.3	Core damage Not Arrested with water available
WTR-INJECT	Water Injection Provided to Cool Debris	All	9.81E-01	Fraction of IVR without water
			0.05	Equipment failures (need basis)
ECF	Early Containment Failure Avoided	WTR-INJECT Fails	1	LMT without water
		WTR-INJECT Success	0.001	HPME w/ or w/o water
			0.001	LMT w/water
MCCI	Degree of MCCI	All	0.5	Extensive MCCI
WW-VENT	Wetwell Vent Used for Initial Pressure Control	All	0.0E+00	Vent left open. No operator action required
			0	Hardware failures (need basis)
DW-VENT	Drywell Vent Used for Pressure Control	All	1.00	Operator fails to open WW vent given failure to open WW (high dependence)
			0.0E+00	Operator failure given WW hardware failure
			1	DW hardware given WW hardware failure (need basis)
			1	DW failure (independent) - (need basis)

APET-Base Case

BWR MARK I WW/DW VENTING EVENT TREE FOR CD-003



Endstate	Probability
WW Vent	1.000
DW Vent	0.000
No Vent	0.000
No Vent	0.000
DW Vent	0.000
No Vent	0.000
No Vent	0.000

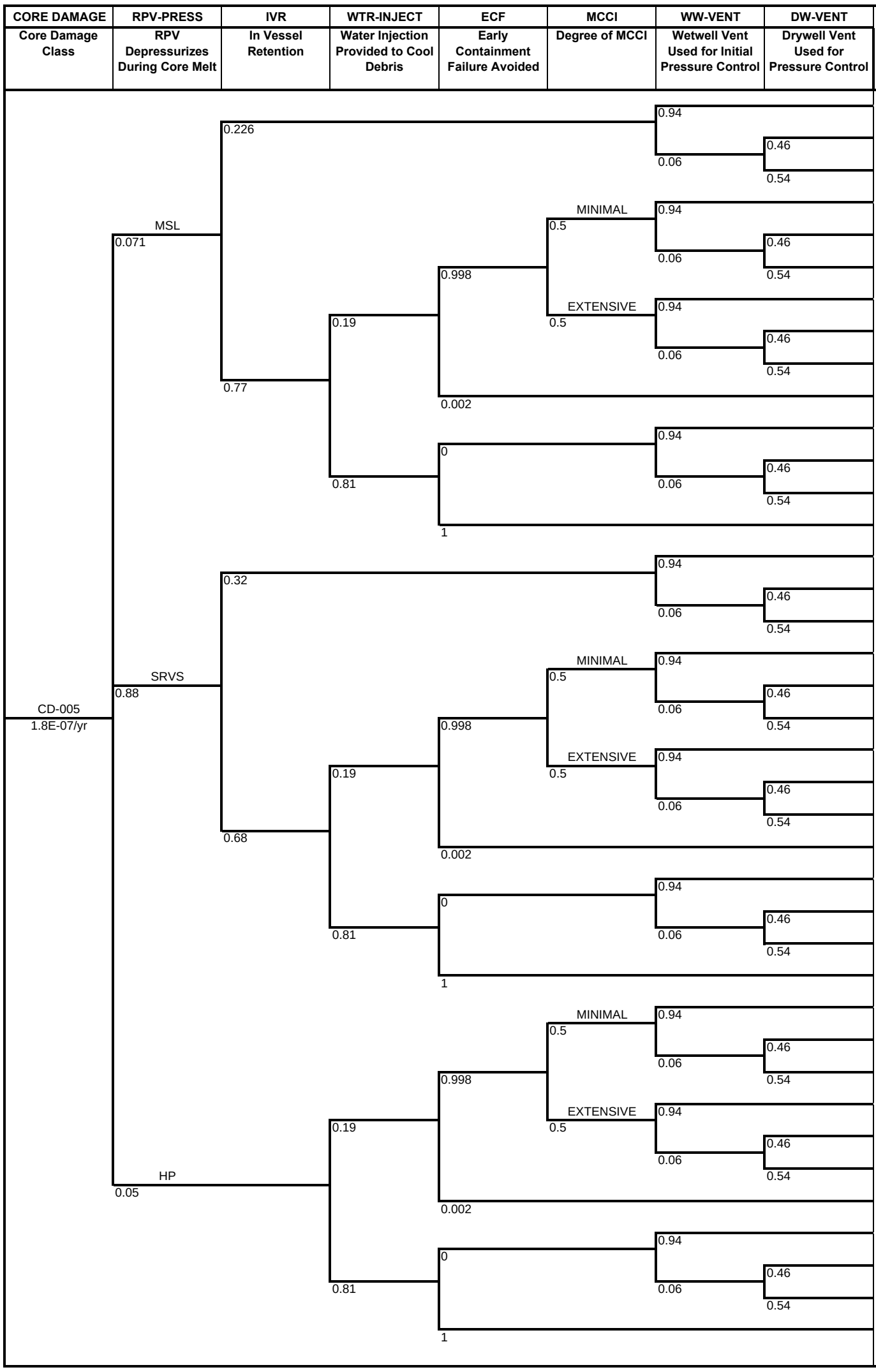
Summary	
No Vent	0.000
WW Vent	1.000
DW Vent	0.000

WW Fails	0.000	
DW Fails Given WW F	1.00	Assume operators not taking actions to vent
No Vent		

APET-Base Case

BWR MARK I ACCIDENT PROGRESSION EVENT TREE FOR CD-005

(RCIC Lost on ED, FLEX Fails, Cont. Re-Isolated)



CORE DAMAGE	RPV-PRESS	IVR	WTR-INJECT	ECF	MCCI	WW-VENT	DW-VENT	Release Category	Frequency (/yr)	Name
Core Damage Class	RPV Depressurizes During Core Melt	In Vessel Retention	Water Injection Provided to Cool Debris	Early Containment Failure Avoided	Degree of MCCI	Wetwell Vent Used for Initial Pressure Control	Drywell Vent Used for Pressure Control			
								MSL-IVR-WW	2.6E-09/yr	APET-001
								MSL-IVR-DW	8.0E-11/yr	APET-002
								MSL-IVR-OP	9.2E-11/yr	APET-003
								MSL-MIN-WW	8.6E-10/yr	APET-004
								MSL-MIN-DW	2.6E-11/yr	APET-005
								MSL-MIN-OP	3.0E-11/yr	APET-006
								MSL-EXT-WW	8.6E-10/yr	APET-007
								MSL-EXT-DW	2.6E-11/yr	APET-008
								MSL-EXT-OP	3.0E-11/yr	APET-009
								MSL-LMT	3.7E-12/yr	APET-010
								MSL-DRY-WW	0.0E+00/yr	APET-011
								MSL-DRY-DW	0.0E+00/yr	APET-012
								MSL-DRY-OP	0.0E+00/yr	APET-013
								MSL-DRY-LMT	7.8E-09/yr	APET-014
								SRV-IVR-WW	4.5E-08/yr	APET-015
								SRV-IVR-DW	1.4E-09/yr	APET-016
								SRV-IVR-OP	1.6E-09/yr	APET-017
								SRV-MIN-WW	9.3E-09/yr	APET-018
								SRV-MIN-DW	2.8E-10/yr	APET-019
								SRV-MIN-OP	3.3E-10/yr	APET-020
								SRV-EXT-WW	9.3E-09/yr	APET-021
								SRV-EXT-DW	2.8E-10/yr	APET-022
								SRV-EXT-OP	3.3E-10/yr	APET-023
								SRV-LMT	4.0E-11/yr	APET-024
								SRV-DRY-WW	0.0E+00/yr	APET-025
								SRV-DRY-DW	0.0E+00/yr	APET-026
								SRV-DRY-OP	0.0E+00/yr	APET-027
								SRV-DRY-LMT	8.5E-08/yr	APET-028
								HP-MIN-WW	8.2E-10/yr	APET-029
								HP-MIN-DW	2.5E-11/yr	APET-030
								HP-MIN-OP	2.9E-11/yr	APET-031
								HP-EXT-WW	8.2E-10/yr	APET-032
								HP-EXT-DW	2.5E-11/yr	APET-033
								HP-EXT-OP	2.9E-11/yr	APET-034
								HP-LMT	3.5E-12/yr	APET-035
								HP-DRY-WW	0.0E+00/yr	APET-036
								HP-DRY-DW	0.0E+00/yr	APET-037
								HP-DRY-OP	0.0E+00/yr	APET-038
								HP-DRY-LMT	7.4E-09/yr	APET-039
								Total =	**1.8E-07/yr**	

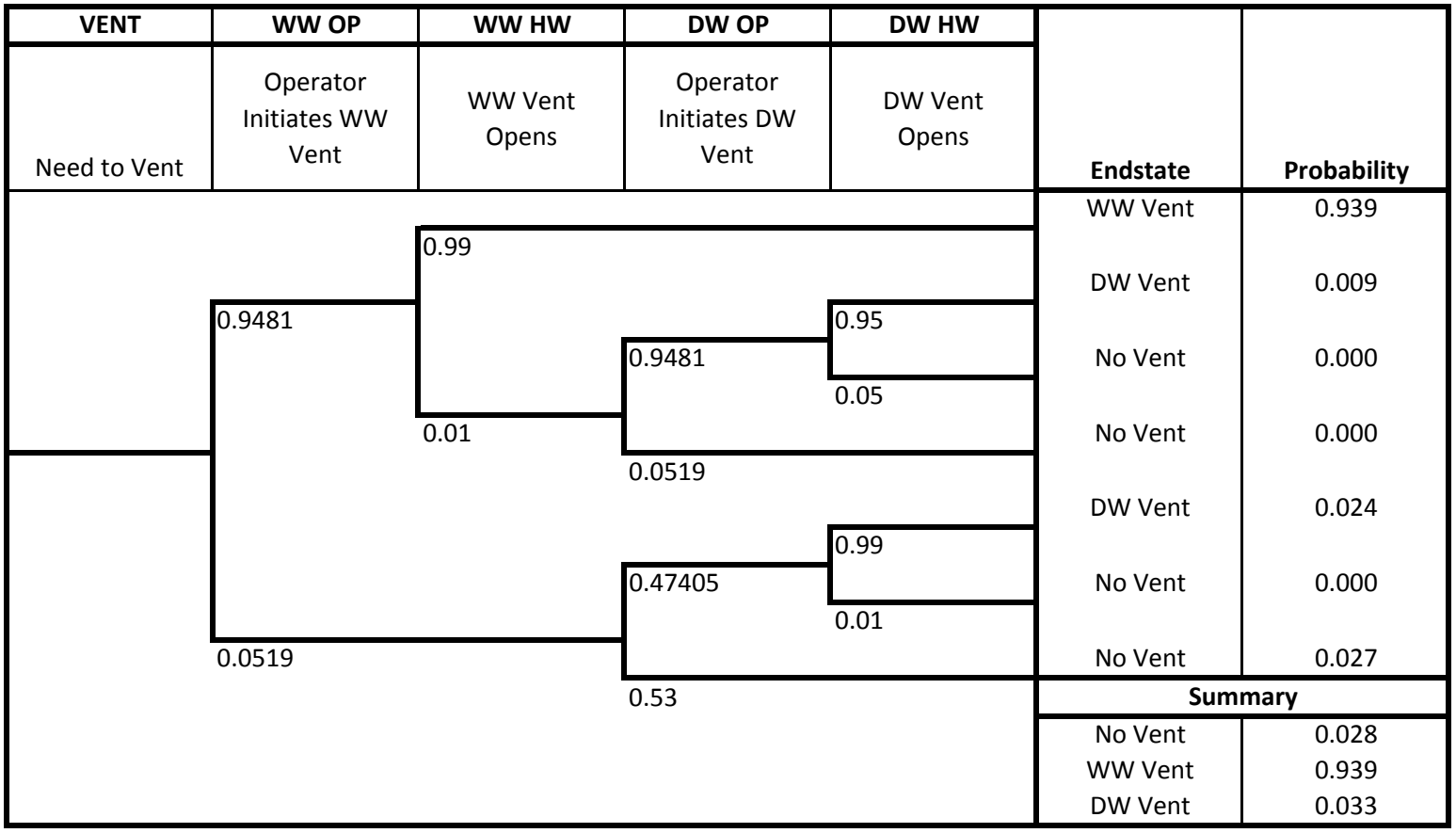
APET-Base Case

BWR MARK I ACCIDENT PROGRESSION EVENT TREE FOR CD-005

Top Event	Description	Condition(s)	Probability	Inputs to the Assumed Failure Probability
CORE DAMAGE	Core Damage Class	CD-005	1.75E-07	RCIC Lost on ED, FLEX Fails, Cont. Re-Isolated
RPV-PRESS	RPV Depressurizes During Core Melt	All	5.25E-01	Operator fails to depressurize RPV prior to vessel being compromised. High dependence on fraction of CD-005 with operator error. HEP from SPAR-H worksheet for fraction with FLEX equipment failures.
			0.15	HP RPV depressurizes via MSL
			0.85	HP RPV depressurizes via SRV seizure
			0.1	MSL & SRV Seizure do not occur
IVR	In Vessel Retention	All	5.49E-01	FLEX alignment for RPV injection would have occurred early in the scenario. Action only requires turning on the pump. High dependence assumed since CD-005 is all human failures.
		MSL Occurs	0.5	Core damage Not Arrested with water available
		SRV Depress Occurs	0.3	Core damage Not Arrested with water available
WTR-INJECT	Water Injection Provided to Cool Debris	All	8.00E-01	Fraction of IVR without water (needs development)
			0.05	Equipment failures (need basis)
ECF	Early Containment Failure Avoided	WTR-INJECT Fails	1	LMT without water
		WTR-INJECT Success	0.001	HPME w/ or w/o water
			0.001	LMT w/water
MCCI	Degree of MCCI	All	0.5	Extensive MCCI
WW-VENT	Wetwell Vent Used for Initial Pressure Control	All	5.2E-02	Operator fails to open WW vent
			0.01	Hardware failures (need basis)
DW-VENT	Drywell Vent Used for Pressure Control	All	0.53	Operator fails to open WW vent given failure to open WW (high dependence)
			5.2E-02	Operator failure given WW hardware failure
			0.05	DW hardware given WW hardware failure (need basis)
			0.01	DW failure (independent) - (need basis)

APET-Base Case

BWR MARK I WW/DW VENTING EVENT TREE FOR CD-005



Endstate	Probability
WW Vent	0.939
DW Vent	0.009
No Vent	0.000
No Vent	0.000
DW Vent	0.024
No Vent	0.000
No Vent	0.027

