

シビアアクシデント評価に関する  
調査研究報告書  
(中間報告)

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一般社団法人 日本原子力学会  
「シビアアクシデント評価」研究専門委員会

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(敬称略, 順不同)

# 1. 緒言

## 1.1 背景

今般の福島第一原子力発電所におけるシビアアクシデントの事象進展を再現するためには、解析コードによるシミュレーションが必要である。既存のシビアアクシデントの事象進展を時系列に沿って再現できる解析コードとしては、MAAP, MELCOR, SAMPSON, THALES 等が挙げられる。これらは、炉心及び圧力容器の損傷の時刻、水素及び放射性物質の放出と言った、シビアアクシデントに伴う諸現象を模擬できる。解析コードは、事故時の複合現象のうち支配的な物理モデルを数値化するとともに、ある条件を仮定して計算するものであり、解析結果はプラント情報として得られた原子炉水位、原子炉圧力、格納容器圧力、放射線線量率等の測定データにより検証できる。ただし、解析コードによる事故の再現には、ある程度の不確かさが含まれることに留意する必要がある。そのため、政府事故調報告書 II.1(3)節に記述されているように、事象進展を十分に再現できないなどの解析上の課題を解決できるように研究を進め、より信頼性の高い解析コードとすることが強く望まれる。

## 1.2 シビアアクシデント研究の現状

これまで数十年にわたり、多くのシビアアクシデント研究が実施され、その研究成果がまとめられている[1-1][1-2]。シビアアクシデントの諸現象には、ジルコニウム-水反応、熔融炉心の再配置、蒸気爆発、燃料-冷却材相互作用、直接格納容器加熱、熔融炉心-コンクリート相互作用、水素爆発、放射性生成物 (FP) エアロゾル挙動といった熱流動の要素が多い。これらの現象解明のための実験が日米欧を中心に多く実施され、得られた実験的知見を踏まえ、日米欧で上述の様な解析コードが開発されてきた。我が国で使用されている解析コードは、米国で開発された MAAP と MELCOR のほか、日本原子力研究開発機構で開発された THALES とエネルギー総合工学研究所で開発された SAMPSON がある。また、圧力容器破損防止のため、炉容器内保持 (IVR) といった、シビアアクシデントマネジメントも考えられている。

実験及び解析研究を踏まえて、日本原子力学会では、炉心熔融から環境への放射性物質の放出する事象シーケンスの頻度とソースタームを確率論的に評価するレベル 2 PSA (確率論的安全評価) 標準を策定した[1-3]。ソースタームとは、環境に放出される放射性物質の種類、性状、放出量、放出時期、放出期間、放出エネルギーで定義される。つまり、このソースタームを適切に評価できれば、福島第一原子力発電所の事故時に発電所敷地外に放出された放射性物質量を定量的に評価できると言える。しかしながら、シビアアクシデント後期では不確かさが大きく、未解明の現象も少なくない。

### 1.3 目的

現在、福島第一原子力発電所事故の事象進展を解明するため、各機関でシミュレーションが行われている。同時に、解析コードの限界も理解されつつあり、解析コードの改良に着手する必要がある。そこで、解析コードの効果的な改良に必要な、改良の優先付けなどを行うため、日本原子力学会熱流動部会では平成 23 年 12 月に「シビアアクシデント評価」研究専門委員会（平成 23 年 12 月～平成 25 年 11 月）を発足した。本委員会では、PIRT サブワーキンググループ（PIRT-SWG）と SAMPSON サブワーキンググループ（SAMPSON-SWG）を設けて効率的に議論を重ねた。PIRT-SWG では、事象進展解析とソースターム評価についてシミュレーションの課題を摘出するため、関連知見の調査を行い、シビアアクシデント時の様々な現象を抽出し、重要項目を選定することを目的とした。SAMPSON-SWG では、我が国で開発された機構論的シミュレーションコード SAMPSON をエネルギー総合工学研究所より貸与いただき、福島第一原子力発電所事故の事象進展解析のための、シミュレーションに対する課題を摘出することを目的とした。本報告書は、PIRT-SWG 及び SAMPSON-SWG の調査研究をまとめたものである。

### 1.4 参考文献

- [1-1] 成合，杉山，ほか「シビアアクシデントに関する熱流動研究の最近の動向」日本原子力学会誌 39 巻 9 号 739-752 頁 (1997).
- [1-2] I. Kataoka, "Review of Thermal-Hydraulic Researches in Severe Accidents in Light Water Reactors," J. Nucl. Sci. Technol., Vol. 50, No. 1, pp. 1-14 (2013).
- [1-3] 日本原子力学会「日本原子力学会標準 原子力発電所の出力運転状態を対象とした確率論的安全評価に関する実施基準（レベル 2 PSA 編）：2008」AESJ-SC-P009:2008 (2009).

## 2. PIRT-SWG

### 2.1 事象進展解析の課題の抽出（熱水力 PIRT）

福島第一原子力発電所事故の事象進展を解明するためには、シビアアクシデント解析コードによる炉心の溶融及び移行挙動、並びにソースターム評価を行う必要がある。また、燃料デブリの取り出しを含む中長期的な廃止措置に取り組むためには、炉心溶融物の存在位置及び分布を推定することが不可欠である。そこで、事象進展解明及び炉内状況把握のための解析コードの予測精度を高めることを目的として、事象進展解析に係る課題を抽出した。課題の抽出にあたっては、3号機を検討対象とし、1号機及び2号機の特有のシナリオについては、3号機シナリオの枠組みの中で適宜補足することとした。

課題の抽出には、PIRT (Phenomena Identification Ranking Table) という手法を用いた。PIRT とは、設計評価項目と流動上の各基本単位で発生する現象を表形式で組み合わせ、評価結果への影響の大きさ等の観点で専門家によりランク付けすることで、発生現象の重要度を考慮して課題を抽出できる表作成の手法及び表の作成結果である[2-1]。欧州では、PWRのシビアアクシデントを主な対象として、多くのシビアアクシデント研究者によって PIRT を実施し、1000 程度の現象を同定し、106 個の重要かつ知見不足の現象を抽出した[2-2]。今回の PIRT においては、BWR を対象として、海水の注入などの福島第一原子力発電所事故特有の現象も取り入れる必要がある。

3号機では、地震発生／原子炉スクラム、RCIC 起動、津波襲来／全電源喪失、RCIC 停止、(代替格納容器スプレー)、HPCI 起動、HPCI 停止、原子炉減圧操作、外部注水、炉心露出、(格納容器ベント)、炉心損傷による崩落、下部ヘッドへの炉心溶融物移行、原子炉容器損傷、格納容器への炉心溶融物移行、水素爆発といったシナリオが想定される。本 PIRT では、これらのシナリオを5つの時間フェーズに分割し、原子炉スクラムから燃料の溶融開始までを第1フェーズ、炉心領域からの移行開始までを第2フェーズ、原子炉容器破損までを第3フェーズ、格納容器破損までを第4フェーズ、水素爆発までを第5フェーズとした。図 2-1 に事象進展に対するフェーズを示す。

プラントシステムは、原子炉容器内・格納容器内・原子炉建屋内の3つに大別した。さらに、原子炉容器内では、炉心、シュラウドヘッド、スタンドパイプとセパレーター、ドライヤー、上部ヘッド、主蒸気ライン、上部ダウンカマー、下部ダウンカマー、下部ヘッド、再循環ループの10個の物理領域(サブシステム・機器)に分割した。格納容器内では、ペデスタルキャビティ、ドライウエル、ドライウエルヘッド、ベントライン／ウェットウエルダウンカマー、ウェットウエルの5個に分割した。原子炉建屋内では、アイソレーションコンデンサー、原子炉建屋の部屋、非常用ガス処理系、オペレーションフロア、ブローアウトパネル、使用済み燃料プール、設備プールの7個に分割した。

同定された現象の重要度レベルを決めるためには主要な指標が必要となる。PIRT で、この指標を FoM (Figure of Merit) と呼び、各時間フェーズにおいて選定する必要がある。FoM

は、第 1 フェーズでは被覆管最高温度と燃料最高エンタルピー、第 2 フェーズでは炉心平均温度、第 3 フェーズでは原子炉容器壁最高温度と下部ヘッド内コリウム最高温度、第 4 フェーズでは格納容器最高圧力及び温度、第 5 フェーズではガス（水素、酸素、水蒸気）濃度と設定した。

現象の同定には、現在利用可能な情報及び知識レベルでブレインストーミングを行うこととした。同研究専門委員会に係るメンバーは熱流動及びシビアアクシデント解析の専門家ではあるが、燃料については核燃料部会の専門家の協力も得た。毎週 2 回程度の集中議論を行い、FoM に影響を与える事象について詳細度には必ずしもこだわらず、考え得るものを抽出する方針とした。その結果、原子炉容器内では 677 件、格納容器内では 358 件、原子炉建屋内では 124 件の計 1159 件が抽出された。

次に、同定された現象についてランク付けを行うため、各時間フェーズで FoM に影響を与える重要度を定義した。High (H) は FoM に大きく影響、Medium (M) は FoM に中程度に影響、Low (L) は FoM にほとんど影響しない、Not Applicable (N/A) は FoM に無関係とすることとした。

併せて、現状の知識レベル (State of Knowledge : SoK) も 3 分類に設定した。Known (K) は、現象がよく理解され、実験データや解析モデルにおける不確かさが小さい。Partially known (P) は、現象は一般的に理解されているが、実験データが限られ解析モデルにおける不確かさが中程度であり、更なる研究が必要である。Unknown (U) は、現象がよく理解されておらず、実験データがほとんどなく解析モデルにおける不確かさが大きく、解析は仮定に大きく依存するものであり、現象を理解するためには研究が必須である。

ランク付けは、専門家による議論を通じて行われた（詳細は付録 A 参照）。その結果、表 2-1 に示すような重要度レベル及び知識レベルのランキングが明示された（詳細は表 2-5 参照）。同定された現象 1159 件から、重要度が高く (H)、知識レベルが十分でない (P 又は U) 現象を抽出すると、208 件と集約された。さらに再整理した上で、大項目に整理すると、表 2-2 に示すように 88 件に集約された。全体的には、炉心から離れるに従って、知識レベルが K に対する P と U の比率が高くなり、知識が十分でなくなる傾向がある。現象の重要度については、事象進展を左右するシビアアクシデント特有の熱流動的現象に加えて、計装配管等の破損など燃料やガスの移行経路となる部位の挙動が重要であることが示された。再臨界は起こりにくいと考えられるが、万一発生した場合には影響が大きいことから重要度が高いと示された。また、コリウム内の混合物質の性状や物性値も挙げられている。福島第一発電所事故特有の海水の影響も選定されている。これらの整理の中から、特に重要と考えられる事象について以下に列挙する。

燃料と構造物間の輻射伝熱、炉心部コリウム移行挙動、計装管溶融などの挙動、主蒸気管等の FP 沈着による発熱、コリウム凝固と再溶融、デブリベッド特性・挙動、溶融金属酸化反応、溶融プール特性、コリウム・下部ヘッド間ギャップ

冷却，再臨界，下部ヘッド・制御棒案内管などの損傷過程，下部ヘッドからのコリウム流出挙動，海水影響，ペDESTAL部コリウム移行，ペDESTAL壁の酸化，MCCI，ペDESTAL部サンプ内コリウム挙動，ドライウェル部からの漏えい，DCH，漏えいパスにおけるF P沈着，ベローズの損傷と漏えい，ウェットウェル部からの漏えい，格納容器破損箇所からの水素漏えい，原子炉建屋内水素拡散混合挙動

福島第一事故の事象進展を評価するために，現象として重要なものが抽出されている。これらについては，シミュレーションコードによってモデル化されていない現象もあり，これらの影響評価を今後実施し，また必要に応じてモデル化を進める必要がある。従って，本PIRTの結果を踏まえて，解析コードの高度化のために研究計画を具体化する必要があると考える。

## 2.2 ソースターム評価の課題の抽出（ソースタームPIRT）

福島第一原子力発電所事故のソースターム評価には，大気拡散からのソースターム推定方法（SPEEDIコードを用いた逆推定）と事象進展解析からのソースターム推定方法（MELCORコード等を用いた順推定）の異なる方法がある。両者を組み合わせてソースターム評価の精度を向上させる努力を進めているところである。ここでは，上述の事象進展解析コードのソースターム評価の予測精度を高めることを目的として，ソースターム評価に係る課題を抽出した。

前節と同様に，課題の抽出にはPIRT手法を用いた。ただし，事象進展解析と異なり，ソースタームPIRTではFoMが環境へのソースターム放出量となる。そのため，抽出される現象，ランキングの重要度レベル及び知識レベルを整理する必要がある。

ソースターム評価は，環境への放出の観点から事象晩期に起こる現象の方が重要であることから，前節の第3フェーズまでをひとまとめにした。よって，時間フェーズは3分割にし，原子炉スクラムから原子炉容器破損までの早期，原子炉容器破損から格納容器破損までの中期，格納容器破損以降（格納容器破損後，2～3週間程度）の後期と設定した。プラントシステムの分割は，基本的には前節と同様だが，ソースターム評価に必要なものに限られる。専門家の協力を得て，前節と同様のブレインストーミングを行い，現象を同定した結果，68件が抽出された。

重要度レベルと知識レベルのランク付けを行うため，EURSAFE[2-2]と同様に，専門家による投票を行い，整理した。ある閾値を用いてランク付けを行った後，そのランキングについて議論を行い，表2-3に示すようなランキング結果が明示された（詳細は表2-6参照）。

本PIRTにおいてランキングがHighとなった現象を重要事象として表2-4に整理した。これらは，福島第一原子力発電所事故における環境へのソースターム放出量予測という観点で重要と判断された現象である。早期フェーズでは，圧力容器内での現象が多く抽



出され、特に溶融燃料からの FP 等の放出(2108)が高い得点を示した。中期以降のフェーズでは、压力容器の外での挙動が多く抽出されており、特に MCCI やヨウ素化学に関する事象が重要事象として数多く挙げられる傾向が見られた。また、同表で挙げられた事象のうち現状の知識レベル (SoK) が P, 又は U については、解析コードによる事故進展解析技術の高度化といった観点で優先度が高い項目と考えられる。

本 PIRT の結果を踏まえて、解析コードの高度化のための研究計画を具体化する必要があると考える。

### 2.3 まとめ

福島第一原子力発電所でおきたシビアアクシデント現象の把握、さらには事故で放出されたソースタームを評価するためには、解析コードによるシミュレーションが欠かせない。そのシミュレーションの評価精度を向上するため、事象進展及びソースターム評価の 2 つの観点から PIRT を実施し、課題の抽出を行った。今後、本結果を踏まえて、実験も含めて解析コードの高度化のための研究計画が具体化されるべきである。

なお、本 PIRT も定期的に見直し、より充実していくことが必要である。

### 2.4 参考文献

- [2-1] G.E. Wilson and B.E. Bouyack, "The role of the PIRT process in experiments, code development and code applications associated with reactor safety analysis," Nucl. Eng. Des., Vol.186, pp.23-37 (1998).
- [2-2] D. Magallon, A. Mailliat, et al., "European expert network for the reduction of uncertainties in severe accident safety issues (EURSAFE)," Nucl. Eng. Des., Vol. 235, pp. 209-346 (2005).

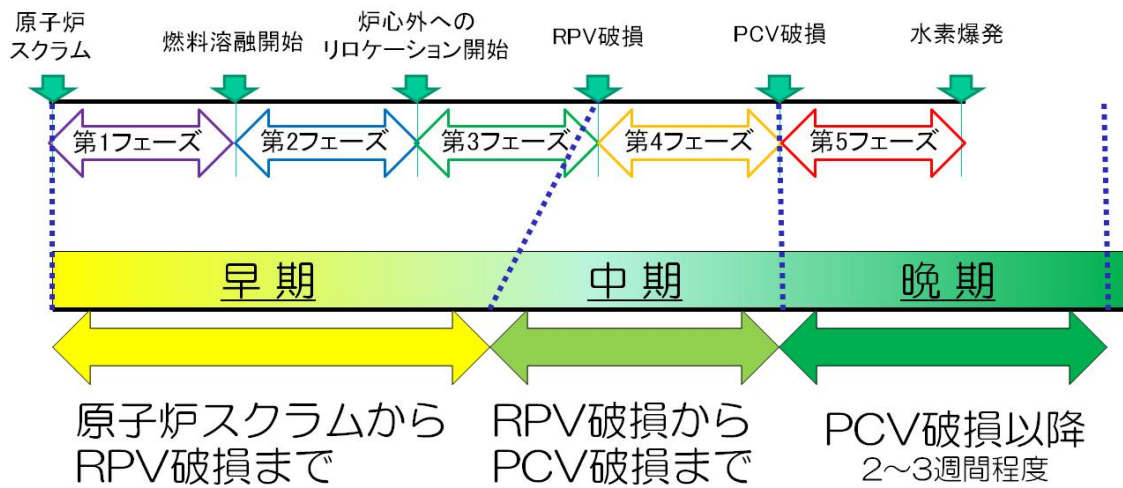


図 2-1 時間フェーズの設定 (上段：熱水カ PIRT, 下段：ソースターム PIRT)

表 2-1 熱水力 PIRT で同定された現象，重要度レベル，知識レベル

システム	物理領域 (サブシステム・機器)	同定された現象	重要度レベル															知識レベル			H & P or U	項目整理
			第1フェーズ			第2フェーズ			第3フェーズ			第4フェーズ			第5フェーズ			K	P	U		
			H	M	L	H	M	L	H	M	L	H	M	L	H	M	L					
原子炉内	炉心	178	16	39	36	52	69	48	47	42	87	5	12	161	4	38	132	67	102	9	54	12
	シュラウドヘッド	32	0	1	26	0	1	31	0	1	31	0	3	29	0	6	26	17	12	3	0	0
	スタンドパイプ/セパレータ	32	0	0	29	0	4	28	0	4	28	4	3	25	7	2	23	16	14	2	2	1
	ドライヤー	24	0	0	24	0	4	20	0	4	20	4	1	19	6	3	15	11	6	7	2	1
	上部ヘッド	24	0	2	22	1	6	17	1	6	17	4	6	14	3	7	14	11	9	4	1	1
	主蒸気ライン	32	0	7	22	5	8	18	5	8	18	3	7	21	5	7	0	0	5	2	1	1
	上部ダウンカマー	31	1	3	26	0	5	26	0	5	26	2	12	17	1	12	18	20	6	5	0	0
	下部ダウンカマー	123	2	6	38	2	7	37	42	49	31	0	23	100	1	9	113	28	82	13	0	9
	下部ヘッド	164	0	3	26	1	1	32	78	41	19	21	72	70	14	52	97	25	123	15	0	18
	再循環ループ	37	0	0	29	0	2	29	2	4	31	0	3	34	2	8	27	17	13	7	0	0
小計	677	19	61	278	61	107	286	175	164	308	43	142	490	43	144	465	212	372	67	60	43	
格納容器内	ベデスタルキャビティ	140	0	0	40	0	0	40	0	0	40	69	35	36	54	37	49	24	97	19	67	13
	ドライウエル	105	0	0	50	0	0	50	0	0	50	46	31	28	39	30	36	16	74	15	45	11
	ドライウエルヘッド	33	0	1	28	1	1	30	1	1	30	14	5	14	17	2	14	14	17	2	4	4
	ベントライン/ウェットウエルダウンカマー	40	0	0	36	0	0	36	0	0	36	7	7	26	5	5	30	10	23	7	6	5
	ウェットウエル	40	0	0	33	0	0	34	0	0	34	9	9	22	12	7	21	12	22	6	3	2
	小計	358	0	1	187	1	1	190	1	1	190	145	87	126	127	81	150	76	233	49	125	35
原子炉建屋内	アイソレーションコンデンサー	16	0	9	4	3	2	8	2	2	12	0	2	9	0	4	9	7	9	0	2	1
	原子炉建屋の部屋	65	0	0	10	0	0	10	0	0	10	0	0	11	17	35	13	5	60	0	17	7
	非常用ガス処理系	2	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	1	1	0	0	0
	オペレーションフロア	30	0	0	9	0	0	9	0	0	9	0	0	9	4	11	15	0	30	0	3	2
	ブローアウトパネル	4	0	0	0	0	0	0	0	0	0	0	0	0	2	2	0	3	1	0	1	1
	使用済み燃料プール	6	0	0	4	0	0	4	0	0	4	0	0	4	0	2	4	0	6	0	0	0
	設備プール	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0
小計	124	0	9	27	3	2	31	2	2	35	0	2	33	23	56	42	16	108	0	23	10	
合計	1159	19	71	492	65	110	507	178	167	533	188	231	649	193	281	657	304	713	116	208	88	

注) 重要度レベルでは H: High, M: Medium, L: Low. 知識レベルでは K: Known, P: Partially known, U: Unknown.

