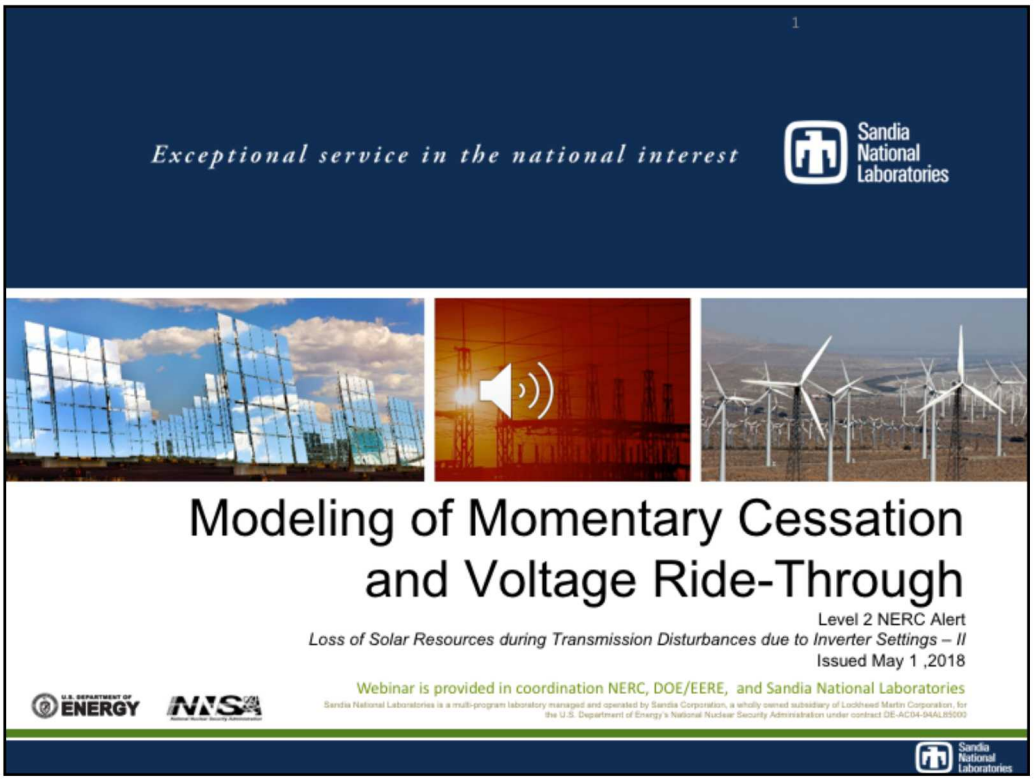


Narration:
Hello. Welcome to a webinar on the modeling of momentary cessation. This webinar is in response to a Level 2 NERC alert titled “Loss of Solar Resources During Transmission Disturbances due to Inverter Settings” issued on May 1, 2018.

# Introduction

- This webinar includes audio – push the audio button on each slide to hear the accompanying narration for that slide
- Webinar addresses situations where you need to accurately model MC and/or eliminate MC
- NERC held a webinar on this Alert. It's recommended to view that before viewing this webinar.
  - Webinar is technical in nature
  - Provides examples on how to fill out the data worksheet
  - Explains motivations behind the alert

https://www.nerc.com/pa/rrm/Webinars%20DL/Inverter_Alert_2_Webinar_20180511.pdf


NERC

Industry Recommendation

Loss of Solar Resources during Transmission Disturbances due to Inverter Settings - II

Initial Distribution: May 1, 2018

NERC has identified adverse characteristics of inverter-based resource performance during grid faults that could present potential risks to reliability of the BPS. As the penetration of inverter-based resources (particularly solar PV resources) continues to increase in North America, these adverse characteristics need to be widely communicated. This Level 2 Industry Recommendation alerts industry to these adverse characteristics observed with BPS-connected solar PV resources, and provides recommended actions to address fault ride-through and timely restoration of current injection by all inverter-based resources connected to the BPS.
(See Background section for more information.)

Although this NERC Alert pertains specifically to BES solar PV resources, the same characteristics may exist for non-BES[1] solar PV resources connected to the BPS regardless of installed generating capacity or interconnection voltage. Owners and operators of those facilities are encouraged to consult their inverter manufacturers, review inverter settings, and implement the recommendations described herein. While this NERC alert focuses on solar PV, we encourage similar activities for other inverter-based resources such as, but not limited to, battery energy storage and wind resources.

For more information, see the October 9, 2017 Canyon 2 Fire Disturbance Report.

About NERC Alerts >>

Status: Acknowledgement Required[2] by Midnight Eastern on May 8, 2018
Reporting Required by Midnight Eastern on July 31, 2018

PUBLIC: No Restrictions
More on handling >>

RELIABILITY | ACCOUNTABILITY

CCR

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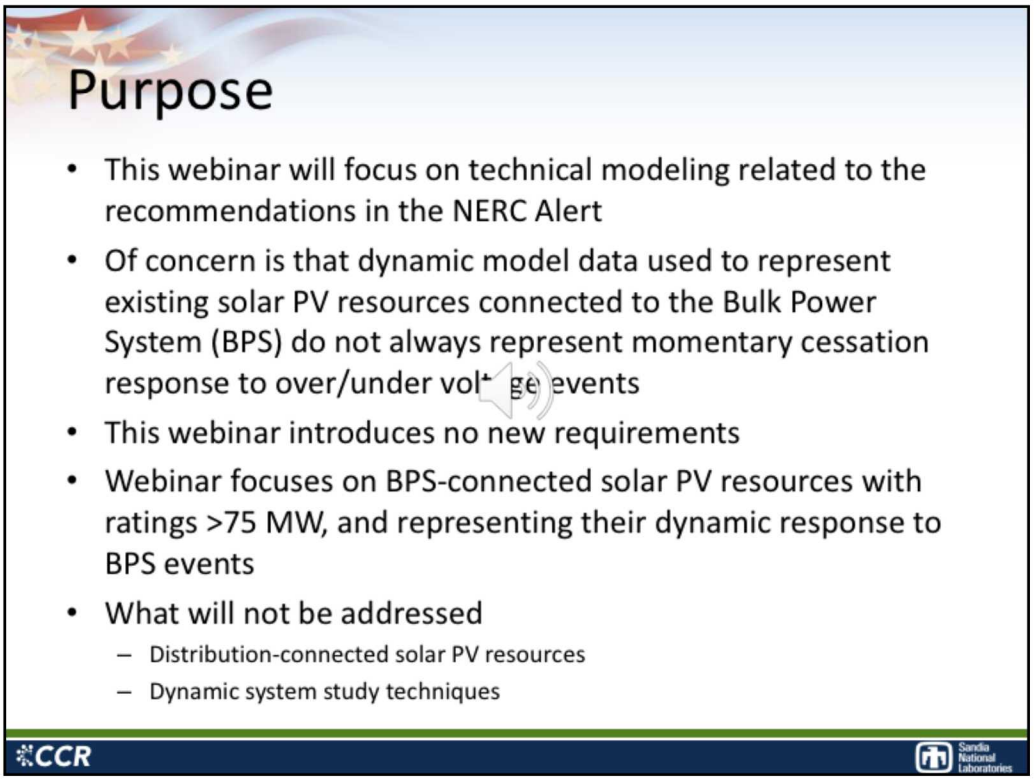
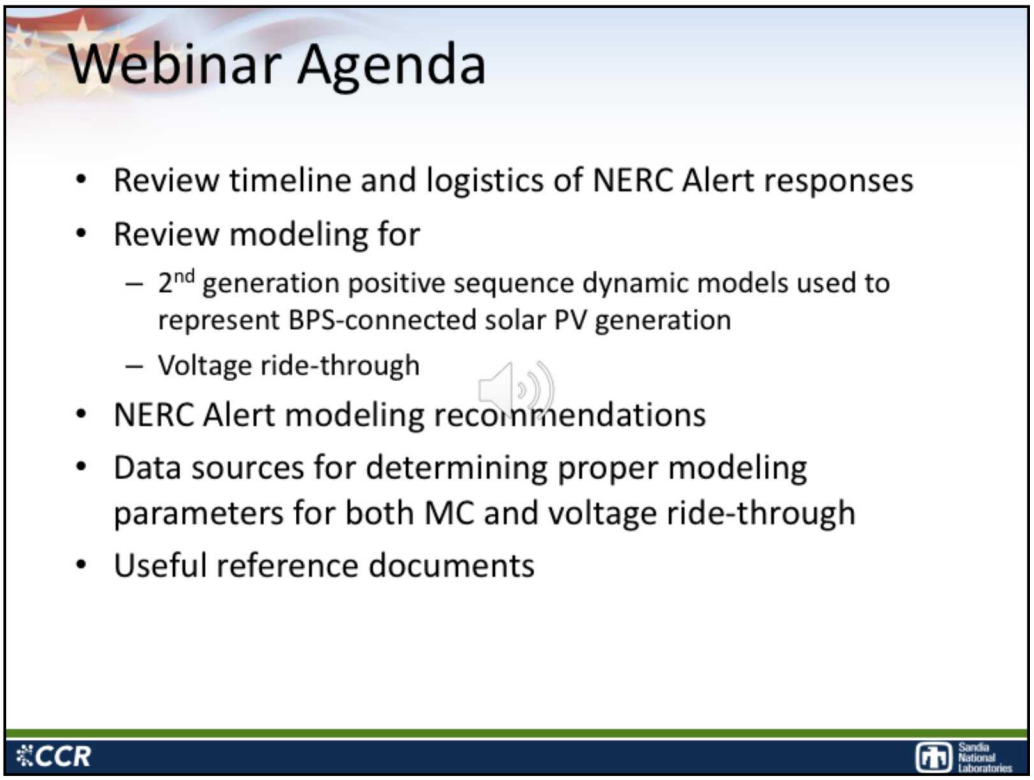
Narration:
This webinar is technical in nature, provides examples on how to fill out the data worksheet, and explains motivations behind the alert issued May 1, 2018.
This webinar addresses model parameters associated with the NERC alert shown.
NERC has held a webinar on this alert previously. It's recommended to view that before viewing this webinar. Please note that this webinar includes audio narration which may be heard by pushing the audio button on each slide.




