WECC

Underfrequency Load Shedding Work Group Update

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Status of the UFLS Assessment

- The UFLSWG produces an assessment of the WECC Off-Nominal Frequency Load Shedding Plan every two years
- The current assessment represents a study period from 2022 to 2024 and the selected cases were 2023HS and 2024LSP
- The study was planned to be complete by the end of 2024; however, at the review stage it was found that, for the 2023HS North Island 25% imbalance contingency, there were frequencies dipping below 58Hz
- Previous assessments were reviewed and the same issue was found

PRC-006-5 D.B.3.1 Violation

D.B.3. Each Planning Coordinator shall adopt a UFLS program, coordinated across the Western Interconnection, including notification of and a schedule for implementation by UFLS entities within its area, that meets the following performance characteristics in simulations of underfrequency conditions resulting from an imbalance scenario, where an imbalance = [(load — actual generation output) / (load)], of up to 25 percent within the identified island(s). *[VRF: High][Time Horizon: Long-term Planning]*

D.B.3.1. Frequency shall remain above the Underfrequency Performance Characteristic curve in PRC-006-5 - Attachment 1, either for 60 seconds or until a steady-state condition between 59.3 Hz and 60.7 Hz is reached, and

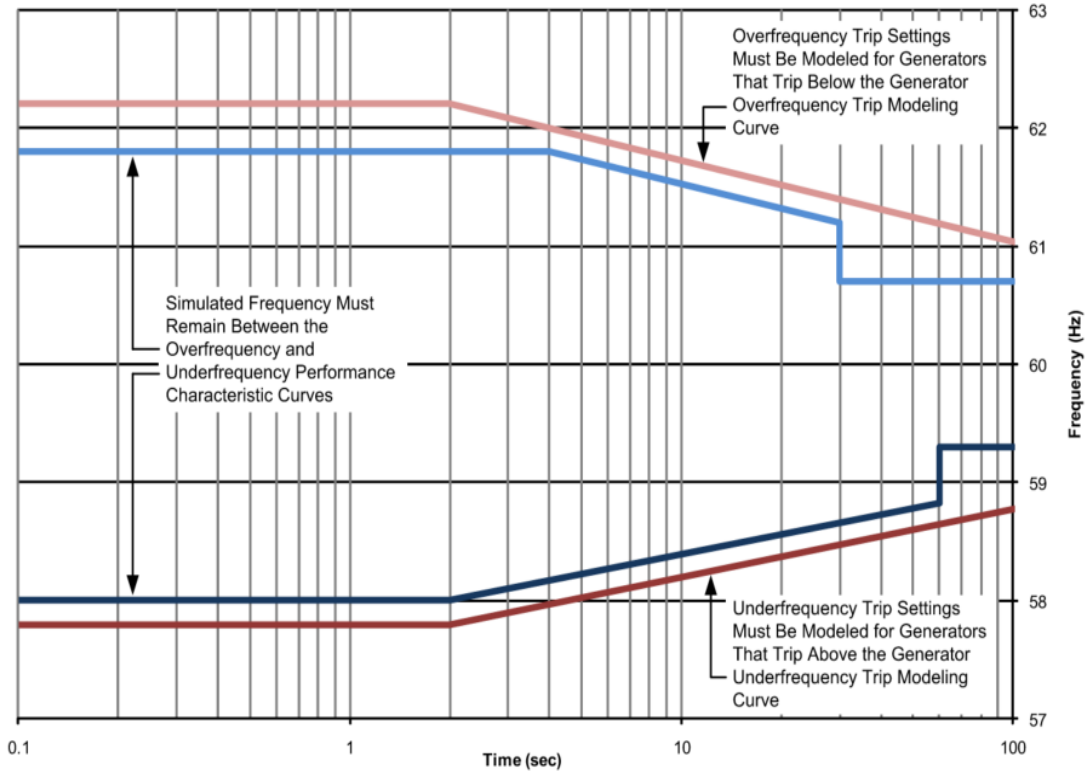
D.B.3.2. Frequency shall remain below the Overfrequency Performance Characteristic curve in PRC-006-5 - Attachment 1, either for 60 seconds or until a steady-state condition between 59.3 Hz and 60.7 Hz is reached, and