表 2-2 熱水力 PIRT で重要度が高く知識レベルが十分でない現象の整理(1/2)

No.	RPV or PCV	Subsystem Component	Phenomena	1st Phase FoM: Fuel Rod Enthalpy	2nd Phase FoM: Enthalpy or Avr.Temp. for Core Region	3rd Phase FoM: RPV wall or Corium Maximum Temp.	4th Phase FoM: Maximum Press. and Temp. in PCV	5th Phase FoM: Concent. of Hydrogen, Oxygen and Steam	SOK
1	RPV	Core	Zr-Water Reaction	H	H	M	L	H	P
2			Heat transfer between core materials	N/A	H	H	H	L	P
3			Radiation heat transfer between corium and structures	N/A	H	H	L	L	P
4			Melting of control rod	N/A	H	M	L	L	P
5			Physical properties of core materials	N/A	H	H	M	M	P
6			Corium relocation	N/A	H	H	M	M	P
7			Molten pool behavior	N/A	H	H	L	L	P
8			Oxidation reaction between corium and water	N/A	L	H	L	M	U
9			Solidification of corium	N/A	H	H	H	M	P
10			Melting of corium (particle and crust)	N/A	H	H	L	L	P
11			Re-criticality	N/A	H	H	L	L	P
12			Instrumentation tube related behavior	N/A	M	H	M	H	P
13		Standpipe & Separator	FP deposition/accumulation	L	M	M	H	H	P
14		Dryer	FP deposition/accumulation	L	M	M	H	H	P
15		Upper Head	FP deposition/accumulation	L	M	M	H	H	P
16		Main Steam Line	FP deposition/accumulation	L	H	H	M	H	P
17		Lower down comer	FP accumulation at leakage path	M	H	H	H	H	U
18			Heat transfer between core materials	N/A	N/A	H	M	L	P
19			Corium relocation	N/A	N/A	H	M	M	U
20			Fuel-coolant interaction (FCI)	N/A	N/A	H	M	M	P
21			Solidification of corium	N/A	N/A	H	L	L	U
22			Melting of corium (particle and crust)	N/A	N/A	H	L	L	P
23			Physical properties of core materials	N/A	N/A	H	L	L	P
24			Debris bed properties and behavior	N/A	N/A	H	L	L	P
25		Lower head	Heat transfer between core materials/structures	N/A	N/A	H	M	M	U
26			Debris bed properties and behavior	N/A	N/A	H	M	L	P
27			Oxidation reaction between structures/molten metal	N/A	L	M	L	H	P
28			Corium relocation	N/A	N/A	H	M	M	P
29			Molten pool behavior	N/A	N/A	H	M	L	P
30			Fuel-coolant interaction (FCI)	N/A	N/A	H	M	M	P
31			Solidification of corium	N/A	N/A	H	M	L	P
32			Physical properties of core materials	N/A	N/A	H	M	M	U
33			Melting of corium (particle and crust)	N/A	N/A	H	L	L	P
34			Re-criticality	N/A	N/A	H	M	L	P
35			Formation of gap between corium and lower head	N/A	N/A	H	M	L	P
36			Crack formation in lower head	N/A	N/A	H	M	M	P
37			Mechanical/Chemical damage of lower head	N/A	N/A	H	H	M	P
38			Material relocation through control rod guide tubes	N/A	N/A	H	H	H	P
39			Material relocation through SRM/IRM/TIP/ICM	N/A	N/A	H	H	H	P
40			Radiation heat transfer between corium and structures	N/A	N/A	H	L	H	P
41			Melting of lower head material	N/A	N/A	H	H	H	P
42			Sea salt effect	N/A	N/A	H	H	H	U

表2-2 熱水力PIRTで重要度が高く知識レベルが十分でない現象の整理 (2/2)

43	PCV	Pedestal Cavity	Heat transfer between core materials/structures	L	L	L	H	H	P	
44			Debris bed properties and behavior	N/A	N/A	N/A	H	L	P	
45			Corium relocation	N/A	N/A	N/A	H	H	U	
46			Molten corium concrete interaction (MCCI)	N/A	N/A	N/A	H	H	U	
47			Heat transfer between core materials	N/A	N/A	N/A	H	H	P	
48			Re-criticality	N/A	N/A	N/A	H	L	P	
49			Oxidation reaction of pedestal wall	L	L	L	M	H	P	
50			Fuel-coolant interaction (FCI)	N/A	N/A	N/A	H	H	P	
51			Direct Containment Heating (DCH)	N/A	N/A	N/A	H	H	P	
52			Pedestal water level change	L	L	L	H	M	P	
53			Melting of structures in pedestal internal	N/A	N/A	N/A	H	H	U	
54			Corium flow into sump pit	N/A	N/A	N/A	H	H	P	
55			Drywell	Deposition situation of corium on pedestal floor	N/A	N/A	N/A	H	M	P
56				Corium leak into connecting piping inside sump	N/A	N/A	N/A	H	H	P
57		Leakage through containment vessel penetration		L	L	L	H	H	U	
58		Heat transfer between core materials/structures		L	L	L	H	H	P	
59		Drywell water level change		L	L	L	H	M	P	
60		Molten corium concrete interaction (MCCI)		N/A	N/A	N/A	H	H	U	
61		Direct Containment Heating (DCH)		N/A	N/A	N/A	H	H	P	
62		Crust properties and formation/remelting behavior		N/A	N/A	N/A	H	H	P	
63		Re-criticality		N/A	N/A	N/A	H	L	P	
64		Oxidation reaction of drywell structures		L	L	L	M	H	P	
65		Melting of structures in drywell internal		N/A	N/A	N/A	H	H	U	
66		Heat release from drywell wall		L	L	L	H	H	P	
67		Drywell Head		Mechanical damage of drywell head	L	L	L	H	H	P
68				Pressure loss of bulk head plate in head	L	L	L	M	H	P
69			FP accumulation at leakage path	M	H	H	H	H	U	
70			Direct Containment Heating (DCH)	N/A	N/A	N/A	H	H	P	
71	Drywell vent line and downcomer to Wetwell	Mechanical damage of pipe line	L	L	L	H	H	P		
72		Direct Containment Heating (DCH)	N/A	N/A	N/A	H	H	P		
73		Change of failure crack area on bellows	L	L	L	H	H	P		
74		Leakage through bellows	L	L	L	H	H	P		
75		Water level change in Drywell/Wetwell ventilation line	L	L	L	H	M	U		
76	Wetwell	Mechanical damage of wetwell	L	L	L	H	H	P		
77		Leakage from wetwell	N/A	N/A	N/A	H	H	P		
78	Isolation Condenser	Leakage from wetwell	L	H	H	N/A	M	P		
79	R/B	R/B Compartments	Gas/water leak	N/A	N/A	N/A	N/A	H	P	
80			PCV ventilation piping sheet degradation	N/A	N/A	N/A	N/A	H	P	
81			Gas reflux flow through PCV ventilation line and stack	N/A	N/A	N/A	N/A	H	P	
82			Gas reflux flow through PCV	N/A	N/A	N/A	N/A	H	P	
83			Mixing and accumulation	N/A	N/A	N/A	N/A	H	P	
84			Hydrogen flame and combustion	N/A	N/A	N/A	N/A	H	P	
85			Gas mixing and composition fraction change	N/A	N/A	N/A	N/A	H	P	
86		Operation floor	Gas mixing and composition fraction change	N/A	N/A	N/A	N/A	H	P	
87			Hydrogen flame and combustion	N/A	N/A	N/A	N/A	H	P	
88		Blowout Panel	Opening of the blowout panel	N/A	N/A	N/A	N/A	H	P	

表 2-3 ソースターム PIRT で同定された現象，重要度レベル，知識レベル

システム	物理領域（ソースターム放出）又は特徴	同定された現象	重要度レベル									知識レベル			H & P or U
			初期			中期			後期			K	P	U	
			H	M	L	H	M	L	H	M	L				
原子炉内	炉心（炉容器内での放出）	14	4	9	1	1	7	6	0	3	11	3	4	7	4
	原子炉容器・配管（炉容器内での移行）	10	1	9	0	1	9	0	0	6	4	9	1	0	0
	計装配管等（炉容器から格納容器への移行）	3	2	0	1	3	0	0	3	0	0	0	3	0	3
	小計	27	7	18	2	5	16	6	3	9	15	12	8	7	7
格納容器内	ペDESTALキャビティ（格納容器内での放出）	2	0	0	2	1	1	0	1	1	0	1	1	0	1
	ドライウェル／ウェットウェル（格納容器内でのエアロゾル挙動）	16	1	6	9	2	14	0	3	11	1	12	4	0	2
	トップヘッドフランジ等（格納容器から建屋への移行）	5	0	0	5	3	0	2	4	0	1	0	4	1	4
	小計	23	1	6	16	6	15	2	8	12	2	13	9	1	7
原子炉建屋内	原子炉建屋（建屋内でのエアロゾル挙動）	2	0	0	2	0	0	2	1	1	0	1	0	1	0
*	ヨウ素化学反応	13	0	5	7	1	11	1	13	0	0	0	11	2	13
*	ヨウ素化学形態	3	0	1	2	0	2	1	3	0	0	1	1	1	2
合計		68	8	30	29	12	44	12	28	22	17	27	30	13	29

注) 重要度レベルでは H: High, M: Medium, L: Low。知識レベルでは K: Known, P: Partially known, U: Unknown。

ヨウ素化学は格納容器及び原子炉建屋で見られるため，\*で表記。

表 2-4 ソースターム PIRT のスクリーニング結果 (1/2)

番号	現象	時間フェーズ			SoK
		早期	中期	後期	
1. In-vessel Release					
2106	Pellet form change and radionuclides release at the time of the clad rupture	High			P
2107	Radionuclides release after pellet is exposed to the atmosphere in the core by clad melting	High			U
2108	Radionuclides release from molten fuel	High	High		U
2111	Influence on iodine/cesium chemical form and hydrogen production from molten/re-solidified fuel due to the B4C control rod existence	High			U
2. Gas/Aerosol Behaviour in Vessel, Loop, and Steam line					
2201	Condensation/Re-vaporization/Adsorption	High	High		K
3. Transport in RPV and PCV					
2301	Leakage via instruments, penetration, etc	High	High	High	P
2302	Leakage via gasket	High	High	High	P
2303	Leakage by RPV damage		High	High	P
4. Ex-vessel Release					
2401	MCCI (Concrete erosion)		High	High	P
5. Aerosol Behaviour in Containment					
2501	Scrubbing by steam flow from SRV to S/C	High			K
2502	Scrubbing with the vent from D/W to S/C		High	High	P
2503	Scrubbing due to water injection to the pedestal floor			High	P
2507	Condensation / Re-vaporization / Adsorption		High		K
2513	Deposition by gravitational settling			High	K
6. Transfer out of Containment					
2601	Leakage via instruments, penetrations, gasket, etc		High	High	P
2602	Wetwell vent		High	High	P
2603	Drywell vent		High	High	P
2605	Migration of radioactive material by the injection water into the reactor			High	U
7. Aerosol Behaviour in Reactor Building					
2701	Aerosol Behaviour in Reactor Building			High	K

表 2-4 ソースターム PIRT のスクリーニング結果 (2/2)

番号	現象	時間フェーズ			SoK
		早期	中期	後期	
8. Iodine chemistry					
2801	Generation of acidic substances by radiolysis			High	P
2802	Hydrolysis			High	P
2803	Re-volatilization of iodine by acidification pH decrease			High	P
2804	Iodine chemical reaction in water pool			High	P
2805	Decomposition reaction of iodine in the atmosphere			High	P
2806	Transfer between gas phase and water pool			High	P
2807	Recombination reaction of iodine in the atmosphere			High	P
2808	Wall deposition of iodine in the atmosphere			High	P
2809	Wall adsorption and desorption of iodine by chemical adsorption process			High	P
2810	Effect of impurities in the water pool			High	P
2811	Iodine chemistry under high water temperature conditions			High	P
2812	Effects of seawater			High	U
2813	Iodine release from R/B contaminated water		High	High	U
9. Chemical form (Iodine, Cesium)					
2901	Re-evaporation of I2 by the decomposition of CsI			High	K
2902	Effects of seawater			High	U
2903	A generation ratio for the inorganic iodine of the organic iodine			High	P



表 2-5 熱水力 PIRT

RPV or PCV	Subsystem/Component	Phenomenon (Ranking scale: High, Medium, Low, N/A) SoK(state of knowledge): Known, Partially known, Unknown	1st phase	2nd phase	3rd phase	4th phase	5th phase	SoK
			Fuel Heat Up	Fuel Melting	Relocation from the Core	PCV Deposition	Hydrogen Leak and Explosion	
			FoM: Fuel Rod Enthalpy	FoM: Enthalpy or Average Temperature for Core Region	FoM: Maximum Temperature in RPV wall or Corium Maximum Temperature	FoM: Maximum Pressure and Temperature in PCV	FoM: Concentration of Hydrogen, Oxygen and Steam	
1	RPV	Core	H	H	M	M	M	K
2		Core Water Level Change	H	H	M	M	L	K
3		Core Flowrate Change	H	L	L	L	L	K
4		Core Coolant Temperature Change	H	H	H	H	M	K
5		Core Pressure Change	H	L	L	L	L	K
6		Boiling due to Depressurization	H	L	L	L	L	K
7		Gap Conductance between Fuel Pellets and Cladding	H	L	L	L	L	K
8		Gas (Condensable/Incondensable) Temperature Change in Channel Region	M	L	L	M	M	K
9		Temperature Change in Fuel Cladding	H	H	L	L	M	K
10		Temperature Change in Fuel Pellets	H	H	L	L	M	K
11		Temperature Change in Control Rods	L	M	L	L		P
12		Decay Heat in Intact Fuel Assemblies	H	M	L	L	L	K
13		Gamma Ray Heat Generation in Core Internals (Except Fuel Rods)	L	L	L	L	L	K
14		Temperature Change in Gaps between Fuel Pellets and Cladding	M	L	L	L	M	K
15		Temperature Change in Channel Boxes	M	H	L	L	M	P
16		Temperature Change in Tie Plates	L	L	L	L	L	K
17		Temperature Change in Spacers	L	L	L	L	L	K
18		Heat Transfer between Water and Fuel Cladding	H	H	L	L	L	K
19		Heat Transfer between Water and Channel Boxes	M	M	L	L	L	K
20		Heat Transfer between Water and Control Rods	L	M	L	L		K
21		Heat Transfer between Water and Tie Plates	L	L	L	L	L	K
22		Heat Transfer between Water and Spacers	M	L	L	L	L	K
23		Heat Transfer between Fuel Cladding and Spacers	L	L	L	L	L	K
24		Heat Transfer between Fuel Cladding and Gas	H	H	L	L	M	K
25		Heat Transfer between Fuel Pellets and Gas	M	L	L	L	L	K
26		Heat Transfer between Channel Boxes and Gas	L	L	L	L	M	K
27		Heat Transfer between Control Rods and Gas	L	M	L	L		K
28		Heat Transfer between Tie Plates and Gas	L	L	L	L	L	K
29		Heat Transfer between Spacers and Gas	L	L	L	L	L	K
30		Hydrogen Absorption in Fuel Cladding	M	M	L	L	M	K
31		Fuel Pellets Composition (Including MOX Fuels and Gd <sub>2</sub> O <sub>3</sub> )	M	M	L	L	M	K
32		Fuel Rod Growth (Cladding Irradiation Growth)	M	L	L	L	L	K
33		Pressure Change in Gap between Fuel Pellets and Cladding	M	M	L	L	L	K
34		Gas Composition Change in Gap between Fuel Pellets and Cladding	M	L	L	L	L	K
35		Ballooning of Fuel Cladding	M	L	L	L	L	P
36		Contraction of Fuel Cladding Outer Diameter (Creep Down)	M	M	L	L	L	K
37		Fuel Cladding Rupture	L	L	L	L	L	K
38		Changes in Bonding Status of Fuel Pellets to Cladding	L	L	L	L	L	P
39		Pellet Cracks, Grains and Relocation in Cladding	M	L	L	L	L	P
40		Water Flow into Gap between Fuel Pellets and Cladding	N/A	N/A	N/A	L	M	P
41		Steam Flow into Gap between Fuel Pellets and Cladding	M	M	L	L	M	P
42		Zr-Water Reaction Facilitation by Water Flow into Gap between Fuel Pellets and Cladding	N/A	N/A	N/A	L	H	P
43		Core Axial Power Distribution Change	H	H	L	L	M	K
44		Core Radial Power Distribution Change	H	H	L	L	M	K
45		Fuel Axial Exposure(Burn-up) Distribution	M	H	L	L	M	K

45	Fuel Radial Exposure(Burn-up) Distribution	M	H	L	L	M	K
46	Pressure Loss Change for Core Flow Paths	M	M	L	L	L	K
47	Changes in Flowrate Distribution between Fuel Channels and Bypasses	M	M	L	L	L	K
48	Changes in Flowrate Distribution in each Fuel Channel	M	M	L	L	L	K
49	Changes in Pressure Loss at Core Inlet	M	L	L	L	L	K
50	Pressure Loss Increase by Fuel Cladding Swelling	M	L	L	L	L	K
51	Change in 2-Phase Flow Regime Status in Fuel Channels	M	M	L	L	L	K
52	Change in 2-Phase Flow Regime Status in Bypass Regions	M	L	L	L	L	K
53	Gas Natural Circulation above Water Level	H	H	H	L	M	K
54	CCFL at Upper Tie Plate	M	M	L	L	L	K
55	CCFL at Bypass Region	M	M	L	L	L	K
56	CCFL at Core Inlet	M	M	L	L	L	K
57	Changes in Gas Composition in Core Region	M	M	L	L	M	P
58	Changes in Gas Spatial Distribution in Core Region	M	M	L	L	M	K
59	Changes in Gas Mixture Properties in Core Region	M	M	L	L	M	K
60	Changes in the Amount of Residual Burnable Poisons	L	L	L	L	L	K
61	Changes in Properties of Fuel Materials	M	M	L	L	L	K
62	Changes in Properties of Core Internals	L	M	M	L	L	K
63	Zr-Water Reaction Including Oxidation and Hydrogen Production	H	H	M	L	H	P
64	SUS-Water Reaction Including Oxidation and Hydrogen Production	M	M	L	L	H	K
65	Reaction between Water and Other Substances (e.g. B4C), Including Oxidation and Hydrogen Production	M	M	L	L	M	P
66	Heat Transfer between Water(Liquid Phase) and Corium	N/A	H	H	M	L	P
67	Heat Transfer between Gaseous Phase and Corium	N/A	H	H	H	L	P
68	Heat Transfer between Fuel Cladding and Corium	N/A	H	H	L	L	P
69	Heat Transfer between control rods and Corium	N/A	H	H	L	L	P
70	Heat Transfer between Channel Boxes and Corium	N/A	H	H	L	L	P
71	Heat Transfer between Core Shroud and Corium	N/A	H	H	L	L	P
72	Heat Transfer between Water Rods (or Channels) and Corium	N/A	M	M	L	L	P
73	Heat Transfer between Water(Liquid Phase) and Particulate Corium	N/A	H	H	M	L	P
74	Heat Transfer between Gaseous Phase and Particulate Corium	N/A	H	H	H	L	P
75	Heat Transfer between Fuel Cladding and Particulate Corium	N/A	M	M	L	L	P
76	Heat Transfer between control rods and Particulate Corium	N/A	M	M	L	L	P
77	Heat Transfer between Channel Boxes and Particulate Corium	N/A	M	M	L	L	P
78	Heat Transfer between Core Shroud and Particulate Corium	N/A	L	M	L	L	P
79	Heat Transfer between Water Rods (or Channels) and Particulate Corium	N/A	L	L	L	L	P
80	Heat Transfer between Water(Liquid Phase) and Crust	N/A	H	H	M	L	P
81	Heat Transfer between Gaseous Phase and Crust	N/A	H	H	H	L	P
82	Heat Transfer between Fuel Cladding and Crust	N/A	M	H	L	L	P
83	Heat Transfer between control rods and Crust	N/A	M	H	L	L	P
84	Heat Transfer between Channel Boxes and Crust	N/A	M	H	L	L	P
85	Heat Transfer between Core Shroud and Crust	N/A	M	H	L	L	P
86	Heat Transfer between Water Rods (or Water Channels) and Crust	N/A	M	M	L	L	P
87	Heat Transfer between Crusts and Corium	N/A	H	H	L	L	P
88	Heat Transfer between Core Support Plate and Corium	N/A	H	H	L	L	P
89	Heat Transfer between Core Support Plate and Crusts	N/A	H	H	L	L	P
90	Heat Transfer between Core Fuel Support Coupling and Corium	N/A	H	H	L	L	P
91	Radiation Heat Transfer among Fuel Rods	H	H	L	L	L	K
92	Radiation Heat Transfer between Channel Boxes and Fuel Rods	L	M	L	L	L	K
93	Radiation Heat Transfer between Water Rods (or Water Channels) and Fuel Rods	L	M	L	L	L	K
94	Radiation Heat Transfer among Channel Boxes	M	M	L	L	L	K
95	Radiation Heat Transfer between Channel Boxes and Core Shroud	M	M	L	L	L	K
96	Radiation Heat Transfer between control rods and Core Shroud	L	M	L	L	L	K
97	Radiation Heat Transfer between control rods and Channel Boxes	L	M	L	L	L	K