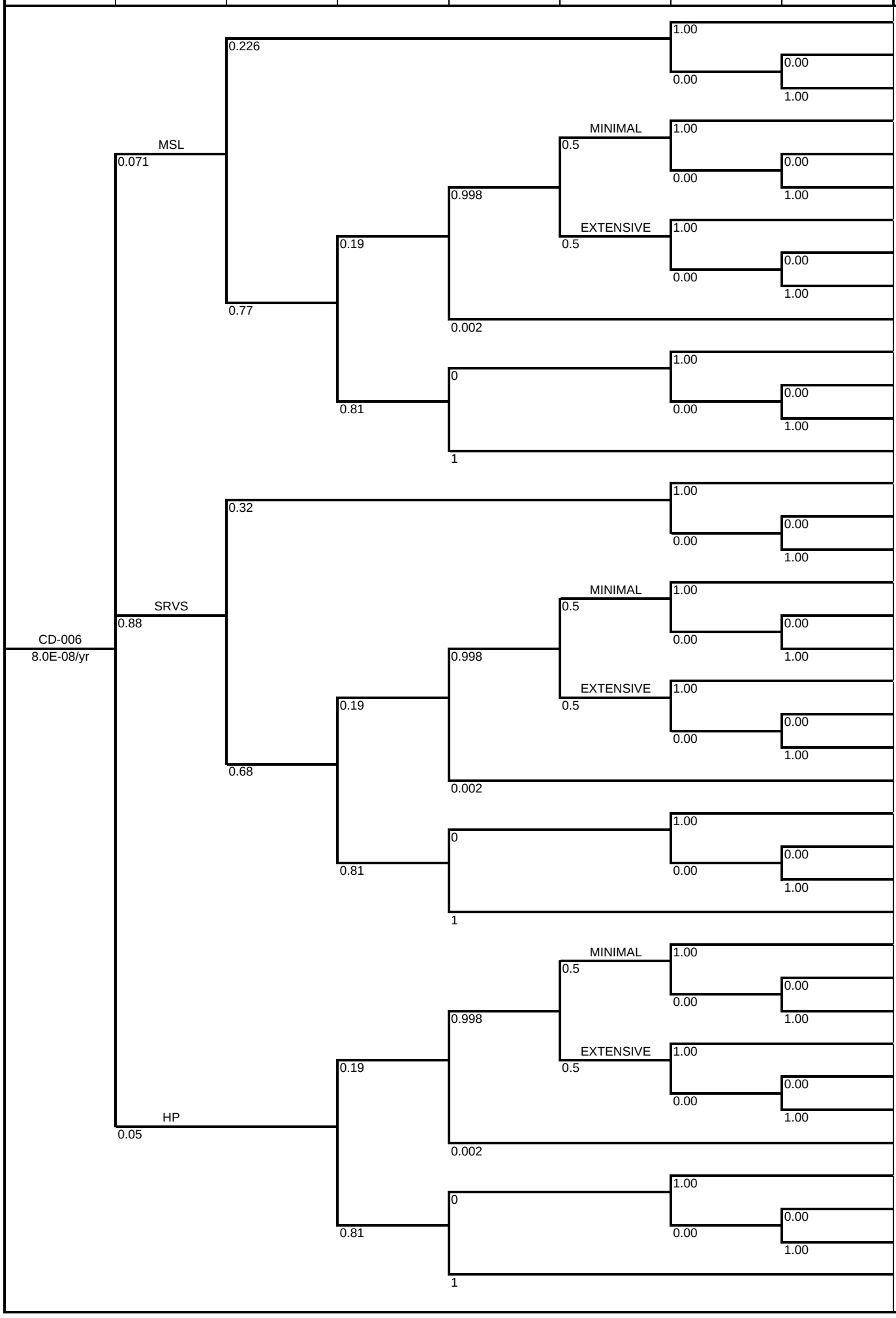
Summary	
No Vent	0.028
WW Vent	0.939
DW Vent	0.033

WW Fails	0.061
DW Fails Given WW F	0.54
No Vent	

APET-Base Case

BWR MARK I ACCIDENT PROGRESSION EVENT TREE FOR CD-006

(RCIC Lost on ED, FLEX Fails, WW Vent Not Re-Isolated)



CORE DAMAGE	RPV-PRESS	IVR	WTR-INJECT	ECF	MCCI	WW-VENT	DW-VENT			
Core Damage Class	RPV Depressurizes During Core Melt	In Vessel Retention	Water Injection Provided to Cool Debris	Early Containment Failure Avoided	Degree of MCCI	Wetwell Vent Used for Initial Pressure Control	Drywell Vent Used for Pressure Control	Release Category	Frequency (/yr)	Name
								MSL-IVR-WW	1.3E-09/yr	APET-001
								MSL-IVR-DW	0.0E+00/yr	APET-002
								MSL-IVR-OP	0.0E+00/yr	APET-003
								MSL-MIN-WW	4.2E-10/yr	APET-004
								MSL-MIN-DW	0.0E+00/yr	APET-005
								MSL-MIN-OP	0.0E+00/yr	APET-006
								MSL-EXT-WW	4.2E-10/yr	APET-007
								MSL-EXT-DW	0.0E+00/yr	APET-008
								MSL-EXT-OP	0.0E+00/yr	APET-009
								MSL-LMT	1.7E-12/yr	APET-010
								MSL-DRY-WW	0.0E+00/yr	APET-011
								MSL-DRY-DW	0.0E+00/yr	APET-012
								MSL-DRY-OP	0.0E+00/yr	APET-013
								MSL-DRY-LMT	3.6E-09/yr	APET-014
								SRV-IVR-WW	2.2E-08/yr	APET-015
								SRV-IVR-DW	0.0E+00/yr	APET-016
								SRV-IVR-OP	0.0E+00/yr	APET-017
								SRV-MIN-WW	4.6E-09/yr	APET-018
								SRV-MIN-DW	0.0E+00/yr	APET-019
								SRV-MIN-OP	0.0E+00/yr	APET-020
								SRV-EXT-WW	4.6E-09/yr	APET-021
								SRV-EXT-DW	0.0E+00/yr	APET-022
								SRV-EXT-OP	0.0E+00/yr	APET-023
								SRV-LMT	1.8E-11/yr	APET-024
								SRV-DRY-WW	0.0E+00/yr	APET-025
								SRV-DRY-DW	0.0E+00/yr	APET-026
								SRV-DRY-OP	0.0E+00/yr	APET-027
								SRV-DRY-LMT	3.9E-08/yr	APET-028
								HP-MIN-WW	4.0E-10/yr	APET-029
								HP-MIN-DW	0.0E+00/yr	APET-030
								HP-MIN-OP	0.0E+00/yr	APET-031
								HP-EXT-WW	4.0E-10/yr	APET-032
								HP-EXT-DW	0.0E+00/yr	APET-033
								HP-EXT-OP	0.0E+00/yr	APET-034
								HP-LMT	1.6E-12/yr	APET-035
								HP-DRY-WW	0.0E+00/yr	APET-036
								HP-DRY-DW	0.0E+00/yr	APET-037
								HP-DRY-OP	0.0E+00/yr	APET-038
								HP-DRY-LMT	3.4E-09/yr	APET-039
								Total =	**8.0E-08/yr**	

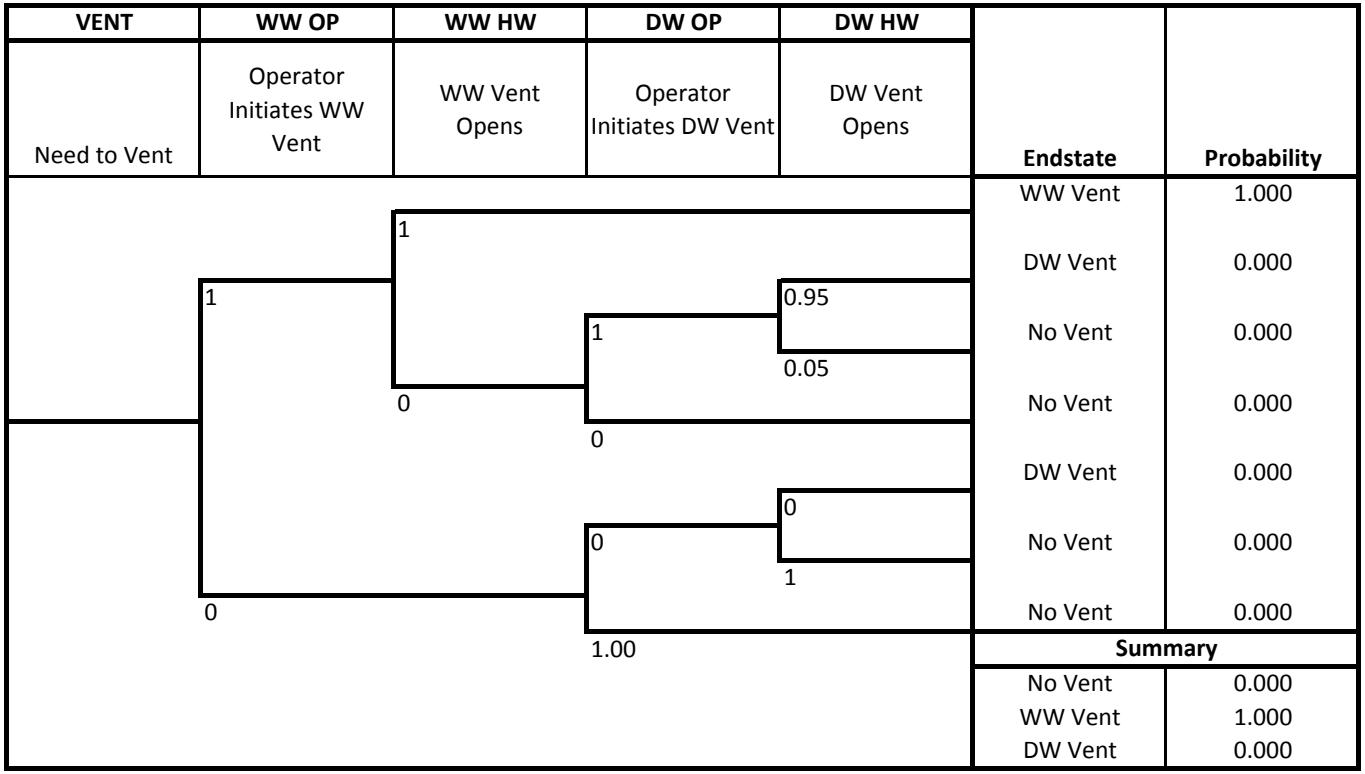
APET-Base Case

BWR MARK I ACCIDENT PROGRESSION EVENT TREE FOR CD-006

Top Event	Description	Condition(s)	Probability	Inputs to the Assumed Failure Probability
CORE DAMAGE	Core Damage Class	CD-006	8.02E-08	RCIC Lost on ED, FLEX Fails, WW Vent Not Re-Isolated
RPV-PRESS	RPV Depressurizes During Core Melt	All	5.25E-01	Operator fails to depressurize RPV prior to vessel being compromised. High dependence on fraction of CD-005 with operator error. HEP from SPAR-H worksheet for fraction with FLEX equipment failures.
			0.15	HP RPV depressurizes via MSL
			0.85	HP RPV depressurizes via SRV seizure
			0.1	MSL & SRV Seizure do not occur
IVR	In Vessel Retention	All	5.49E-01	FLEX alignment for RPV injection would have occurred early in the scenario. Action only requires turning on the pump. High dependence assumed since CD-005 is all human failures.
		MSL Occurs	0.5	Core damage Not Arrested with water available
		SRV Depress Occurs	0.3	Core damage Not Arrested with water available
WTR-INJECT	Water Injection Provided to Cool Debris	All	8.00E-01	Fraction of IVR without water (needs development)
			0.05	Equipment failures (need basis)
ECF	Early Containment Failure Avoided	WTR-INJECT Fails	1	LMT without water
		WTR-INJECT Success	0.001	HPME w/ or w/o water
			0.001	LMT w/water
MCCI	Degree of MCCI	All	0.5	Extensive MCCI
WW-VENT	Wetwell Vent Used for Initial Pressure Control	All	0.0E+00	Vent left open. No operator action required
			0	Hardware failures (need basis)
DW-VENT	Drywell Vent Used for Pressure Control	All	1.00	Operator fails to open WW vent given failure to open WW (high dependence)
			0.0E+00	Operator failure given WW hardware failure
			1	DW hardware given WW hardware failure (need basis)
			1	DW failure (independent) - (need basis)

APET-Base Case

BWR MARK I WW/DW VENTING EVENT TREE FOR CD-006



Endstate	Probability
WW Vent	1.000
DW Vent	0.000
No Vent	0.000
No Vent	0.000
DW Vent	0.000
No Vent	0.000
No Vent	0.000

Summary

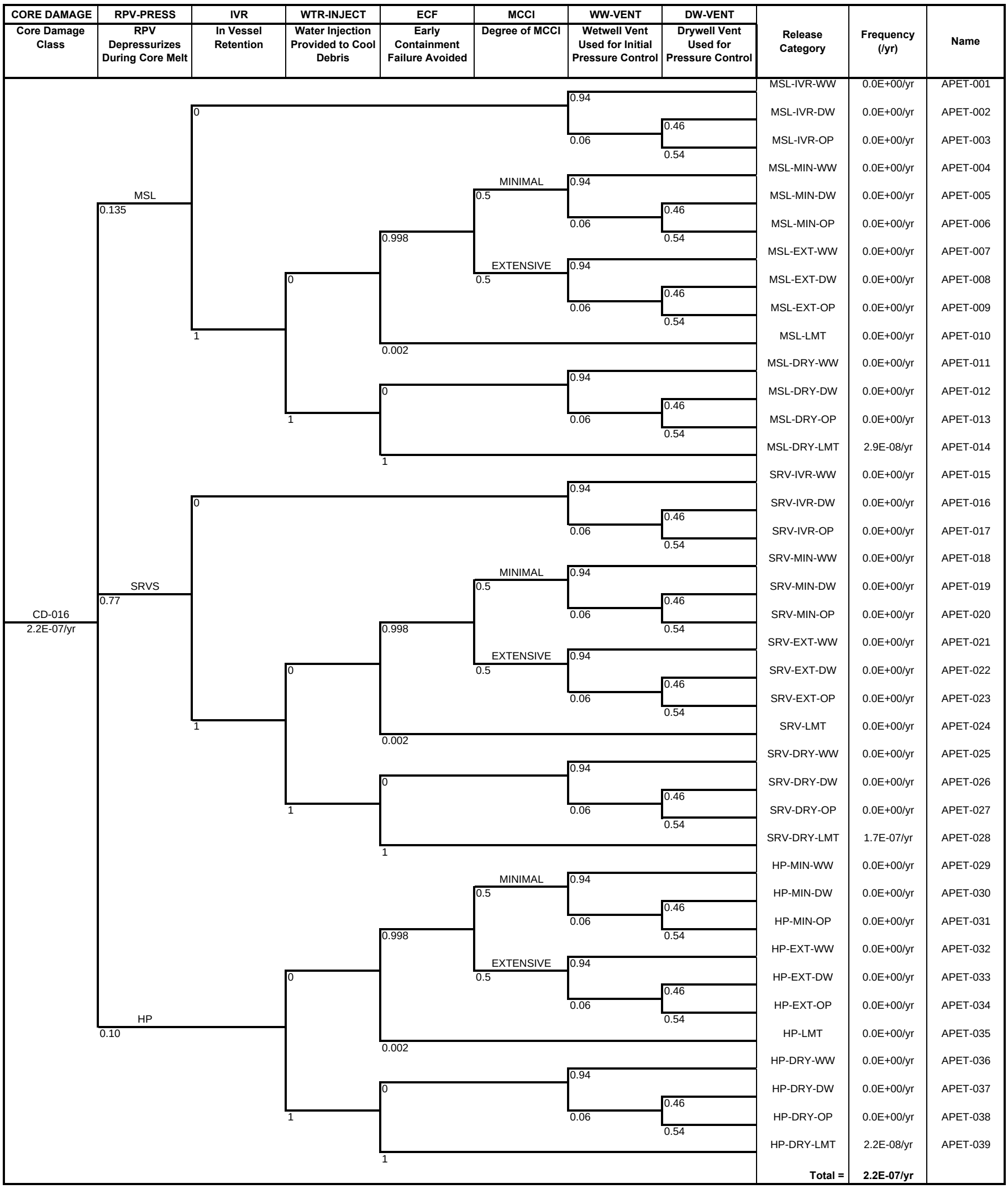
No Vent	0.000
WW Vent	1.000
DW Vent	0.000

WW Fails	0.000	
DW Fails Given WW F	1.00	Assume operators not taking actions to vent
No Vent		