D.B.3.3. Volts per Hz (V/Hz) shall not exceed 1.18 per unit for longer than two seconds cumulatively per simulated event, and shall not exceed 1.10 per unit for longer than 45 seconds cumulatively per simulated event at each generator bus and generator step-up transformer high-side bus associated with each of the following:

D.B.3.3.1. Individual generating units greater than 20 MVA (gross nameplate rating) directly connected to the BES

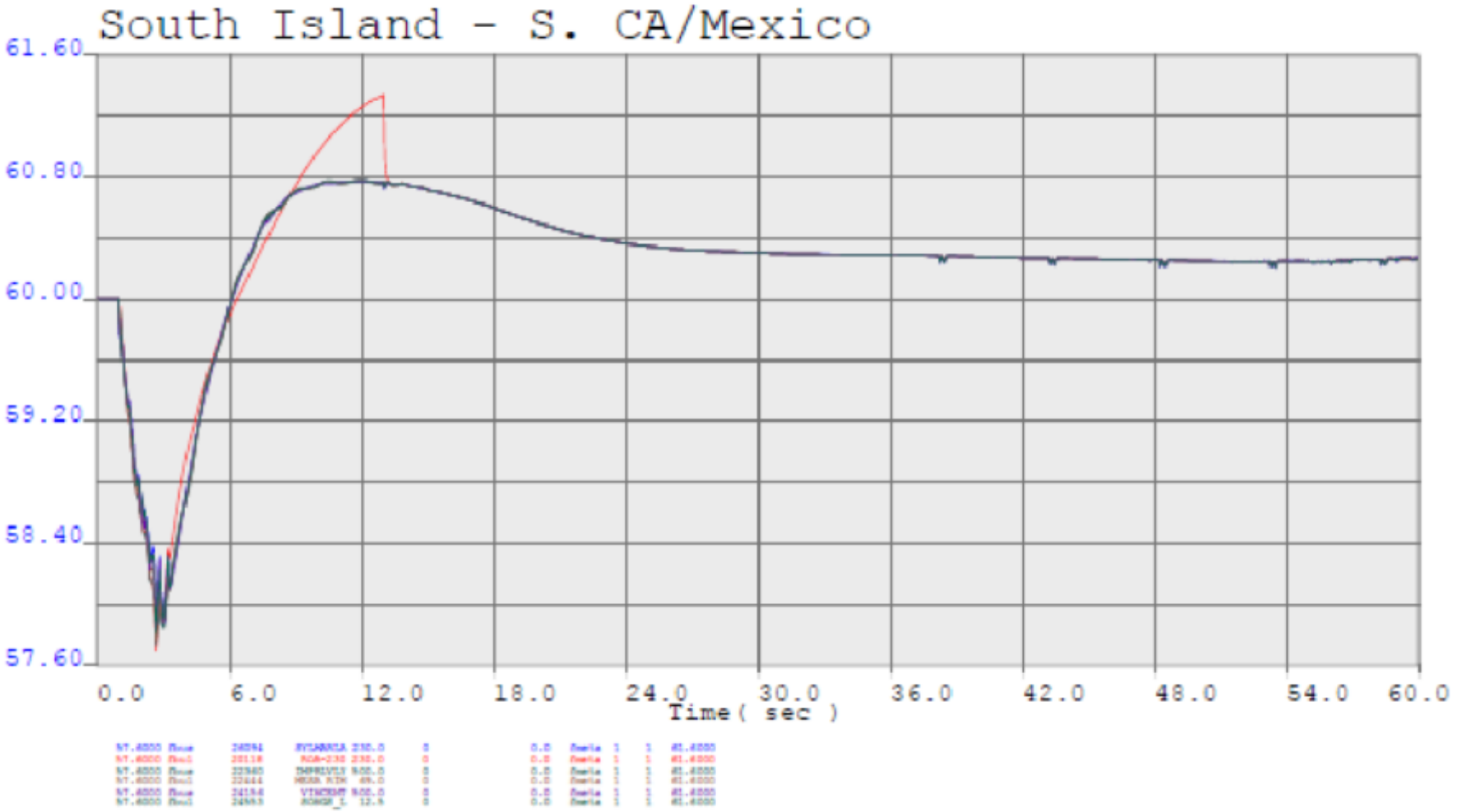
D.B.3.3.2. Generating plants/facilities greater than 75 MVA (gross aggregate nameplate rating) directly connected to the BES