98	Radiation Heat Transfer between Corium and Shroud	N/A	H	H	L	L	P
99	Radiation Heat Transfer between Crusts and Shroud	N/A	M	M	L	L	P
100	Radiation Heat Transfer between Particulate Corium and Shroud	N/A	M	M	L	L	P
101	Radiation Heat Transfer between Corium and Core Support Plate	N/A	H	H	L	L	P
102	Radiation Heat Transfer between Crusts and Core Support Plate	N/A	M	M	L	L	P
103	Radiation Heat Transfer between Particulate Corium and Core Support Plate	N/A	L	L	L	L	P
104	Fuel Pellet Expansion (Thermal Expansion, Gas Swelling, Solid Swelling)	M	M	L	L	L	K
105	FP Absorption into Fuel Pellet	L	L	L	L	L	P
106	FP Release from Pellet to Gap between Fuel Pellets and Cladding (Gap Release)	M	M	L	L	M	P
107	FP Release from Damaged Fuel Rods to Channel Region	M	M	L	L	M	P
108	Melting of Fuel Cladding	N/A	H	M	L	L	K
109	Melting of Fuel Pellet	N/A	H	M	L	L	K
110	Melting of control rod	N/A	H	M	L	L	P
111	Melting of Channel Box	N/A	H	M	L	L	P
112	Melting of Spacers	N/A	M	L	L	L	P
113	Melting of Tie Plates	N/A	M	L	L	L	P
114	Phase changing condition change for core materials (including eutectic)	N/A	H	H	M		P
115	Fuel Rod Collapse and Moving to the Lower Region	N/A	H	H	L	L	P
116	Channel Blockage by Collapsed Fuel Rods	N/A	H	M	L	L	P
117	Melted Fuel 'Candling'	N/A	H	M	L	L	P
118	Channel and Bypass Blockage by Melted Fuel	N/A	H	M	L	L	P
119	Corium Temperature Change	N/A	H	H	L	L	P
120	Formation of Molten Pool	N/A	H	H	L	L	P
121	Natural Circulation in Molten Pool	N/A	H	H	L	L	P
122	Molten Core Flow out of Crust Crack	N/A	H	H	L	L	P
123	Corium Transverse Flow above Blocked Flowpaths	N/A	H	H	L	L	P
124	Corium Spatial Distribution	N/A	L	H	L	L	P
125	Vaporization inside Corium (including FP release)	N/A	M	M	L	L	P
126	Decay Heat Generation from Corium	N/A	H	H	L	L	K
127	Corium-Water Reaction (Including Oxidation and Hydrogen Production)	N/A	L	H	L	M	U
128	Changes in Corium Properties by Mixed Composition	N/A	H	H	L	L	P
129	Crust generation by solidification of corium	N/A	H	H	L	L	P
130	Corium relocation type through breached core support plate	N/A	N/A	H	M	M	P
131	Change in Ablated Area for Core Support Plate	N/A	N/A	H	L	L	P
132	Changes in Particle Corium (Debris) Composition	N/A	L	L	L	L	P
133	Changes in Particle Corium Shape and Size	N/A	L	L	L	L	P
134	Particulate Corium (Debris) Relocation	N/A	L	M	L	L	P
135	Particle Corium Uneven Distribution	N/A	L	L	L	L	P
136	Crust Formation on Fuel Cladding	N/A	M	M	L	M	P
137	Void Generation inside Crust	N/A	M	M	L	L	P
138	Water Flow around Crust	N/A	M	M	L	L	P
139	Gaseous Flow around Crust	N/A	M	M	L	L	P
140	Formation of Crust Crack	N/A	M	M	L	L	P
141	Crust Temperature Change	N/A	M	M	L	L	P
142	Changes in Crust Properties by Mixed Composition	N/A	M	M	L	L	P
143	Crust-Water Reaction (Including Oxidation and Hydrogen Production)	N/A	M	M	L	M	U
144	Water Flow into Crust	N/A	M	M	L	M	P
145	Crust remelting due to change in the heat transfer status to corium or water	N/A	H	H	L	L	P
146	Particulate corium remelting due to change in the heat transfer status	N/A	H	H	L	L	P
147	Decay Heat Generation from Crust	N/A	M	H	L	L	P
148	Molten Core Re-Criticality	N/A	H	H	L	L	P
149	Molten Core Reflooding by Injection Restart	N/A	H	M	M	L	K

150		FP deposition on core internals	L	L	M	L	M	P
151		FP re-vaporization	L	L	M	L	M	P
152		Decay heat generation from FP	L	L	M	L	M	P
153		FP reaction including iodine chemistry	L	L	L	L	L	P
154		Adsorption and release of gaseous FP	L	L	L	L	L	P
155		Corium Jet through Breached Core Support Plate	N/A	N/A	H	M	M	P
156		Corium Flow into control rod guide tubes through Breached Fuel Support Coupling	N/A	N/A	H	L	L	P
157		Corium Flow to the Downcomer through Breached Core Shroud	N/A	N/A	H	L	L	P
158		Corium Flow out of the Core Inlet Orifice	N/A	N/A	H	L	L	P
159		Corium Solidification inside Fuel Support Coupling	N/A	N/A	H	L	L	P
160		Instrumentation Tube Break	N/A	M	H	M	M	P
161		Corium Flow into Instrumentation Tube	N/A	M	H	L	M	P
162		Water Flow into Instrumentation Tube	N/A	M	M	L	M	P
163		Corium Solidification inside Instrumentation Tube	N/A	M	M	H	M	P
164		Gas Leak Flow into Instrumentation Tube	N/A	M	M	L	H	P
165		Water Radiolysis	L	L	L	L	L	K
166		Seasalt intake to corium	N/A	M	M	M	M	U
167		Seasalt impact for corium thermodynamic properties	N/A	M	M	L	L	U
168		Seasalt impact for FP reaction and composition	L	L	L	L	L	P
169		Corrosion of Core Internals by Seasalt (including Marine Lives)	L	L	L	L	L	U
170		Impact of Seasalt Deposition on Heat Transfer	M	M	M	L	L	U
171		Channel (Bypass) Flowpath Blockage by Seasalt Deposition	L	M	L	L	L	U
172		Seasalt Dissolution by Reflooding	L	M	L	L	L	P
173		Influence on Heat Transfer by Seasalt Concentration Change	L	L	L	L	L	P
174		Influence on Instrumentation and Measurements by Seasalt Concentration Change	L	L	L	L	L	U
175		Corrosion of Core Internals by Boron	L	L	L	L	L	U
176		Impact of Boron Deposition on Heat Transfer	L	L	M	L	L	P
177		Channel (Bypass) Flowpath Blockage by Boron Deposition	L	M	L	L	L	P
178		Boron Dissolution by Reflooding	L	L	L	L	L	P
179	Shroud head	Radiation Heat Transfer between Intact Fuel Rods and Shroud Head	M	L	L	L	L	K
180		Radiation Heat Transfer between Corium and Shroud Head	N/A	L	L	L	M	K
181		Radiation Heat Transfer between Crust and Shroud Head	N/A	L	L	L	L	K
182		Radiation Heat Transfer between Shroud Sidewall and Shroud Head	L	L	L	L	L	K
183		Radiation Heat Transfer between Particulate Corium and Shroud Head	N/A	L	L	L	L	P
184		Heat Transfer between Gas and Shroud Head	L	L	L	M	M	K
185		Shroud Head Break or Deformation by Thermal Stress	L	L	L	L	L	K
186		Shroud Head Oxidation with Steam (Including Reaction Heat and Hydrogen Production)	L	L	L	L	M	K
187		Gamma Ray Heat Generation in Shroud Head	L	L	L	L	L	K
188		Temperature Change in Shroud Head Structure	L	L	L	L	L	K
189		Droplet Spray	N/A	L	L	L	L	K
190		Droplet Deposition on Shroud Head Structure	N/A	L	L	L	L	K
191		Condensation Heat Transfer on Shroud Head	L	L	L	L	L	K
192		Pressure Change in Shroud Head	L	M	M	L	M	K
193		Gas Flow in Shroud Head	L	L	L	L	L	K
194		Gas Composition Change in Shroud Head	L	L	L	M	M	K
195		Gas Temperature Change in Shroud Head	L	L	L	M	M	K
196		FP deposition on shroud head	L	L	L	L	L	P
197		FP re-vaporization	L	L	L	L	L	P
198		Decay heat generation from FP	L	L	L	L	L	K
199		FP Leakage from Flange between Shroud Sidewall and Head	L	L	L	L	L	P
200		FP reaction including iodine chemistry	L	L	L	L	L	P
201		Gas Leakage from Flange between Shroud Sidewall and Head	L	L	L	L	L	P
202		Corrosion of Shroud Head by Seasalt (Including Marine Lives)	L	L	L	L	L	U

203		Influence for heat transfer by salt deposition	L	L	L	L	L	U	
204		Spray Nozzle Blockage by Seasalt Deposition	L	L	L	L	L	P	
205		Re-solution of salt by reflooding	L	L	L	L	L	P	
206		Seasalt impact for FP reaction and composition	L	L	L	L	L	P	
207		Corrosion of Shroud Head by Boron	L	L	L	L	L	U	
208		Influence for heat transfer by boron deposition	L	L	L	L	L	P	
209		Spray Nozzle Blockage by Boron Deposition	L	L	L	L	L	P	
210		Re-solution of boron by reflooding	L	L	L	L	L	P	
211	Standpipe & Separator	Radiation Heat Transfer between Intact Fuel Rods and Standpipe/Separator	L	L	L	L	L	K	
212		Radiation Heat Transfer between Corium and Standpipe/Separator	N/A	L	L	L	L	K	
213		Radiation Heat Transfer between Crust and Standpipe/Separator	N/A	L	L	L	L	K	
214		Radiation Heat Transfer between Intact Control Rod and Standpipe/Separator	L	L	L	L	L	K	
215		Radiation Heat Transfer between Shroud Structure and Standpipe/Separator	L	L	L	L	L	K	
216		Radiation Heat Transfer between Particulate Corium and Standpipe/Separator	N/A	L	L	L	L	P	
217		Heat Transfer between Gas and Standpipe/Separator	L	L	L	M	M	K	
218		Standpipe/Separator Temperature Change	L	L	L	L	H	K	
219		Gamma Heat Generation in Standpipe/Separator	L	L	L	L	L	K	
220		Condensation Heat Transfer on Standpipe/Separator	L	L	L	L	L	K	
221		Pressure Change in Standpipe/Separator	L	M	M	M	M	K	
222		Gas Temperature Change in Standpipe/Separator	L	L	L	H	H	K	
223		Gas Flow in Standpipe/Separator	L	L	L	L	L	K	
224		Gas Composition Change in Standpipe/Separator	L	L	L	L	H	K	
225		Standpipe/Separator Break or Deformation by Thermal Stress	L	L	L	L	L	K	
226		Standpipe/Separator Oxidation with Steam (Including Reaction Heat and Hydrogen Production)	L	L	L	M	H	K	
227		FP deposition on standpipe/separator	L	M	M	H	H	P	
228		FP re-vaporization	L	M	M	H	H	P	
229		Decay heat generation from FP	L	M	M	H	H	K	
230		FP reaction including iodine chemistry	L	L	L	L	L	P	
231	Corrosion of Standpipe/Separator by Seasalt (Including Marine Lives)	L	L	L	L	L	U		
232		Influence for heat transfer by salt deposition	L	L	L	L	L	P	
233		Pick-off Ring Flowpath Blockage by Seasalt Deposition	L	L	L	L	L	P	
234		Separator Inlet Flowpath Blockage by Seasalt Deposition	L	L	L	L	L	P	
235		Re-solution of salt by reflooding	L	L	L	L	L	P	
236		Seasalt impact for FP reaction and composition	L	L	L	L	L	P	
237		Corrosion of Standpipe/Separator by Boron	L	L	L	L	L	U	
238		Influence for heat transfer by boron deposition	L	L	L	L	L	P	
239		Pick-off Ring Flowpath Blockage by Boron Deposition	L	L	L	L	L	P	
240		Separator Inlet Flowpath Blockage by Boron Deposition	L	L	L	L	L	P	
241		Re-solution of boron by reflooding	L	L	L	L	L	P	
242		Standpipe/Separator Tilt by Shroud Head Deformation	L	L	L	L	L	P	
243	Dryer	Dryer Temperature Change	L	L	L	L	H	K	
244			Gamma Heat Generation in Dryer	L	L	L	L	L	K
245			Heat Transfer between Gas and Dryer	L	L	L	L	M	K
246			Condensation Heat Transfer on Dryer	L	L	L	L	L	K
247			Pressure Change in Dryer	L	M	M	M	M	K
248			Gas Flow in Dryer	L	L	L	L	L	K
249			Gas Temperature Change in Dryer	L	L	L	H	M	K
250			Gas Composition Change in Dryer	L	L	L	L	H	K
251			Dryer Break or Deformation by Thermal Stress	L	L	L	L	L	K
252			Dryer Oxidation with steam (Including Reaction Heat and Hydrogen Production)	L	L	L	L	H	K
253			FP deposition on dryer	L	M	M	H	H	P
254			FP re-vaporization	L	M	M	H	H	P

255		Decay heat generation from FP	L	M	M	H	H	K
256		FP reaction including iodine chemistry	L	L	L	L	L	P
257		Corrosion of Dryer by Seasalt (Including Marine Lives)	L	L	L	L	L	U
258		Influence for heat transfer by salt deposition	L	L	L	L	L	U
259		Dryer Flowpath Blockage by Seasalt Deposition	L	L	L	L	L	U
260		Re-solution of salt by reflooding	L	L	L	L	L	U
261		Seasalt impact for FP reaction and composition	L	L	L	L	L	P
262		Corrosion of Dryer by Boron	L	L	L	L	L	U
263		Impact of Boron Deposition on Heat Transfer	L	L	L	L	L	U
264		Dryer Flowpath Blockage by Boron Deposition	L	L	L	L	L	U
265		Re-solution of boron by reflooding	L	L	L	L	L	P
266		Dryer Structure Tilt	L	L	L	L	L	P
267	Upper Head	Heat Transfer between Gas and Upper Head Wall	L	L	L	H	M	K
268		Gamma Heat Generation in Upper Head	L	L	L	L	L	K
269		Upper Head Temperature Change	L	L	L	M	M	K
270		Radiation Heat Transfer from Upper Head to Drywell Head	M	M	M	H	L	K
271		Condensation Heat Transfer on Upper Head	L	L	L	L	L	K
272		Pressure Change in Steam Dome	L	M	M	H	H	K
273		Gas Flow in Steam Dome	L	L	L	L	L	K
274		Gas Temperature Change in Steam Dome	L	L	L	H	M	K
275		Gas Composition Change in Steam Dome	L	L	L	L	H	K
276		Upper Head Oxidation with Steam (Including Reactin Heat and Hydrogen Production)	L	L	L	L	M	K
277		FP deposition on upper head	L	M	M	M	M	P
278		FP re-vaporization	L	M	M	M	M	P
279		Decay heat generation from FP	L	M	M	M	M	K
280		FP reaction including iodine chemistry	L	L	L	L	L	P
281		Gas Leakage from RPV flange to Drywell Head	L	H	H	M	H	P
282		Corrosion of Upper Head by Seasalt (Including Marine Lives)	L	L	L	L	L	U
283		Influence for heat transfer by salt deposition	L	L	L	L	L	U
284		Re-solution of salt by droplet	L	L	L	L	L	P
285		Influence on Instrumentation and Measurements by Seasalt Concentration Change	L	L	L	L	L	U
286		Seasalt impact for FP reaction and composition	L	L	L	L	L	P
287		Corrosion of Upper Head by Boron	L	L	L	L	L	P
288		Influence for heat transfer by boron deposition	L	L	L	L	L	U
289		Re-solution of boron by reflooding	L	L	L	L	L	P
290		Degradation or Falling of Lagging Material	M	M	M	M	L	P
291	Main Steam Line	Main Steam Line Creep Rupture	N/A	M	M	L	L	K
292		Break Flow from Main Steam Line Break	N/A	M	M	L	L	K
293		Gas Flow in Main Steam Line	L	L	L	L	L	K
294		Pressure Change in Main Steam Line	L	M	M	H	H	K
295		Gas Temperature Change in Main Steam Line	L	M	M	H	M	K
296		Gas Composition Change in Main Steam Line	L	L	L	L	H	K
297		Main Steam Line Temperature Change	L	M	M	L	L	K
298		Heat Transfer between Gas and Main Steam Line	L	L	L	M	L	K
299		Heat Transfer between water and Main Steam Line	L	L	L	L	L	K
300		Condensation Heat Transfer on Main Steam Line	L	L	L	L	L	K
301		Heat Transfer to Drywell through Lagging Material	L	L	L	L	L	K
302		Safety Relief Valve Opening Characteristics	M	H	H	L	H	K
303		Leakage from Safety Relief Valve to Drywell	M	H	H	L	H	K
304		Pressure Loss at Safety Relief Valve	M	H	H	L	M	K
305		Safety Relief Valve Temperature Change	L	L	L	L	L	K
306		Heat Transfer between Gas and Safety Relief Valve Blowdown Piping	L	L	L	L	L	K
307		Safety Relief Valve Blowdown Piping Break	L	L	L	L	L	K