Narration:
Read slide

At this point, we wish to draw a distinction between the models and the model data (or parameters). The 2nd generation RE dynamic models have the capability to model momentary current cessation, but in many cases inappropriate model parameters are being used in regional base cases.

While the NERC Alert applies specifically to BPS-connected PV plants greater than 75MW nameplate, NERC encourages all BPS-connected PV to take these actions.




Narration:
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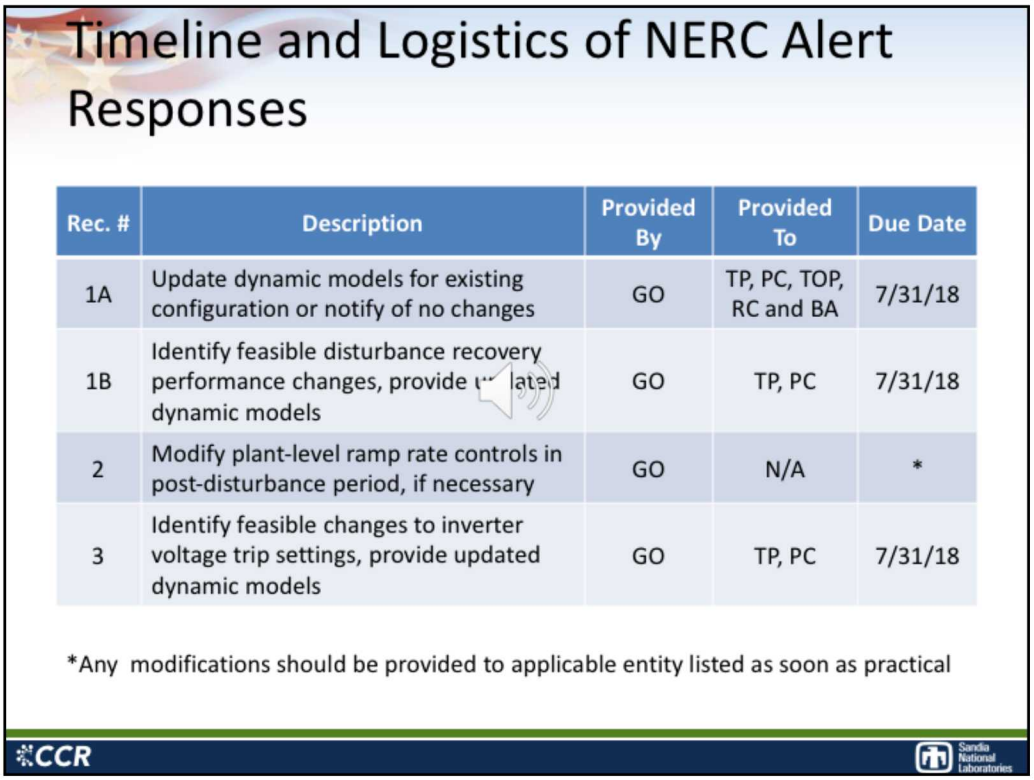
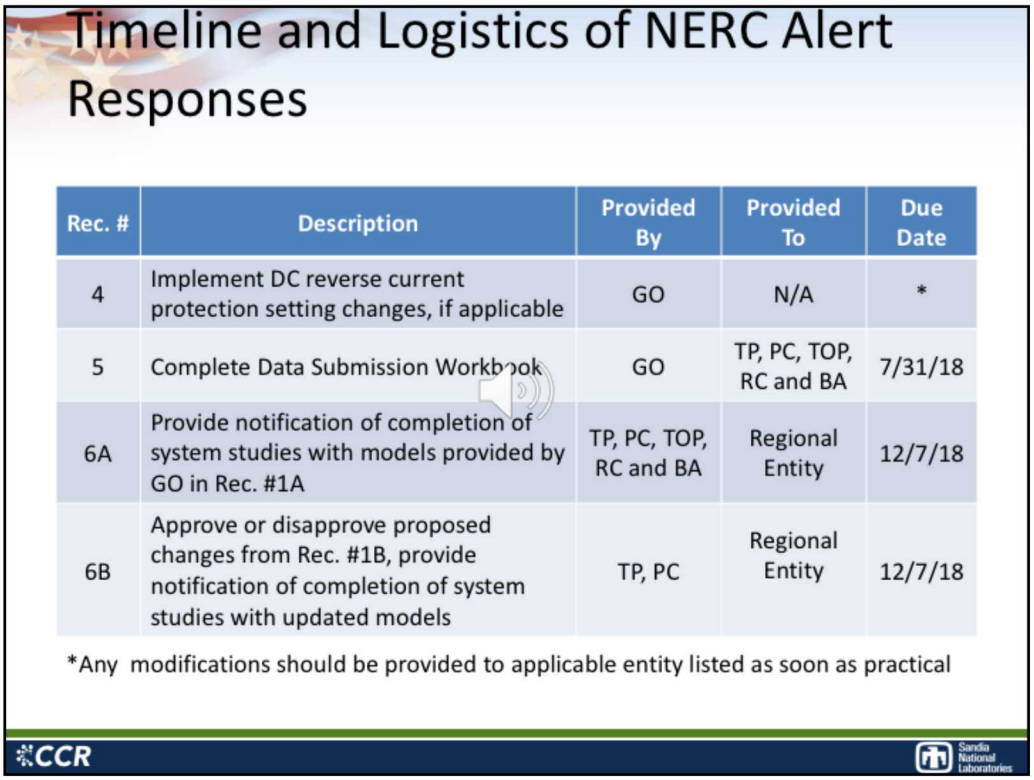



Narration:
The timeline and logistics of the required response to the NERC Alerts are provided in this slide and the following slide for convenience. This information was obtained from the NERC Alert itself. The modelling recommendations discussed in this webinar are relevant to all NERC recommendations except for #5.