APET-Base Case

BWR MARK I ACCIDENT PROGRESSION EVENT TREE FOR CD-016

(RCIC Succeeds Early (0-6 hrs), FLEX Succeeds, No Venting, ED)



CORE DAMAGE	RPV-PRESS	IVR	WTR-INJECT	ECF	MCCI	WW-VENT	DW-VENT	Release Category	Frequency (/yr)	Name
Core Damage Class	RPV Depressurizes During Core Melt	In Vessel Retention	Water Injection Provided to Cool Debris	Early Containment Failure Avoided	Degree of MCCI	Wetwell Vent Used for Initial Pressure Control	Drywell Vent Used for Pressure Control			
								MSL-IVR-WW	0.0E+00/yr	APET-001
								MSL-IVR-DW	0.0E+00/yr	APET-002
								MSL-IVR-OP	0.0E+00/yr	APET-003
								MSL-MIN-WW	0.0E+00/yr	APET-004
								MSL-MIN-DW	0.0E+00/yr	APET-005
								MSL-MIN-OP	0.0E+00/yr	APET-006
								MSL-EXT-WW	0.0E+00/yr	APET-007
								MSL-EXT-DW	0.0E+00/yr	APET-008
								MSL-EXT-OP	0.0E+00/yr	APET-009
								MSL-LMT	0.0E+00/yr	APET-010
								MSL-DRY-WW	0.0E+00/yr	APET-011
								MSL-DRY-DW	0.0E+00/yr	APET-012
								MSL-DRY-OP	0.0E+00/yr	APET-013
								MSL-DRY-LMT	2.9E-08/yr	APET-014
								SRV-IVR-WW	0.0E+00/yr	APET-015
								SRV-IVR-DW	0.0E+00/yr	APET-016
								SRV-IVR-OP	0.0E+00/yr	APET-017
								SRV-MIN-WW	0.0E+00/yr	APET-018
								SRV-MIN-DW	0.0E+00/yr	APET-019
								SRV-MIN-OP	0.0E+00/yr	APET-020
								SRV-EXT-WW	0.0E+00/yr	APET-021
								SRV-EXT-DW	0.0E+00/yr	APET-022
								SRV-EXT-OP	0.0E+00/yr	APET-023
								SRV-LMT	0.0E+00/yr	APET-024
								SRV-DRY-WW	0.0E+00/yr	APET-025
								SRV-DRY-DW	0.0E+00/yr	APET-026
								SRV-DRY-OP	0.0E+00/yr	APET-027
								SRV-DRY-LMT	1.7E-07/yr	APET-028
								HP-MIN-WW	0.0E+00/yr	APET-029
								HP-MIN-DW	0.0E+00/yr	APET-030
								HP-MIN-OP	0.0E+00/yr	APET-031
								HP-EXT-WW	0.0E+00/yr	APET-032
								HP-EXT-DW	0.0E+00/yr	APET-033
								HP-EXT-OP	0.0E+00/yr	APET-034
								HP-LMT	0.0E+00/yr	APET-035
								HP-DRY-WW	0.0E+00/yr	APET-036
								HP-DRY-DW	0.0E+00/yr	APET-037
								HP-DRY-OP	0.0E+00/yr	APET-038
								HP-DRY-LMT	2.2E-08/yr	APET-039
								Total =	**2.2E-07/yr**	

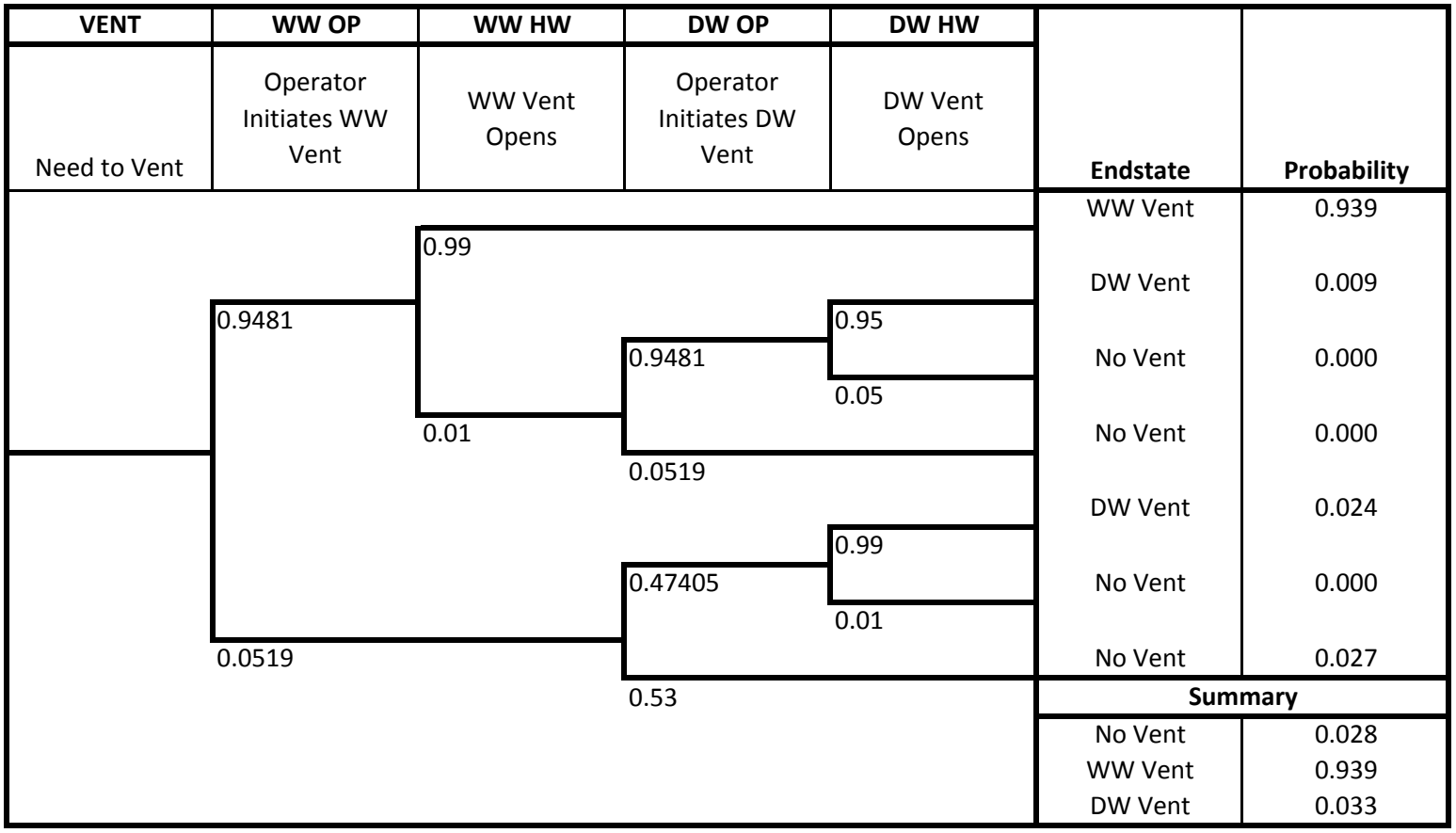
APET-Base Case

BWR MARK I ACCIDENT PROGRESSION EVENT TREE FOR CD-016

Top Event	Description	Condition(s)	Probability	Inputs to the Assumed Failure Probability
CORE DAMAGE	Core Damage Class	CD-016	2.16E-07	RCIC Succeeds Early (0-6 hrs), FLEX Succeeds, No Venting, ED
RPV-PRESS	RPV Depressurizes During Core Melt	All	1	Operator fails to depressurize RPV prior to vessel being compromised
			0.15	HP RPV depressurizes via MSL
			0.85	HP RPV depressurizes via SRV seizure
			0.1	MSL & SRV Seizure do not occur
IVR	In Vessel Retention	All	1	RPV Injection Unavailable in a Timely Manner
		MSL Occurs	0.5	Core damage Not Arrested with water available
		SRV Depress Occurs	0.3	Core damage Not Arrested with water available
WTR-INJECT	Water Injection Provided to Cool Debris	All	1	Human action
				Equipment failures
ECF	Early Containment Failure Avoided	WTR-INJECT Fails	1	LMT without water
		WTR-INJECT Success	0.001	HPME w/ or w/o water
			0.001	LMT w/water
MCCI	Degree of MCCI	All	0.5	Extensive MCCI
WW-VENT	Wetwell Vent Used for Initial Pressure Control	All	5.2E-02	Operator fails to open WW vent
			0.01	Hardware failures (need basis)
DW-VENT	Drywell Vent Used for Pressure Control	All	0.53	Operator fails to open WW vent given failure to open WW (high dependence)
			5.2E-02	Operator failure given WW hardware failure
			0.05	DW hardware given WW hardware failure (need basis)
			0.01	DW failure (independent) - (need basis)

APET-Base Case

BWR MARK I WW/DW VENTING EVENT TREE FOR CD-016



Endstate	Probability
WW Vent	0.939
DW Vent	0.009
No Vent	0.000
No Vent	0.000
DW Vent	0.024
No Vent	0.000
No Vent	0.027

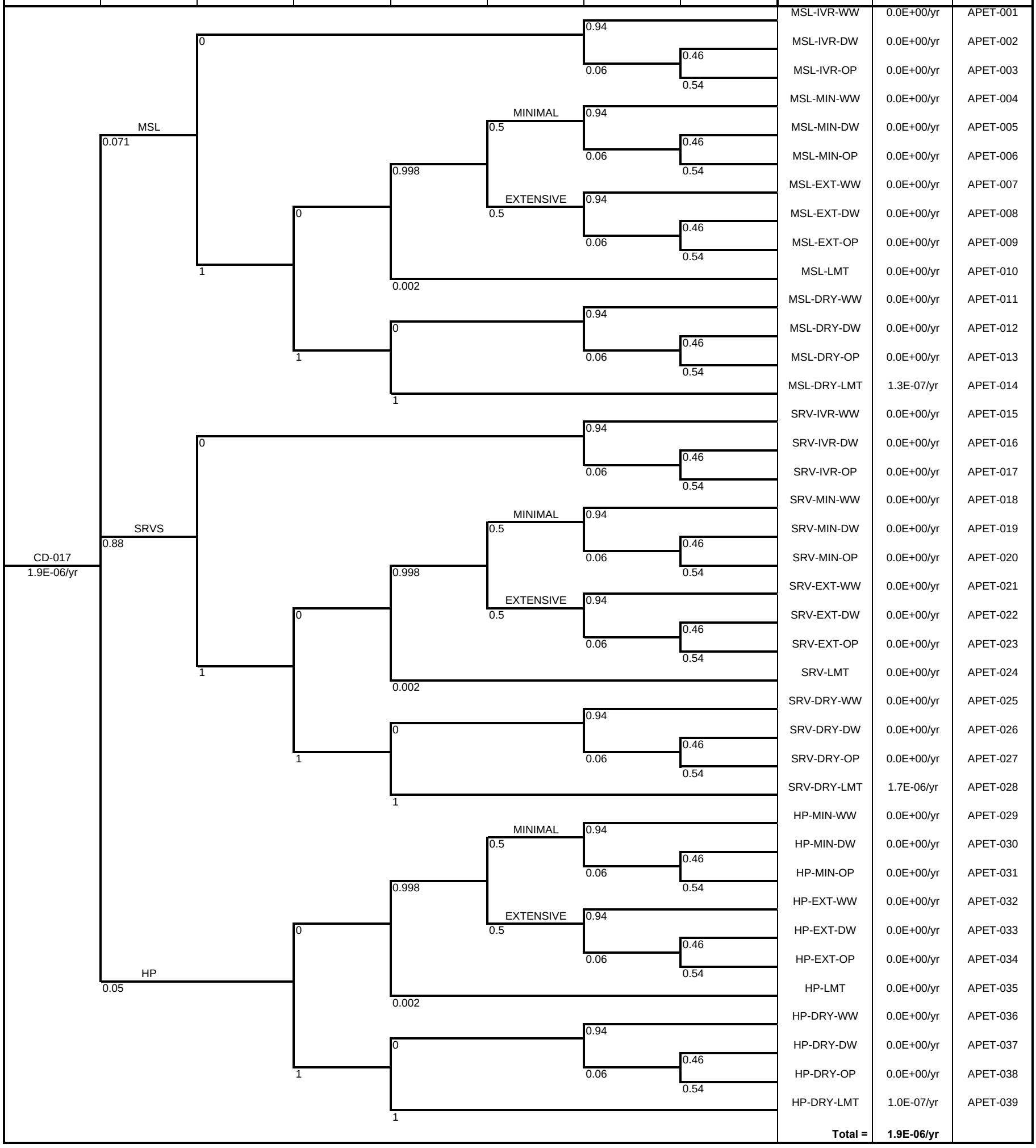
Summary	
No Vent	0.028
WW Vent	0.939
DW Vent	0.033

WW Fails	0.061
DW Fails Given WW F	0.54
No Vent	

APET-Base Case

BWR MARK I ACCIDENT PROGRESSION EVENT TREE FOR CD-017

(Operators Fail to Deploy FLEX)



CORE DAMAGE	RPV-PRESS	IVR	WTR-INJECT	ECF	MCCI	WW-VENT	DW-VENT	Release Category	Frequency (/yr)	Name
Core Damage Class	RPV Depressurizes During Core Melt	In Vessel Retention	Water Injection Provided to Cool Debris	Early Containment Failure Avoided	Degree of MCCI	Wetwell Vent Used for Initial Pressure Control	Drywell Vent Used for Pressure Control			
								MSL-IVR-WW	0.0E+00/yr	APET-001
								MSL-IVR-DW	0.0E+00/yr	APET-002
								MSL-IVR-OP	0.0E+00/yr	APET-003
								MSL-MIN-WW	0.0E+00/yr	APET-004
								MSL-MIN-DW	0.0E+00/yr	APET-005
								MSL-MIN-OP	0.0E+00/yr	APET-006
								MSL-EXT-WW	0.0E+00/yr	APET-007
								MSL-EXT-DW	0.0E+00/yr	APET-008
								MSL-EXT-OP	0.0E+00/yr	APET-009
								MSL-LMT	0.0E+00/yr	APET-010
								MSL-DRY-WW	0.0E+00/yr	APET-011
								MSL-DRY-DW	0.0E+00/yr	APET-012
								MSL-DRY-OP	0.0E+00/yr	APET-013
								MSL-DRY-LMT	1.3E-07/yr	APET-014
								SRV-IVR-WW	0.0E+00/yr	APET-015
								SRV-IVR-DW	0.0E+00/yr	APET-016
								SRV-IVR-OP	0.0E+00/yr	APET-017
								SRV-MIN-WW	0.0E+00/yr	APET-018
								SRV-MIN-DW	0.0E+00/yr	APET-019
								SRV-MIN-OP	0.0E+00/yr	APET-020
								SRV-EXT-WW	0.0E+00/yr	APET-021
								SRV-EXT-DW	0.0E+00/yr	APET-022
								SRV-EXT-OP	0.0E+00/yr	APET-023
								SRV-LMT	0.0E+00/yr	APET-024
								SRV-DRY-WW	0.0E+00/yr	APET-025
								SRV-DRY-DW	0.0E+00/yr	APET-026
								SRV-DRY-OP	0.0E+00/yr	APET-027
								SRV-DRY-LMT	1.7E-06/yr	APET-028
								HP-MIN-WW	0.0E+00/yr	APET-029
								HP-MIN-DW	0.0E+00/yr	APET-030
								HP-MIN-OP	0.0E+00/yr	APET-031
								HP-EXT-WW	0.0E+00/yr	APET-032
								HP-EXT-DW	0.0E+00/yr	APET-033
								HP-EXT-OP	0.0E+00/yr	APET-034
								HP-LMT	0.0E+00/yr	APET-035
								HP-DRY-WW	0.0E+00/yr	APET-036
								HP-DRY-DW	0.0E+00/yr	APET-037
								HP-DRY-OP	0.0E+00/yr	APET-038
								HP-DRY-LMT	1.0E-07/yr	APET-039
								Total =	**1.9E-06/yr**	