308		Safety Relief Valve Blowdown Piping Break Flow	L	L	L	L	L	K
309		MSIV Closure	M	M	M	M	M	K
310		Pressure Wave by MSIV Closure	L	N/A	N/A	N/A	N/A	K
311		Gas Leakage from MSIV	M	M	M	M	M	K
312		FP deposition on main steam line	L	L	L	M	M	K
313		FP re-vaporization	L	L	L	M	M	K
314		Decay heat generation from FP	M	H	H	M	M	K
315		FP accumulation at leakage path	M	H	H	H	H	U
316		Radiation heat transfer to drywell	L	L	L	L	L	K
317		Influence on Heat Transfer by Seasalt Concentration Change	L	L	L	L	L	P
318		Influence on Instrumentation and Measurements by Seasalt Concentration Change	L	L	L	L	L	U
319		Seasalt impact for FP reaction and composition	L	L	L	L	L	P
320		FP reaction including iodine chemistry	L	L	L	L	L	P
321		Failure of RPV nozzle welding by thermal stress	N/A	M	M	M	L	P
322		Degradation or Falling of Lagging Material	L	L	L	L	L	P
323	Upper down comer	Heat Transfer between Gas and Upper Downcomer Wall	L	L	L	M	M	K
324		Gamma Heat Generation in Upper Downcomer Wall	L	L	L	L	L	K
325		Upper Downcomer Wall (and Feedwater Sparger) Temperature Change	L	L	L	L	M	K
326		Condensation Heat Transfer on Upper Downcomer Wall (and Feedwater Sparger)	L	L	L	L	L	K
327		Pressure Change in Upper Downcomer	L	M	M	H	M	K
328		Change in water level in upper down comer	H	L	L	L	L	K
329		Gas Flow in Upper Downcomer	L	L	L	L	L	K
330		Gas Temperature Change in Upper Downcomer	L	L	L	H	M	K
331		Gas Composition Change in Upper Downcomer	L	L	L	L	H	K
332		Upper Downcomer Wall (and Feedwater Sparger) Break or Deformation by Thermal Stress	L	L	L	L	L	K
333		Upper Downcomer Wall (and Feedwater Sparger) Oxidation with Steam (Including Reaction Heat and Hydrogen Production)	L	L	L	L	M	K
334		FP deposition on upper down comer	L	L	L	M	M	P
335		FP re-vaporization	L	L	L	M	M	P
336		Decay heat generation from FP	L	L	L	M	M	K
337		FP reaction including iodine chemistry	L	L	L	L	L	P
338		Radiation heat transfer to drywell	M	M	M	M	L	K
339		Corrosion of Upper Head by Seasalt (Including Marine Lives)	L	L	L	L	L	U
340		Influence for heat transfer by salt deposition	L	L	L	L	L	U
341		Re-solution of salt by reflooding	L	L	L	L	L	K
342		Influence on Instrumentation and Measurements by Seasalt Concentration Change	L	L	L	L	L	U
343		Corrosion of Upper Head by Boron	L	L	L	L	L	U
344		Influence for heat transfer by boron deposition	L	L	L	L	L	U
345		Re-solution of boron by reflooding	L	L	L	L	L	K
346		Seasalt impact for FP reaction and composition	L	L	L	L	L	P
347		Gas Flow to Main Steam Line	L	L	L	M	M	K
348		FP Flow to Main Steam Line	L	L	L	M	M	K
349		Gas Flow to Feedwater Line	L	L	L	M	M	K
350		FP Flow to Feedwater Line	L	L	L	M	M	K
351		Heat Transfer to Drywell through Lagging Material	M	M	M	M	L	K
352		Failure of RPV nozzle welding by thermal stress	N/A	M	M	M	L	P
353		Degradation or Falling of Lagging Material	M	M	M	M	L	P
354		Lower D/C	Heat transfer between water and shroud wall	L	H	H	L	L
355	Heat transfer between water and jet pump		L	L	L	L	L	K
356	Heat transfer between water and pump deck		L	L	L	L	L	K
357	Heat transfer between water and RPV wall		L	L	M	L	L	K
358	Heat transfer between gas and shroud wall		L	L	L	M	L	K
359	Heat transfer between gas and jet pump		L	L	L	L	L	K

360	Heat transfer between gas and pump deck	L	L	L	L	L	K
361	Heat transfer between gas and RPV wall	L	L	L	M	L	K
362	Heat transfer between water and corium	N/A	N/A	H	L	L	P
363	Heat transfer between gas and corium	N/A	N/A	M	M	L	P
364	Heat transfer between corium and shroud wall	N/A	N/A	H	L	L	P
365	Heat transfer between corium and jet pump	N/A	N/A	M	L	L	P
366	Heat transfer between corium and pump deck	N/A	N/A	M	L	L	P
367	Heat transfer between corium and RPV wall	N/A	N/A	H	L	L	P
368	Heat transfer between water and crust	N/A	N/A	M	L	L	P
369	Heat transfer between gas and crust	N/A	N/A	M	L	L	P
370	Heat transfer between corium and crust	N/A	N/A	H	L	L	P
371	Heat transfer between crust and shroud wall	N/A	N/A	H	L	L	P
372	Heat transfer between crust and jet pump	N/A	N/A	M	L	L	P
373	Heat transfer between crust and pump deck	N/A	N/A	M	L	L	P
374	Heat transfer between crust and RPV wall	N/A	N/A	H	L	L	P
375	Heat transfer between water and particulate corium	N/A	N/A	H	L	L	P
376	Heat transfer between gas and particulate corium	N/A	N/A	H	M	L	P
377	Heat transfer between particulate corium and shroud wall	N/A	N/A	H	L	L	P
378	Heat transfer between particulate corium and jet pump	N/A	N/A	M	L	L	P
379	Heat transfer between particulate corium and pump deck	N/A	N/A	M	L	L	P
380	Heat transfer between particulate corium and RPV wall	N/A	N/A	H	L	L	P
381	Heat Transfer to Drywell through Lagging Material	M	M	M	M	L	K
382	Radiation heat transfer between corium and shroud wall	N/A	N/A	M	L	L	P
383	Radiation heat transfer between corium and jet pump	N/A	N/A	M	L	L	P
384	Radiation heat transfer between corium and pump deck	N/A	N/A	M	L	L	P
385	Radiation heat transfer between corium and RPV wall	N/A	N/A	M	L	L	P
386	Radiation heat transfer between particulate corium and shroud wall	N/A	N/A	M	L	L	P
387	Radiation heat transfer between particulate corium and jet pump	N/A	N/A	M	L	L	P
388	Radiation heat transfer between particulate corium and pump deck	N/A	N/A	M	L	L	P
389	Radiation heat transfer between particulate corium and RPV wall	N/A	N/A	M	L	L	P
390	Radiation heat transfer between crust and shroud wall	N/A	N/A	M	L	L	P
391	Radiation heat transfer between crust and jet pump	N/A	N/A	L	L	L	P
392	Radiation heat transfer between crust and pump deck	N/A	N/A	M	L	L	P
393	Radiation heat transfer between crust and RPV wall	N/A	N/A	M	L	L	P
394	Radiation heat transfer to drywell	M	M	M	M	L	K
395	Heat generation by gamma ray in Lower D/C structure	L	L	M	L	L	K
396	Failure of shroud wall by thermal stress	L	L	M	L	L	P
397	Failure of RPV nozzle welding by thermal stress	N/A	N/A	M	M	L	P
398	CCFL in suction part in jet pump	L	L	L	L	L	K
399	Change in water level in Lower D/C	H	H	M	L	L	K
400	Change in pressure in Lower D/C	L	M	M	M	L	K
401	Change of flow regime in Lower D/C	L	L	L	L	L	K
402	Decompression boiling	H	L	M	L	L	K
403	Change in water temperature in Lower D/C	M	L	M	L	L	K
404	Change in gas temperature in lower down comer	L	L	M	L	L	K
405	Change in gas composition in Lower D/C	L	L	L	L	H	K
406	Change in temperature in shroud wall	M	M	H	L	L	K
407	Change in temperature in jet pumps	L	L	H	L	L	K
408	Change in temperature in pump deck	L	L	H	L	L	K
409	Change in temperature in RPV sidewall	M	M	H	M	L	K
410	Corium relocation type through breached core shroud to lower plenum	N/A	N/A	H	M	M	P
411	Corium spreading in Lower D/C	N/A	N/A	H	L	L	U
412	Ablation of outer wall surface of shroud by corium	N/A	N/A	H	L	L	P



413	Change in area of failure opening in shroud	N/A	N/A	H	M	L	K
414	Flow of water and gas through failure opening in shroud	N/A	N/A	M	M	L	K
415	Corium submerged in water by water injection	N/A	N/A	H	L	L	K
416	FCI pre-mixing by contact between corium and water pool	N/A	N/A	H	M	L	P
417	FCI triggering by vapor film collapse	N/A	N/A	H	M	M	P
418	Atomization of corium in water pool and rapid steam generation (FCI)	N/A	N/A	H	M	M	P
419	Pressure wave by FCI	N/A	N/A	H	M	L	P
420	Temperature increases of water and gas by FCI	N/A	N/A	H	M	L	P
421	Failure of RPV lower head by FCI	N/A	N/A	H	M	L	P
422	Scattering of corium, particulate corium and crust in Lower D/C by FCI	N/A	N/A	H	M	L	P
423	Impact for FCI by seawater	N/A	N/A	L	L	L	U
424	Change in corium temperature	N/A	N/A	H	L	L	P
425	Blockage of failure opening in Lower D/C by freezing of corium	N/A	N/A	H	L	L	U
426	Change in physical property by material mixing in corium	N/A	N/A	H	L	L	P
427	Oxidation reaction between corium and water (steam) (including hydrogen generation and reaction heat)	N/A	N/A	M	L	M	U
428	Oxidation reaction between shroud and steam (including hydrogen generation and reaction heat)	L	M	M	L	M	P
429	Oxidation reaction between jet pump and steam (including hydrogen generation and reaction heat)	L	L	L	L	L	P
430	Oxidation reaction between pump deck and steam (including hydrogen generation and reaction heat)	L	L	L	L	L	P
431	Oxidation reaction between RPV sidewall and steam (including hydrogen generation and reaction heat)	L	L	L	L	M	P
432	Crust generation by solidification of corium	N/A	N/A	H	L	L	P
433	Crust remelting due to change in the heat transfer status to corium or water	N/A	N/A	M	L	L	P
434	Particulate corium remelting due to change in the heat transfer status	N/A	N/A	M	L	L	P
435	Corium spreading in circumferential direction in Lower D/C	N/A	N/A	M	L	L	P
436	Decay heat in corium	N/A	N/A	H	L	L	P
437	Relocation of corium by failure of pump deck	N/A	N/A	M	L	L	P
438	Relocation of corium by failure of jet pump	N/A	N/A	M	L	L	P
439	Particulation of corium by contact with water	N/A	N/A	H	L	L	P
440	Change in physical property of particulate corium	N/A	N/A	H	L	L	P
441	Change in size and shape of particulate corium	N/A	N/A	M	L	L	P
442	Entrainment of particulate corium from corium falling into water	N/A	N/A	H	L	L	P
443	Aggregation and bed formation of particulate corium	N/A	N/A	H	L	L	P
444	Change in temperature of particulate corium	N/A	N/A	H	L	L	P
445	Decay heat in particulate corium	N/A	N/A	H	L	L	P
446	Change in temperature of crust	N/A	N/A	H	L	L	P
447	Bubble formation in crust	N/A	N/A	M	L	L	P
448	Water inflow into crust through crack on surface of crust	N/A	N/A	M	L	L	P
449	Decay heat in crust	N/A	N/A	H	L	L	P
450	Change in physical property by material mixing in crust	N/A	N/A	M	L	L	P
451	Oxidation reaction between crust and water (steam) (including hydrogen generation and reaction heat)	N/A	N/A	M	L	L	U
452	Flow path blockage in Lower D/C (including jet pump) by crust	N/A	N/A	H	L	L	P
453	Recriticality	N/A	N/A	M	L	L	P
454	Flow of corium (including particulate corium) out of RPV side wall	N/A	N/A	N/A	M	L	P
455	Flow of corium (including particulate corium) into recirculation loop piping	N/A	N/A	M	L	L	P
456	Radiation decomposition of water	L	L	L	L	L	K
457	FP deposition on Lower D/C	L	L	L	L	L	P
458	FP re-vaporization	L	L	L	L	L	P
459	Decay heat generation from FP	L	L	L	L	L	P
460	FP release from corium surface	N/A	N/A	M	M	M	U
461	FP reaction including iodine chemistry	L	L	L	L	L	P
462	Adsorption and release of gaseous FP	L	L	L	L	L	P
463	Thermal failure of pump deck by radiation heat transfer from lower head	N/A	N/A	H	L	M	K
464	Corrosion of structure in Lower D/C by salt content of seawater (including marine lives)	L	L	L	L	L	U
465	Seasalt intake to corium	N/A	N/A	M	M	M	U

466		Influence for heat transfer by salt deposition	L	L	L	L	L	U
467		Flow path blockage in jet pump by salt deposition	L	L	L	L	L	U
468		Re-solution of salt by reflooding	L	L	L	L	L	P
469		Influence on Heat Transfer by Seasalt Concentration Change	L	L	L	L	L	P
470		Influence on Instrumentation and Measurements by Seasalt Concentration Change	L	L	L	L	L	U
471		Seasalt impact for FP reaction and composition	L	L	L	L	L	P
472		Corrosion of structure in Lower D/C by boron	L	L	L	L	L	U
473		Influence for heat transfer by boron deposition	L	L	L	L	L	P
474		Flow path blockage in jet pump by boron deposition	L	L	L	L	L	U
475		Re-solution of boron by reflooding	L	L	L	L	L	P
476		Degradation or Falling of Lagging Material	M	M	M	M	L	P
477	Lower head	Heat transfer between water and lower head including crack	L	L	H	M	L	K
478		Heat transfer between water and penetration tubes (control rod guide tubes, drain lines, and instrumentation tubes)	L	L	H	M	L	K
479		Heat transfer between gas and lower head including crack	N/A	L	H	L	L	K
480		Heat transfer between gas and penetration tubes (control rod guide tubes, drain lines, and instrumentation tubes)	N/A	L	M	L	L	K
481		Heat transfer between corium and water (including CHF)	N/A	N/A	H	M	L	P
482		Heat transfer between corium and gas	N/A	N/A	H	M	M	P
483		Heat transfer between corium and penetration tubes (control rod guide tubes, drain lines, and instrumentation tubes)	N/A	N/A	H	M	L	P
484		Heat transfer between corium and lower head	N/A	N/A	H	M	L	P
485		Heat transfer between particulate corium and water	N/A	N/A	H	L	L	P
486		Heat transfer between particulate corium and gas	N/A	N/A	H	M	M	U
487		Heat transfer between particulate corium and penetration tubes (control rod guide tubes, drain lines, and instrumentation tubes)	N/A	N/A	H	L	L	U
488		Heat transfer between particulate corium and lower head	N/A	N/A	H	L	L	P
489		Heat transfer between particulate corium and light metal layer	N/A	N/A	H	L	L	U
490		Heat transfer between crust and water (including CHF, inner crack and gap)	N/A	N/A	H	L	L	P
491		Heat transfer between crust and gas	N/A	N/A	M	L	L	P
492		Heat transfer between corium and crust	N/A	N/A	H	M	L	P
493		Heat transfer between crust and penetration tubes (control rod guide tubes, drain lines, and instrumentation tubes)	N/A	N/A	H	M	L	P
494		Heat transfer between crust and lower head	N/A	N/A	H	M	L	P
495		Heat transfer between crust and light metal layer	N/A	N/A	M	L	L	P
496		Heat transfer between light metal layer and water (including CHF)	N/A	N/A	M	L	L	P
497		Heat transfer between light metal layer and gas	N/A	N/A	L	L	L	P
498		Heat transfer between light metal layer and penetration tubes (control rod guide tubes, drain lines, and instrumentation tubes)	N/A	N/A	M	L	L	P
499		Heat transfer between light metal layer and lower head	N/A	N/A	M	M	L	P
500		Heat transfer between heavy metal layer in corium pool and lower head	N/A	N/A	L	L	L	P
501		Heat transfer between heavy metal layer in corium pool and penetration tubes (control rod guide tubes, drain lines, and instrumentation tubes)	N/A	N/A	L	L	L	P
502		Heat transfer between heavy metal layer in corium pool and metal-oxide layer in corium	N/A	N/A	L	L	L	P
503		Radiation heat transfer between particulate corium and core	N/A	N/A	M	L	M	K
504		Radiation heat transfer between light metal layer and core	N/A	N/A	M	L	M	K
505		Radiation heat transfer between corium and lower head	N/A	N/A	H	L	L	K
506		Particulate Corium Bed Porosity	N/A	N/A	H	M	L	P
507		Change in temperature of penetration tubes (control rod guide tubes, drain lines, and instrumentation tubes)	L	L	H	L	H	K
508		Change in temperature of RPV lower head	L	L	H	M	M	K
509		Deformation of RPV lower head by thermal stress	L	L	H	M	L	K
510		Failure of RPV nozzle welding by thermal stress	N/A	N/A	M	M	L	P
511	Oxidation reaction between penetration tubes (control rod guide tubes, drain lines, and instrumentation tubes) and steam (including hydrogen generation and reaction heat)	N/A	L	M	L	H	P	
512	Oxidation reaction between lower head and steam (including hydrogen generation and reaction heat)	N/A	L	M	L	M	P	
513	Change in pressure in lower plenum	L	L	H	H	M	K	
514	Change in water temperature in lower plenum	L	L	M	L	L	K	
515	Change in gas temperature in lower plenum	L	L	M	M	M	K	

516	Change in gas composition in lower plenum	L	L	L	L	H	K
517	Decompression boiling	M	L	M	L	M	K
518	Change in temperature inside corium	N/A	N/A	H	M	L	P
519	Non-uniform corium spreading in lower head	N/A	N/A	H	M	L	P
520	Evaporation of materials from inside corium (including FP)	N/A	N/A	M	L	L	P
521	Corium jet into water pool	N/A	N/A	H	M	M	P
522	Formation of corium pool	N/A	N/A	H	M	L	P
523	Stratification of corium pool	N/A	N/A	H	M	L	P
524	Atomization of corium by contact with water (jet breakup)	N/A	N/A	H	M	L	P
525	Change in temperature in light metal layer	N/A	N/A	H	M	L	P
526	Change in temperature in heavy metal layer	N/A	N/A	H	M	L	P
527	Change in composition of particulate corium	N/A	N/A	H	M	L	P
528	Change in size and shape of particulate corium	N/A	N/A	H	L	L	P
529	Crust generation by solidification of corium	N/A	N/A	H	L	L	P
530	Accumulation and bed formation of particulate corium	N/A	N/A	H	L	L	P
531	Non-uniform spreading of particulate corium bed	N/A	N/A	H	M	L	P
532	Change in temperature of particulate corium bed	N/A	N/A	H	M	L	P
533	Decay heat in particulate corium	N/A	N/A	H	M	L	P
534	Oxidation reaction between light metal layer and water (steam) (including hydrogen generation and reaction heat)	N/A	N/A	M	L	H	P
535	FCI pre-mixing by contact between corium and water pool	N/A	N/A	H	L	L	P
536	FCI triggering by vapor film collapse	N/A	N/A	H	M	M	P
537	Particulation of corium in water pool and rapid steam generation (FCI)	N/A	N/A	H	M	M	P
538	Pressure wave by FCI	N/A	N/A	H	M	M	P
539	Temperature increases by FCI	N/A	N/A	H	M	M	P
540	Failure of RPV lower head by FCI	N/A	N/A	H	M	M	P
541	Scattering of corium and material in lower plenum by FCI	N/A	N/A	H	M	M	P
542	Impact for FCI by seawater	N/A	N/A	L	L	L	U
543	Mixing state and physical property of corium	N/A	N/A	H	M	L	P
544	Oxidation reaction between corium and water (steam) (including hydrogen generation and reaction heat)	N/A	N/A	M	L	M	U
545	Natural convection in corium pool	N/A	N/A	H	L	L	P
546	Decay heat of corium	N/A	N/A	H	L	L	P
547	Solidification of corium	N/A	N/A	H	M	L	P
548	Flow of water in lower plenum	L	L	H	L	L	K
549	Reflooding of molten material in lower plenum by water injection	N/A	N/A	H	M	M	K
550	Flow of gas in lower plenum	L	L	M	L	L	K
551	Change in an amount of purge water in CRD guide tube	M	L	H	L	L	K
552	Change in water level in lower plenum	M	M	H	L	M	K
553	Radiation decomposition of water	L	L	L	L	L	K
554	Bubble formation in crust	N/A	N/A	M	L	L	P
555	Water inflow into crust through crack on surface of crust	N/A	N/A	M	M	L	P
556	Oxidation reaction between crust and water (steam) (including hydrogen generation and reaction heat)	N/A	N/A	M	L	M	U
557	Change in physical property by material mixing in crust	N/A	N/A	H	M	M	U
558	Change in temperature of crust	N/A	N/A	H	M	M	P
559	Decay heat in crust	N/A	N/A	H	L	L	P
560	Recriticality	N/A	N/A	H	M	L	P
561	Gap formation between corium and lower head	N/A	N/A	H	M	L	P
562	Inflow of coolant into gap between corium and lower head	N/A	N/A	H	M	M	P
563	Crack formation on lower head	N/A	N/A	H	L	L	P
564	Inflow of coolant into crack on lower head	N/A	N/A	H	L	L	P
565	Corrosion of lower head by corium jet	N/A	N/A	H	M	M	P
566	Erosion of lower head by corium pool	N/A	N/A	H	M	M	P
567	Flow of corium out of lower head bottom section by lower head failure	N/A	N/A	N/A	H	L	P
568	Crust remelting due to change in the heat transfer status to corium or water	N/A	N/A	H	L	L	P