GO: Generator Owner
TP: Transmission Planner
PC: Planning Coordinator
TOP: Transmission Operators
RC: Reliability Coordinator
BA: Balancing Authority
TBD's are unspecified in NERC alert




Narration:
There is no audio associated with this slide

GO: Generator Owner
TP: Transmission Planner
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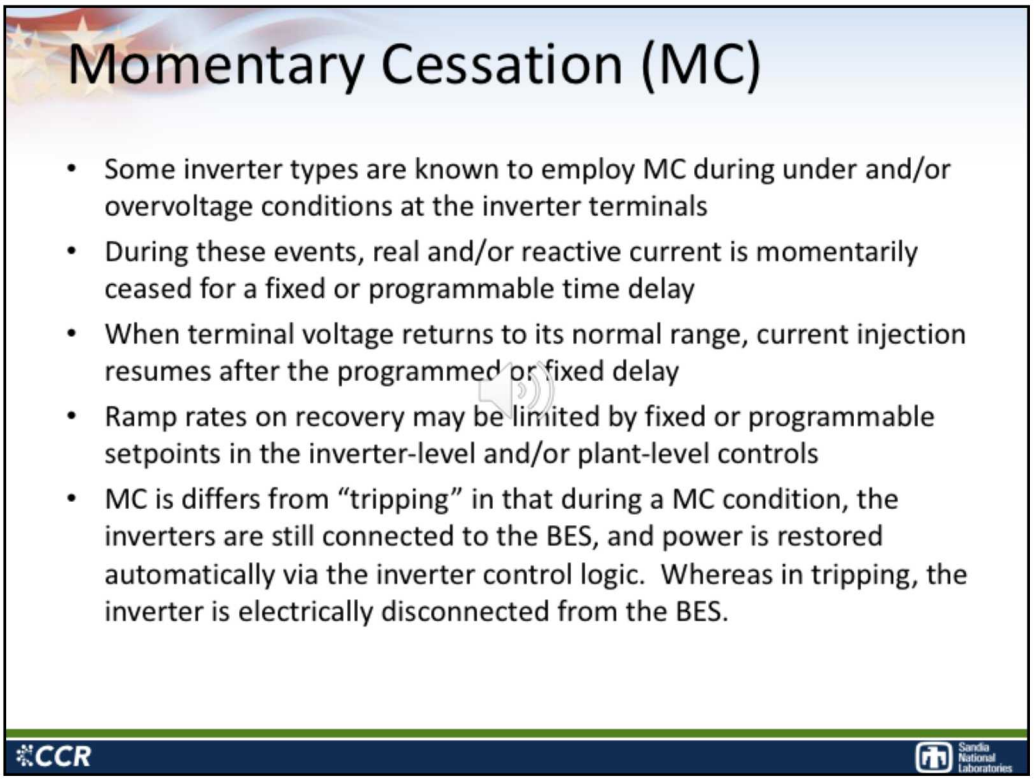


Narration:
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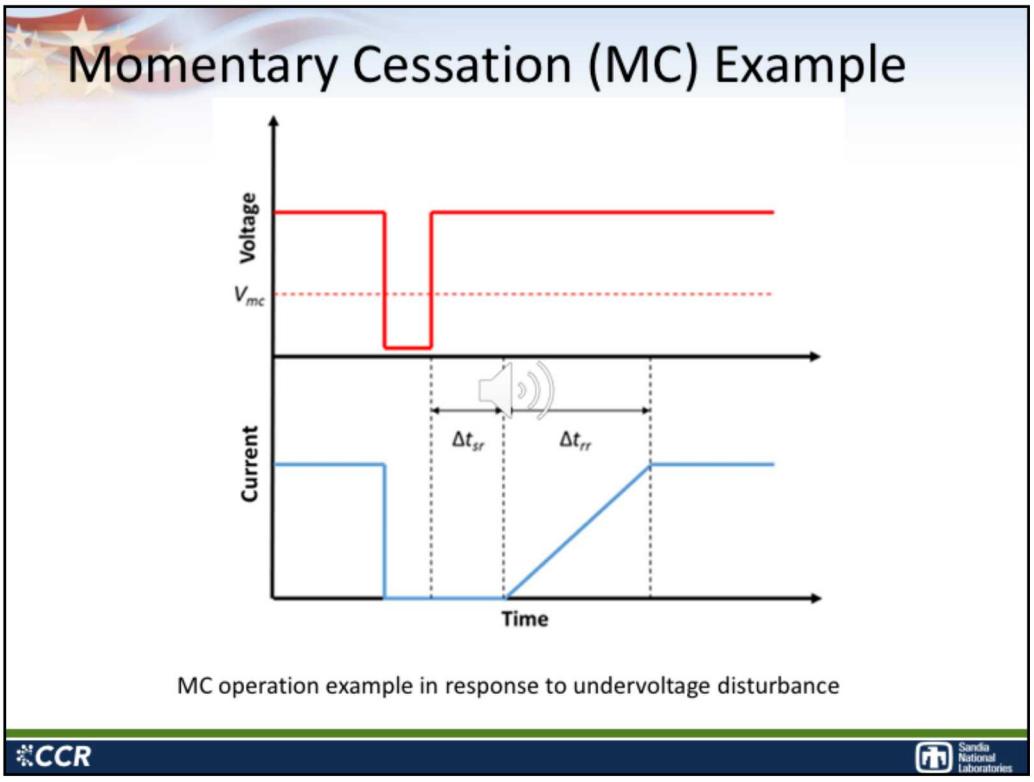
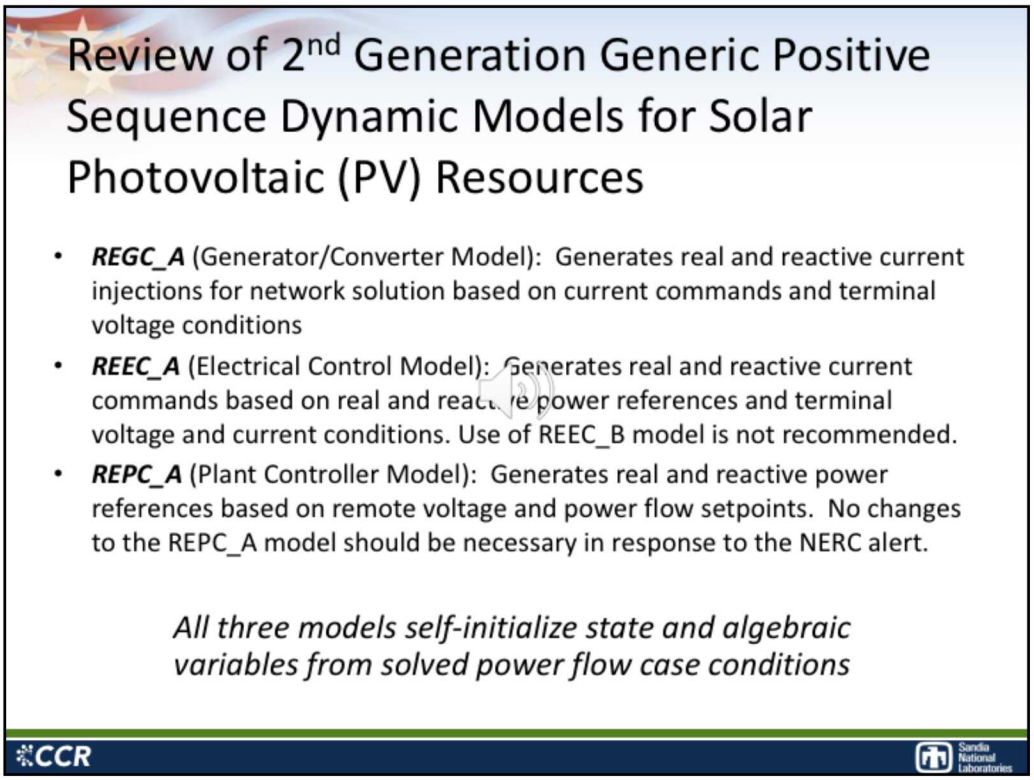