D.B.3.3.3. Facilities consisting of one or more units connected to the BES at a common bus with total generation above 75 MVA gross nameplate rating.



Generator Overfrequency Trip Modeling (Requirement R4 Parts 4.4-4.6)
Overfrequency Performance Characteristic (Requirement R3 Part 3.2)
Underfrequency Performance Characteristic (Requirement R3 Part 3.1)
Generator Underfrequency Trip Modeling (Requirement R4 Parts 4.1-4.3)

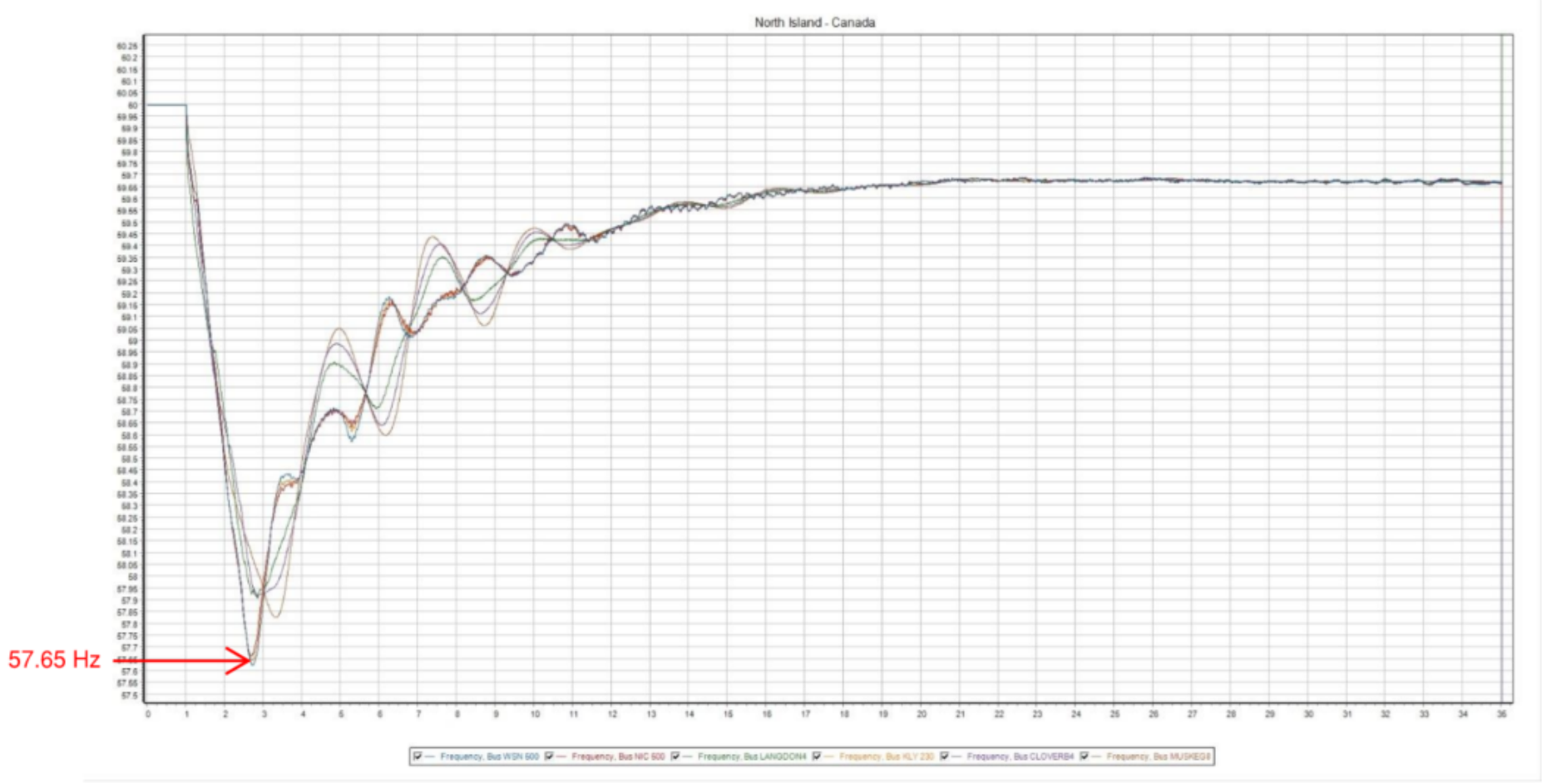
2019 UFLS Assessment



2019 UFLS Assessment, South Island 25% Imbalance Simulation

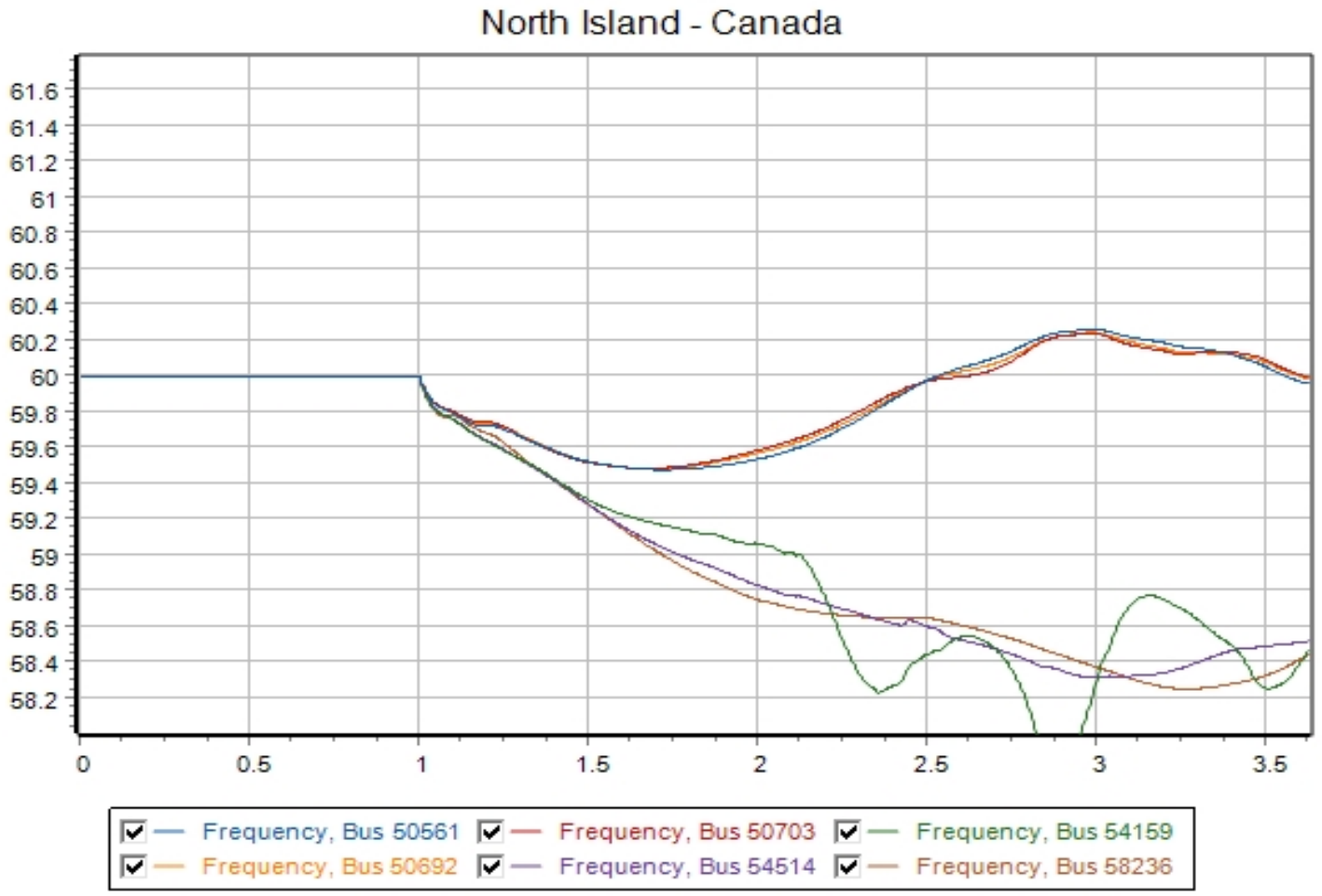
2021 UFLS Assessment

21HS—25%



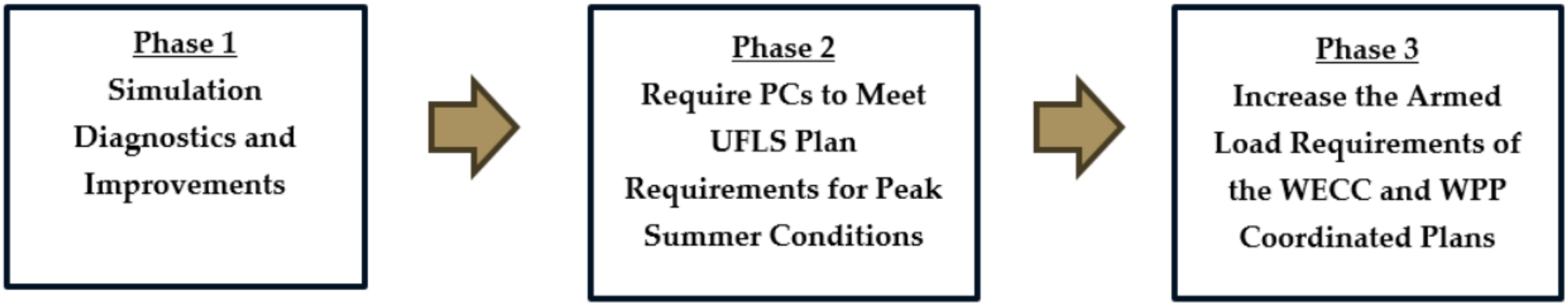
2021 UFLS Assessment, North Island (Canada) 25% Imbalance Simulation

2023 Current UFLS Assessment



2023 UFLS Assessment, North Island (Canada) 25% Imbalance Simulation

Corrective Action Plan



Phase 1: System Diagnostics and Improvements

- Existing Model review—in further review of the UFLS cases, several helpful model updates were identified by UFLSGWG members and UFLS study participants, such as:
  - Update and review of the UFLS relays in the cases
  - Correction of erroneous substation load levels
  - Corrections to UFLS relay tripping times
  - Poor generator terminal voltage (<0.95) in base cases requires further review
  - Generators with missing or old models should be updated in the UFLS cases
  - Ensure tripping flags on generator relays (trip or alarm) are set to the appropriate status
  - V/Hz issues should be identified in the simulation and each PC should evaluate the affected units with issues in their control area and validate the behavior of the model. If model updates are required, these should be communicated to the necessary people including the parties performing the assessment. It is also possible that certain generator models were missing in the assessment cases.
  - Review of applicable generator spinning reserves in the UFLS cases or generators operating in the simulation below Pmin (impacts simulated inertia in the case).