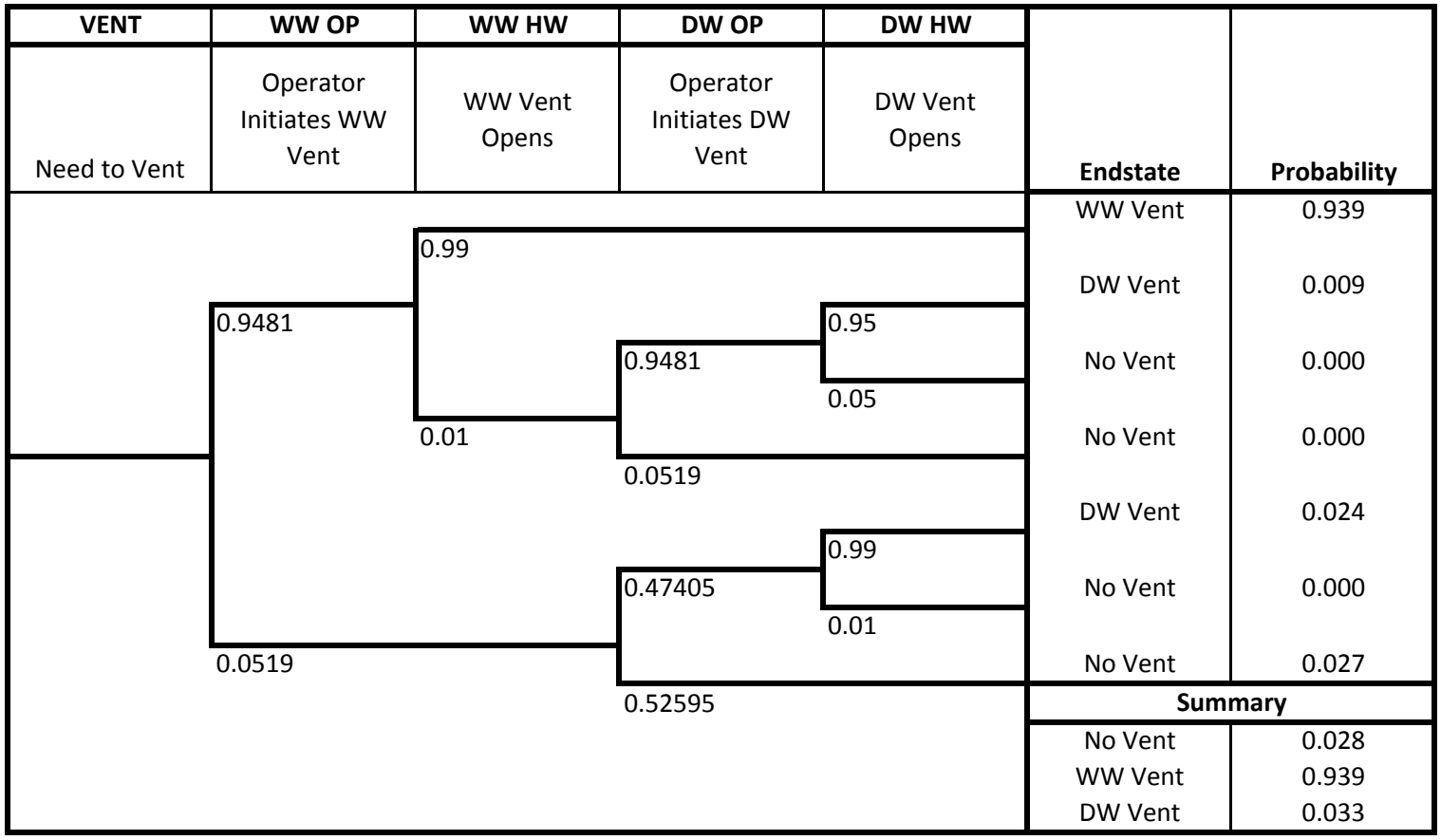
APET-Base Case

BWR MARK I ACCIDENT PROGRESSION EVENT TREE FOR CD-017

Top Event	Description	Condition(s)	Probability	Inputs to the Assumed Failure Probability
CORE DAMAGE	Core Damage Class	CD-017	1.90E-06	Operators Fail to Deploy FLEX
RPV-PRESS	RPV Depressurizes During Core Melt	All	5.25E-01	Operator fails to depressurize RPV prior to vessel being compromised. High dependence on fraction of CD-017 with operator error. HEP from SPAR-H worksheet for fraction with FLEX equipment failures.
			0.15	HP RPV depressurizes via MSL
			0.85	HP RPV depressurizes via SRV seizure
			0.1	MSL & SRV Seizure do not occur
IVR	In Vessel Retention	All	1.00E+00	FLEX alignment for RPV injection precluded by core damage.
		MSL Occurs	0.5	Core damage Not Arrested with water available
		SRV Depress Occurs	0.3	Core damage Not Arrested with water available
WTR-INJECT	Water Injection Provided to Cool Debris	All	1.00E+00	Fraction of IVR without water (needs development)
			0.05	Equipment failures (need basis)
ECF	Early Containment Failure Avoided	WTR-INJECT Fails	1	LMT without water
		WTR-INJECT Success	0.001	HPME w/ or w/o water
			0.001	LMT w/water
MCCI	Degree of MCCI	All	0.5	Extensive MCCI
WW-VENT	Wetwell Vent Used for Initial Pressure Control	All	5.2E-02	Operator fails to open WW vent
			0.01	Hardware failures (need basis)
DW-VENT	Drywell Vent Used for Pressure Control	All	0.53	Operator fails to open WW vent given failure to open WW (high dependence)
			5.2E-02	Operator failure given WW hardware failure
			0.05	DW hardware given WW hardware failure (need basis)
			0.01	DW failure (independent) - (need basis)

APET-Base Case

BWR MARK I WW/DW VENTING EVENT TREE FOR CD-017



Endstate	Probability
WW Vent	0.939
DW Vent	0.009
No Vent	0.000
No Vent	0.000
DW Vent	0.024
No Vent	0.000
No Vent	0.027

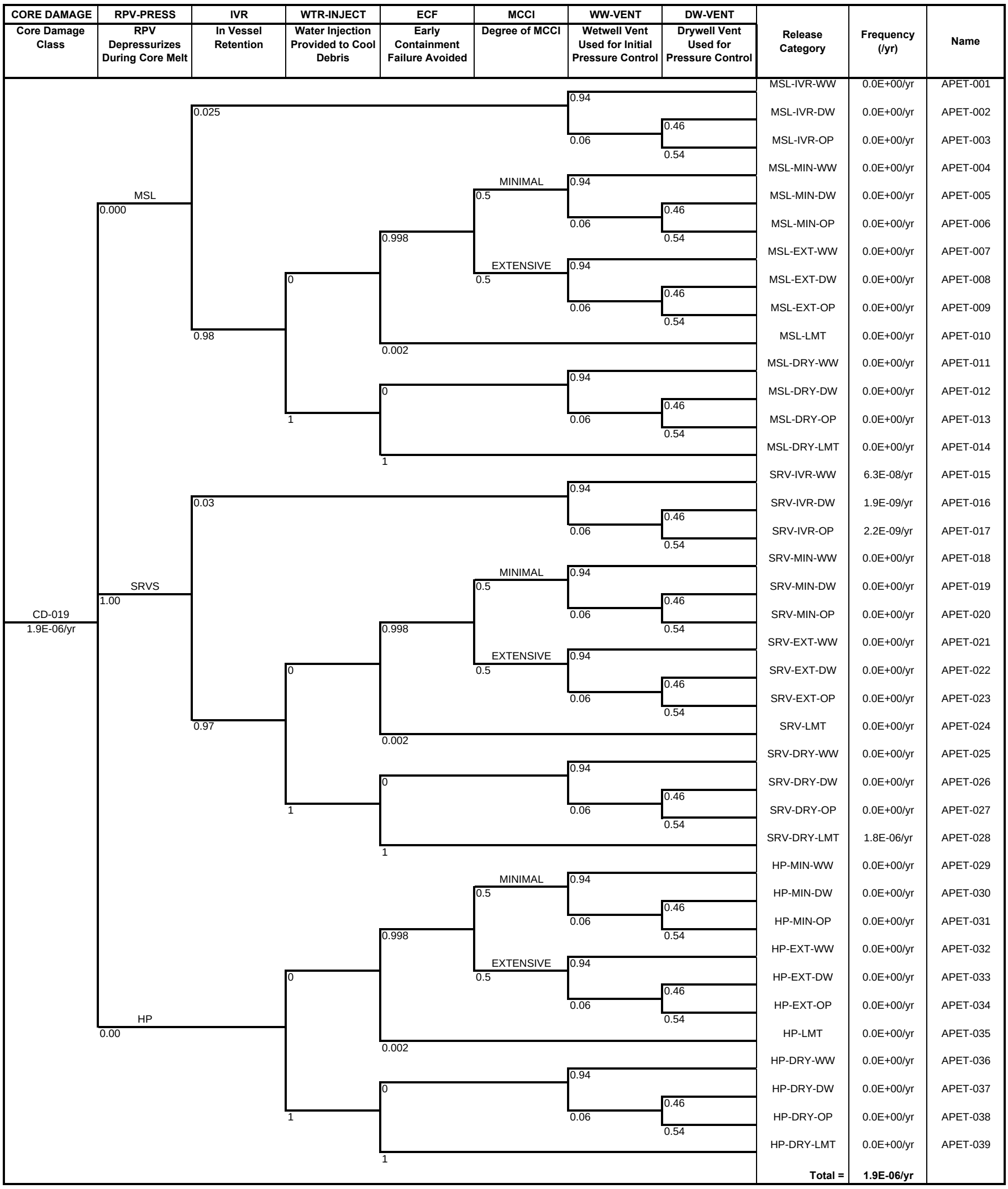
Summary	
No Vent	0.028
WW Vent	0.939
DW Vent	0.033

WW Fails	0.061
DW Fails Given WW F	0.54
No Vent	

APET-Base Case

BWR MARK I ACCIDENT PROGRESSION EVENT TREE FOR CD-019

(RCIC Fails before FLEX can be deployed)



CORE DAMAGE	RPV-PRESS	IVR	WTR-INJECT	ECF	MCCI	WW-VENT	DW-VENT	Release Category	Frequency (/yr)	Name
Core Damage Class	RPV Depressurizes During Core Melt	In Vessel Retention	Water Injection Provided to Cool Debris	Early Containment Failure Avoided	Degree of MCCI	Wetwell Vent Used for Initial Pressure Control	Drywell Vent Used for Pressure Control			
								MSL-IVR-WW	0.0E+00/yr	APET-001
								MSL-IVR-DW	0.0E+00/yr	APET-002
								MSL-IVR-OP	0.0E+00/yr	APET-003
								MSL-MIN-WW	0.0E+00/yr	APET-004
								MSL-MIN-DW	0.0E+00/yr	APET-005
								MSL-MIN-OP	0.0E+00/yr	APET-006
								MSL-EXT-WW	0.0E+00/yr	APET-007
								MSL-EXT-DW	0.0E+00/yr	APET-008
								MSL-EXT-OP	0.0E+00/yr	APET-009
								MSL-LMT	0.0E+00/yr	APET-010
								MSL-DRY-WW	0.0E+00/yr	APET-011
								MSL-DRY-DW	0.0E+00/yr	APET-012
								MSL-DRY-OP	0.0E+00/yr	APET-013
								MSL-DRY-LMT	0.0E+00/yr	APET-014
								SRV-IVR-WW	6.3E-08/yr	APET-015
								SRV-IVR-DW	1.9E-09/yr	APET-016
								SRV-IVR-OP	2.2E-09/yr	APET-017
								SRV-MIN-WW	0.0E+00/yr	APET-018
								SRV-MIN-DW	0.0E+00/yr	APET-019
								SRV-MIN-OP	0.0E+00/yr	APET-020
								SRV-EXT-WW	0.0E+00/yr	APET-021
								SRV-EXT-DW	0.0E+00/yr	APET-022
								SRV-EXT-OP	0.0E+00/yr	APET-023
								SRV-LMT	0.0E+00/yr	APET-024
								SRV-DRY-WW	0.0E+00/yr	APET-025
								SRV-DRY-DW	0.0E+00/yr	APET-026
								SRV-DRY-OP	0.0E+00/yr	APET-027
								SRV-DRY-LMT	1.8E-06/yr	APET-028
								HP-MIN-WW	0.0E+00/yr	APET-029
								HP-MIN-DW	0.0E+00/yr	APET-030
								HP-MIN-OP	0.0E+00/yr	APET-031
								HP-EXT-WW	0.0E+00/yr	APET-032
								HP-EXT-DW	0.0E+00/yr	APET-033
								HP-EXT-OP	0.0E+00/yr	APET-034
								HP-LMT	0.0E+00/yr	APET-035
								HP-DRY-WW	0.0E+00/yr	APET-036
								HP-DRY-DW	0.0E+00/yr	APET-037
								HP-DRY-OP	0.0E+00/yr	APET-038
								HP-DRY-LMT	0.0E+00/yr	APET-039
								Total =	**1.9E-06/yr**	