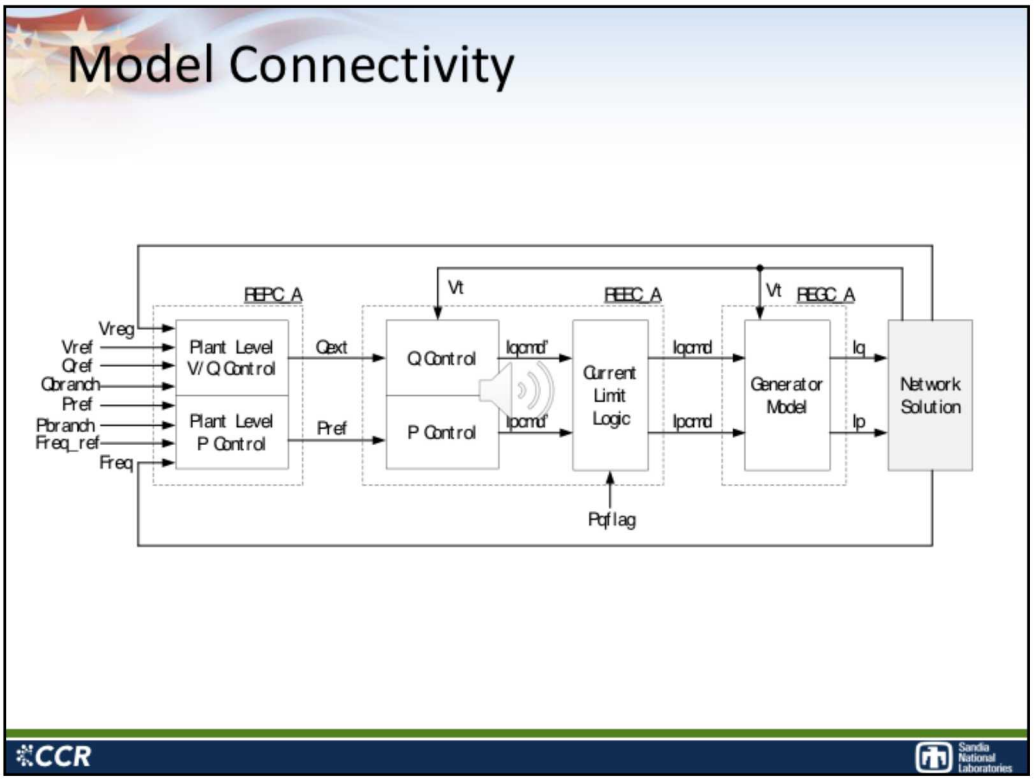

Narration:
This diagram shows momentary cessation graphically. MC is defined as a decrease of inverter current to zero, while the inverter remains connected to the grid, as a result of inverter terminal voltage falling below a threshold, shown here as Vmc. The inverter current output remains zero after the terminal voltage recovers, for a duration delta tsr. After delta tsr, the inverter current recovers using a controlled ramp rate over period delta trr. The values delta tsr, delta trr and Vmc are parameters unique to individual inverters.



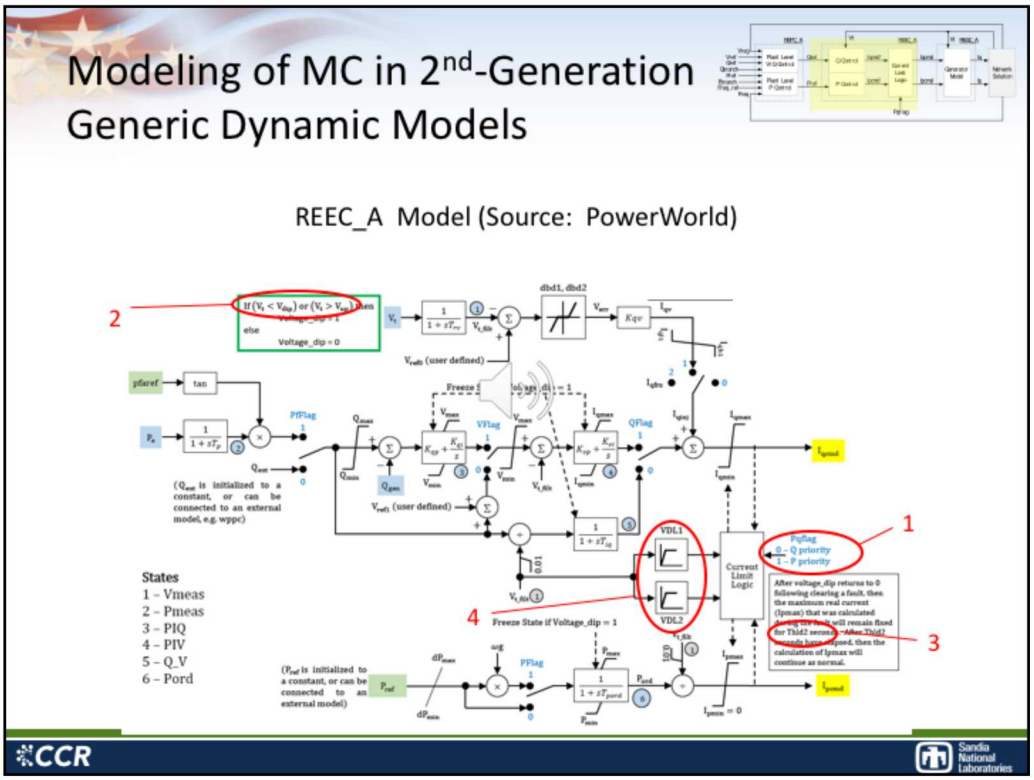

Narration:
Proper modeling of MC requires the adjustment of specific parameters in the REEC_A model and the the REGC_A model. These models are the 2nd Generation Generic Positive Sequence Dynamic Models for Solar Photovoltaic (PV) Resources. Though local studies may utilize other models to represent solar PV systems, the 2nd generation generic models are required for interconnection-wide dynamics base cases. The generic models are identical across all major software platforms.

Read bullets 1,2,3

The physical plant controller could be configured to limit ramp rate recovery after a momentary cessation event. Such a limitation is not modeled within the REPC_A model and will not be reflected if it does occur. GOs should ensure, per the NERC Alert, that plant controllers do not restrict recover ramp rate recovery after an MC event . The use of the REEC_B electrical control model is not recommended for inverters that operate with momentary current cessation during BPS faults due to limitations in modeling MC behavior. We will review the relevant models associated with this Momentary Cessation.




Narration:
The diagram shows the configuration of models used for PV plant modeling and the signals that are passed between the REPC_A, REEC_A and REGC_A subsystem models. Our focus today will identify values for REEC_A and REGC_A that must be confirmed. There are NO changes needed to the plant controller model (REPC_A), although it is shown here for context.




Narration:
This diagram shows the 2nd generation REEC_A model which should be checked and updated as necessary per Recommendation 1A. The source of this diagram is from PowerWorld modeling documentation, however, its important to note that the same model is available in other bulk power system simulation programs.

In this diagram we will review the relevant parameters that apply to momentary cessation and the NERC Alert.

1. Ensure the model parameter PQflag is set to reflect actual active or reactive current priority during and immediately following voltage disturbance.

2. Set model parameters vdip and vup to reflect the actual lower and upper thresholds of inverter terminal voltage at which momentary current cessation is triggered. Vdip is represented in the earlier slide (Slide #8) depicting momentary cessation as the parameter Vmc. Vup is not shown in that earlier slide.

note that:

A) Some inverters may use a family of voltage versus time points to define the thresholds of momentary cessation, instead of a single value.
B) Since the REEC_A model only allows a single value, we recommend selecting the most conservative value for grid modeling purposes. That means the thresholds closest to nominal voltage.
C) The NERC Modeling Notification recommends that the GO provide the voltage versus time curves in the Comments column of Data Submission Worksheet.

3. Set model parameter Thld2 to represent the actual delay in beginning active current recovery following terminal voltage recovery. Thld2 is represented in the earlier slide as the parameter delta tsr. Note that the 2nd generation models do not accommodate recovery delay for reactive current; if reactive recovery is delayed, note that in the Comments column of Data Submission Worksheet.

4. Set model parameters VDL1 and VDL2 tables to properly reflect the inverter's actual voltage-dependent active and reactive current limits. These parameters are used to drive appropriate current limits to zero during momentary cessation.

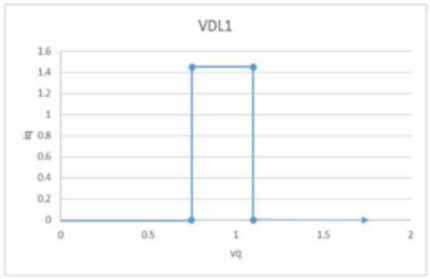
The GO should consult with the inverter manufacturer to find the existing setpoints for each of these parameters.