569	Particulate corium remelting due to change in the heat transfer status	N/A	N/A	H	L	L	P
570	Change in area of failure opening in lower head bottom section	N/A	N/A	N/A	H	L	P
571	Formation of flow path by ablation between control rod guide tubes and lower plenum	N/A	N/A	H	M	M	P
572	Formation of flow path by jet impingement to control rod guide tubes	N/A	N/A	H	M	M	P
573	Flow of corium through failed control rod guide tubes from/to lower plenum	N/A	N/A	H	M	L	P
574	Flow of water through failed control rod guide tubes from/to lower plenum	N/A	N/A	H	M	L	P
575	Flow of gas through failed control rod guide tubes from/to lower plenum	N/A	N/A	H	H	M	P
576	Purge water steaming in control rod guide tubes due to corium inflow	N/A	N/A	M	M	M	P
577	Formation of flow path to pedestal by ablation of control rod guide tube internals	N/A	N/A	N/A	H	H	P
578	Changes in breached area in control rod guide tubes to pedestal (including blockage)	N/A	N/A	N/A	M	M	P
579	Ejection of control rod guide tubes	N/A	N/A	N/A	H	H	P
580	Flow of corium out of control rod guide tubes into pedestal	N/A	N/A	N/A	H	L	P
581	Flow of water out of control rod guide tubes into pedestal	N/A	N/A	N/A	H	H	P
582	Flow of gas out of control rod guide tubes into pedestal	N/A	N/A	N/A	H	H	P
583	Formation of flow path between SRM/IRM tubes and lower plenum	N/A	N/A	M	M	M	P
584	Formation of flow path by jet impingement to SRM/IRM tubes	N/A	N/A	M	M	M	P
585	Flow of corium through failed SRM/IRM tubes from/to lower plenum	N/A	N/A	M	M	L	P
586	Flow of water through failed SRM/IRM tubes from/to lower plenum	N/A	N/A	M	M	L	P
587	Flow of gas through failed SRM/IRM tubes from/to lower plenum	N/A	N/A	M	H	M	P
588	Ejection of SRM/IRM tubes	N/A	N/A	N/A	H	M	P
589	Flow of corium out of SRM/IRM tubes into pedestal	N/A	N/A	N/A	M	L	P
590	Flow of water out of SRM/IRM tubes into pedestal	N/A	N/A	N/A	M	M	P
591	Flow of gas out of SRM/IRM tubes into pedestal	N/A	N/A	N/A	H	M	P
592	Formation of flow path between TIP/ICM tubes and lower plenum	N/A	N/A	H	H	H	P
593	Formation of flow path by jet impingement to TIP/ICM tubes	N/A	N/A	M	M	M	P
594	Flow of corium through failed TIP/ICM tubes from/to lower plenum	N/A	N/A	M	M	L	P
595	Flow of water through failed TIP/ICM tubes from/to lower plenum	N/A	N/A	M	M	L	P
596	Flow of gas through failed TIP/ICM tubes from/to lower plenum	N/A	N/A	M	H	M	P
597	Formation of flow path to Pedestal by ablation of TIP/ICM tube internals	N/A	N/A	N/A	H	H	P
599	Ejection of TIP/ICM tubes	N/A	N/A	N/A	H	M	P
600	Flow of corium out of TIP/ICM tubes into pedestal	N/A	N/A	N/A	M	L	P
601	Flow of water out of TIP/ICM tubes into pedestal	N/A	N/A	N/A	M	M	P
602	Flow of gas out of TIP/ICM tubes into pedestal	N/A	N/A	N/A	H	M	P
603	Flow of gas out of TIP tubes into PCV	N/A	N/A	N/A	H	H	P
604	Formation of flow path to Pedestal by ablation of RPV drain lines	N/A	N/A	N/A	M	M	P
605	Changes in breached area in RPV drain lines to pedestal (including blockage)	N/A	N/A	N/A	M	M	P
606	Flow of corium out of RPV drain lines into pedestal	N/A	N/A	N/A	M	M	P
607	Flow of water out of RPV drain lines into pedestal	N/A	N/A	N/A	M	M	P
608	Flow of gas out of RPV drain lines into pedestal	N/A	N/A	N/A	M	M	P
609	Deformation of lower head	N/A	N/A	H	L	L	P
610	Corium Focusing Effect on Lower Head Sidewall	N/A	N/A	L	L	L	P
611	Change in area of failure opening in lower head side section	N/A	N/A	N/A	M	M	P
612	Flow of corium out of lower head side section by lower head failure	N/A	N/A	N/A	H	L	P
613	Failure of shroud support leg	N/A	N/A	M	L	L	P
614	Change in flow resistance in shroud support leg	N/A	N/A	L	L	L	K
615	FP deposition on lower head	L	L	L	L	L	P
616	FP re-vaporization	L	L	L	L	L	K
617	Decay heat generation from FP	L	L	M	L	L	K
618	FP release from corium surface	N/A	N/A	M	M	M	U
619	FP reaction including iodine chemistry	L	L	L	L	L	P
620	Adsorption and release of gaseous FP	L	L	L	L	L	P
621	Buckling of Control Rod Guide Tubes	N/A	H	L	L	M	K

622		Radiation heat transfer between corium and pump deck bottom surface	N/A	N/A	H	L	H	P
623		Corrosion of structure in lower plenum by salt content of seawater (including marine lives)	L	L	L	L	L	U
624		Melting point change for lower head materials	N/A	N/A	H	M	M	P
625		Eutectic (Corium and lower head materials)	N/A	N/A	H	M	M	P
626		Melting of lower head penetration lines	N/A	N/A	H	H	H	P
627		Melting of lower head wall	N/A	N/A	H	M	M	P
628		Melting of jet pump	N/A	N/A	M	L	L	P
629		Melting of pump deck	N/A	N/A	M	L	L	P
630		Melting of shroud	N/A	N/A	M	L	L	P
631		Influence for heat transfer by salt deposition	L	L	M	L	L	U
632		Seasalt intake to corium	N/A	N/A	H	H	H	U
633		Seasalt impact for corium thermodynamic properties	N/A	N/A	H	L	L	U
634		Re-solution of salt by reflooding	L	L	M	L	L	P
635		Influence on Heat Transfer by Seasalt Concentration Change	L	L	L	L	L	P
636		Influence on Instrumentation and Measurements by Seasalt Concentration Change	L	L	L	L	L	U
637		Seasalt impact for FP reaction and composition	L	L	L	L	L	P
638		Corrosion of structure in lower plenum by boron	L	L	L	L	L	U
639		Influence for heat transfer by boron deposition	L	L	M	L	L	U
640		Re-solution of boron by reflooding	L	L	M	L	L	P
641	Recirculation Loop	Heat transfer between recirculation loop piping and water	L	L	L	L	L	K
642		Heat transfer between recirculation loop piping and gas	L	L	L	L	L	K
643		Heat Transfer to Drywell through Lagging Material	L	L	L	L	L	K
644		Radiation heat transfer to drywell	L	L	L	L	L	K
645		Change in temperature of recirculation loop piping	L	L	L	L	M	K
646		Change in pressure in recirculation loop piping	L	L	L	L	M	K
647		Change in water level in recirculation loop piping	L	L	L	L	M	K
648		Change in water temperature in recirculation loop piping	L	L	L	L	M	K
649		Change in flow of water and/or steam in in recirculation loop piping (including flow regime)	L	L	L	L	L	K
650		Change in gas temperature in recirculation loop piping	L	L	L	L	M	K
651		Change in gas composition in recirculation loop piping	L	L	L	L	H	K
652		Change in flow of corium in recirculation loop piping	N/A	N/A	L	L	L	P
653		Oxidation reaction between recirculation loop piping and steam (including hydrogen generation and reaction heat)	L	L	L	L	M	P
654		Leakage of gas from breached gasket or PLR pump seal	N/A	M	H	M	H	K
655		Leakage of water from breached gasket or PLR pump seal	N/A	M	H	M	M	K
656		Water Radiolysis	L	L	L	L	L	K
657		Bubble formation in crust	N/A	N/A	L	L	L	P
658		Flow path blockage in recirculation loop piping by solidification of corium	N/A	N/A	L	L	L	U
659		Corrosion of structure in recirculation loop piping by salt content of seawater (including marine lives)	L	L	L	L	L	U
660		Influence for heat transfer by salt deposition	L	L	M	L	L	U
661		Seasalt intake to corium	N/A	N/A	L	L	L	U
662		Re-solution of salt by reflooding	L	L	L	L	L	P
663		Influence on Heat Transfer by Seasalt Concentration Change	L	L	L	L	L	P
664		Influence on Instrumentation and Measurements by Seasalt Concentration Change	L	L	L	L	L	U
665		Seasalt impact for FP reaction and composition	L	L	L	L	L	P
666		Corrosion of structure in recirculation loop piping by boron	L	L	L	L	L	U
667		Influence for heat transfer by boron deposition	L	L	L	L	L	P
668		Re-solution of boron by reflooding	L	L	L	L	L	P
669		FP deposition on recirculation loop	L	L	L	L	L	P
670		FP re-vaporization	L	L	L	L	L	K
671		Decay heat generation from FP	L	L	L	L	L	K
672		Leakage of FP from recirculation loop piping	L	L	M	L	L	K
673		FP release from corium surface	N/A	N/A	M	M	M	U

674			FP reaction including iodine chemistry	L	L	L	L	L	P
675			Adsorption and release of gaseous FP	L	L	L	L	L	P
676			Melting of recirculation piping	N/A	N/A	M	L	L	P
677			Degradation or Falling of Lagging Material	L	L	L	L	L	P
678	PCV	Pedestal/Cavity	Liquid film flow of corium at outer surface of penetration pipes (control rod guide tube, drain line, instrumentation tube) sticking out from RPV bottom (<- Liquid film flow of corium at protrusion surface of penetration pipes (control rod guide tube, drain line, instrumentation tube) )	N/A	N/A	N/A	M	L	P
679			Thermal conduction of penetration pipes (control rod guide tube, drain line, instrumentation tube) sticking out from RPV bottom (<- Thermal conduction on protrusion surface of penetration pipes (control rod guide tube, drain line, instrumentation tube) )	L	L	L	M	L	P
680			Heat transfer between corium and outer surface of penetration pipes (control rod guide tube, drain line, instrumentation tube) sticking out from RPV bottom (<- Heat transfer between corium and outer surface of protrusion on penetration pipes (control rod guide tube, drain line, instrumentation tube) )	N/A	N/A	N/A	M	L	P
681			Heat transfer between corium and water (including CHF)	N/A	N/A	N/A	H	H	P
682			Heat transfer between corium and gas	N/A	N/A	N/A	H	H	P
683			Heat transfer between crust and water (including CHF)	N/A	N/A	N/A	H	H	P
684			Heat transfer between crust and gas	N/A	N/A	N/A	H	H	P
685			Heat transfer between crust and corium (including heat transfer enhancement at gas generation due to MCC1)	N/A	N/A	N/A	H	H	P
686			Heat transfer between corium particle and water	N/A	N/A	N/A	H	H	P
687			Heat transfer between corium particle and gas	N/A	N/A	N/A	H	H	P
688			Heat transfer between corium particle and pedestal floor/wall	N/A	N/A	N/A	H	H	P
689			Heat transfer between pedestal floor/wall and corium	N/A	N/A	N/A	H	H	P
690			Heat transfer between pedestal floor/wall and crust	N/A	N/A	N/A	H	H	P
691			Heat transfer between pedestal floor/wall and water	L	L	L	H	H	P
692			Heat transfer between pedestal floor/wall and gas	L	L	L	M	L	P
693			Heat transfer from lower head to gas in pedestal region	L	L	L	M	L	P
694			Heat transfer from protrusion of penetration pipes (control rod guide tube, drain line, instrumentation tube) to water (leak flow)	N/A	N/A	N/A	M	L	K
695			Heat transfer from protrusion of penetration pipes (control rod guide tube, drain line, instrumentation tube) to gas	L	L	L	M	L	K
696			Radiation between lower head and pedestal floor/wall	L	L	L	M	L	K
697			Radiation between lower head and pedestal internal structure	L	L	L	M	L	K
698			Radiation between corium and pedestal wall	N/A	N/A	N/A	M	M	K
699			Radiation between corium and RPV wall	N/A	N/A	N/A	M	M	K
700			Radiation between corium and pedestal internal structure	N/A	N/A	N/A	M	M	K
701			Radiation between crust and pedestal wall	N/A	N/A	N/A	M	M	K
702			Radiation between crust and RPV wall	N/A	N/A	N/A	M	M	K
703			Radiation between crust and pedestal internal structure	N/A	N/A	N/A	M	M	K
704			Radiation between corium particle and pedestal wall	N/A	N/A	N/A	M	M	K
705			Radiation between corium particle and RPV wall	N/A	N/A	N/A	M	M	K
706			Radiation between corium particle and pedestal internal structure	N/A	N/A	N/A	L	L	K
707			Particulate Corium Bed Porosity	N/A	N/A	N/A	H	L	P
708			Pedestal deformation/failure due to thermal stress	N/A	N/A	N/A	L	L	P
709			Pedestal wall heatup due to corium adhesion to pedestal wall	N/A	N/A	N/A	H	H	P
710			Pressure change in pedestal	L	L	L	H	M	K
711			Gas temperature change in pedestal	L	L	L	H	M	K
712			Water temperature change in pedestal	L	L	L	H	L	K
713			Thermal conduction / Temperature change of corium	N/A	N/A	N/A	H	H	P
714			Thermal conduction / Temperature change of crust	N/A	N/A	N/A	H	H	P
715			Thermal conduction / Temperature change of pedestal floor/wall	L	L	L	H	H	K
716			Gas flow in pedestal internal space	L	L	L	H	M	K
717			Local gas flow and turbulence	L	L	L	L	L	P
718			Water flow on pedestal floor	L	L	L	H	L	K
719			Ejection conditions (corium, mixture state of water/steam) of corium jet	N/A	N/A	N/A	H	H	P
720			Oxidation of grating due to collision of corium jet with grating and oxidation	N/A	N/A	N/A	L	H	U
721			Splash of corium towards pedestal floor by collision of	N/A	N/A	N/A	L	H	P

	corium with grating						
722	Gas composition change in pedestal	L	L	L	M	H	K
723	Erosion of pedestal floor / wall	N/A	N/A	N/A	H	H	P
724	Physical properties of concrete ingredients (C, Si, etc.)	N/A	N/A	N/A	H	H	P
725	Mass transfer of concrete ingredients into corium	N/A	N/A	N/A	H	H	P
726	Water evaporation from concrete by concrete heating	N/A	N/A	N/A	H	H	P
727	Gas generation (H <sub>2</sub> , CO, CO <sub>2</sub> , etc.) from concrete-corium interaction (reaction?)	N/A	N/A	N/A	H	H	P
728	Aerosol generation from concrete-corium interaction (reaction?)	N/A	N/A	N/A	H	H	P
729	Heat generation from chemical reaction between corium and concrete ingredients	N/A	N/A	N/A	H	H	P
730	Corium flow / spread in pedestal	N/A	N/A	N/A	H	M	P
731	Corium flow into drywel by spread in pedestal (Mark-I)	N/A	N/A	N/A	H	H	P
732	Corium entrainment in pedestal by sparging gas	N/A	N/A	N/A	H	H	P
733	Generation of corium particle due to breakup at jet drop	N/A	N/A	N/A	H	H	P
734	Corium ejection from crack in the crust (inclusion generation of corium particle)	N/A	N/A	N/A	H	H	P
735	Outflow of corium particle with water flow	N/A	N/A	N/A	L	H	P
736	Composition of corium particle	N/A	N/A	N/A	M	M	P
737	Size / configuration of corium particle	N/A	N/A	N/A	M	M	P
738	Aggregation / debris bed formation of corium particle	N/A	N/A	N/A	M	M	P
739	Generation / attenuation of decay heat from corium particle	N/A	N/A	N/A	H	H	P
740	Temperature change of corium particle bed	N/A	N/A	N/A	H	H	P
741	Corium solidification	N/A	N/A	N/A	H	M	P
742	Generation / attenuation of decay heat from corium	N/A	N/A	N/A	H	H	P
743	Oxidation reaction (including generation of hydrogen and reaction heat) between corium ingredients and water (steam)	N/A	N/A	N/A	H	H	U
744	Mixture state (fuel, structure, concrete, etc.) and physical properties of corium ingredients	N/A	N/A	N/A	H	H	P
745	Corium stratification	N/A	N/A	N/A	H	M	P
746	Remixing of corium stratification associated with corium flow and internal gas generation	N/A	N/A	N/A	H	M	P
747	Change in corium deposit conditions on the pedestal floor	N/A	N/A	N/A	H	L	P
748	Crust segregation and waftage	N/A	N/A	N/A	H	M	P
749	Crust generation on the surface of penetration pipes sticking out of RPV lower head	N/A	N/A	N/A	H	L	U
750	Crust remelting due to change in the heat transfer status to corium or water	N/A	N/A	N/A	H	H	P
751	Particulate corium remelting due to change in the heat transfer status	N/A	N/A	N/A	H	H	P
752	Water flow into crust	N/A	N/A	N/A	H	M	P
753	Bubble formation in crust	N/A	N/A	N/A	M	M	P
754	Crack generation in crust	N/A	N/A	N/A	H	M	P
755	Generation / attenuation of decay heat from crust	N/A	N/A	N/A	H	H	K
756	Oxidation reaction (including generation of hydrogen and reaction heat) between crust ingredients and water (steam)	N/A	N/A	N/A	M	H	U
757	Mixture state (fuel, structure, concrete, etc.) and physical properties of crust	N/A	N/A	N/A	H	H	P
758	Recriticality	N/A	N/A	N/A	H	L	P
759	Oxidation (including generation of hydrogen and reaction heat) of pedestal wall by steam	L	L	L	M	H	P
760	Radiation decomposition of water	L	L	L	L	L	K
761	FCI's premixing due to corium contact to water pool	N/A	N/A	N/A	M	M	P
762	FCI triggering by vapor film collapse	N/A	N/A	N/A	H	M	P
763	Corium atomization and rapid steam generation (FCI) in water pool	N/A	N/A	N/A	H	H	P
764	Pressure wave due to FCI	N/A	N/A	N/A	H	M	P
765	Temperature increas of water and gas by FCI	N/A	N/A	N/A	H	M	P
766	Pedestal failure due to FCI	N/A	N/A	N/A	H	H	P
767	Dispersion of corium and pedestal internal material due to FCI	N/A	N/A	N/A	H	H	P
768	Impact for FCI by seawater	N/A	N/A	N/A	L	L	U
769	Droplet behavior in the pedestal free space	L	L	L	L	L	P
770	Condensation heat transfer on the pedestal wall and internal surfaces	L	L	L	L	L	P
771	Interaction between gas and water film flow on the pedestal wall and internal surfaces	L	L	L	L	L	P
772	FP particle transport by gas in the pedestal	L	L	L	L	L	P