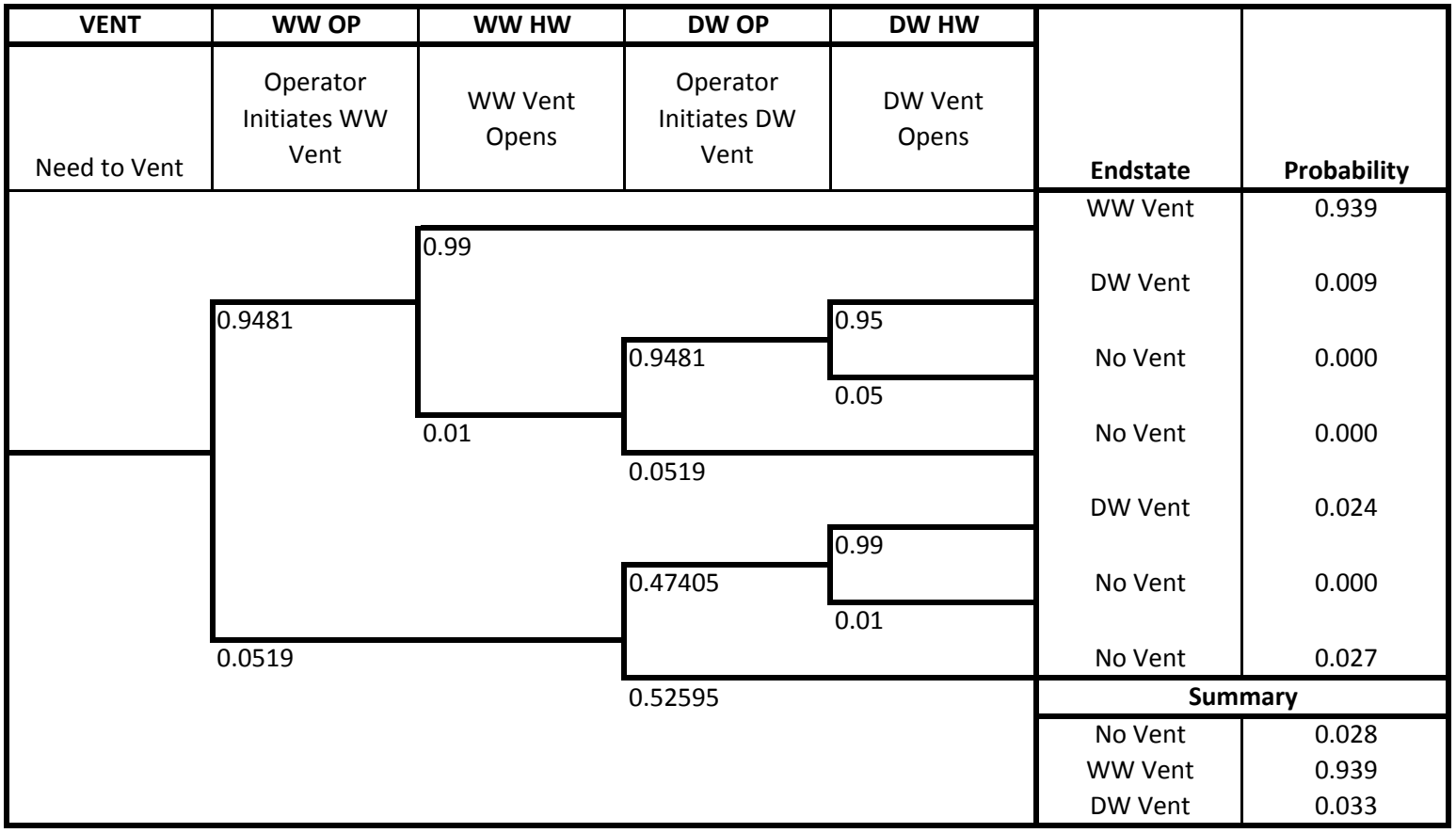
APET-Base Case

BWR MARK I ACCIDENT PROGRESSION EVENT TREE FOR CD-019

Top Event	Description	Condition(s)	Probability	Inputs to the Assumed Failure Probability
CORE DAMAGE	Core Damage Class	CD-019	1.91E-06	RCIC Fails before FLEX can be deployed
RPV-PRESS	RPV Depressurizes During Core Melt	All	0.00E+00	RPV already at low pressure.
			0.15	HP RPV depressurizes via MSL
			0.85	HP RPV depressurizes via SRV seizure
			0.1	MSL & SRV Seizure do not occur
IVR	In Vessel Retention	All	9.50E-01	FLEX alignment for RPV injection would be impeded by early onset of core damage. (need basis)
		MSL Occurs	0.5	Core damage Not Arrested with water available
		SRV Depress Occurs	0.3	Core damage Not Arrested with water available
WTR-INJECT	Water Injection Provided to Cool Debris	All	1.00E+00	Fraction of IVR without water
			0.05	Equipment failures (need basis)
ECF	Early Containment Failure Avoided	WTR-INJECT Fails	1	LMT without water
		WTR-INJECT Success	0.001	HPME w/ or w/o water
			0.001	LMT w/water
MCCI	Degree of MCCI	All	0.5	Extensive MCCI
WW-VENT	Wetwell Vent Used for Initial Pressure Control	All	5.2E-02	Operator fails to open WW vent
			0.01	Hardware failures (need basis)
DW-VENT	Drywell Vent Used for Pressure Control	All	0.53	Operator fails to open WW vent given failure to open WW (high dependence)
			5.2E-02	Operator failure given WW hardware failure
			0.05	DW hardware given WW hardware failure (need basis)
			0.01	DW failure (independent) - (need basis)

APET-Base Case

BWR MARK I WW/DW VENTING EVENT TREE FOR CD-019



Endstate	Probability
WW Vent	0.939
DW Vent	0.009
No Vent	0.000
No Vent	0.000
DW Vent	0.024
No Vent	0.000
No Vent	0.027

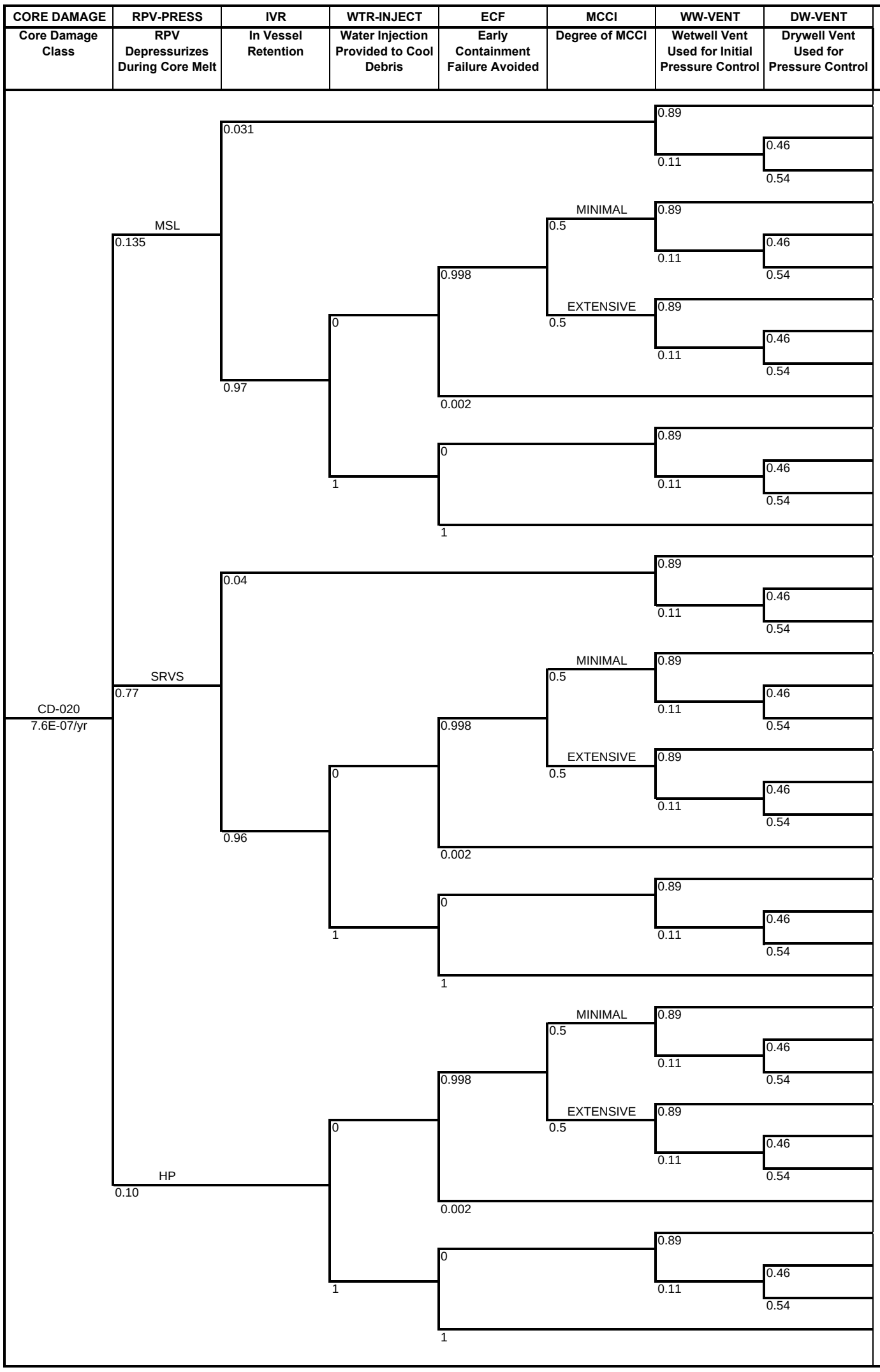
Summary	
No Vent	0.028
WW Vent	0.939
DW Vent	0.033

WW Fails	0.061
DW Fails Given WW F	0.54
No Vent	

APET-Base Case

BWR MARK I ACCIDENT PROGRESSION EVENT TREE FOR CD-020

(RCIC Hardware Failures, Operator fails to ED)



CORE DAMAGE	RPV-PRESS	IVR	WTR-INJECT	ECF	MCCI	WW-VENT	DW-VENT	Release Category	Frequency (/yr)	Name
Core Damage Class	RPV Depressurizes During Core Melt	In Vessel Retention	Water Injection Provided to Cool Debris	Early Containment Failure Avoided	Degree of MCCI	Wetwell Vent Used for Initial Pressure Control	Drywell Vent Used for Pressure Control			
								MSL-IVR-WW	2.9E-09/yr	APET-001
								MSL-IVR-DW	1.6E-10/yr	APET-002
								MSL-IVR-OP	1.9E-10/yr	APET-003
								MSL-MIN-WW	0.0E+00/yr	APET-004
								MSL-MIN-DW	0.0E+00/yr	APET-005
								MSL-MIN-OP	0.0E+00/yr	APET-006
								MSL-EXT-WW	0.0E+00/yr	APET-007
								MSL-EXT-DW	0.0E+00/yr	APET-008
								MSL-EXT-OP	0.0E+00/yr	APET-009
								MSL-LMT	0.0E+00/yr	APET-010
								MSL-DRY-WW	0.0E+00/yr	APET-011
								MSL-DRY-DW	0.0E+00/yr	APET-012
								MSL-DRY-OP	0.0E+00/yr	APET-013
								MSL-DRY-LMT	1.0E-07/yr	APET-014
								SRV-IVR-WW	2.3E-08/yr	APET-015
								SRV-IVR-DW	1.3E-09/yr	APET-016
								SRV-IVR-OP	1.5E-09/yr	APET-017
								SRV-MIN-WW	0.0E+00/yr	APET-018
								SRV-MIN-DW	0.0E+00/yr	APET-019
								SRV-MIN-OP	0.0E+00/yr	APET-020
								SRV-EXT-WW	0.0E+00/yr	APET-021
								SRV-EXT-DW	0.0E+00/yr	APET-022
								SRV-EXT-OP	0.0E+00/yr	APET-023
								SRV-LMT	0.0E+00/yr	APET-024
								SRV-DRY-WW	0.0E+00/yr	APET-025
								SRV-DRY-DW	0.0E+00/yr	APET-026
								SRV-DRY-OP	0.0E+00/yr	APET-027
								SRV-DRY-LMT	5.6E-07/yr	APET-028
								HP-MIN-WW	0.0E+00/yr	APET-029
								HP-MIN-DW	0.0E+00/yr	APET-030
								HP-MIN-OP	0.0E+00/yr	APET-031
								HP-EXT-WW	0.0E+00/yr	APET-032
								HP-EXT-DW	0.0E+00/yr	APET-033
								HP-EXT-OP	0.0E+00/yr	APET-034
								HP-LMT	0.0E+00/yr	APET-035
								HP-DRY-WW	0.0E+00/yr	APET-036
								HP-DRY-DW	0.0E+00/yr	APET-037
								HP-DRY-OP	0.0E+00/yr	APET-038
								HP-DRY-LMT	7.6E-08/yr	APET-039
								Total =	**7.6E-07/yr**	

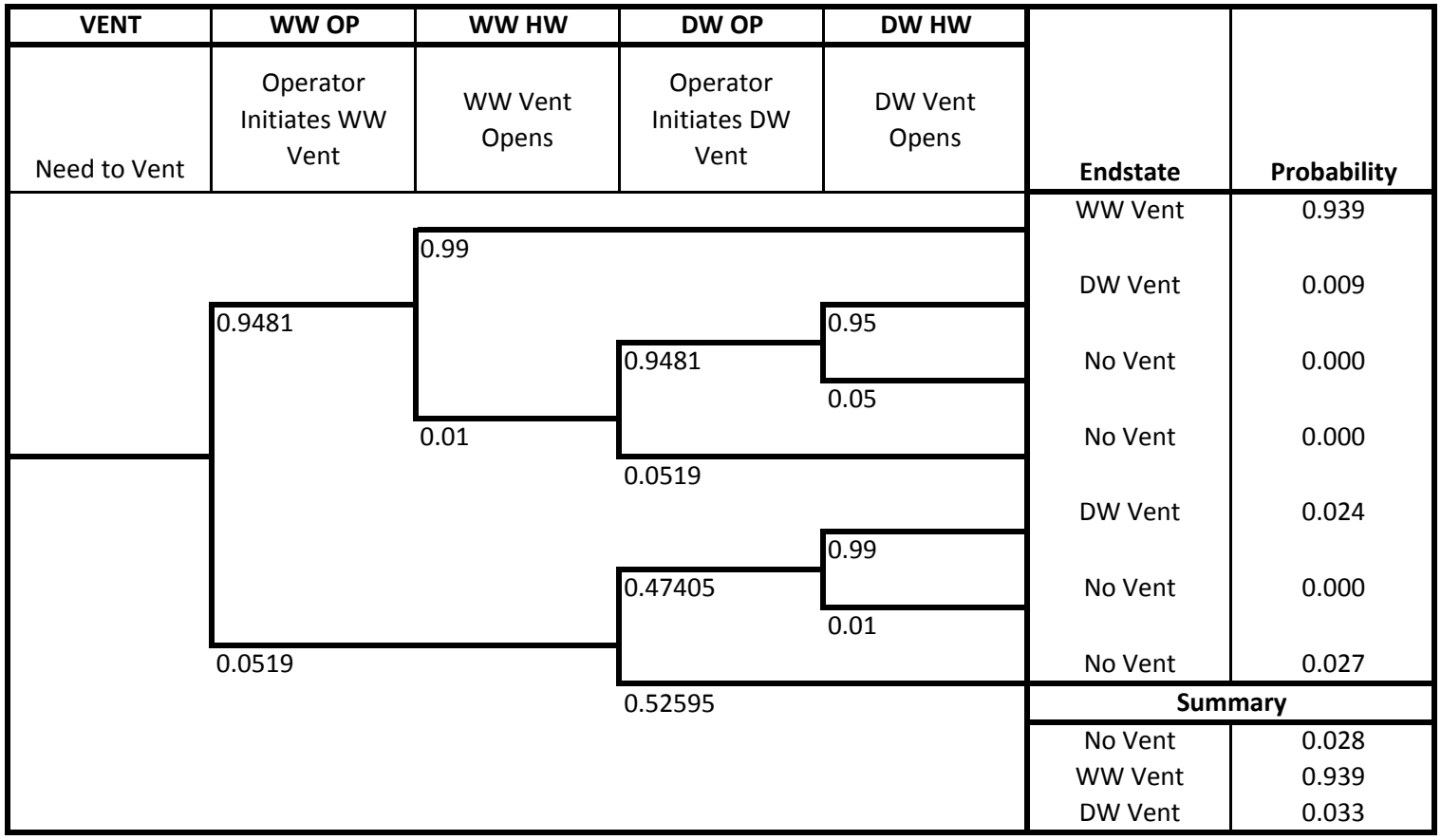
APET-Base Case

Bases for APET - CD-020

Top Event	Description	Condition(s)	Probability	Inputs to the Assumed Failure Probability
CORE DAMAGE	Core Damage Class	CD-020	7.61E-07	RCIC Hardware Failures, Operator fails to ED
RPV-PRESS	RPV Depressurizes During Core Melt	All	1	Assume complete dependence. Operator has already failed to depressurize RPV prior to core damage
			0.15	HP RPV depressurizes via MSL
			0.85	HP RPV depressurizes via SRV seizure
			0.1	MSL & SRV Seizure do not occur
IVR	In Vessel Retention	All	9.38E-01	RPV Injection Unavailable in a Timely Manner
		MSL Occurs	0.5	Core damage Not Arrested with water available
		SRV Depress Occurs	0.3	Core damage Not Arrested with water available
WTR-INJECT	Water Injection Provided to Cool Debris	All	1	Human action
			0.05	Equipment failures (need basis)
ECF	Early Containment Failure Avoided	WTR-INJECT Fails	1	LMT without water
		WTR-INJECT Success	0.001	HPME w/ or w/o water
			0.001	MLMT w/water
MCCI	Degree of MCCI	All	0.5	Extensive MCCI
WW-VENT	Wetwell Vent Used for Initial Pressure Control	All	0.1	Operator fails to open WW vent
			0.01	Hardware failures
DW-VENT	Drywell Vent Used for Pressure Control	All	0.55	Operator fails to open WW vent given failure to open WW (high dependence)
			0.1	Operator failure given WW hardware failure
			0.05	DW hardware given WW hardware failure
			0.01	DW failure (independent)