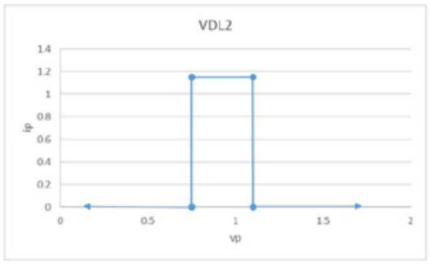
# VDL Tables: Example

- Low voltage threshold: 0.75 pu
- High voltage threshold: 1.1 pu

**Table 2: VDL1 and VDL2 Settings**

| VDL1 | | VDL2 | |
|---|---|---|---|
| vq | iq | vp | ip |
| 0.74 | 0 | 0.74 | 0 |
| 0.75 | 1.45 | 0.75 | 1.15 |
| 1.1 | 1.45 | 1.1 | 1.15 |
| 1.11 | 0 | 1.11 | 0 |

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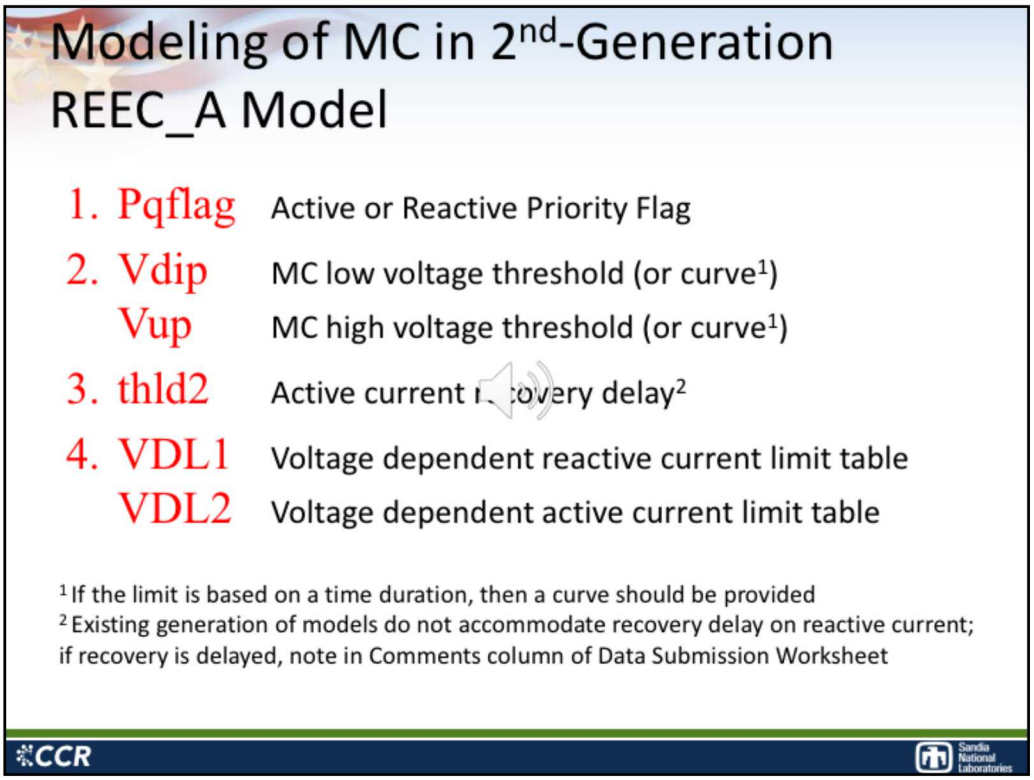
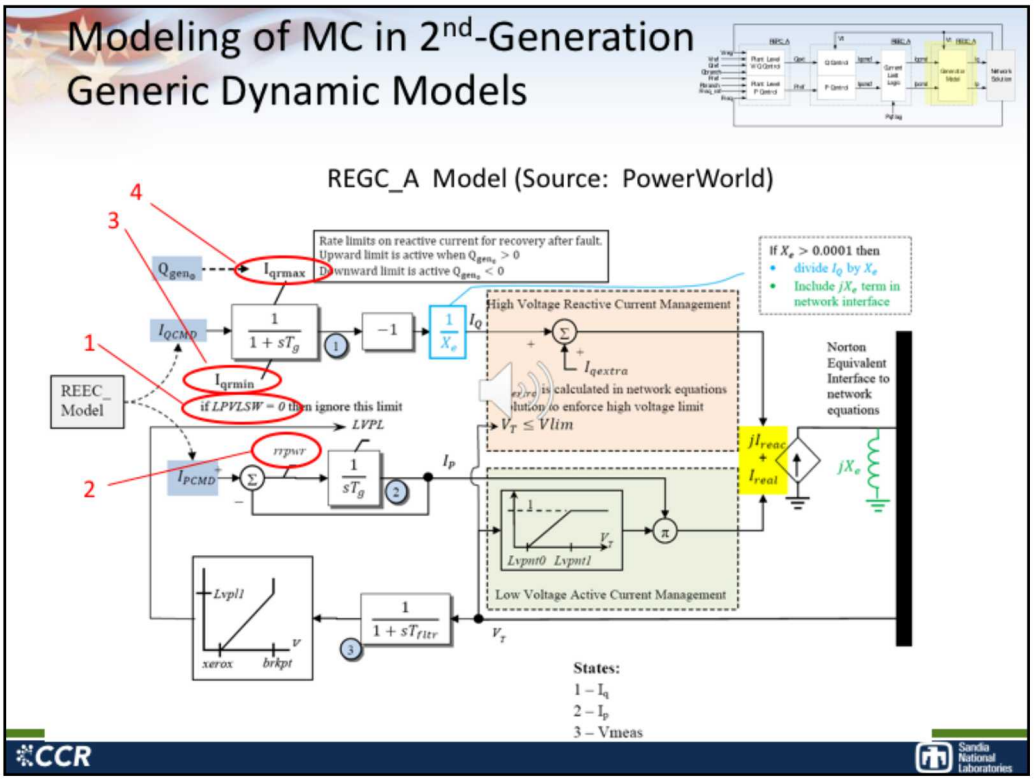
Narration:
This slide shows an example of how the VDL1 and VDL2 tables are populated to represent momentary cessation in a particular inverter. For this inverter, its real and reactive current limits are momentarily reduced from 1.15 pu and 1.45 pu, respectively, to zero when the inverter terminal voltage is less that 0.75 pu or greater than 1.1 pu.




Narration:
To summarize, this slide lists the model parameters for the REEC_A model which need to be reviewed and updated. The GO should consult with the inverter manufacturer to find the existing setpoints for each of these parameters. Note that VDL1 and VDL2 are not individual parameters, but tables of 8 parameters each.

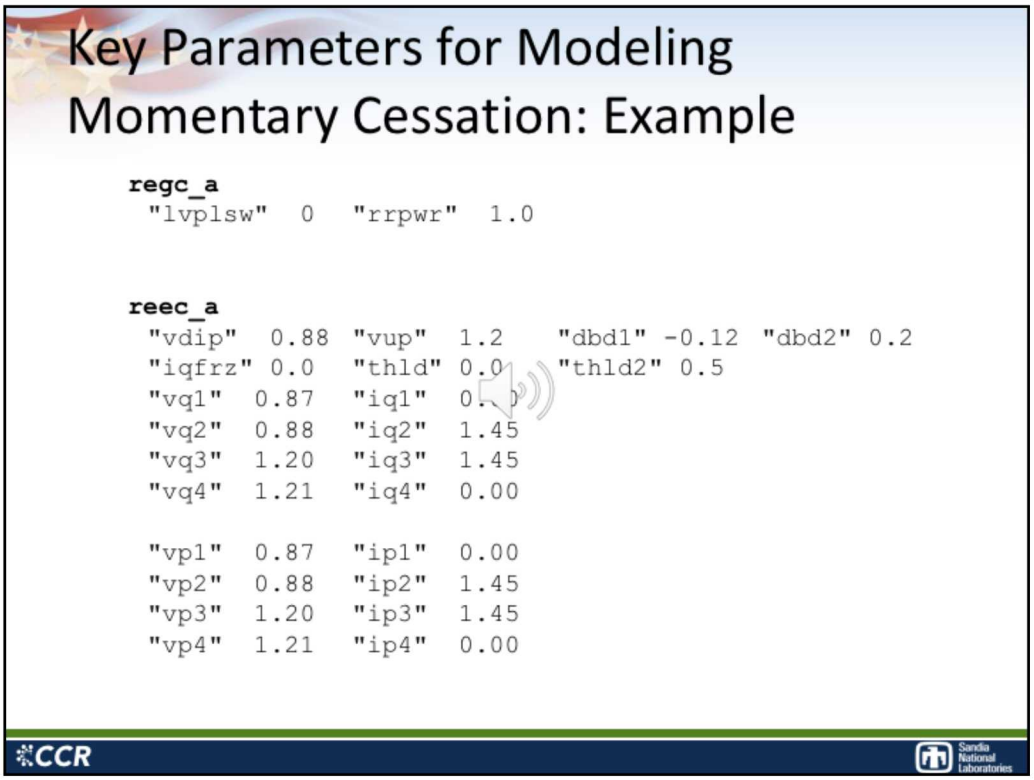



Narration:
This diagram shows the 2nd generation REGC_A model which should be checked and updated as necessary per Recommendation 1A. The source of this diagram is from PowerWorld modeling documentation.

1. Set the model parameter LVPLSW to zero to prevent override of VLD1 and VLD2 settings in REEC_A model.
2. Set the model parameter rrpwr to the active current recovery rate following an event that invokes momentary cessation.
3. Set the model parameter lqrmax to limit the upward reactive current ramp rate.
4. Set the model parameter lqrmin to limit the downward reactive current rate limit.