773		FP particle agglomeration/fragmentation in the pedestal	L	L	L	L	L	P
774		FP particle deposition on the pedestal wall and internal surfaces	L	L	L	L	L	P
775		FP transport by water flow on the pedestal wall and internal surfaces	L	L	L	L	L	P
776		FP re-entrainment	L	L	L	L	L	P
777		FP deposition on pedestal wall	L	L	L	M	M	P
778		FP re-vaporization	L	L	L	M	M	K
779		Decay heat generation from FP	L	L	L	M	M	K
780		FP release from corium surface	N/A	N/A	N/A	M	M	U
781		FP reaction including iodine chemistry	L	L	L	L	L	P
782		Adsorption and release of gaseous FP	L	L	L	L	L	P
783		Direct Containment Heating (DCH)	N/A	N/A	N/A	H	H	P
784		Pedestal water level change	L	L	L	H	M	P
785		Thermal stratification	L	L	L	L	L	P
786		Collision of corium with penetration tube support beams and oxidation	N/A	N/A	N/A	M	M	U
787		Collision of corium with CRD purge lines and oxidation	N/A	N/A	N/A	M	M	U
788		Collision of corium with other structures in the pedestal and oxidation	N/A	N/A	N/A	M	M	U
789		Melting point change for penetration pipings sticking out of RPV lower head	N/A	N/A	N/A	M	M	U
790		Eutectic (Corium and metal in pedestal internals)	N/A	N/A	N/A	H	H	U
791		Melting of penetration pipes sticking out of RPV lower head	N/A	N/A	N/A	H	H	P
792		Melting of gratings	N/A	N/A	N/A	L	L	P
793		Melting of penetration tube support beams	N/A	N/A	N/A	L	L	P
794		Melting of CRD purge lines	N/A	N/A	N/A	L	L	P
795		Melting of other structures in the pedestal	N/A	N/A	N/A	H	H	U
796		Seasalt intake to corium	N/A	N/A	N/A	L	L	U
797		Seasalt impact for corium thermodynamic properties	N/A	N/A	N/A	L	L	U
798		Corrosion of pedestal internals by seasalt (including marine lives)	L	L	L	L	L	U
799		Salt effects on heat transfer	L	L	L	L	L	U
800		Salt remelting from flood	L	L	L	L	L	U
801		Influence on Heat Transfer by Seasalt Concentration Change	L	L	L	L	L	P
802		Seasalt impact for FP reaction and composition	L	L	L	L	L	P
803		Boron corrosion of pedestal internal structure	L	L	L	L	L	U
804		Boron effects on heat transfer	L	L	L	L	L	U
805		Boron remelting from flood	L	L	L	L	L	P
806		FP aerosol absorption in water pool at upper surface of corium	N/A	N/A	N/A	L	L	P
807		FP release from water pool at upper surface of corium	N/A	N/A	N/A	M	L	P
808		Corium flow into sump pit (drainage pit) and reaction	N/A	N/A	N/A	H	H	P
809		Heat transfer between sump floor/wall and corium	N/A	N/A	N/A	H	H	P
810		Heat transfer between sump floor/wall and crust	N/A	N/A	N/A	H	H	P
811		Heat transfer between sump floor/wall and corium particle	N/A	N/A	N/A	H	H	P
812		Heat transfer between sump cover and corium	N/A	N/A	N/A	L	L	P
813		Heat transfer between sump cover and crust	N/A	N/A	N/A	L	L	P
814		Heat transfer between sump cover and corium particle	N/A	N/A	N/A	L	L	P
815		Heat capacity of structure inside sump	N/A	N/A	N/A	M	M	P
816		Deposition situation of corium on pedestal floor	N/A	N/A	N/A	H	M	P
817		Corium leak into connecting piping inside sump	N/A	N/A	N/A	H	H	P
818	Drywell	Attack on containment vessel shell (interaction between metal and corium)	N/A	N/A	N/A	H	H	U
819		Containment vessel penetration seal degradation (Seal degradation at containment vessel penetration)	L	L	L	H	H	P
820		Water leak from deteriorated part of containment vessel penetration	L	L	L	H	M	P
821		Gas leak from deteriorated part of containment vessel penetration	L	L	L	H	H	P
822		Deformation / failure of drywell internal equipment due to thermal stress	L	L	L	L	L	P
823		Deformation / failure of drywell wall by thermal stress	L	L	L	H	H	P
824		Heat transfer between corium and water (including CHF)	N/A	N/A	N/A	H	H	P



825	Heat transfer between corium and gas	N/A	N/A	N/A	H	H	P
826	Heat transfer between crust and water (including CHF)	N/A	N/A	N/A	H	H	P
827	Heat transfer between crust and gas	N/A	N/A	N/A	H	H	P
828	Heat transfer between crust and corium	N/A	N/A	N/A	H	H	P
829	Heat transfer between corium particle and water	N/A	N/A	N/A	H	H	P
830	Heat transfer between corium particle and gas	N/A	N/A	N/A	H	H	P
831	Heat transfer between corium particle and drywell floor/wall	N/A	N/A	N/A	H	H	P
832	Heat transfer between drywell floor/wall and corium	N/A	N/A	N/A	H	H	P
833	Heat transfer between drywell floor/wall and crust	N/A	N/A	N/A	H	H	P
834	Heat transfer between drywell floor/wall and water	L	L	L	H	H	P
835	Heat transfer between drywell floor/wall and gas	L	L	L	M	L	P
836	Heat transfer from drywell internal structure (lagging material, biological shield wall) to water	L	L	L	M	L	P
837	Heat transfer from drywell internal structure (lagging material, biological shield wall) to gas	L	L	L	M	L	P
838	Radiation between corium and drywell wall	N/A	N/A	N/A	M	M	K
839	Radiation between corium and drywell internal structure	N/A	N/A	N/A	M	M	K
840	Radiation between crust and drywell wall	N/A	N/A	N/A	M	M	K
841	Radiation between crust and drywell internal structure	N/A	N/A	N/A	M	M	K
842	Radiation between corium particle and drywell wall	N/A	N/A	N/A	M	M	K
843	Radiation between corium particle and drywell internal structure	N/A	N/A	N/A	M	M	K
844	Particulate Corium Bed Porosity	N/A	N/A	N/A	M	L	P
845	Gas stratification in drywell	L	L	L	H	H	K
846	Jet/plume gas interaction and entrainment effects	L	L	L	L	L	P
847	Pressure change in drywell	L	L	L	H	H	K
848	Gas temperature change in drywell	L	L	L	H	H	K
849	Gas composition change in drywell	L	L	L	M	H	K
850	Thermal conduction / temperature change of corium	N/A	N/A	N/A	M	H	P
851	Thermal conduction / temperature change of crust	N/A	N/A	N/A	M	H	P
852	Thermal conduction / temperature change of drywell floor/wall	L	L	L	M	H	K
853	Thermal conduction / temperature change of drywell internal structure	L	L	L	M	L	K
854	Water temperature change in drywell	L	L	L	M	L	K
855	Gas flow in drywell	L	L	L	H	H	K
856	Local gas flow and turbulence	L	L	L	L	L	P
857	Water flow in drywell	L	L	L	H	M	K
858	Drywell water level change	L	L	L	H	M	P
859	Thermal stratification	L	L	L	L	L	P
860	Erosion of drywell floor (concrete)	N/A	N/A	N/A	H	H	P
861	Physical properties of concrete ingredients (C, Si, etc.)	N/A	N/A	N/A	H	H	P
862	Transition of concrete ingredients into corium	N/A	N/A	N/A	H	H	P
863	Water evaporation from concrete by concrete heating	N/A	N/A	N/A	H	H	P
864	Gas generation (H <sub>2</sub> , CO, CO <sub>2</sub> , etc.) from concrete-corium interaction (reaction?)	N/A	N/A	N/A	H	H	P
865	Aerosol generation from concrete-corium interaction (reaction?)	N/A	N/A	N/A	H	H	P
866	Heat generation from chemical reaction between corium and concrete ingredients	N/A	N/A	N/A	H	H	P
867	Reaction (including generation of hydrogen and reaction heat) between corium ingredients and water (steam)	N/A	N/A	N/A	H	H	U
868	Corium flow / spread in drywell	N/A	N/A	N/A	H	L	P
869	Outflow of corium particle with water flow	N/A	N/A	N/A	H	L	P
870	Composition of corium particle	N/A	N/A	N/A	M	M	P
871	Size / configuration of corium particle	N/A	N/A	N/A	L	M	P
872	Aggregation / debris bed formation of corium particle	N/A	N/A	N/A	L	M	P
873	Generation / attenuation of decay heat from corium particle	N/A	N/A	N/A	H	M	P
874	Temperature change of corium particle bed	N/A	N/A	N/A	M	M	P
875	Corium solidification	N/A	N/A	N/A	H	M	P
876	Generation / attenuation of decay heat from corium	N/A	N/A	N/A	M	M	P
877	Mixture state (fuel, structure, concrete, etc.) and physical properties of corium ingredients	N/A	N/A	N/A	H	H	P

878		Corium stratification	N/A	N/A	N/A	M	M	P
879		Direct Containment Heating (DCH)	N/A	N/A	N/A	H	H	P
880		Water flow into crust	N/A	N/A	N/A	H	M	P
881		Bubble formation in crust	N/A	N/A	N/A	M	M	P
882		Crack formation in crust	N/A	N/A	N/A	M	M	P
883		Crust composition	N/A	N/A	N/A	H	M	P
884		Generation / attenuation of decay heat from crust	N/A	N/A	N/A	H	M	P
885		Crust remelting due to change in the heat transfer status to corium or water	N/A	N/A	N/A	H	H	P
886		Particulate corium remelting due to change in the heat transfer status	N/A	N/A	N/A	H	H	P
887		Oxidation reaction (including generation of hydrogen and reaction heat) between crust ingredients and water (steam)	N/A	N/A	N/A	M	M	U
888		Mixture state (fuel, structure, concrete, etc.) and physical properties of crust	N/A	N/A	N/A	M	M	P
889		Recriticality	N/A	N/A	N/A	H	L	P
890		Oxidation (including generation of hydrogen and reaction heat) of drywell wall by steam	L	L	L	M	H	P
891		Oxidation (including generation of hydrogen and reaction heat) of drywell internal structure by steam	L	L	L	L	H	P
892		Radiation decomposition of water	L	L	L	L	L	K
893		FP aerosolization	L	L	L	M	M	P
894		FP deposition on drywell wall	L	L	L	M	M	P
895		FP re-vaporization	L	L	L	M	M	P
896		Decay heat generation from FP	L	L	L	M	M	P
897		FP removal from drywell internal space by spray	N/A	N/A	N/A	M	M	U
898		FP particle transport by gas in the drywell	L	L	L	L	L	P
899		FP particle agglomeration/fragmentation in the drywell	L	L	L	L	L	P
900		FP particle deposition on the drywell wall and internal surfaces	L	L	L	L	L	P
901		FP transport by water flow on the drywell wall and internal surfaces	L	L	L	L	L	P
902		FP re-entrainment	L	L	L	L	L	P
903		FP release from corium surface	N/A	N/A	N/A	M	M	U
904		FP reaction including iodine chemistry	L	L	L	L	L	P
905		Adsorption and release of gaseous FP	L	L	L	L	L	P
906		Eutectic (Corium and metal in pedestal internals)	N/A	N/A	N/A	H	H	U
907		Droplet behavior in the drywell free space	L	L	L	L	L	P
908		Condensation heat transfer on the drywell wall	L	L	L	H	L	P
909		Interaction between gas and water film flow on the drywell wall and internal surfaces	L	L	L	L	L	P
910		Seasalt intake to corium	N/A	N/A	N/A	L	L	U
911		Seasalt impact for corium thermodynamic properties	N/A	N/A	N/A	L	L	U
912		Corrosion of drywell internals by seasalt (including marine lives)	L	L	L	L	L	U
913		Salt effects on heat transfer	L	L	L	L	L	U
914		Salt remelting from flood	L	L	L	L	L	U
915		Influence on Heat Transfer by Seasalt Concentration Change	L	L	L	L	L	P
916		Influence on Instrumentation and Measurements by Seasalt Concentration Change	L	L	L	L	L	U
917		Seasalt impact for FP reaction and composition	L	L	L	L	L	P
918		Boron corrosion of drywell internal structure	L	L	L	L	L	U
919		Boron effects on heat transfer	L	L	L	L	L	U
920		Boron remelting from flood	L	L	L	L	L	U
921		Heat release from drywell wall	L	L	L	H	L	P
922		Steam condensation by PCV spray	L	L	L	H	H	P
923	Drywell Head	Heat transfer between DW head inner wall and gas	L	L	L	H	H	K
924		Heat transfer between DW head inner wall and water	L	L	L	H	M	K
925		Gas stratification in DW head internal space	L	L	L	H	H	K
926		Gas composition in DW head internal space	L	L	L	M	H	K
927		Steam condensation in DW head	L	L	L	H	H	K
928		Gas flow in DW head	L	L	L	H	H	K
929		Pressure change in DW head internal space	L	L	L	H	H	K
930		Temperature change in DW head internal space	L	L	L	H	H	K

931		Thermal conduction / Temperature change of DW head	L	L	L	H	H	K	
932		Deformation / failure of drywell head by thermal stress	L	L	L	H	H	P	
933		Seal failure of DW head flange	L	L	L	H	H	K	
934		Gas flow from DW head flange	L	L	L	H	H	K	
935		Pressure loss of bulk head plate in head (including air duct)	L	L	L	M	H	P	
936		Gas flow through air conditioner duct	L	L	L	M	M	P	
937		Local gas flow and turbulence	L	L	L	L	L	P	
938		Jet/plume gas interaction and entrainment effects	L	L	L	L	L	P	
939		Droplet behavior in the drywell head free space	L	L	L	L	L	P	
940		Condensation heat transfer on the drywell head wall	L	L	L	L	L	P	
941		Interaction between gas and water film flow on the drywell head wall	L	L	L	L	L	P	
942		FP attachment	N/A	M	M	H	H	K	
943		FP reevaporation	N/A	L	L	M	H	K	
944		Generation / attenuation of FP decay heat	N/A	L	L	M	H	K	
945		FP particle transport by gas in the drywell head	L	L	L	L	L	P	
946		FP particle agglomeration/fragmentation in the drywell head	L	L	L	L	L	P	
947		FP particle deposition on the drywell head wall	L	L	L	L	L	P	
948		FP transport by water flow on the drywell head wall	L	L	L	L	L	P	
949		FP re-entrainment	L	L	L	L	L	P	
950		FP accumulation at leakage path	M	H	H	H	H	U	
951		FP reaction including iodine chemistry	L	L	L	L	L	P	
952		Thermal stratification	L	L	L	L	L	P	
953		Direct Containment Heating (DCH)	N/A	N/A	N/A	H	H	P	
954		Influence on Instrumentation and Measurements by Seasalt Concentration Change	L	L	L	L	L	U	
955		Seasalt impact for FP reaction and composition	L	L	L	L	L	P	
956	Drywell vent line and downcomer to Wetwell	Deformation / failure of pipe line due to thermal stress	L	L	L	H	H	P	
957		Flow resistance	L	L	L	M	L	K	
958		Heat transfer between vent pipe and water	L	L	L	L	L	K	
959		Heat transfer between vent pipe and gas	L	L	L	L	L	K	
960		Pressure change in vent line	L	L	L	M	M	K	
961		Gas temperature change in vent line	L	L	L	H	L	K	
962		Water temperature change in vent line	L	L	L	L	L	K	
963		Temperature change of vent pipe	L	L	L	L	L	K	
964		Gas flow in vent line	L	L	L	M	L	K	
965		Local gas flow and turbulence	L	L	L	L	L	P	
966		Water flow in vent line	L	L	L	L	L	K	
967		Gas composition change in vent line	L	L	L	M	H	K	
968		Corium particle entrainment by gas / water	N/A	N/A	N/A	L	L	P	
969		Heat transfer between entrainment corium particle and vent pipe	N/A	N/A	N/A	L	L	P	
970		Heat transfer between entrainment corium particle and water	N/A	N/A	N/A	L	L	P	
971		Droplet behavior in the drywell vent line free space	L	L	L	L	L	P	
972		Condensation heat transfer on the drywell vent line inner surface	L	L	L	L	L	P	
973		FP particle transport by gas in the drywell vent line and downcomer	L	L	L	L	L	P	
974		FP particle agglomeration/fragmentation in the drywell vent line	L	L	L	L	L	P	
975		FP particle deposition on the drywell vent line	L	L	L	L	L	P	
976		FP deposition on vent line	L	L	L	M	M	P	
977		FP re-vaporization	L	L	L	M	M	P	
978		Decay heat generation from FP	L	L	L	M	M	P	
979		FP transport by water flow on the drywell vent line and downcomer	L	L	L	L	L	P	
980		FP re-entrainment	L	L	L	L	L	P	
981		FP reaction including iodine chemistry	L	L	L	L	L	P	
982		Local water flow in the drywell vent line and downcomer	L	L	L	L	L	P	
983			Direct Containment Heating (DCH)	N/A	N/A	N/A	H	H	P

984		Change of failure crack area on bellows	L	L	L	H	H	P	
985		Water leak from failure crack on bellows	L	L	L	H	L	P	
986		Gas leak from failure crack on bellows	L	L	L	H	H	P	
987		Corrosion of piping by seasalt (including marine lives)	L	L	L	L	L	U	
988		Water level change in Drywell/Wetwell ventilation line	L	L	L	H	M	U	
989		Salt effects on heat transfer	L	L	L	L	L	U	
990		Salt remelting from flood	L	L	L	L	L	U	
991		Influence on Heat Transfer by Seasalt Concentration Change	L	L	L	L	L	P	
992		Seasalt impact for FP reaction and composition	L	L	L	L	L	P	
993		Boron corrosion of vent pipe	L	L	L	L	L	U	
994		Boron effects on heat transfer	L	L	L	L	L	U	
995		Boron remelting from flood	L	L	L	L	L	U	
996	Wetwell	Deformation / failure of Wetwell by thermal stress	L	L	L	H	H	P	
997		Pressure change in wetwell	L	L	L	H	H	K	
998		Water flow in wetwell	L	L	L	M	M	K	
999		Temperature change in wetwell structure	L	L	L	M	H	K	
1000		Gas composition change in wetwell	L	L	L	M	H	K	
1001		Corium particle entrainment by gas / water	N/A	N/A	N/A	M	M	P	
1002		Corium particle waftage	N/A	N/A	N/A	M	M	P	
1003		Corium particle deposition / accumulation	N/A	N/A	N/A	M	M	P	
1004		Heat transfer between pool water in wetwell and corium particle	N/A	N/A	N/A	M	M	P	
1005		Gas ejection	L	L	L	L	H	K	
1006		Steam condensation (with/without non-condensable gases)	L	L	L	H	H	K	
1007		Temperature stratification (three-dimensional temperature distribution)	L	L	L	H	H	K	
1008		Stratification of gas composition	L	L	L	L	H	K	
1009		Dynamic load on wetwell wall (with/without non-condensable gases)	L	L	L	M	L	K	
1010		Scrubbing	N/A	L	L	M	M	P	
1011		Gas flow at vacuum breaker valve	L	L	L	H	H	K	
1012		Local gas flow and turbulence	L	L	L	L	L	P	
1013		Water level change	L	L	L	H	H	K	
1014		Droplet behavior in the wetwell above water level	L	L	L	L	L	P	
1015		Condensation heat transfer on the wetwell wall above water level	L	L	L	L	L	P	
1016		Interaction between gas and water film flow on the wetwell wall above water level	L	L	L	L	L	P	
1017		FP particle transport by gas in the wetwell	L	L	L	L	L	P	
1018		FP particle agglomeration/fragmentation in the wetwell	L	L	L	L	L	P	
1019		FP particle deposition on the wetwell wall above water level	L	L	L	L	L	P	
1020		FP transport by water flow on the wetwell wall above water wall	L	L	L	L	L	P	
1021		FP re-entrainment	L	L	L	L	L	P	
1022		FP reaction including iodine chemistry	L	L	L	L	L	P	
1023		Corrosion of wetwell by seasalt (including marine lives)	L	L	L	L	L	U	
1024		Adsorption and release of gaseous FP	L	L	L	L	L	P	
1025		Salt remelting from flood	L	L	L	L	L	U	
1026		Influence on Heat Transfer by Seasalt Concentration Change	L	L	L	L	L	P	
1027		Influence for heat transfer between wetwell and torus room by seawater	L	L	L	L	L	U	
1028		Influence on Instrumentation and Measurements by Seasalt Concentration Change	L	L	L	L	L	U	
1029		Seasalt impact for FP reaction and composition	L	L	L	L	L	P	
1030		Boron corrosion of wetwell wall	L	L	L	L	L	U	
1031		Boron effects on heat transfer	L	L	L	L	L	P	
1032		Boron remelting from flood	L	L	L	L	L	U	
1033		Heat release from wetwell wall to torus room	L	L	L	H	M	K	
1034		Gas leak from wetwell (vacuum breaker)	N/A	N/A	N/A	H	H	P	
1035		Water leak from wetwell (vacuum breaker)	N/A	N/A	N/A	H	H	P	
1036	React or	Isolation	Heat transfer between steam and inner wall of IC heat transfer tube	M	L	L	L	L	K