APET-Base Case

BWR MARK I WW/DW VENTING EVENT TREE FOR CD-020



Endstate	Probability
WW Vent	0.939
DW Vent	0.009
No Vent	0.000
No Vent	0.000
DW Vent	0.024
No Vent	0.000
No Vent	0.027

Summary	
No Vent	0.028
WW Vent	0.939
DW Vent	0.033

WW Fails	0.061
DW Fails Given WW F	0.54
No Vent	

APET-Alternative 3A

Summary of APET Results

APET Sequence		Release Category		CD-002	CD-003	CD-005	CD-006	CD-016	CD-017	CD-019	CD-020	Totals
APET-001		MSL-IVR-WW		3.11E-10	8.30E-11	2.63E-09	1.28E-09	---	---	---	2.86E-09	7.17E-09
APET-002		MSL-IVR-DW		9.45E-12	---	7.98E-11	---	---	---	---	1.62E-10	2.52E-10
APET-003		MSL-IVR-OP		1.09E-11	---	9.21E-11	---	---	---	---	1.88E-10	2.91E-10
APET-004		MSL-MIN-WW		3.47E-11	9.25E-12	3.67E-09	1.79E-09	1.11E-08	5.14E-08	---	9.01E-09	7.70E-08
APET-005		MSL-MIN-DW		1.05E-12	---	1.11E-10	---	3.38E-10	1.56E-09	---	5.12E-10	2.52E-09
APET-006		MSL-MIN-OP		1.22E-12	---	1.29E-10	---	3.90E-10	1.80E-09	---	5.91E-10	2.91E-09
APET-007		MSL-EXT-WW		3.47E-11	9.25E-12	3.67E-09	1.79E-09	1.11E-08	5.14E-08	---	9.01E-09	7.70E-08
APET-008		MSL-EXT-DW		1.05E-12	---	1.11E-10	---	3.38E-10	1.56E-09	---	5.12E-10	2.52E-09
APET-009		MSL-EXT-OP		1.22E-12	---	1.29E-10	---	3.90E-10	1.80E-09	---	5.91E-10	2.91E-09
APET-010		MSL-LMT		1.48E-13	3.71E-14	1.57E-11	7.18E-12	4.75E-11	2.19E-10	---	4.05E-11	3.31E-10
APET-011		MSL-DRY-WW		---	---	---	---	---	---	---	---	---
APET-012		MSL-DRY-DW		---	---	---	---	---	---	---	---	---
APET-013		MSL-DRY-OP		---	---	---	---	---	---	---	---	---
APET-014		MSL-DRY-LMT		4.01E-09	1.00E-09	1.78E-09	8.17E-10	5.41E-09	2.50E-08	---	7.93E-08	1.17E-07
APET-015		SRV-IVR-WW		2.42E-08	6.44E-09	4.55E-08	2.22E-08	---	---	6.27E-08	2.27E-08	1.84E-07
APET-016		SRV-IVR-DW		7.33E-10	---	1.38E-09	---	---	---	1.90E-09	1.29E-09	5.31E-09
APET-017		SRV-IVR-OP		8.47E-10	---	1.59E-09	---	---	---	2.20E-09	1.49E-09	6.13E-09
APET-018		SRV-MIN-WW		1.86E-09	4.96E-10	4.00E-08	1.96E-08	6.30E-08	6.35E-07	7.03E-07	5.04E-08	1.51E-06
APET-019		SRV-MIN-DW		5.65E-11	---	1.22E-09	---	1.91E-09	1.93E-08	2.13E-08	2.86E-09	4.67E-08
APET-020		SRV-MIN-OP		6.53E-11	---	1.40E-09	---	2.21E-09	2.23E-08	2.46E-08	3.30E-09	5.39E-08
APET-021		SRV-EXT-WW		1.86E-09	4.96E-10	4.00E-08	1.96E-08	6.30E-08	6.35E-07	7.03E-07	5.04E-08	1.51E-06
APET-022		SRV-EXT-DW		5.65E-11	---	1.22E-09	---	1.91E-09	1.93E-08	2.13E-08	2.86E-09	4.67E-08
APET-023		SRV-EXT-OP		6.53E-11	---	1.40E-09	---	2.21E-09	2.23E-08	2.46E-08	3.30E-09	5.39E-08
APET-024		SRV-LMT		7.95E-12	1.99E-12	1.71E-10	7.84E-11	2.69E-10	2.71E-09	3.00E-09	2.27E-10	6.47E-09
APET-025		SRV-DRY-WW		---	---	---	---	---	---	---	---	---
APET-026		SRV-DRY-DW		---	---	---	---	---	---	---	---	---
APET-027		SRV-DRY-OP		---	---	---	---	---	---	---	---	---
APET-028		SRV-DRY-LMT		2.15E-07	5.37E-08	1.95E-08	8.92E-09	3.07E-08	3.09E-07	3.42E-07	4.43E-07	1.42E-06
APET-029		HP-MIN-WW		2.78E-11	7.41E-12	3.51E-09	1.71E-09	8.24E-09	3.81E-08	---	6.89E-09	5.85E-08
APET-030		HP-MIN-DW		8.44E-13	---	1.06E-10	---	2.50E-10	1.16E-09	---	3.91E-10	1.90E-09
APET-031		HP-MIN-OP		9.75E-13	---	1.23E-10	---	2.89E-10	1.33E-09	---	4.52E-10	2.20E-09
APET-032		HP-EXT-WW		2.78E-11	7.41E-12	3.51E-09	1.71E-09	8.24E-09	3.81E-08	---	6.89E-09	5.85E-08
APET-033		HP-EXT-DW		8.44E-13	---	1.06E-10	---	2.50E-10	1.16E-09	---	3.91E-10	1.90E-09
APET-034		HP-EXT-OP		9.75E-13	---	1.23E-10	---	2.89E-10	1.33E-09	---	4.52E-10	2.20E-09
APET-035		HP-LMT		1.19E-13	2.97E-14	1.50E-11	6.86E-12	3.52E-11	1.63E-10	---	3.10E-11	2.51E-10
APET-036		HP-DRY-WW		---	---	---	---	---	---	---	---	---
APET-037		HP-DRY-DW		---	---	---	---	---	---	---	---	---
APET-038		HP-DRY-OP		---	---	---	---	---	---	---	---	---
APET-039		HP-DRY-LMT		3.21E-09	8.02E-10	1.71E-09	7.82E-10	4.01E-09	1.85E-08	---	6.06E-08	8.96E-08
		Sum		2.52E-07	6.31E-08	1.75E-07	8.02E-08	2.16E-07	1.90E-06	1.91E-06	7.61E-07	5.36E-06

APET-Alternative 3A

Results Interpretation

Vessel Depress Mode		CD-002	CD-003	CD-005	CD-006	CD-016	CD-017	CD-019	CD-020	Totals	
MSL		4.41E-09	1.10E-09	1.24E-08	5.69E-09	2.92E-08	1.35E-07	0.00E+00	1.03E-07	2.90E-07	5%
SRV		2.45E-07	6.11E-08	1.53E-07	7.03E-08	1.65E-07	1.67E-06	1.91E-06	5.82E-07	4.85E-06	91%
HP		3.27E-09	8.17E-10	9.19E-09	4.21E-09	2.16E-08	9.98E-08	0.00E+00	7.61E-08	2.15E-07	4%
In-Vessel Retention											
IVR		2.61E-08	6.52E-09	5.13E-08	2.35E-08	0.00E+00	0.00E+00	6.68E-08	2.87E-08	2.03E-07	4%
MCCI											
MIN		2.05E-09	5.13E-10	5.03E-08	2.31E-08	8.78E-08	7.72E-07	7.49E-07	7.44E-08	1.76E-06	33%
EXT		2.05E-09	5.13E-10	5.03E-08	2.31E-08	8.78E-08	7.72E-07	7.49E-07	7.44E-08	1.76E-06	33%
DRY		2.22E-07	5.55E-08	2.30E-08	1.05E-08	4.01E-08	3.52E-07	3.42E-07	5.83E-07	1.63E-06	30%
Release Pathway											
WW		2.83E-08	7.54E-09	1.43E-07	6.96E-08	1.65E-07	1.45E-06	1.47E-06	1.58E-07	3.49E-06	65%
DW		8.60E-10	0.00E+00	4.33E-09	0.00E+00	5.00E-09	4.40E-08	4.46E-08	8.98E-09	1.08E-07	2%
OP		9.93E-10	0.00E+00	5.00E-09	0.00E+00	5.78E-09	5.08E-08	5.15E-08	1.04E-08	1.24E-07	2%
LMT		2.22E-07	5.55E-08	2.32E-08	1.06E-08	4.04E-08	3.56E-07	3.45E-07	5.83E-07	1.64E-06	31%
Containment Performance											
CCFP		0.88	0.88	0.16	0.13	0.21	0.21	0.21	0.78	0.33	

Important Contributors to Core Damage

Seq Name	Description	Core Damage Timing	CD Frequency	% of CD	Dominant Contributor(s)	% of PDS	% of CDF	APET Implications
CD-002	RCIC & Early Venting Succeed, FLEX fails late, Cont. Re-isolated	>24 hrs	2.52E-07	5%	Operators fail to depoly FLEX in a timely manner	17%	1%	FLEX Failed due to human errors. Not due to limited time
					FLEX Hardware failures	83%	4%	FLEX hardware unavailable
CD-003	RCIC & Early Venting Succeed, FLEX fails late, WW Vent Not Re-Isolated	>24 hrs	6.31E-08	1%	Operators fail to depoly FLEX in a timely manner & don't re-isolate Cont.	17%	0.20%	Multiple human failures
					FLEX Hardware failures	83%	0.98%	FLEX hardware unavailable
CD-005	RCIC Lost on ED, FLEX Fails, Cont. Re-Isolated	12 hrs	1.75E-07	3%	Operator failure to control pressure and deploy FLEX	100%	3%	Many human failures
CD-006	RCIC Lost on ED, FLEX Fails, WW Vent Not Re-Isolated	~12 hrs	8.02E-08	2%	Operator failure to control pressure, deploy FLEX and close vent	100%	2%	Many human failures AND WW vent is Open
CD-008	RCIC & Early DW Venting Succeed, FLEX fails late, Cont. Re-isolated	>>24 hrs	2.80E-09	0.1%	Operators fail to depoly FLEX in a timely manner	17%	0%	FLEX Failed due to human errors. Not due to limited time
					FLEX Hardware failures	83%	0%	FLEX hardware unavailable
CD-009	RCIC & Early DW Venting Succeed, FLEX fails late, DW Vent Open	>>24 hrs	7.00E-10	0.01%	Operators fail to depoly FLEX in a timely manner & don't re-isolate Cont.	17%	0.00%	Multiple human failures
					FLEX Hardware failures	83%	0.01%	FLEX hardware unavailable
CD-011	RCIC Lost on ED, FLEX Fails, DW Vent Re-Isolated	~12 hrs	1.94E-09	0.04%	Operator failure to control pressure and deploy FLEX	100%	0%	Many human failures
CD-012	RCIC Lost on ED, FLEX Fails, DW Vent Not Re-Isolated	~12 hrs	8.90E-10	0.02%	Operator failure to control pressure, deploy FLEX and close DW vent	100%	0%	Many human failures AND DW vent is Open
CD-014	RCIC Early, Cont. Not Vented, RCIC Lost on SP-T	~24 hrs	1.43E-08	0.3%	Operator failure to control SP-T	100%	0%	Single human failure
CD-016	RCIC Succeeds Early (0-6 hrs), FLEX Succeeds, No Venting, ED	12 hrs	2.16E-07	4%	Operators fail to vent	100%	4%	Operators fail to early vent.
CD-017	RCIC Succeeds Early (0-6 hrs), FLEX Late/Unavail	~8 hrs	1.9E-06/yr	36%	Operators Fail to Deploy FLEX	100%	36%	Human errors with FLEX (due to PSFs other than time avail)
CD-019	RCIC Fails Early, Operator ED, FLEX Late/Unavail	~1 hr	1.9E-06/yr	36%	RCIC Fails before FLEX can be deployed	70%	25%	None. No preceding human failures.
					Operators Fail to Deploy within Available Time	30%	11%	FLEX Failed due to human errors, but due to limited time
CD-020	RCIC Fails Early, No ED, FLEX ineffective	~1 hr	7.61E-07	14%	RCIC Hardware Failures, Operator fails to ED	25%	4%	None. Preceding human failure to depressurize RPV.
					Other hazard-induced failures (e.g., loss of DC)	75%	11%	Mitigating actions not feasible?
						These cells are not linked to the ET split fractions		

APET-Alternative 3A

Phenomenological Inputs

Top Event	Description	Condition(s)	Probability	Inputs to the Assumed Failure Probability
RPV-PRESS	RPV Depressurizes During Core Melt	All	0.15	HP RPV depressurizes via MSL
			0.85	HP RPV depressurizes via SRV seizure
			0.1	MSL & SRV Seizure do not occur
IVR	In Vessel Retention	MSL Occurs	0.5	Core damage Not Arrested with water available
		SRV Depress Occurs	0.3	Core damage Not Arrested with water available
ECF	Early Containment Failure Avoided	WTR-INJECT Fails	1	LMT without water
		WTR-INJECT Success	0.001	HPME w/ or w/o water
			0.001	LMT w/water
MCCI	Degree of MCCI	All	0.5	Extensive MCCI