For iqrmax and iqrmin, any of the following should be reported: Ramp rate limits, reduced current limit for a specified period of time, or no limit is imposed.

The proper setpoint for each of these parameters should be provided by your inverter manufacturer.



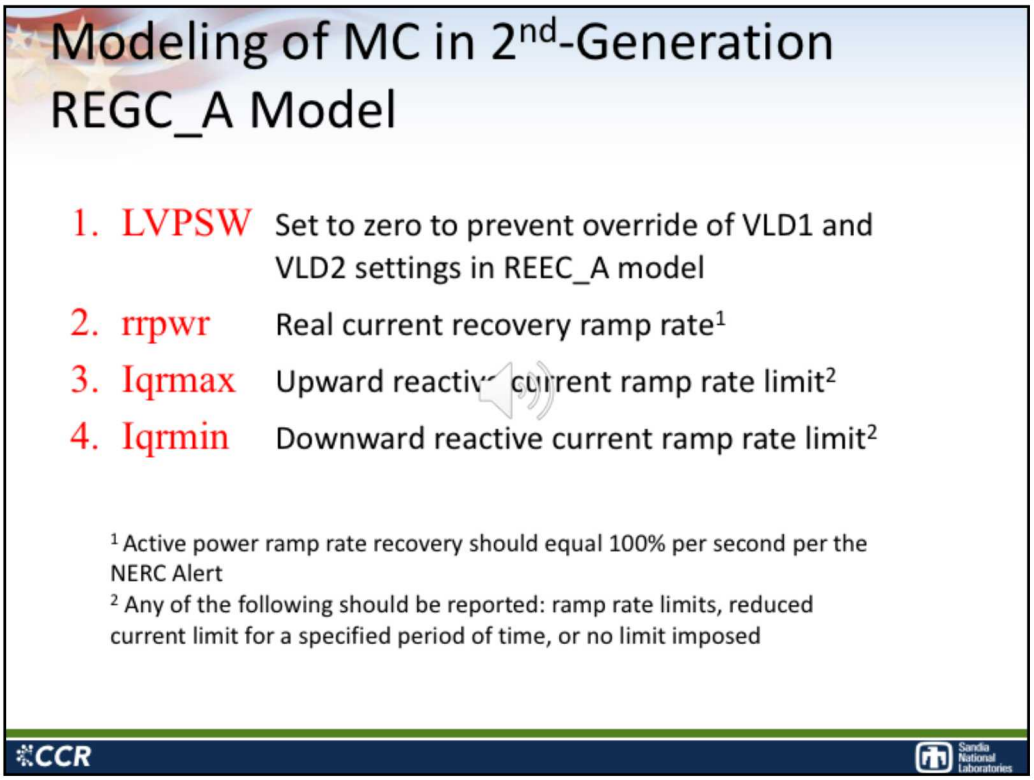

Narration:

This slide shows an example of the REGC_A and REEC_A parameters used to represent momentary cessation in a particular inverter.

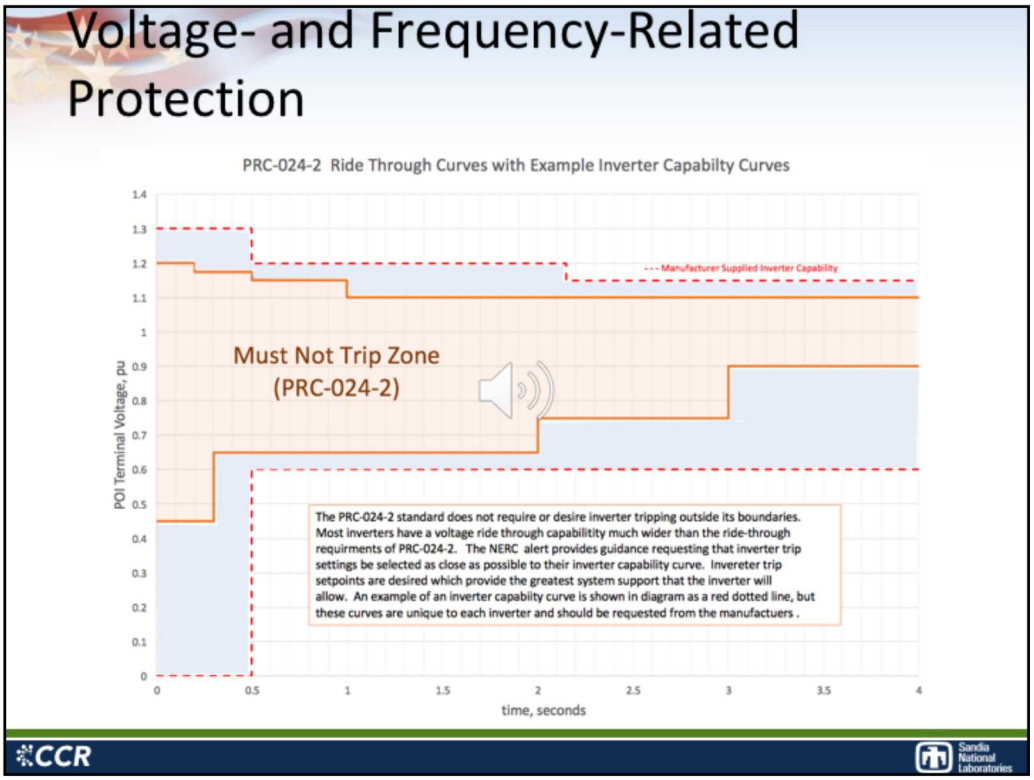
Parameter “rrpwr” in REGC_A allows for a 1.0 pu per second active current ramp-up return of nominal terminal voltage.

The inverter enters the momentary cessation mode of operation for terminal voltages outside a range of 0.88 to 1.2 pu by driving the real and reactive current limits to zero.

Real current then begins ramping from zero after 0.5 seconds following the return of terminal voltage within the 0.88 to 1.2 pu range.

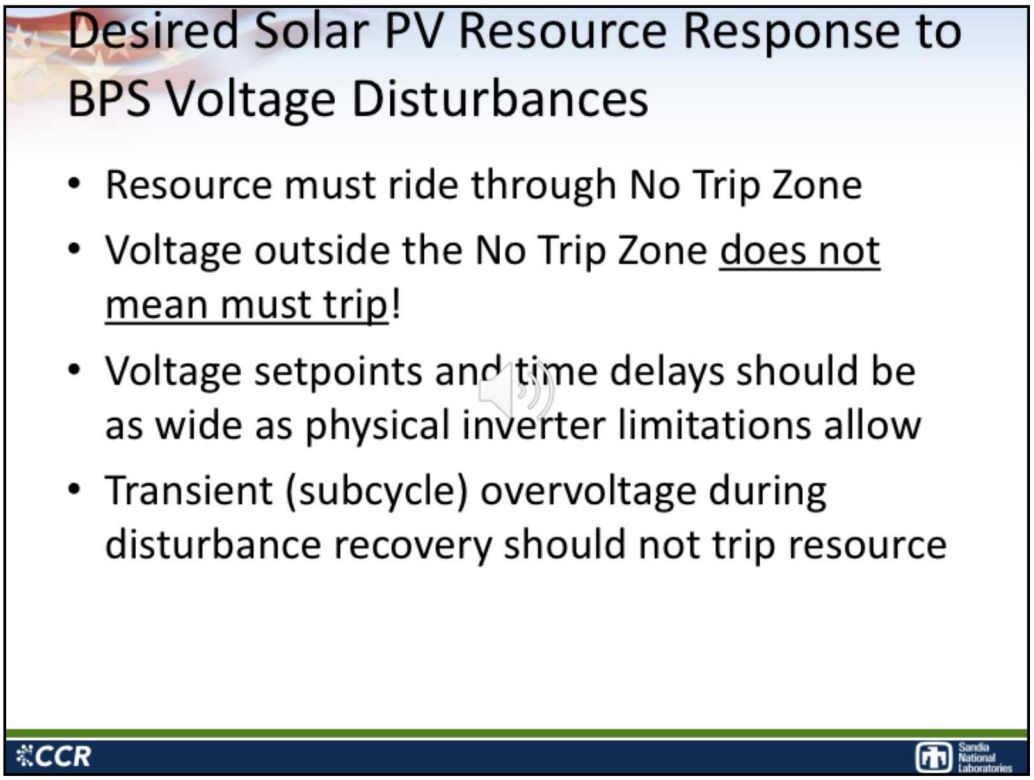



Narration:
In summary, this slide lists the model parameters for the REGC_A model which need to be reviewed and updated. The GO should consult with the inverter manufacturer to find the existing setpoint for each of these parameters.