Phase 1: System Diagnostics and Improvements

- Enhance Model Detail—in the UFLS simulations, pre- and post-contingency low voltages and poor system performance in portions of the models used for simulation. The UFLSWG and UFLS study participants should review the following device-specific models for potential use in the UFLS assessment. Typical device model names are included in parentheses:
  - Capacitor and Reactor switching models (MSC1/MSR1)
  - Transmission line switching models for high and low voltage (tlin1, tlin1O)
  - Out-of-step models (OOSLEN)
  - Generator overspeed (GP3, LHSRT, global simulation settings)
  - Remedial Action Schemes (RAS) that could operate during a UFLS-type event
  - Other schemes that would be expected operate in the time frame of the simulations
  - Use of software features to highlight and report potential data errors or model deficiencies

Phase 2: Require PCs to Meet UFLS Plan Requirements for Peak Summer Conditions

	Modeled Armed Load Validation 2023 Heavy Summer Case				
Load Shedding Block	North Island (WPP & WECC plans)			South Island (SILTP plan)	
	Plan Design WPP	Plan Design WECC	Modeled	Plan Design SILTP	Modeled
1	5.6% (59.3 Hz)	5.3% (59.1 Hz)	7.02% (≥ 59.1 Hz)	5.3% (59.1 Hz)	5.88% (59.1 Hz)
2	5.6% (59.2 Hz)	5.9% (58.9 Hz)	4.29% (≥ 58.9, < 59.1 Hz)	5.9% (58.9 Hz)	5.89% (58.9 Hz)
3	5.6% (59.0 Hz)	6.5% (58.7 Hz)	4.78% (≥ 58.7, <58.9 Hz)	6.5% (58.7 Hz)	6.53% (58.7 Hz)
4	5.6% (58.8 Hz)	6.7% (58.5 Hz)	4.65% (≥ 58.5, < 58.7 Hz)	6.7% (58.5 Hz)	6.64% (58.5 Hz)
5	5.6% (58.6 Hz)	6.7% (58.3 Hz)	3.32% (≥58.3, < 58.5 Hz)	6.7% (58.3 Hz)	6.2% (58.3 Hz)
< 58.3 Hz	N/A	N/A	1.54%	N/A	17.13%
TOTAL	28.0%	31.1%	25.60	35.1%	48.27%
UF	6.0%	6.0%	4.48%	6.0%	6.15%

Phase 2: Require PCs to Meet UFLS Plan Requirements for Peak Summer Conditions

PRELIMINARY

			CALIFORNIA						CANADA		GREAT BASIN & MOUNTAIN						NORTHWEST										SOUTHWEST						
23HS	Plan	Plan Requirement (Peak)	BANC	CAISO	CEN	IID	LDWP	TID	AESO	BCH	IPC	NWMT	PACE	PSCO	WARM	WAUM	AVA	BPA	CHPD	DOPD	GCPD	PACW	PGE	PSE	SCL	TPWR	APS	EPE	NVE	PNM	SRP	TEP	WALC
BLOCK0																																	
59.3	SILTP			1.5																													
59.5	SILTP		7.7	0.5	6.2	5.2	7.3	5.2		0.1			0.7		0.0												4.9		5.1	6.0	3.3	5.0	1.0
59.5>14CY			1.1							0.0				0.1																			5.2
BLOCK1																																	
59.1	WECC	5.30%		4.3			0.1	1.0	7.3	8.5	9.3	6.7	9.3	5.3	4.2	4.6	1.3	2.5		5.3	3.4	0.5	2.7		6.7		0.2	5.5	2.4	1.1	1.7		4.0
59.3	WPP	5.60%	1.1		5.4					1.3			0.3		0.1		8.4	4.3	6.9	1.8	8.5	4.6	5.8	6.7	2.8	6.1			1.7				
59.1>14CY										0.2																							
59.3>14CY																				1.2													
BLOCK2																																	
58.9	WECC	5.90%	6.7	6.0	6.0	5.8	7.0	4.0	20.7	2.6	4.6	4.4	4.9	15.5	13.6												4.9	6.1	3.0	5.6	5.2	5.2	1.8
59.2	WPP	5.60%			3.9					0.9							5.1	2.5	6.7	4.7	4.6	3.2	4.8	5.6	5.0	2.7							
58.9>14CY			0.7							0.1																							2.9
59.2>14CY																				1.5													
BLOCK3																																	
58.7	WECC	6.50%	6.9	6.2	10.0	6.2	6.9	6.1	6.5	2.5	6.1	5.5	6.8	5.4	3.9	4.7	0.7	1.4		2.9	1.8	0.3	1.5		3.7		6.0	6.5	0.9	4.5	6.3	5.8	3.1
59	WPP	5.60%								2.2							6.2	3.6	7.5	1.7	6.1	2.3	1.0	6.6	5.6	5.2			2.0				
58.7>14CY			0.9																														4.1
59.0>14CY										0.0										4.7									0.8				
BLOCK4																																	
58.5	WECC	6.70%	7.8	6.5	7.0	6.8	7.7	7.6	8.3	5.3	8.3	7.3	9.9	5.7	4.9	4.2	1.4	2.8		5.9	3.8	0.5	3.0		7.5		6.2	3.2	3.7	6.8	5.7	5.8	4.5
58.8	WPP	5.60%								3.6							6.5	4.6	4.3	7.3	2.1	4.1	2.9	5.6	12.4	6.2			6.1				
58.5>14CY			1.1							0.3																							1.7
58.8>14CY																		0.4															
BLOCK4.5																																	
58.4										2.0																			1.6				
BLOCK5																																	
58.3	WECC	6.70%	6.1	6.2	0.7	6.0	8.7	3.0	4.7	3.5	5.1	3.4	5.5	6.1	5.6												6.1	4.5	3.1	8.0	5.9	6.9	4.4
58.6	WPP	5.60%								1.0							6.9	3.6	4.4	1.2	1.0	3.6	2.7	5.5	6.1	4.8			3.0				
			36.3	31.2	39.2	30.0	37.7	26.9	47.5	33.5	33.4	27.3	37.4	38.0	32.3	13.5	36.5	25.3	29.8	30.8	31.3	19.1	24.4	30.0	49.8	25.0	28.3	25.8	32.6	32.0	28.1	28.7	18.8