APET-Base Case

Summary of APET Results

APET Sequence		Release Category		CD-002	CD-003	CD-005	CD-006	CD-016	CD-017	CD-019	CD-020	Totals
APET-001		MSL-IVR-WW		3.11E-10	8.30E-11	2.63E-09	1.28E-09	---	---	---	2.86E-09	7.17E-09
APET-002		MSL-IVR-DW		9.45E-12	---	7.98E-11	---	---	---	---	1.62E-10	2.52E-10
APET-003		MSL-IVR-OP		1.09E-11	---	9.21E-11	---	---	---	---	1.88E-10	2.91E-10
APET-004		MSL-MIN-WW		3.47E-11	9.25E-12	8.55E-10	4.18E-10	---	---	---	---	1.32E-09
APET-005		MSL-MIN-DW		1.05E-12	---	2.60E-11	---	---	---	---	---	2.70E-11
APET-006		MSL-MIN-OP		1.22E-12	---	3.00E-11	---	---	---	---	---	3.12E-11
APET-007		MSL-EXT-WW		3.47E-11	9.25E-12	8.55E-10	4.18E-10	---	---	---	---	1.32E-09
APET-008		MSL-EXT-DW		1.05E-12	---	2.60E-11	---	---	---	---	---	2.70E-11
APET-009		MSL-EXT-OP		1.22E-12	---	3.00E-11	---	---	---	---	---	3.12E-11
APET-010		MSL-LMT		1.48E-13	3.71E-14	3.65E-12	1.67E-12	---	---	---	---	5.51E-12
APET-011		MSL-DRY-WW		---	---	---	---	---	---	---	---	---
APET-012		MSL-DRY-DW		---	---	---	---	---	---	---	---	---
APET-013		MSL-DRY-OP		---	---	---	---	---	---	---	---	---
APET-014		MSL-DRY-LMT		4.01E-09	1.00E-09	7.79E-09	3.57E-09	2.92E-08	1.35E-07	---	9.95E-08	2.80E-07
APET-015		SRV-IVR-WW		2.42E-08	6.44E-09	4.55E-08	2.22E-08	---	---	6.27E-08	2.27E-08	1.84E-07
APET-016		SRV-IVR-DW		7.33E-10	---	1.38E-09	---	---	---	1.90E-09	1.29E-09	5.31E-09
APET-017		SRV-IVR-OP		8.47E-10	---	1.59E-09	---	---	---	2.20E-09	1.49E-09	6.13E-09
APET-018		SRV-MIN-WW		1.86E-09	4.96E-10	9.34E-09	4.56E-09	---	---	---	---	1.63E-08
APET-019		SRV-MIN-DW		5.65E-11	---	2.83E-10	---	---	---	---	---	3.40E-10
APET-020		SRV-MIN-OP		6.53E-11	---	3.27E-10	---	---	---	---	---	3.93E-10
APET-021		SRV-EXT-WW		1.86E-09	4.96E-10	9.34E-09	4.56E-09	---	---	---	---	1.63E-08
APET-022		SRV-EXT-DW		5.65E-11	---	2.83E-10	---	---	---	---	---	3.40E-10
APET-023		SRV-EXT-OP		6.53E-11	---	3.27E-10	---	---	---	---	---	3.93E-10
APET-024		SRV-LMT		7.95E-12	1.99E-12	3.99E-11	1.83E-11	---	---	---	---	6.81E-11
APET-025		SRV-DRY-WW		---	---	---	---	---	---	---	---	---
APET-026		SRV-DRY-DW		---	---	---	---	---	---	---	---	---
APET-027		SRV-DRY-OP		---	---	---	---	---	---	---	---	---
APET-028		SRV-DRY-LMT		2.15E-07	5.37E-08	8.50E-08	3.90E-08	1.65E-07	1.67E-06	1.84E-06	5.57E-07	4.62E-06
APET-029		HP-MIN-WW		2.78E-11	7.41E-12	8.18E-10	4.00E-10	---	---	---	---	1.25E-09
APET-030		HP-MIN-DW		8.44E-13	---	2.48E-11	---	---	---	---	---	2.57E-11
APET-031		HP-MIN-OP		9.75E-13	---	2.87E-11	---	---	---	---	---	2.97E-11
APET-032		HP-EXT-WW		2.78E-11	7.41E-12	8.18E-10	4.00E-10	---	---	---	---	1.25E-09
APET-033		HP-EXT-DW		8.44E-13	---	2.48E-11	---	---	---	---	---	2.57E-11
APET-034		HP-EXT-OP		9.75E-13	---	2.87E-11	---	---	---	---	---	2.97E-11
APET-035		HP-LMT		1.19E-13	2.97E-14	3.49E-12	1.60E-12	---	---	---	---	5.24E-12
APET-036		HP-DRY-WW		---	---	---	---	---	---	---	---	---
APET-037		HP-DRY-DW		---	---	---	---	---	---	---	---	---
APET-038		HP-DRY-OP		---	---	---	---	---	---	---	---	---
APET-039		HP-DRY-LMT		3.21E-09	8.02E-10	7.45E-09	3.41E-09	2.16E-08	9.98E-08	---	7.61E-08	2.12E-07
		Sum		2.52E-07	6.31E-08	1.75E-07	8.02E-08	2.16E-07	1.90E-06	1.91E-06	7.61E-07	5.36E-06

APET-Base Case

Results Interpretation

Vessel Depress Mode		CD-002	CD-003	CD-005	CD-006	CD-016	CD-017	CD-019	CD-020	Totals	
MSL		4.41E-09	1.10E-09	1.24E-08	5.69E-09	2.92E-08	1.35E-07	0.00E+00	1.03E-07	2.90E-07	5%
SRV		2.45E-07	6.11E-08	1.53E-07	7.03E-08	1.65E-07	1.67E-06	1.91E-06	5.82E-07	4.85E-06	91%
HP		3.27E-09	8.17E-10	9.19E-09	4.21E-09	2.16E-08	9.98E-08	0.00E+00	7.61E-08	2.15E-07	4%
In-Vessel Retention											
IVR		2.61E-08	6.52E-09	5.13E-08	2.35E-08	0.00E+00	0.00E+00	6.68E-08	2.87E-08	2.03E-07	4%
MCCI											
MIN		2.05E-09	5.13E-10	1.17E-08	5.38E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.97E-08	0%
EXT		2.05E-09	5.13E-10	1.17E-08	5.38E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.97E-08	0%
DRY		2.22E-07	5.55E-08	1.00E-07	4.60E-08	2.16E-07	1.90E-06	1.84E-06	7.32E-07	5.12E-06	95%
Release Pathway											
WW		2.83E-08	7.54E-09	7.02E-08	3.43E-08	0.00E+00	0.00E+00	6.27E-08	2.56E-08	2.29E-07	4%
DW		8.60E-10	0.00E+00	2.13E-09	0.00E+00	0.00E+00	0.00E+00	1.90E-09	1.45E-09	6.34E-09	0%
OP		9.93E-10	0.00E+00	2.46E-09	0.00E+00	0.00E+00	0.00E+00	2.20E-09	1.68E-09	7.33E-09	0%
LMT		2.22E-07	5.55E-08	1.00E-07	4.60E-08	2.16E-07	1.90E-06	1.84E-06	7.32E-07	5.12E-06	95%
Containment Performance											
CCFP		0.88	0.88	0.59	0.57	1.00	1.00	0.97	0.96	0.96	

Important Contributors to Core Damage

Seq Name	Description	Core Damage Timing	CD Frequency	% of CD	Dominant Contributor(s)	% of PDS	% of CDF	APET Implications
CD-002	RCIC & Early Venting Succeed, FLEX fails late, Cont. Re-isolated	>24 hrs	2.52E-07	5%	Operators fail to depoly FLEX in a timely manner	17%	1%	FLEX Failed due to human errors. Not due to limited time
					FLEX Hardware failures	83%	4%	FLEX hardware unavailable
CD-003	RCIC & Early Venting Succeed, FLEX fails late, WW Vent Not Re-Isolated	>24 hrs	6.31E-08	1%	Operators fail to depoly FLEX in a timely manner & don't re-isolate Cont.	17%	0.20%	Multiple human failures
					FLEX Hardware failures	83%	0.98%	FLEX hardware unavailable
CD-005	RCIC Lost on ED, FLEX Fails, Cont. Re-Isolated	12 hrs	1.75E-07	3%	Operator failure to control pressure and deploy FLEX	100%	3%	Many human failures
CD-006	RCIC Lost on ED, FLEX Fails, WW Vent Not Re-Isolated	~12 hrs	8.02E-08	2%	Operator failure to control pressure, deploy FLEX and close vent	100%	2%	Many human failures AND WW vent is Open
CD-008	RCIC & Early DW Venting Succeed, FLEX fails late, Cont. Re-isolated	>>24 hrs	2.80E-09	0.1%	Operators fail to depoly FLEX in a timely manner	17%	0%	FLEX Failed due to human errors. Not due to limited time
					FLEX Hardware failures	83%	0%	FLEX hardware unavailable
CD-009	RCIC & Early DW Venting Succeed, FLEX fails late, DW Vent Open	>>24 hrs	7.00E-10	0.01%	Operators fail to depoly FLEX in a timely manner & don't re-isolate Cont.	17%	0.00%	Multiple human failures
					FLEX Hardware failures	83%	0.01%	FLEX hardware unavailable
CD-011	RCIC Lost on ED, FLEX Fails, DW Vent Re-Isolated	~12 hrs	1.94E-09	0.04%	Operator failure to control pressure and deploy FLEX	100%	0%	Many human failures
CD-012	RCIC Lost on ED, FLEX Fails, DW Vent Not Re-Isolated	~12 hrs	8.90E-10	0.02%	Operator failure to control pressure, deploy FLEX and close DW vent	100%	0%	Many human failures AND DW vent is Open
CD-014	RCIC Early, Cont. Not Vented, RCIC Lost on SP-T	~24 hrs	1.43E-08	0.3%	Operator failure to control SP-T	100%	0%	Single human failure
CD-016	RCIC Succeeds Early (0-6 hrs), FLEX Succeeds, No Venting, ED	12 hrs	2.16E-07	4%	Operators fail to vent	100%	4%	Operators fail to early vent.
CD-017	RCIC Succeeds Early (0-6 hrs), FLEX Late/Unavail	~8 hrs	1.9E-06/yr	36%	Operators Fail to Deploy FLEX	100%	36%	Human errors with FLEX (due to PSFs other than time avail)
CD-019	RCIC Fails Early, Operator ED, FLEX Late/Unavail	~1 hr	1.9E-06/yr	36%	RCIC Fails before FLEX can be deployed	70%	25%	None. No preceding human failures.
					Operators Fail to Deploy within Available Time	30%	11%	FLEX Failed due to human errors, but due to limited time
CD-020	RCIC Fails Early, No ED, FLEX ineffective	~1 hr	7.61E-07	14%	RCIC Hardware Failures, Operator fails to ED	25%	4%	None. Preceding human failure to depressurize RPV.
					Other hazard-induced failures (e.g., loss of DC)	75%	11%	Mitigating actions not feasible?
						These cells are not linked to the ET split fractions		

APET-Base Case

Phenomenological Inputs

Top Event	Description	Condition(s)	Probability	Inputs to the Assumed Failure Probability
RPV-PRESS	RPV Depressurizes During Core Melt	All	0.15	HP RPV depressurizes via MSL
			0.85	HP RPV depressurizes via SRV seizure
			0.1	MSL & SRV Seizure do not occur
IVR	In Vessel Retention	MSL Occurs	0.5	Core damage Not Arrested with water available
		SRV Depress Occurs	0.3	Core damage Not Arrested with water available
ECF	Early Containment Failure Avoided	WTR-INJECT Fails	1	LMT without water
		WTR-INJECT Success	0.001	HPME w/ or w/o water
			0.001	LMT w/water
MCCI	Degree of MCCI	All	0.5	Extensive MCCI

SPAR-H WORKSHEET

Human Action: Operator Action Description
Diagnosis HEP = 1.00E+00
Execution HEP = 2.00E-02
Total HEP = 1.00E+00

Diagnosis Worksheet

PSFs	PSF Levels	Multiplier for Diagnosis		If non-nominal PSF levels are selected, please note specific reasons in this column
1. Available Time	Inadequate[a]	1.0		
	Barely adequate ≈2/3 x nominal	10		
	Nominal time	**1**	x	
	Extra time (between 1 and 2 x nominal and > than 30 min)	0.1		
	Expansive (> 2 x nominal and > 30 min)	0.01		
2. Stress	**Extreme**	**5**	x	Extreme BDBE conditions unlike ever experienced in lifetime. Concern for self and family.
	High	2		
	Nominal	1		
3. Complexity	Highly	5		Basic actions are straightforward, but requires coodination under difficult conditions
	Moderately	**2**	x	
	Nominal	1		
	Obvious diagnosis	0.1		
4. Experience/Training	Low	10		INPO evaluations will include FLEX.
	Nominal	**1**	x	
	High	0.5		
5. Procedures	Not available	50		FSGs are integrated with EOPs.
	Incomplete	20		
	Available, but poor	5		
	Nominal	**1**	x	
	Diagnostic/symptom oriented	0.5		
6. Ergonomics	Missing/Misleading	50		Information availability will be limited. Communications will be impacted.
	Poor	**10**	x	
	Nominal	1		
	Good	0.5		
7. Fitness for Duty	Unfit[a]	1.0		n/a
	Degraded Fitness	5		
	Nominal	**1**	x	
8. Work Processes	**Poor**	**2**	x	Diffcult work conditions. Normal command and control communications challenged.
	Nominal	1		
	Good	0.8		

a - Total failure probability = 1.0, regardless of other PSFs

BHEP	0.01
Factors	200
Diagnosis HEP	1

Execution Worksheet

PSFs	PSF Levels	Multiplier for Diagnosis		If non-nominal PSF levels are selected, please note specific reasons in this column
1. Available Time	Inadequate[a]	1.0		
	Time available ≈ time required	10		
	Nominal	**1**	x	
	Available > 5x time required	0.1		
	Available > 50x time required	0.01		
2. Stress	**Extreme**	**5**	x	Extreme BDBE conditions unlike ever experienced in lifetime. Concern for self and family.
	High	2		
	Nominal	1		
3. Complexity	Highly	5		Basic actions are straightforward, but requires communications under difficult conditions
	Moderately	**2**	x	
	Nominal	1		
4. Experience/Training	Low	3		INPO evaluations will include FLEX.
	Nominal	**1**	x	
	High	0.5		
5. Procedures	Not available	50		FSGs are integrated with EOPs.
	Incomplete	20		
	Available, but poor	5		
	Nominal	**1**	x	
6. Ergonomics	Missing/Misleading	50		FLEX requires well planned, plug and play capability
	Poor	10		
	Nominal	**1**	x	
	Good	0.5		
7. Fitness for Duty	Unfit[a]	1.0		n/a
	Degraded Fitness	5		
	Nominal	**1**	x	
8. Work Processes	**Poor**	**2**	x	
	Nominal	1		
	Good	0.5		