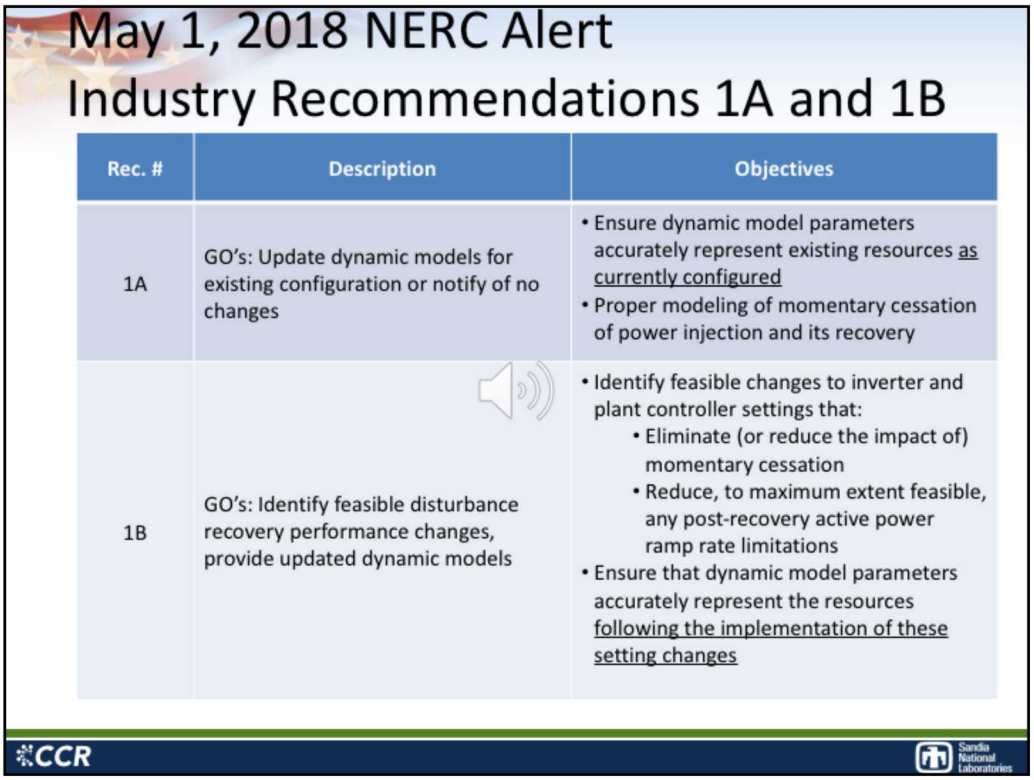

Narration:

In some cases models are used to represent low/high voltage or frequency tripping, typically using the Low/High Voltage Ride Through Generation Protection (LHVRT) model. There is a similar model used for frequency (LHFRT). Voltage or frequency related Tripping is not modeled using either the REEC_A or REGC_A Models

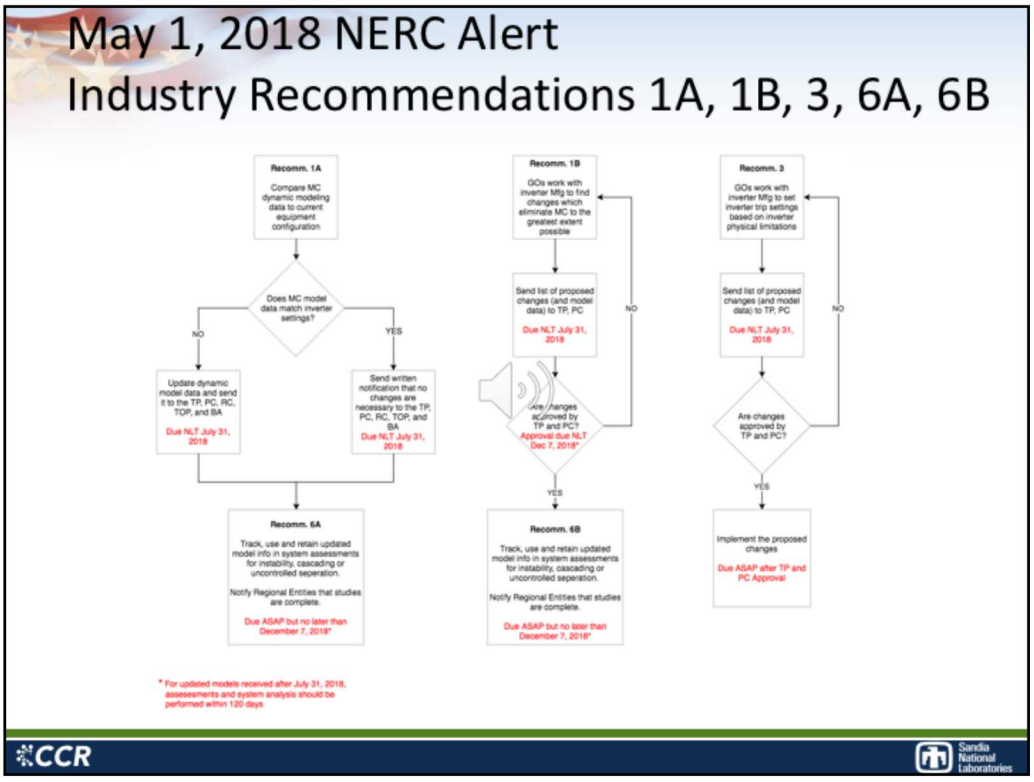



Narration: The PRC-024-2 Performance ride-through curves apply to plant protection modeling, but not to MC modeling

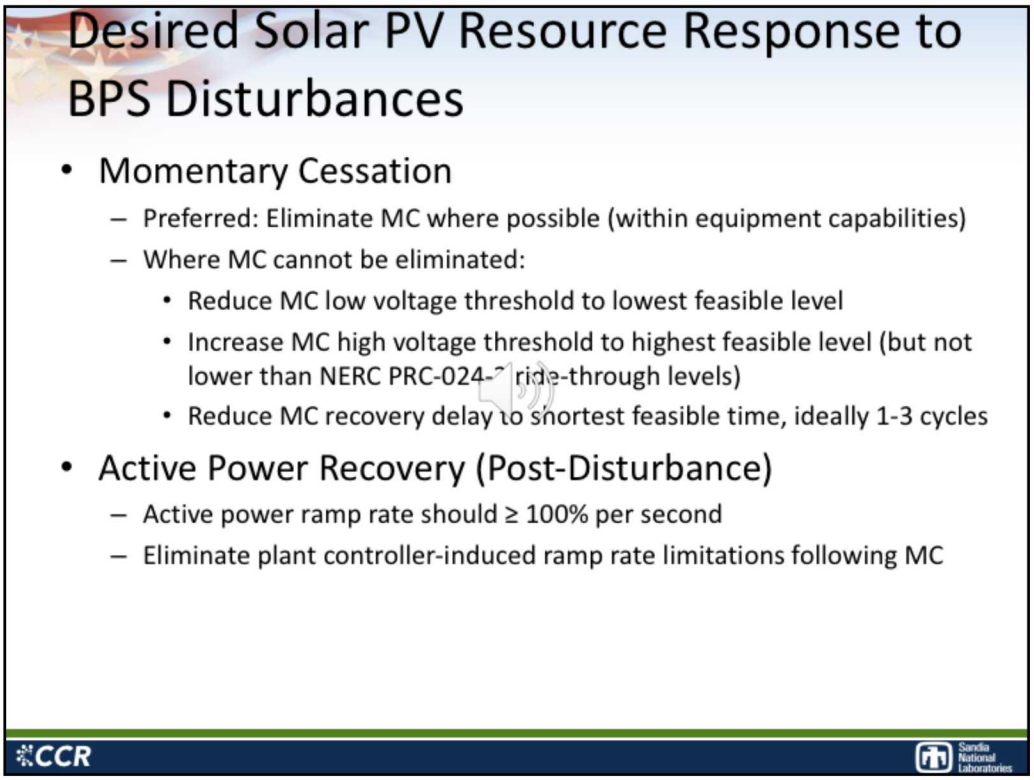
1. Resource must ride through No Trip Zone
2. Voltage outside the No Trip Zone does not mean must trip! It is favorable for the inverter to remain online if it can safely do so.
3. Voltage setpoints and time delays should be as wide as physical inverter limitations allow
4. Operation outside the orange boundary is preferred to have resource ride-through, if the resource can safely accomplish it
5. Transient (subcycle) overvoltage during disturbance recovery should not trip the resource- The data may need to be collected from the PV Manufacturer