1037	building	Condenser	Heat transfer between condensate and inner wall of IC heat transfer tube	L	L	L	L	L	K
1038			Heat transfer between pool water and outer wall of IC heat transfer tube	M	L	L	L	L	K
1039			Heat transfer between air and IC heat transfer tube in case of low pool water level	M	L	L	L	L	P
1040			Fouling factor of heat transfer tube (inner/outer surface)	M	L	L	L	L	K
1041			Degradation of condensation heat transfer coefficient due to non-condensable gas (Hydrogen, Noble gas)	L	H	L	L	L	K
1042			Volatile FP attachment into IC heat transfer tube	N/A	N/A	L	L	L	P
1043			Volatile FP reevaporation from IC heat transfer tube	N/A	N/A	L	L	L	P
1044			Heat generation of volatile FP attached inside IC heat transfer tube	N/A	N/A	L	L	L	P
1045			Pressure change (pressure loss) along IC system	M	L	L	N/A	N/A	P
1046			Pressure of IC heat transfer tube	M	L	L	N/A	N/A	K
1047			Water level in IC tank (shell side)	M	L	L	N/A	N/A	K
1048			Gas leak inside PCV boundary	M	M	M	M	M	P
1049			Water leak inside PCV boundary	M	M	M	M	M	P
1050			Gas leak outside PCV boundary	L	H	H	N/A	M	P
1051			Water leak outside PCV boundary	L	H	H	N/A	M	P
1052	R/B Compartments	Heat transfer between gas/water and walls in R/B compartments	L	L	L	L	M	P	
1053		Heat transfer between gas/water and pipes in R/B compartments	L	L	L	L	M	P	
1054		Heat transfer between gas/water and equipment in R/B compartments	L	L	L	L	M	P	
1055		Gas/water flow between neighboring compartments	L	L	L	L	M	P	
1056		Gas/water leak through the hatch on top of the wetwell to the torus room	N/A	N/A	N/A	N/A	M	P	
1057		Gas/water leak through the bellows hole to torus room	N/A	N/A	N/A	N/A	M	P	
1058		PCV ventilation piping sheet degradation by halogen compound chemical reaction	N/A	N/A	N/A	N/A	H	P	
1059		Gas leak from valves on steam piping systems (MSIV, RCIC etc) to R/B compartments	N/A	N/A	N/A	N/A	M	P	
1060		Gas leak from flanges in steam piping systems (MS, RCIC etc) to R/B compartments	N/A	N/A	N/A	N/A	M	P	
1061		Gas/water leak from valves on RPV injection lines (FW, CS, HPCI, LPCI etc) to R/B compartments	N/A	N/A	N/A	N/A	M	P	
1062		Gas/water leak from flanges in RPV injection lines (FW, CS, HPCI, LPCI etc) to R/B compartments	N/A	N/A	N/A	N/A	M	P	
1063		Gas/water leak from valves on PCV cooling system piping (sprays and local cooling) to R/B compartments	N/A	N/A	N/A	N/A	M	P	
1064		Gas/water leak from flanges in PCV cooling system piping (sprays and local cooling) to R/B compartments	N/A	N/A	N/A	N/A	M	P	
1065		Gas leak from valves on gas system piping (inert gas injection, FCS etc) to R/B compartments	N/A	N/A	N/A	N/A	M	P	
1066		Gas leak from flanges in gas system piping (inert gas injection, FCS etc) to R/B compartments	N/A	N/A	N/A	N/A	M	P	
1067		Gas/water leak from valves on pedestal sump piping to R/B compartments	N/A	N/A	N/A	N/A	H	P	
1068		Gas/water leak from flanges in pedestal sump piping to R/B compartments	N/A	N/A	N/A	N/A	H	P	
1069		Gas/water leak from valves on CRD system piping to R/B compartments	N/A	N/A	N/A	N/A	M	P	
1070		Gas/water leak from flanges in CRD system piping to R/B compartments	N/A	N/A	N/A	N/A	M	P	
1071		Gas/water leak from valves on instrumentation lines to R/B compartments	N/A	N/A	N/A	N/A	H	P	
1072		Gas/water leak from flanges in instrumentation lines to R/B compartments	N/A	N/A	N/A	N/A	H	P	
1073		Gas/water leak from valves on PCV other utility system piping to R/B compartments	N/A	N/A	N/A	N/A	M	P	
1074		Gas/water leak from flanges in PCV other utility system piping to R/B compartments	N/A	N/A	N/A	N/A	M	P	
1075		Gas/water leak through PCV piping penetration	N/A	N/A	N/A	N/A	M	P	
1076		Gas/water leak from seal of electric cable penetration	N/A	N/A	N/A	N/A	H	P	
1077		Gas/water leak through PCV equipment/personnel hatch	N/A	N/A	N/A	N/A	H	P	
1078		Rupture disk break in PCV ventilation line	N/A	N/A	N/A	N/A	M	K	
1079		Gas/water leak through PCV ventilation lines	N/A	N/A	N/A	N/A	M	P	
1080		Gas/water flow through PCV ventilation line to environment	N/A	N/A	N/A	N/A	M	P	
1081		Pressure change in R/B compartments	L	L	L	L	M	P	
1082		Pressure change in R/B piping and air stack	L	L	L	L	M	P	
1083		Successful operation of PCV ventilation	N/A	N/A	N/A	L	M	K	
1084		Gas reflux flow through PCV ventilation line and stack to another unit	N/A	N/A	N/A	N/A	H	P	
1085	Gas reflux flow through PCV ventilation line to SGTs line	N/A	N/A	N/A	N/A	H	P		
1086	Gas reflux flow through PCV ventilation line to R/B ventilation ducts	N/A	N/A	N/A	N/A	H	P		
1087	Chimney effect at the elevator	L	L	L	L	M	K		
1088	Chimney effect at the stairways	L	L	L	L	M	K		
1089	Chimney effect at R/B air conditioner/ventilation ducts	L	L	L	L	M	K		

1090		Filtration characteristics such as efficiency and pressure loss at SGTS system	N/A	N/A	N/A	N/A	L	P
1091		Gas mixing and composition fraction change in R/B compartments	N/A	N/A	N/A	N/A	H	P
1092		Gas composition stratification in R/B compartments	N/A	N/A	N/A	N/A	M	P
1093		Hydrogen accumulation at locally elevated piping (e.g. inverted U-shaped piping)	N/A	N/A	N/A	N/A	H	P
1094		Thermal stratification at R/B compartments	N/A	N/A	N/A	N/A	M	P
1095		Gas mixture thermodynamic properties change in R/B compartments	N/A	N/A	N/A	N/A	L	P
1096		Changes in gas mixing and concentration for each composition in pipings	N/A	N/A	N/A	N/A	H	P
1097		Gas mixture thermodynamic properties change in ventilation lines	N/A	N/A	N/A	N/A	L	P
1098		Oxidation of metal component in R/B compartments with steam (including hydrogen generation and reaction heat)	N/A	N/A	N/A	N/A	H	P
1099		Steam condensation in R/B compartment structures	N/A	N/A	N/A	N/A	L	P
1100		Ignition event for hydrogen combustion	N/A	N/A	N/A	N/A	M	P
1101		Catalytic effect by metal components in R/B compartments	N/A	N/A	N/A	N/A	M	P
1102		Hydrogen flame propagation regime	N/A	N/A	N/A	N/A	H	P
1103		Hydrogen combustion transition to detonation	N/A	N/A	N/A	N/A	H	P
1104		Pressure load to the structures in R/B	N/A	N/A	N/A	N/A	H	P
1105		Local gas flow and turbulence in the R/B compartments	L	L	L	L	M	P
1106		Droplet behavior in R/B compartment free space	N/A	N/A	N/A	N/A	M	P
1107		Interaction between gas and water film flow on R/B compartment walls	N/A	N/A	N/A	N/A	M	P
1108		FP particle transport by gas flow in R/B compartments	N/A	N/A	N/A	N/A	L	P
1109		FP deposition on R/B compartment structures	N/A	N/A	N/A	N/A	L	P
1110		FP re-entrainment from R/B compartment structures	N/A	N/A	N/A	N/A	L	P
1111		FP re-vaporization from R/B compartment structures	N/A	N/A	N/A	N/A	L	P
1112		FP particle agglomeration/fragmentation in R/B compartments	N/A	N/A	N/A	N/A	L	P
1113		FP transport by water flow on R/B compartment structures	N/A	N/A	N/A	N/A	L	P
1114		Seasalt impact for FP reaction and composition	N/A	N/A	N/A	N/A	L	P
1115		FP accumulation at leakage paths	N/A	N/A	N/A	N/A	L	P
1116		FP reaction including iodine chemistry	N/A	N/A	N/A	N/A	L	P
1117	SGTS	Gas leak through SGTS line valves or seals to R/B compartments	N/A	N/A	N/A	N/A	M	P
1118		Ventilation ratio by SGTS	N/A	N/A	N/A	N/A	M	K
1119	Operati on Floor	Heat transfer between gas/water and walls in the operation floor	L	L	L	L	M	P
1120		Heat transfer between gas/water and pipes in the operation floor	L	L	L	L	M	P
1121		Heat transfer between gas/water and equipment in the operation floor	L	L	L	L	M	P
1122		Pressure change in the operation floor	L	L	L	L	M	P
1123		Gas inflow from the stairways	L	L	L	L	M	P
1124		Gas inflow from the elevator	L	L	L	L	M	P
1125		Gas inflow from operation floor air conditioner/ventilation ducts	L	L	L	L	M	P
1126		Gas inflow from the drywell head flange	N/A	N/A	N/A	N/A	H	P
1127		Gas mixing and composition fraction change in the operation floor	N/A	N/A	N/A	N/A	H	P
1128		Gas composition stratification in the operation floor	N/A	N/A	N/A	N/A	M	P
1129		Gas flow in the operation floor	L	L	L	L	M	P
1130		Oxidation of metal component in the operation floor with steam (including hydrogen generation and reaction heat)	N/A	N/A	N/A	N/A	L	P
1131		Steam condensation on the operation floor structures	N/A	N/A	N/A	N/A	L	P
1132		Local gas flow and turbulence in the operation floor	L	L	L	L	L	P
1133		Droplet behavior in operation floor free space	N/A	N/A	N/A	N/A	L	P
1134		Interaction between gas and water film flow on the operation floor or walls	N/A	N/A	N/A	N/A	L	P
1135		FP particle transport by gas flow in the operation floor	N/A	N/A	N/A	N/A	L	P
1136		FP deposition on the operation floor structures	N/A	N/A	N/A	N/A	L	P
1137		FP re-entrainment from operation floor structures	N/A	N/A	N/A	N/A	L	P
1138		FP re-vaporization from operation floor structures	N/A	N/A	N/A	N/A	L	P
1139		FP particle agglomeration/fragmentation in the operation floor	N/A	N/A	N/A	N/A	L	P
1140		FP transport by water flow on the operation floor	N/A	N/A	N/A	N/A	L	P
1141		Seasalt impact for FP reaction and composition	N/A	N/A	N/A	N/A	L	P

1142		FP accumulation at leakage paths	N/A	N/A	N/A	N/A	L	P
1143		FP reaction including iodine chemistry	N/A	N/A	N/A	N/A	L	P
1144		Absorption and release of gaseous FP from the spent fuel pool	N/A	N/A	N/A	N/A	L	P
1145		Ignition event for hydrogen combustion	N/A	N/A	N/A	N/A	M	P
1146		Catalytic effect by metal components in the operation floor	N/A	N/A	N/A	N/A	M	P
1147		Hydrogen flame propagation regime	N/A	N/A	N/A	N/A	H	P
1148		Hydrogen combustion transition to detonation	N/A	N/A	N/A	N/A	H	P
1149	Blowout Panel	Opening of the blow-out panel	N/A	N/A	N/A	N/A	H	P
1150		Design pressure of the blowout panel	N/A	N/A	N/A	N/A	M	K
1151		Opening area of the blowout panel	N/A	N/A	N/A	N/A	H	K
1152		Installation location of blowout panel	N/A	N/A	N/A	N/A	M	K
1153	Spent Fuel Pool	Heat transfer between gas/water and the spent fuel pool	L	L	L	L	M	P
1154		Steam condensation on the spent fuel pool interface	N/A	N/A	N/A	N/A	L	P
1155		Decay heat from spent fuel in the pool	L	L	L	L	L	P
1156		Spent fuel pool water radiolysis	L	L	L	L	L	P
1157		Temperature change in the spent fuel pool	L	L	L	L	L	P
1158		Metal - water reaction of spent fuel and pool water (hydrogen generation)	N/A	N/A	N/A	N/A	M	P
1159	Equipment Pool	Steam condensation at pool surface	N/A	N/A	N/A	N/A	L	P

表 2-6 ソースターム PIRT

No.	System	Subsystem / Component	Major phenomenon	Phenomenon / Related phenomena, other specific features	Early phase	Middle phase	Late phase	SoK
					Heat up/ Melting/ Relocation	PCV Deposition	Release to environment	
			1. In-vessel Release					
2101	RPV	Core	(1) Radionuclides (FPs and actinides) behaviour before cladding damage	<b>Radionuclides generating</b> Related parameters - Irradiation history - Neutron spectrum <i>Radionuclides generating rate has relatively large error due to estimation error of the cooling state of the fuel assembly.</i> <i>There is area to develop the measurement of radionuclides inventory.</i>	Middle (2.115)	Low (1.115)	Low (1.192)	P
2102	RPV	Core		<b>FP gas release</b> Related parameters - Pellet microstructure - Burnup - Irradiation history (Temperature history) - Pellet characteristics - Atmosphere in the fuel rod - Fuel Temperature - Gas partial pressure, Gas equilibrium partial pressure, the molar density of fuel, and the fuel volume - Pressure <i>Additional FP gas release is small at the temperature in recovering the clad irradiation defect, because the temperature gradient in the pellet is low at the accident. Thus, the internal pressure of fuel rod will affect the timing of the cladding damage.</i> <i>The knowledge of the FP gas release was obtained during steady state condition, but the knowledge about influence of the release due to the crushing pellets is not enough. FP release is different from new fuel and spent fuel. Less knowledge about FP release from high burnup fuel and MOX fuel</i>	Middle (2.115)	Low (1.038)	Low (1.038)	P
2103	RPV	Core		<b>FP movement before the clad damage</b> Related parameters See also 2102 <i>The amount of FP that move to the gap before the accident affect the release of at clad rupture. This is similar to the FP gas release.</i> <i>The knowledge about volatile FP's behavior during steady-state operation is relatively abundant.</i> <i>When fuel center temperature is high during normal operation, the release ratio of Cs exceed 20%.</i>	Middle (2.154)	Low (0.846)	Low (0.846)	K
2104	RPV	Core		<b>Pellet-clad bonding</b> Related parameters - Irradiation history - Pellet/Clad characteristic (binding force) <i>The existence of the bonding layer that is mainly composed (U,Zr)O<sub>2</sub> affects the liquidus line of clad.</i> <i>The knowledge about a bonding generating condition is summarized.</i> <i>There is little knowledge about bonding of the MOX. But the bonding does not occur in the case of Fukushima to be little loaded the MOX fuel.</i>	Middle (2.038)	Low (0.846)	Low (0.846)	K
2105	RPV	Core		<b>Pellet-clad contact</b> <i>The fuel melting behavior is affected by the pellet-clad contacting.</i> <i>Lowering of the fuel liquidus-solidus line by eutectic reaction between fuel and clad</i>	Middle (2.038)	Low (0.846)	Low (0.846)	K
2106	RPV	Core	(2) Radionuclides	<b>Pellet form change and radionuclides release at the time of the clad</b>	High	Low	Low	P



			behavior from clad damage to clad melting	rupture	(Engineering Judgement)	(Engineering Judgement)	(Engineering Judgement)	
				<p>Related parameters</p> <ul style="list-style-type: none"> <li>- The characteristic of the clad creeping</li> <li>- Temperature history during the accident</li> <li>- Internal pressure of fuel rod</li> <li>- the state of fuel and radionuclides before the clad rupture</li> <li>- Temperature history</li> <li>- Atmosphere</li> </ul> <p>See also 2102</p> <p><i>The phenomenon of the crushing pellets, with the weakened binding force of the pellets at high burnup, is known when the pellet temperature is higher than the temperature experienced during irradiation. It may crush finely for the high burnup organization (Rim organization and Pu spot).</i></p> <p><i>When a pellet crushes, a lot of radionuclides are released and affect the radionuclides diffusion. However, it is not clear the behavior before clad rupture.</i></p> <p><i>Crushing pellets due to the rapid decrease of pellet stress with the clad rupture affects the later behaviour (the increasing of radionuclides release, the radionuclides movement inside and outside fuel).</i></p> <p><i>The clad rupture causes the release of radionuclides accumulated in the gap, the foam change with clad crushing, and the additional release by the pellet oxidation with the steam.</i></p> <p><i>The axial distribution of the oxygen potential in fuel rod changes. (The clad is embrittled by hydrogen away from the the ruptured position.)</i></p>				
2107	RPV	Core	(3) Radionuclides behavior in the state that the pellet shape stability was kept after clad melting	<p><b>Radionuclides release after pellet is exposed to the atmosphere in the core by clad melting</b></p> <p>Related parameters</p> <ul style="list-style-type: none"> <li>- Atmosphere (existence of the steam)</li> <li>- Atmosphere (existence of hydrogen produced by the reaction of steam and clad)</li> <li>- Atmosphere (internal leakage of the nitrogen/air by the instrumentation pipe damage)</li> <li>- Specific surface of fuel (including surface depletion)</li> <li>- fuel temperature</li> <li>- Ambient pressure</li> </ul> <p><i>During the state of the pellet dropping (not melting) due to clad melting, the release is mostly due to the thermal effect (diffusion or evaporation) and the chemical reaction. When UO<sub>2</sub> is oxidized with steam, the FP in the crystal lattice of U becomes easy to move. The release behaviour is different the oxidized fuel from reduced fuel.</i></p> <p><i>There is a possibility that the volatility will increase significantly in the high oxygen potential (air infiltration conditions) in specific FP (especially Ru).</i></p> <p><i>The radionuclide release of the elements (I, Te, Cs, Sr, Ba, Pu, Ru) that have been observed in the Fukushima accident.</i></p>	High (2.417)	Middle (1.962)	Low (1.423)	U
2108	RPV	Core	(4) Radionuclides behavior after the fuel melting	<p><b>Radionuclides release from molten fuel</b></p> <p>Related parameters</p> <ul style="list-style-type: none"> <li>- Temperature</li> <li>- Composition</li> <li>- Atmosphere</li> </ul> <p><i>Radionuclides release and evaporation by melting</i></p> <p><i>Radionuclides release rate is increased when fuel is liquefied.</i></p>	High (2.615)	High (2.462)	Middle (1.692)	U
2109	RPV	Core, Lower plenum		<p><b>Radionuclides release from re-solidification fuel</b></p> <p>Related parameters</p> <ul style="list-style-type: none"> <li>- Temperature</li> <li>- Composition</li> </ul>	Middle (1.750)	Middle (2.077)	Middle (1.692)	U