a - Total failure probability = 1.0, regardless of other PSFs

BHEP	0.001
Factors	20
Execution HEP	0.02

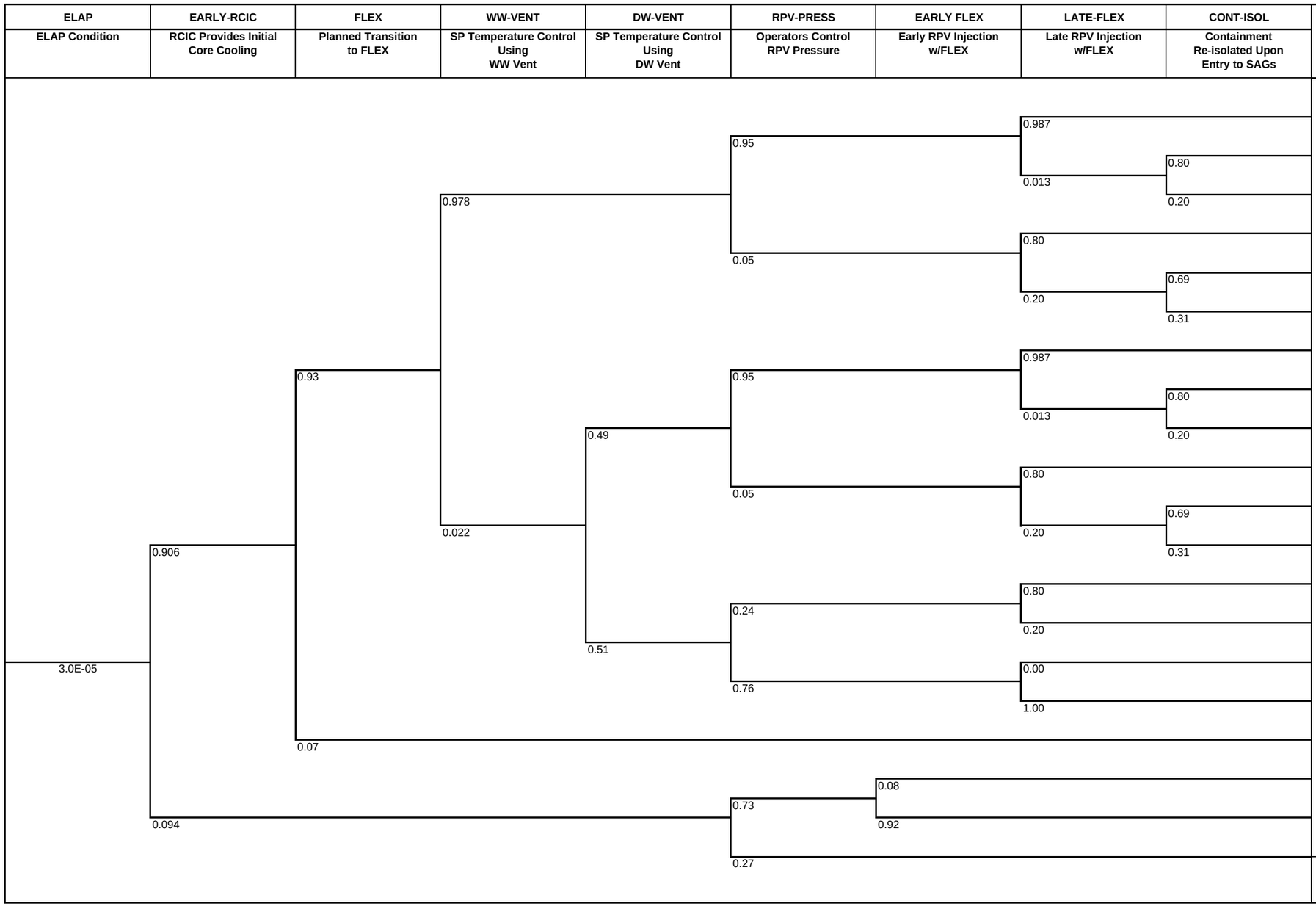
Initital Quantification Results

Seq Name	Description	Core Damage Timing	Sequence Frequency	Seq Class	% of Total
CD-001	Success - FLEX as planned	n/a	2.32E-05	OK	
CD-002	RCIC & Early WW Venting Succeed, FLEX fails late, Cont. Re-isolated	>>24 hrs	2.52E-07	CD-L-HP-IS	1%
CD-003	RCIC & Early WW Venting Succeed, FLEX fails late, WW Vent Open	>>24 hrs	6.31E-08	CD-L-HP-WW	0.2%
CD-004	Success	n/a	9.94E-07	OK	
CD-005	RCIC Lost on ED, FLEX Fails, WW Vent Re-Isolated	~12 hrs	1.75E-07	CD-M-LP-IS	0.6%
CD-006	RCIC Lost on ED, FLEX Fails, WW Vent Not Re-Isolated	~12 hrs	8.02E-08	CD-M-LP-WW	0.3%
CD-007	Success	n/a	2.57E-07	OK	
CD-008	RCIC & Early DW Venting Succeed, FLEX fails late, Cont. Re-isolated	>>24 hrs	2.80E-09	CD-L-HP-IS	0.009%
CD-009	RCIC & Early DW Venting Succeed, FLEX fails late, DW Vent Open	>>24 hrs	7.00E-10	CD-L-HP-DW	0.002%
CD-010		n/a	1.10E-08	OK	
CD-011	RCIC Lost on ED, FLEX Fails, DW Vent Re-Isolated	~12 hrs	1.94E-09	CD-M-LP-IS	0.006%
CD-012	RCIC Lost on ED, FLEX Fails, DW Vent Not Re-Isolated	~12 hrs	8.90E-10	CD-M-LP-DW	0.003%
CD-013	Success	n/a	5.58E-08	OK	
CD-014	RCIC Early, Cont. Not Vented, RCIC Lost on SP-T	~24 hrs	1.43E-08	CD-M-HP-IS	0.05%
CD-015	Success	n/a	0.00E+00	OK	
CD-016	RCIC Succeeds Early (0-6 hrs), FLEX Succeeds, No Venting, ED	~12 hrs	2.17E-07	CD-M-LP-IS	1%
CD-017	RCIC Succeeds Early (0-6 hrs), FLEX Late/Unavail	~8 hrs	1.88E-06	CD-M-HP-IS	6%
CD-018	Success	n/a	1.60E-07	OK	
CD-019	RCIC Fails Early, Operator ED, FLEX Late/Unavail	~1 hr	1.90E-06	CD-E-LP-IS	6%
CD-020	RCIC Fails Early, No ED, FLEX ineffective	~1 hr	7.54E-07	CD-E-HP-IS	3%
		ELAP Freq. =	3.00E-05 /yr		
		Total CDF =	5.34E-06 /yr		17.8%

Screen at 5E-8/yr includes >99% of CDF, next sequence is similar to CD-003, but LP. Next one is not severe
Largest DW vent open scenario is <1E-9/yr
Could screen at 1E-7, but it would exclude the failure to early vent case.

Benefit of FLEX = Factor of >5 reduction in ELAP CDF.
>50% of FLEX failure is due to RCIC failure to operate early (Seq. 19 & 20)

BWR Mark I/II Accident Management Rulemaking Core Damage Event Tree



ELAP	EARLY-RCIC	FLEX	WW-VENT	DW-VENT	RPV-PRESS	EARLY FLEX	LATE-FLEX	CONT-ISOL	Core Damage State	CD Timing	Frequency (/yr)	Name
ELAP Condition	RCIC Provides Initial Core Cooling	Planned Transition to FLEX	SP Temperature Control Using WW Vent	SP Temperature Control Using DW Vent	Operators Control RPV Pressure	Early RPV Injection w/FLEX	Late RPV Injection w/FLEX	Containment Re-isolated Upon Entry to SAGs				
									OK	n/a	2.32E-05	CD-001
									CD-L-HP-IS	>>24 hrs	2.52E-07	CD-002
									CD-L-HP-WW	>>24 hrs	6.31E-08	CD-003
									OK	n/a	9.94E-07	CD-004
									CD-M-LP-IS	~12 hrs	1.75E-07	CD-005
									CD-M-LP-WW	~12 hrs	8.02E-08	CD-006
									OK	n/a	2.57E-07	CD-007
									CD-L-HP-IS	>>24 hrs	2.80E-09	CD-008
									CD-L-HP-DW	>>24 hrs	7.00E-10	CD-009
									OK	n/a	1.10E-08	CD-010
									CD-M-LP-IS	~12 hrs	1.94E-09	CD-011
									CD-M-LP-DW	~12 hrs	8.90E-10	CD-012
									OK	n/a	5.58E-08	CD-013
									CD-M-HP-IS	~24 hrs	1.43E-08	CD-014
									OK	n/a	0.00E+00	CD-015
									CD-M-LP-IS	~12 hrs	2.17E-07	CD-016
									CD-M-HP-IS	~8 hrs	1.88E-06	CD-017
									OK	n/a	1.60E-07	CD-018
									CD-E-LP-IS	~1 hr	1.90E-06	CD-019
									CD-E-HP-IS	~1 hr	7.54E-07	CD-020
										Total CDF =	**5.34E-06**	

SPAR-H WORKSHEET

Human Action: Failure to implement FLEX following early success of RCIC
Diagnosis HEP = 5.00E-02
Execution HEP = 2.00E-02
Total HEP = 6.90E-02

Diagnosis Worksheet

PSFs	PSF Levels	Multiplier for Diagnosis		If non-nominal PSF levels are selected, please note specific reasons in this column
1. Available Time	Inadequate[a]	1.0		Nominal 4 hour coping time. EOPs will trigger transition to FSGs early in event.
	Barely adequate ≈2/3 x nominal	10		
	Nominal time	1		
	Extra time (between 1 and 2 x nominal and > than 30 min)	0.1		
	Expansive (> 2 x nominal and > 30 min)	**0.01**	x	
2. Stress	**Extreme**	**5**	x	Extreme BDBE conditions unlike ever experienced in lifetime. Concern for self and family.
	High	2		
	Nominal	1		
3. Complexity	**Highly**	**5**	x	Basic actions are straightforward, but requires coodination under difficult conditions
	Moderately	2		
	Nominal	1		
	Obvious diagnosis	0.1		
4. Experience/Training	Low	10		INPO evaluations will include FLEX.
	Nominal	**1**	x	
	High	0.5		
5. Procedures	Not available	50		FSGs are integrated with EOPs.
	Incomplete	20		
	Available, but poor	5		
	Nominal	**1**	x	
	Diagnostic/symptom oriented	0.5		
6. Ergonomics	Missing/Misleading	50		Information availability will be limited. Communications will be impacted.
	Poor	**10**	x	
	Nominal	1		
	Good	0.5		
7. Fitness for Duty	Unfit[a]	1.0		n/a
	Degraded Fitness	5		
	Nominal	**1**	x	
8. Work Processes	**Poor**	**2**	x	Diffcult work conditions. Normal command and control communications challenged.
	Nominal	1		
	Good	0.8		

a - Total failure probability = 1.0, regardless of other PSFs

BHEP	0.01
Factors	5
Diagnosis HEP	0.05

Execution Worksheet

PSFs	PSF Levels	Multiplier for Diagnosis		If non-nominal PSF levels are selected, please note specific reasons in this column
1. Available Time	Inadequate[a]	1.0		
	Time available ≈ time required	10		
	Nominal	**1**	x	
	Available > 5x time required	0.1		
	Available > 50x time required	0.01		
2. Stress	**Extreme**	**5**	x	Extreme BDBE conditions unlike ever experienced in lifetime. Concern for self and family.
	High	2		
	Nominal	1		
3. Complexity	Highly	5		Basic actions are straightforward, but requires communications under difficult conditions
	Moderately	**2**	x	
	Nominal	1		
4. Experience/Training	Low	3		INPO evaluations will include FLEX.
	Nominal	**1**	x	
	High	0.5		
5. Procedures	Not available	50		FSGs are integrated with EOPs.
	Incomplete	20		
	Available, but poor	5		
	Nominal	**1**	x	
6. Ergonomics	Missing/Misleading	50		FLEX requires well planned, plug and play capability
	Poor	10		
	Nominal	**1**	x	
	Good	0.5		
7. Fitness for Duty	Unfit[a]	1.0		n/a
	Degraded Fitness	5		
	Nominal	**1**	x	
8. Work Processes	**Poor**	**2**	x	Diffcult work conditions.
	Nominal	1		
	Good	0.5		

a - Total failure probability = 1.0, regardless of other PSFs

BHEP	0.001
Factors	20
Execution HEP	0.02

Important Contributors to Core Damage

Seq Name	Description	Core Damage Timing	CD Frequency	% of CD	Dominant Contributor(s)	% of PDS	% of CDF	APET Implications
CD-002	RCIC & Early Venting Succeed, FLEX fails late, Cont. Re-isolated	>24 hrs	2.52E-07	5%	Operators fail to depoly FLEX in a timely manner	17%	1%	FLEX Failed due to human errors. Not due to limited time
					FLEX Hardware failures	83%	4%	FLEX hardware unavailable
CD-003	RCIC & Early Venting Succeed, FLEX fails late, WW Vent Not Re-Isolated	>24 hrs	6.31E-08	1%	Operators fail to depoly FLEX in a timely manner & don't re-isolate Cont.	17%	0.20%	Multiple human failures
					FLEX Hardware failures	83%	0.98%	FLEX hardware unavailable
CD-005	RCIC Lost on ED, FLEX Fails, Cont. Re-Isolated	12 hrs	1.75E-07	3%	Operator failure to control pressure and deploy FLEX	100%	3%	Many human failures
CD-006	RCIC Lost on ED, FLEX Fails, WW Vent Not Re-Isolated	~12 hrs	8.02E-08	2%	Operator failure to control pressure, deploy FLEX and close vent	100%	2%	Many human failures AND WW vent is Open
CD-008	RCIC & Early DW Venting Succeed, FLEX fails late, Cont. Re-isolated	>>24 hrs	2.80E-09	0.1%	Operators fail to depoly FLEX in a timely manner	17%	0%	FLEX Failed due to human errors. Not due to limited time
					FLEX Hardware failures	83%	0%	FLEX hardware unavailable
CD-009	RCIC & Early DW Venting Succeed, FLEX fails late, DW Vent Open	>>24 hrs	7.00E-10	0.01%	Operators fail to depoly FLEX in a timely manner & don't re-isolate Cont.	17%	0.00%	Multiple human failures
					FLEX Hardware failures	83%	0.01%	FLEX hardware unavailable
CD-011	RCIC Lost on ED, FLEX Fails, DW Vent Re-Isolated	~12 hrs	1.94E-09	0.04%	Operator failure to control pressure and deploy FLEX	100%	0%	Many human failures
CD-012	RCIC Lost on ED, FLEX Fails, DW Vent Not Re-Isolated	~12 hrs	8.90E-10	0.02%	Operator failure to control pressure, deploy FLEX and close DW vent	100%	0%	Many human failures AND DW vent is Open
CD-014	RCIC Early, Cont. Not Vented, RCIC Lost on SP-T	~24 hrs	1.43E-08	0.3%	Operator failure to control SP-T	100%	0%	Single human failure
CD-016	RCIC Succeeds Early (0-6 hrs), FLEX Succeeds, No Venting, ED	12 hrs	2.16E-07	4%	Operators fail to vent	100%	4%	Operators fail to early vent.
CD-017	RCIC Succeeds Early (0-6 hrs), FLEX Late/Unavail	~8 hrs	1.9E-06/yr	36%	Operators Fail to Deploy FLEX	100%	36%	Human errors with FLEX (due to PSFs other than time avail)
CD-019	RCIC Fails Early, Operator ED, FLEX Late/Unavail	~1 hr	1.9E-06/yr	36%	RCIC Fails before FLEX can be deployed	70%	25%	None. No preceding human failures.
					Operators Fail to Deploy within Available Time	30%	11%	FLEX Failed due to human errors, but due to limited time
CD-020	RCIC Fails Early, No ED, FLEX ineffective	~1 hr	7.61E-07	14%	RCIC Hardware Failures, Operator fails to ED	25%	4%	None. Preceding human failure to depressurize RPV.
					Other hazard-induced failures (e.g., loss of DC)	75%	11%	Mitigating actions not feasible?

DC SYSYTEM SEISMIC FRAGILITIES BY SEISMIC INTERVAL

Bin #	Bin Range	Bin Frequency	Bin PGA (g)	DC Fragility	Failure Frequency
1	0.05 - 0.3	5.20E-04	0.12	epsilon	n/a
2	0.3 - 0.5	2.70E-05	0.40	1.32E-03	3.56E-08
3	0.5 - 1.0	1.70E-05	0.70	3.65E-02	6.20E-07
4	> 1.0	4.90E-06	1.21	2.72E-01	1.33E-06
			Total Loss of DC Frequency =		1.99E-06

Limiting DC Seismic Capacity (RASP Handbook)			
Am (g)	**Br**	**Bu**	**HCLPF**
1.6	0.3	0.35	0.55

NOTES:

1. *epsilon* = seismic fragility less than or equal to 1E-7.
2. At a calculated value of >=0.99, the value 1.00 is printed by the cell equation.
3. Fragility (i.e., failure probability) = Φ [ln(A/A_m)/β_c]. A is the g level in question. A_m is the median seismic capacity. β_c = (β_u^2 + β_r^2)^0.5.
4. Seismic Hazard is USGS 2008 from NRC SFP Consequence Analysis (Table 4, pg 34)
5. Conservatively used limiting DC component from RASP Handbook, Vol. 2 (charger/inverter)