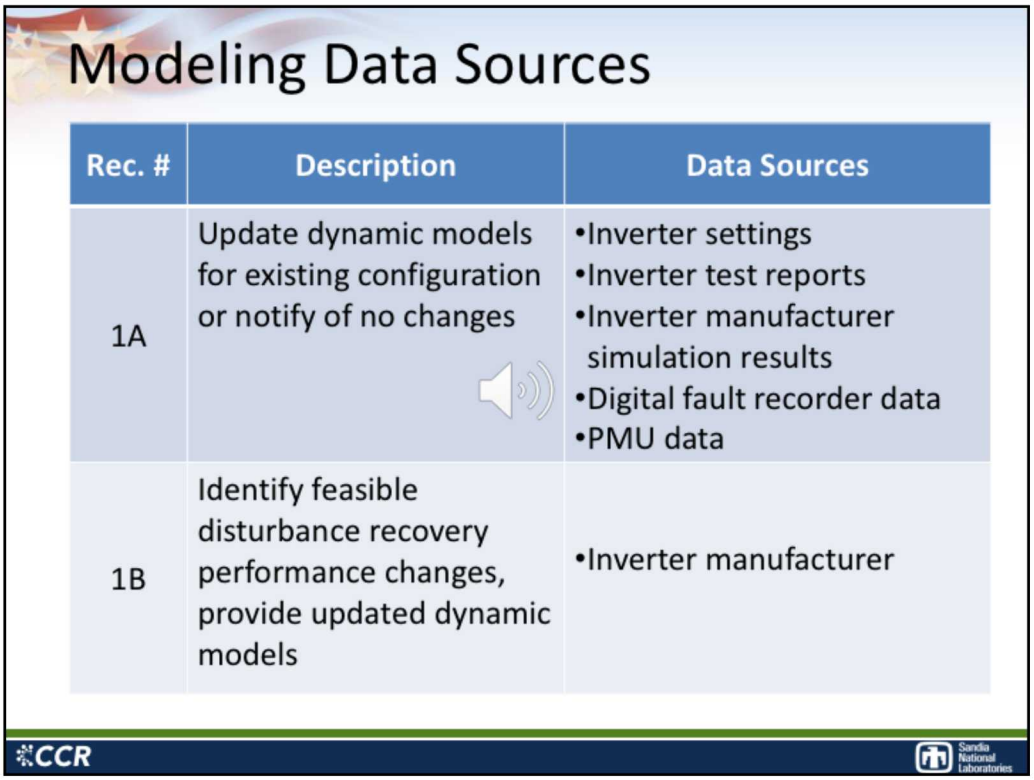

Narration
This slide summarizes the objectives of NERC Alert recommendations 1A and1B.
Read slide



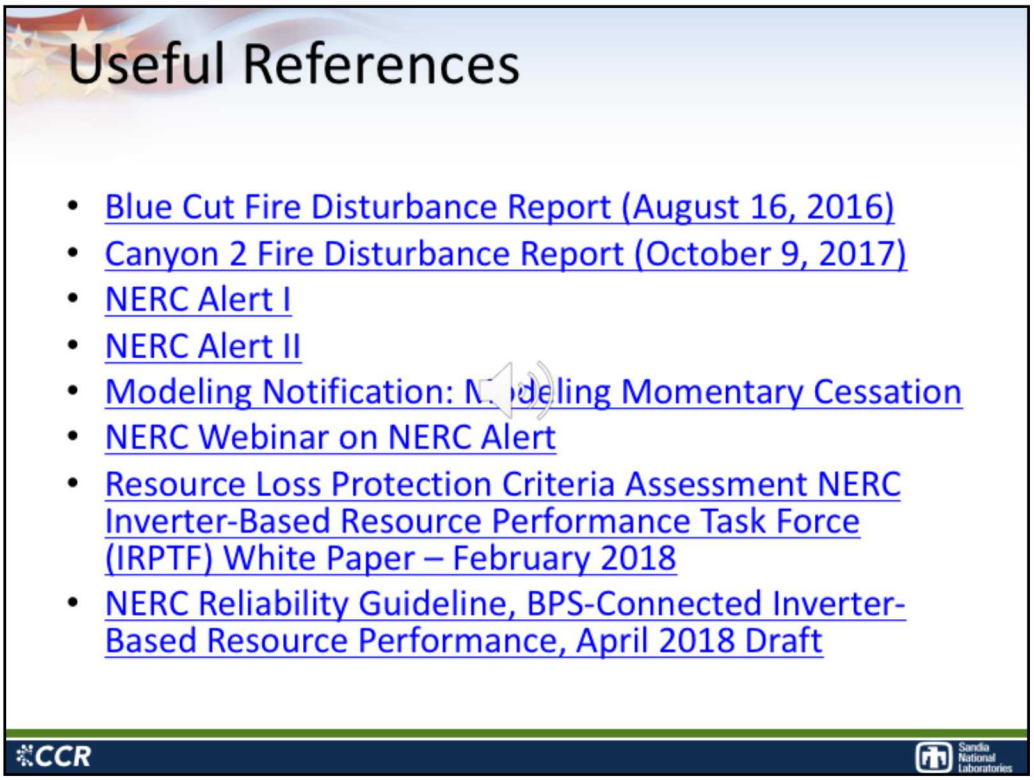

Narration:
The flow chart on this slide indicates the relationship between Recommendations 1A and 1B, which are targeted to the Generator Owners, and Recommendations 6A and 6B, which are targeted at the Transmission Planners and Planning Coordinators. Note that any changes proposed in response to Recommendation 1B require approval by the TP/PC before implementation in the field.



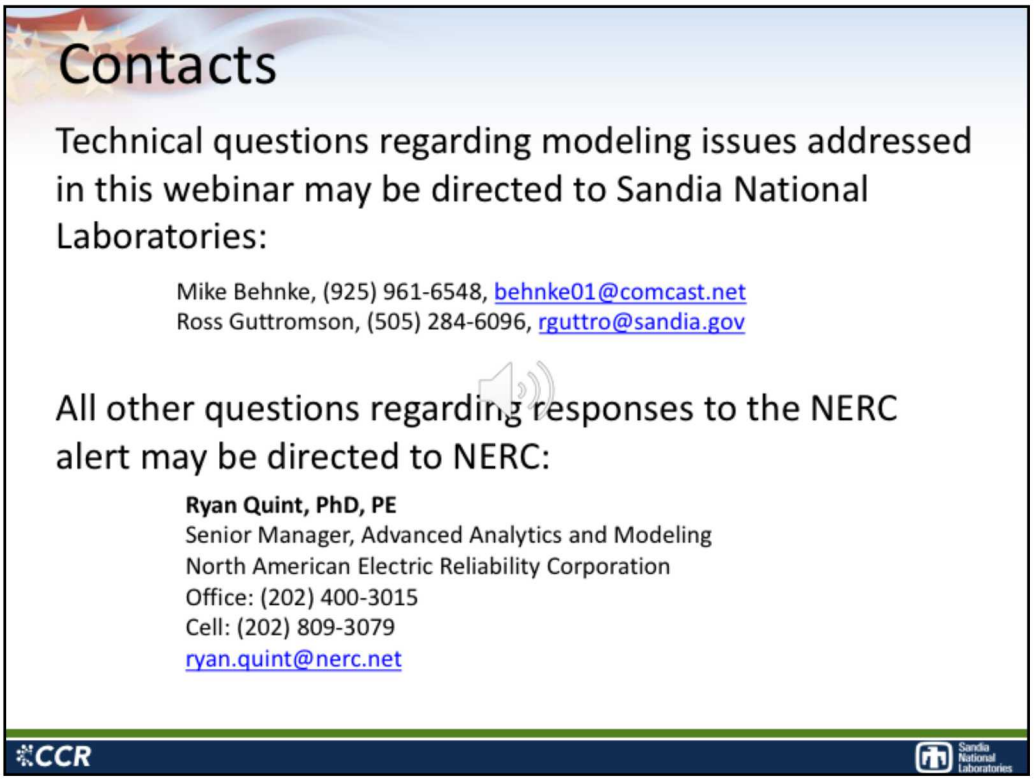

Narration
This slide describes the Desired Solar PV Resource Response to BPS Disturbances
Read slide




Narration
This slide discusses the sources of data for response to NERC Alert recommendations 1A and1B.
Read slide




Narration:
The references, all available on the NERC website, may be helpful in providing a deeper understanding of the issues addressed in this webinar.




Narration:
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