				<ul style="list-style-type: none"> <li>- surface area</li> <li>- Nuclear fission</li> </ul> <p><i>Radionuclides release from the corium solidified above the water surface in a situation which no water is splashed in.</i></p> <p><i>Radionuclides release by re-heating after solidified molten debris has not been assumed so far.</i></p>				
2110	RPV	Core		<p><b>Radionuclides release during the reflow</b></p> <p>Related parameters</p> <ul style="list-style-type: none"> <li>- Cooling rate</li> <li>- FP dissolution to a coolant</li> </ul> <p><i>FP release due to cracking / grain refining of fuel by the reflow</i></p> <p><i>The CORA experiment in Germany provides the result that FP release promotes during reflow.</i></p> <p><i>Less knowledge about the FP release during reflooding.</i></p>	Middle (1.808)	Middle (1.885)	Low (1.654)	U
2111	RPV	Core	(5) Other behaviors and factors which affect the radionuclides release	<p><b>Influence on iodine/cesium chemical form and hydrogen production from molten/re-solidified fuel due to the B4C control rod existence</b></p> <p><i>Influence on behavior of (3) and (4)</i></p> <p><i>Mixing process of fuel and B4C affects the source term. This clarification is important.</i></p> <p><i>The formation of organic iodine increases in B4C control rod.</i></p> <p><i>Less knowledge about the chemical contribution of iodine, cesium, and tellurium, etc. which are included in the control rod and the other constituents.</i></p>	High (2.423)	Middle (2.192)	Middle (1.692)	U
2112	RPV	Core		<p><b>Influence of the MOX (Pu concentration)</b></p> <p><i>It should be considered about composition of Pu concentration, non-uniformity of Pu spots, and chemistry in the fuel rod as an influence on the behaviour of (1) to (4).</i></p> <p><i>If oxygen potential is high, FP is oxidized, and a release rate changes by chemical form (vapor pressure) changing.</i></p> <p><i>The oxygen potential in MOX fuel is higher than UO2 fuel.</i></p>	Middle (2.231)	Middle (1.769)	Low (1.385)	P
2113	RPV	Core, Lower plenum		<p><b>Radionuclides release due to the re-criticality</b></p> <p>Related parameters</p> <ul style="list-style-type: none"> <li>- Debris shape</li> <li>- Composition</li> <li>- Coolant ratio</li> </ul> <p><i>Radionuclides generating and release when partial or extensive re-criticality occurred</i></p> <p><i>It is necessary to make it clear about the re-criticality during the accident.</i></p> <p><i>Influence on behaviour of (2) to (4)</i></p>	Low (1.500)	Middle (1.731)	Low (1.423)	U
2114	RPV	Core		<p><b>Change of the amount of heat generation in the fuel (Decay heat) by the radionuclides release</b></p> <p><i>Due to each stage of the radionuclides release and the changes of the heat source at each place, there is influence of the temperature evaluation that is important to the release behaviour.</i></p> <p><i>Influence on behaviour of (2) to (4). If there is a transition in the fuel rod at (1), there is also influence on behaviour.</i></p>	Middle (2.077)	Middle (1.885)	Low (1.654)	U
2201	RPV	Vessel, Loop, Steam line	2. Gas/Aerosol Behaviour in Vessel, Loop, and Steam line	<p><b>Condensation / Re-vaporization / Adsorption</b></p> <p>Related parameters</p> <ul style="list-style-type: none"> <li>- Vapor partial pressure difference between FP and aerosol surface</li> <li>- Water injection via CS</li> <li>- Mass transfer coefficient, Sherwood number</li> <li>- Amount of FP saturated vapor</li> <li>- FP vapor concentration</li> <li>- Vaporization rate (Condensation rate) of FP vapor in the condensation plane</li> <li>- Diffusion coefficient of the vapor</li> <li>- Diffusion coefficient of the FP gas</li> <li>- Temperature</li> <li>- Vaporization of deposited chemical species</li> <li>- Condensation on the wall surface</li> </ul>	High (2.583)	High (2.654)	Middle (2.231)	K
2202	RPV	Vessel, Loop, Steam		<p><b>Re-suspension</b></p> <p>Related parameters</p>	Middle (2.136)	Middle (2.200)	Low (1.500)	K

		line			- Velocity				
2203	RPV	Vessel, Loop, Steam line			<b>Agglomeration</b> Related phenomena - Thermal agglomeration with Brownian motion - Kinetic agglomeration by the velocity difference - Turbulent agglomeration Related parameters - Temperature caused by decay heat, steam leakage, water injection, and radiation to PCV - Difference of the particle diameter - Difference of the particle velocity	Middle (1.909)	Middle (2.000)	Low (1.455)	K
2204	RPV	Vessel, Loop, Steam line			<b>Deposition by diffused migration</b> Related phenomena - Stefan flow - Interdiffusion - Brownian motion Related parameters - Bulk flow of mixture gas (Non-condensable gas and water vapor) - Concentration gradient of the gas mixture - Mass flux of the steam condensation - Temperature caused by decay heat, steam leakage, water injection, and radiation to PCV	Middle (2.091)	Middle (2.000)	Low (1.625)	K
2205	RPV	Vessel, Loop, Steam line			<b>Diffused deposition by convection</b> Related phenomena - Fluid state (turbulent/laminar flow) - Noncondensable gas generation (high temperature) - Steam generation due to FCI - Chemical reaction between gas - Hydrogen Combustion - Recriticality	Middle (2.091)	Middle (2.273)	Middle (1.792)	K
2206	RPV	Vessel, Loop, Steam line			<b>Deposition by thermophoresis</b> Related parameters - Temperature gradient between gas and wall - Thermophoretic coefficient	Middle (2.000)	Middle (2.091)	Low (1.625)	K
2207	RPV	Vessel, Loop, Steam line			<b>Deposition by gravitational settling</b> Related parameters - Density of the aerosol particles - Particles diameter - Cm(Cunningham) correction factor - Spatial volume - Deposition area	Middle (2.273)	Middle (2.182)	Middle (1.909)	K
2208	RPV	Vessel, Loop, Steam line			<b>Inertial deposition</b> Related parameters - Gas velocity - Stokes number	Middle (2.273)	Middle (2.091)	Middle (1.708)	K
2209	RPV	Vessel, Loop, Steam line			<b>Aerosol growth by hygroscopicity</b>	Middle (2.125)	Middle (1.875)	Middle (1.727)	K
2210	RPV	Lower Plenum			<b>Scrubbing</b> Related phenomena - Water injection into the lower plenum retaining debris <i>There are knowledge in general under the lower temperature during steady state condition.</i>	Middle (2.208)	Middle (2.273)	Middle (1.958)	P
2301	RPV	-	3. Transport in RPV and PCV		<b>Leakage via instruments, penetration, etc</b> Leak potential - In-Core instrument (SRM/IRM,TIP) - Instrumentation pipe - Pump seal Related phenomena - Inertial deposition - Re-suspension by the turbulence diffusion Related parameters - Temperature - Liquidus-solidus line of the instrumentation tube - Leakage area - Pressure	High (Engineering Judgement)	High (Engineering Judgement)	High (Engineering Judgement)	P

2302	RPV	-		<p><b>Leakage via gasket</b></p> <p>Leak potential</p> <ul style="list-style-type: none"> <li>- RPV flange</li> <li>- MSL gasket</li> <li>- MSIV</li> </ul> <p>Related phenomena</p> <p>See also 2301</p> <p>Related parameters</p> <ul style="list-style-type: none"> <li>- Liquidus-solidus line of the RPV wall</li> <li>- Liquidus-solidus line of the CRD guide tube</li> </ul> <p>See also 2301</p>	High (Engineering Judgement)	High (Engineering Judgement)	High (Engineering Judgement)	P
2303	RPV	Lower Head		<p><b>Leakage by RPV damage</b></p> <p>Related parameters</p> <ul style="list-style-type: none"> <li>- Liquidus-solidus line of the RPV wall</li> <li>- Liquidus-solidus line of the CRD guide tube</li> </ul> <p>See also 2301</p>	Low (1.400)	High (2.455)	High (2.364)	P
2401	PCV	Pedestal	4. Ex-vessel Release	<p><b>MCCI (Concrete erosion)</b></p> <p>Related phenomena</p> <ul style="list-style-type: none"> <li>- Concrete erosion</li> <li>- State of the debris layer</li> <li>- Crusting</li> <li>- Heat transfer on the boundary layer of debris</li> <li>- Heat transfer in the gap of concrete debris</li> <li>- Heat transfer between the water and the debris</li> <li>- Spreading on the floor</li> <li>- Chemical reaction with the corium</li> <li>- Generation of non-condensable gas (CO and H<sub>2</sub>) by oxidizing the metal by CO<sub>2</sub> and H<sub>2</sub>O generated by decomposed concrete</li> <li>- Scrubbing and crust generation when there is a pool on the molten pool</li> </ul> <p>Related parameters</p> <ul style="list-style-type: none"> <li>- Heat flux to the concrete, Concrete density, and Enthalpy of eroded concrete</li> <li>- Sensible heat of the concrete, Energy by chemical reaction, and Heat generation by melting the oxides</li> <li>- Components of the concrete</li> <li>- Debris density distribution</li> <li>- Temperature distribution in the crust, Solidification temperature of the debris</li> <li>- Gas film, Slag film</li> <li>- Chemical reaction between the debris and the concrete floor</li> <li>- Convection and temperature distribution in the debris</li> <li>- Debris properties</li> <li>- Vaporization</li> <li>- Steam release from the hydroxide</li> <li>- CO<sub>2</sub> release from carbonate</li> </ul>	Low (0.182)	High (2.875)	High (2.731)	P
2402	PCV	Pedestal		<p><b>Re-entrainment of aerosols by PCV depressurization</b></p> <p><i>Major technical knowledge related to the migration of aerosol behavior in the PCV is generally sufficient.</i></p>	Low (0.333)	Middle (2.125)	Middle (1.833)	K
2501	PCV	S/C	5. Aerosol Behaviour in Containment	<p><b>Scrubbing by steam flow from SRV to S/C</b></p> <p>Related phenomena</p> <ul style="list-style-type: none"> <li>- Inertial impaction</li> <li>- Condensation</li> <li>- Gravity settling</li> <li>- Aerosol collection in the bubbles</li> <li>- Brownian diffusion</li> </ul> <p>Related parameters</p> <ul style="list-style-type: none"> <li>- Bubble rise velocity</li> <li>- Bubble density</li> <li>- Bubble diameter</li> <li>- Velocity at the discharge outlet</li> <li>- Vapor mass flux</li> <li>- Steam ratio in carrier gas</li> <li>- Carrier gas viscosity</li> <li>- Carrier gas pressure</li> <li>- S/C water temperature</li> </ul>	High (Engineering Judgement)	Middle (Engineering Judgement)	N/A (Engineering Judgement)	K

			<ul style="list-style-type: none"> <li>- S/C water level</li> <li>- Diffusion coefficient of the particles</li> <li>- Total pressure of S/C</li> <li>- Steam pressure of S/C</li> <li>- Quencher diameter</li> <li>- <math>C_m</math>(Cunningham) correction factor</li> </ul>				
2502	PCV	S/C	<b>Scrubbing with the vent from D/W to S/C</b> Related parameters <ul style="list-style-type: none"> <li>- vapor flow</li> <li>- S/C water level</li> <li>- S/C water temperature</li> </ul>	Low (1.542)	High (2.625)	High (2.375)	P
2503	PCV	Pedestal	<b>Scrubbing due to water injection to the pedestal floor</b>	Low (0.583)	Middle (2.292)	High (2.333)	P
2504	PCV	D/W, S/C	<b>Trapping due to steam condensation by spray</b> Related phenomena <ul style="list-style-type: none"> <li>- Diffused migration</li> <li>- Stefan flow</li> </ul> Related parameters <ul style="list-style-type: none"> <li>- Steam condensation rate</li> <li>- Molecular weight of steam and gas</li> <li>- Mol fraction of steam and gas</li> <li>- Mol concentration of bulk gas</li> <li>- Particle deposition velocity</li> <li>- Droplet surface area</li> <li>- Spatial volume</li> </ul>	Low (1.273)	Middle (2.167)	Middle (2.208)	K
2505	PCV	D/W, S/C	<b>Trapping due to collision with droplets by spray</b> Related phenomena <ul style="list-style-type: none"> <li>- Interruption</li> <li>- Inertial collision</li> <li>- Brownian diffusion</li> </ul> Related parameters <ul style="list-style-type: none"> <li>- Aerosol particle radius</li> <li>- Spray droplet radius</li> <li>- Reynolds number of droplet</li> <li>- Spray volumetric flow</li> <li>- Spray drop height</li> <li>- Spatial volume</li> <li>- Stokes number</li> <li>- Peclet number</li> </ul>	Low (1.273)	Middle (1.818)	Middle (1.875)	K
2506	PCV	D/W	<b>Steam condensation by drywet cooler</b> Related parameters <ul style="list-style-type: none"> <li>- Steam condensation rate</li> <li>- Bulk gas density</li> <li>- Gas phase volume</li> </ul> <i>Aerosol deposition model to tubes have been constructed.            But there are a large amount of uncertainty.</i>	Low (1.455)	Middle (2.083)	Middle (2.000)	P
2507	PCV	D/W	<b>Condensation / Re-vaporization / Adsorption</b> See also 2201	Middle (1.818)	High (2.455)	Middle (2.208)	K
2508	PCV	D/W	<b>Re-suspension</b> See also 2202	Low (1.455)	Middle (2.125)	Middle (2.083)	K
2509	PCV	D/W	<b>Agglomeration</b> See also 2203	Middle (1.700)	Middle (2.100)	Middle (2.000)	K
2510	PCV	D/W	<b>Deposition by diffused migration</b> See also 2204	Low (1.500)	Middle (1.864)	Middle (1.727)	K
2511	PCV	D/W	<b>Diffused deposition by convection</b> See also 2205	Middle (2.000)	Middle (2.300)	Middle (2.091)	K
2512	PCV	D/W	<b>Deposition by thermophoresis</b> See also 2206	Middle (1.700)	Middle (1.955)	Middle (1.818)	K
2513	PCV	D/W	<b>Deposition by gravitational settling</b>	Middle	Middle	High	K

				See also 2207	(1.792)	(2.273)	(Engineering Judgement)	
2514	PCV	D/W		<b>Inertial deposition</b> See also 2208	Low (1.545)	Middle (1.909)	Middle (1.875)	K
2515	PCV	D/W		<b>Aerosol growth by hygroscopicity</b> See also 2209	Middle (1.792)	Middle (1.875)	Middle (1.727)	K
2516	PCV	D/W		<b>DCH</b> Related parameters - Pressure	Low (1.300)	Middle (1.792)	Low (1.500)	P
2601	PCV	-	6. Transfer out of Containment	<b>Leakage via instruments, penetrations, gasket, etc</b> Leak potential - Top head flange - TIP(Traversing Incore Probe) penetration - CRD (Control Rod Drive) hatch - S/C manhole - Equipment hatch - Electric penetration - Bellows (vent, penetration) - Vacuum breaker (1F1 only) Related phenomena - Inertial deposition - Re-suspension by the turbulence diffusion - Decay heat - MCCI - Radiation from RPV Related parameters - Vapor temperature - Liquidus-solidus line of the organic seal material - Leakage area - PCV pressure	Low (Engineering Judgement)	High (Engineering Judgement)	High (Engineering Judgement)	P
2602	PCV	S/C		<b>Wetwell vent</b> Related phenomena - Inertial depositoin - Scrubbing - Scrubbing at the rapid de-pressurization - Scrubbing at the depressurized boiling - Scrubbing at the time when a large amount of hot gas containing the FP vapor was flowing	Low (1.000)	High (2.455)	High (2.545)	P
2603	PCV	D/W		<b>Drywell vent</b> Related phenomena - Inertial depositoin	Low (1.000)	High (2.636)	High (2.909)	P
2604	PCV	-		<b>Filtered Containment Venting Systems (FCVS)</b>	Low (0.955)	Low (1.455)	Low (1.636)	P
2605	RPV, PCV	-		<b>Migration of radioactive material by the injection water into the reactor</b>	Low (0.800)	Low (1.364)	High (2.364)	U
2701	R/B	-	7. Aerosol Behaviour in Reactor Building	<b>Aerosol Behaviour in Reactor Building</b> Related phenomena - Condensation / Re-vaporization / Adsorption - Re-suspension - Agglomeration - Deposition by diffused migration - Diffused deposition by convection - Deposition by thermophoresis - Deposition by gravitational settling - Inertial deposition - Aerosol growth by hygroscopicity See also 2201 - 2209	Low (Engineering Judgement)	Low (Engineering Judgement)	High (Engineering Judgement)	K
2702	R/B	-		<b>Aerosol deposition on the narrow part (clearance of the shield plugs, etc)</b>	Low (1.292)	Low (1.625)	Middle (2.292)	U
2801	PCV	D/W, S/C	8. Iodine chemistry	<b>Generation of acidic substances by radiolysis</b> Related phenomena - Production of nitric acid from the nitrogen by radiolysis - Production of hydrochloric acid from the cable	Low (1.409)	Middle (2.182)	High (Engineering Judgement)	P

			coating material of the electric wire by radiolysis Related parameters - Nitrogen mass in the atmosphere - Dose rate in the atmosphere - Cable insulator mass - Dose rate of the cable insulator				
2802	PCV	S/C	<b>Hydrolysis</b>	Low (1.409)	Middle (2.300)	High (Engineering Judgement)	P
2803	PCV	S/C	<b>Re-volatilization of iodine by acidification pH decrease</b> Related parameters - Hydrogen-ion concentration - Ionic activity - Ionic strength	Middle (1.708)	Middle (Engineering Judgement)	High (2.545)	P
2804	PCV	S/C	<b>Iodine chemical reaction in water pool</b> Related parameters - The molarity of the active chemical species - Gas pressure in the atmosphere - Water density - Molarity of the iodine species - Reaction rate constant (Forward/Reverse) - Source by radiolysis	Middle (1.708)	Middle (Engineering Judgement)	High (2.545)	P
2805	PCV	D/W, S/C	<b>Decomposition reaction of iodine in the atmosphere</b> Related phenomena - Thermal decomposition reaction - Radiolysis reaction Related parameters - Hydrogen concentration - Ozone concentration - Ambient temperature - Dose rate atmosphere - Oxygen concentration - Water vapor concentration	Low (1.542)	Middle (2.125)	High (2.417)	P
2806	PCV	S/C	<b>Transfer between gas phase and water pool</b> Mass transfer coefficient between atmosphere and water pool Surface area of water pool Atmosphere volume Molarity in the atmosphere and water pool	Middle (2.091)	Middle (Engineering Judgement)	High (2.833)	P
2807	PCV	D/W, S/C	<b>Recombination reaction of iodine in the atmosphere</b> Related parameters - Molarity of I and I <sub>2</sub> - Ambient temperature - Partial pressure of I and I <sub>2</sub> - Equilibrium constant	Low (1.500)	Middle (2.125)	High (2.333)	P
2808	PCV	D/W, S/C	<b>Wall deposition of iodine in the atmosphere</b> Related parameters - I <sub>2</sub> concentration in the atmosphere - the amount of I <sub>2</sub> deposition per unit area - Adsorption rate - Desorption rate	Low (1.625)	Middle (Engineering Judgement)	High (2.545)	P
2809	PCV	D/W, S/C	<b>Wall adsorption and desorption of iodine by chemical adsorption process</b> Related phenomena - Adsorption/Desorption in the atmosphere (Chemical adsorption to the paint with CH <sub>3</sub> I and I <sub>2</sub> ) - Adsorption/Desorption in the water pool (Chemical adsorption to the paint with I <sup>-</sup> , I <sub>2</sub> , and CH <sub>3</sub> I)	Middle (1.792)	Middle (Engineering Judgement)	High (2.545)	P
2810	PCV	-	<b>Effect of impurities in the water pool</b>	Low (1.000)	Middle (1.682)	High (2.400)	P
2811	PCV	-	<b>Iodine chemistry under high water temperature conditions</b>	Middle (1.818)	Middle (2.208)	High (2.545)	P
2812	PCV	-	<b>Effects of seawater</b>	Low (1.100)	Low (1.591)	High (2.400)	U

2813	PCV	-		<b>Iodine release from R/B contaminated water</b>	N/A (Engineering Judgement)	High (Engineering Judgement)	High (Engineering Judgement)	U
			9. Chemical form (Iodine, Cesium)	<i>There are still large uncertainties about the chemical form of iodine. Large amounts of gaseous cesium that can not be explained by conventional knowledge was observed in Fukushima accident.</i>				
2901	RPV	Core, Lower Plenum		<b>Re-evaporation of I2 by the decomposition of CsI</b> Related phenomena - Decomposition of CsI with boric acid - I2 generation due to the oxidation of CsI by an air atmosphere	Middle (1.667)	Middle (2.208)	High (Engineering Judgement)	K
2902	PCV	-		<b>Effects of seawater</b>	Low (1.100)	Low (1.591)	High (2.400)	U
2903	RPV, PCV	-		<b>A generation ratio for the inorganic iodine of the organic iodine</b>	Low (1.500)	Middle (2.167)	High (2.375)	P