Phase 3: Increase the Armed Load Requirements of the WECC and WPP Coordinated Plans

WECC Coordinated Plan Armed Load Requirements

Block	Frequency	Plan Requirement
1	59.1	5.3%
2	58.9	5.9%
3	58.7	6.5%
4	58.5	6.7%
5	58.3	6.7%
	TOTAL	**31.1%**

WPP Coordinated Plan Armed Load Requirements

Block	Frequency	Plan Requirement
1	59.3	5.6%
2	59.2	5.6%
3	59.0	5.6%
4	58.8	5.6%
5	58.6	5.6%
	TOTAL	**28.0%**

Corrective Action Plan Timeline

Specific Action	Responsible Party	Timetable Start	Timetable End	Constraints	Notes
Phase 1 – Simulation diagnostics and improvements; draft of SAR	All	1/1/25	12/1/2025		
Phase 2a – PCs identify UFLS plan changes for peak summer conditions	PCs	1/1/2025	6/1/2025		
Phase 2b - Assess if additional armed load is sufficient	Consultant	6/1/2025	7/1/2025		
Phase 2c – PCs develop CAPs for UFLS entities in their PC areas	PCs	7/1/2025	8/1/2025		
Phase 2d – UFLS entities implement additional load tripping	UFLS entities	8/1/2025	4/1/2026		
Phase 3a – Recommend increasing the Armed Load Requirements of the WECC, SILTP, and WPP Coordinated Plans	All	6/1/2025	12/1/2025		
Phase 3b –PCs develop CAPs for UFLS entities in their PC areas	PCs	12/1/2025	2/1/2026		
Phase 3c –UFLS entities implement additional load tripping	UFLS entities	2/1/2025	9/27/2026	The date of 9/27/2026 is two years after the deficiency was identified.	This would be 7.5 years since the last valid report was issued.
Complete Assessment with PRC-006-5 compliant results	All	1/1/2025	12/1/2026		

Other Updates

- UFLSWG meetings are now occurring bi-monthly
- PowerWorld will be having their contract renewed to continue work soon
- Zach Zornes has been working on model updates and validation

WECC

Electric Reliability and Security for the West

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