DISTRIBUTION MANAGEMENT SYSTEM (DMS)

v2.5

5.4.3.4b Optimize Network (Study Mode)

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Brief Description

Business Process: **5.4.3.5 Optimize Network (Study Mode)**
Process Type: **Sub Process**
Parent Process: **5.X.XXX**
Sibling Processes:

The Network Optimization Tool (Optimization) generates a set of optimal substation power transformer tap positions, voltage regulator tap positions, capacitor bank statuses, and DER/DR power dispatch controls for a defined optimization objective. The following optimization objectives are currently supported:

- **Loss Minimization**
- **Power Factor Correction**
- **Conservation Voltage Reduction**
- **Relieve Violations**
- **Maximize Voltage**
- **Maximize VAr**
- **Return to Nominal**

In study mode, the Optimization is invoked manually by a user for chosen area of the model and objective they want to study. This allows users to generate what if scenarios or evaluate plans on topology that may not be present currently in the network. Users can evaluate the plans in study mode without affecting the real-time operations model and alter as necessary.

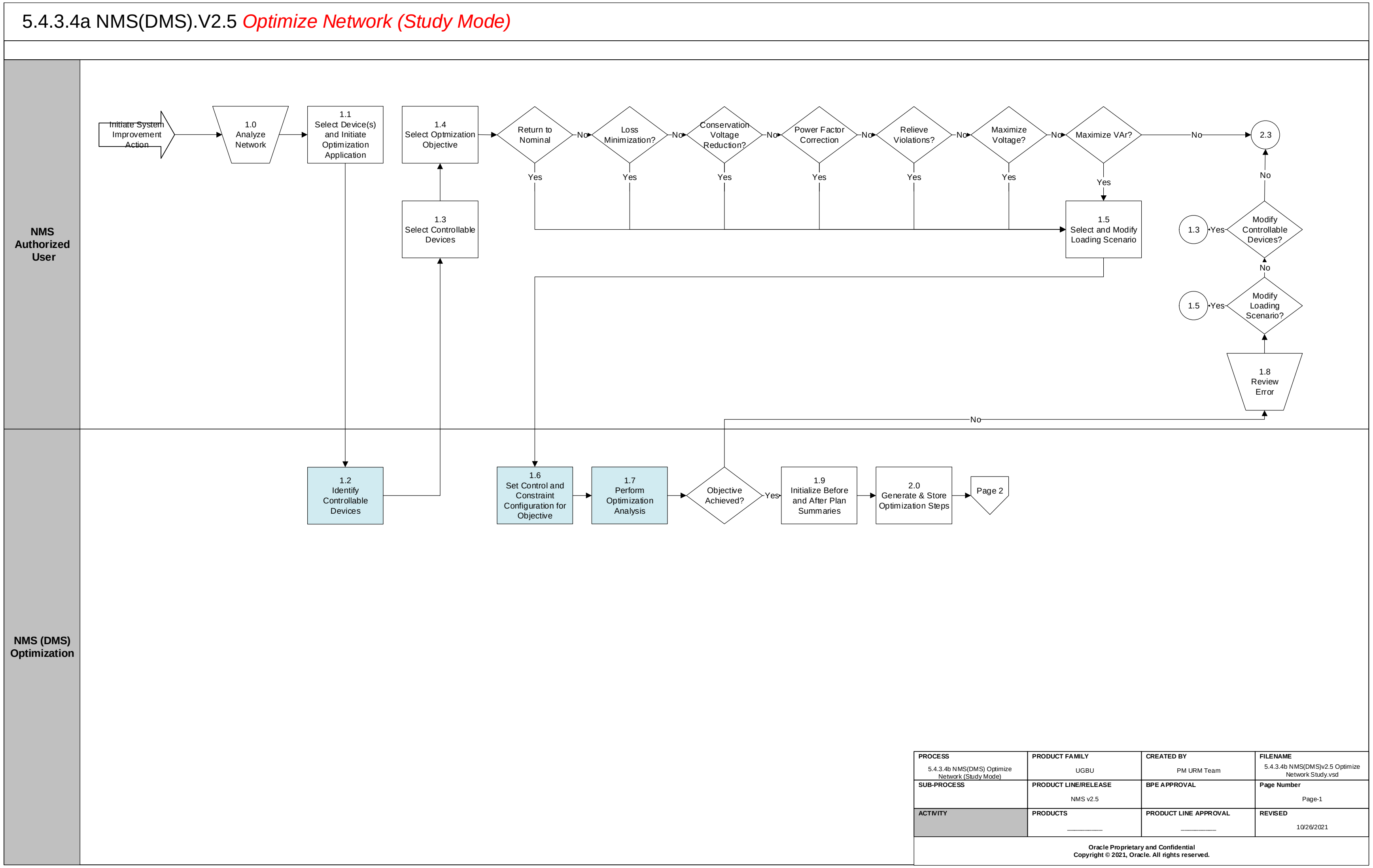
The primary actors for the Optimization application process are as follows:

1. NMS Authorized User: Choses the area, objective, and load conditions for which they would like to generate a plan for.
2. Optimization: The Optimization application runs based on the users inputs and generates a plan that can then be analyzed in study mode.

The general business process for Study Mode Optimization:

1. Trigger Mechanism: A user needs to evaluate the effects of a certain plan on an area of the model using very specific load conditions.
2. Optimization Recommendation: Based on the defined objective and the loading conditions, the Optimization application recommends capacitor, transformer, and DER/DR power dispatch recommendations for optimized operation.
3. Switching Sheet Creation: Based on the Optimization recommendation, the user creates and executes switching sheet for the intended optimization objective while in study mode. This will have no impact or consequence on the real-time operations model and the user can manipulate or change the model as much as needed.

Business Process Model Page 1


5.4.3.4a NMS(DMS).V2.5 Optimize Network (Study Mode)
NMS Authorized User
NMS (DMS) Optimization
Initiate System Improvement Action
1.0 Analyze Network
1.1 Select Device(s) and Initiate Optimization Application
1.2 Identify Controllable Devices
1.3 Select Controllable Devices
1.4 Select Optmization Objective
Return to Nominal
No
Loss Minimization?
No
Conservation Voltage Reduction?
No
Power Factor Correction
No
Relieve Violations?
No
Maximize Voltage?
No
Maximize VAr?
No
2.3
Yes
Yes
Yes
Yes
Yes
Yes
Yes
1.5 Select and Modify Loading Scenario
No
1.3
Yes
Modify Controllable Devices?
No
1.5
Yes
Modify Loading Scenario?
1.8 Review Error
No
1.6 Set Control and Constraint Configuration for Objective
1.7 Perform Optimization Analysis
Objective Achieved?
Yes
1.9 Initialize Before and After Plan Summaries
2.0 Generate & Store Optimization Steps
Page 2

PROCESS	PRODUCT FAMILY	CREATED BY	FILENAME
5.4.3.4b NMS(DMS) Optimize Network (Study Mode)	UGBU	PM URM Team	5.4.3.4b NMS(DMS)v2.5 Optimize Network Study.vsd
SUB-PROCESS	PRODUCT LINE/RELEASE	BPE APPROVAL	Page Number
	NMS v2.5		Page-1
ACTIVITY	PRODUCTS	PRODUCT LINE APPROVAL	REVISED
	________	________	10/26/2021

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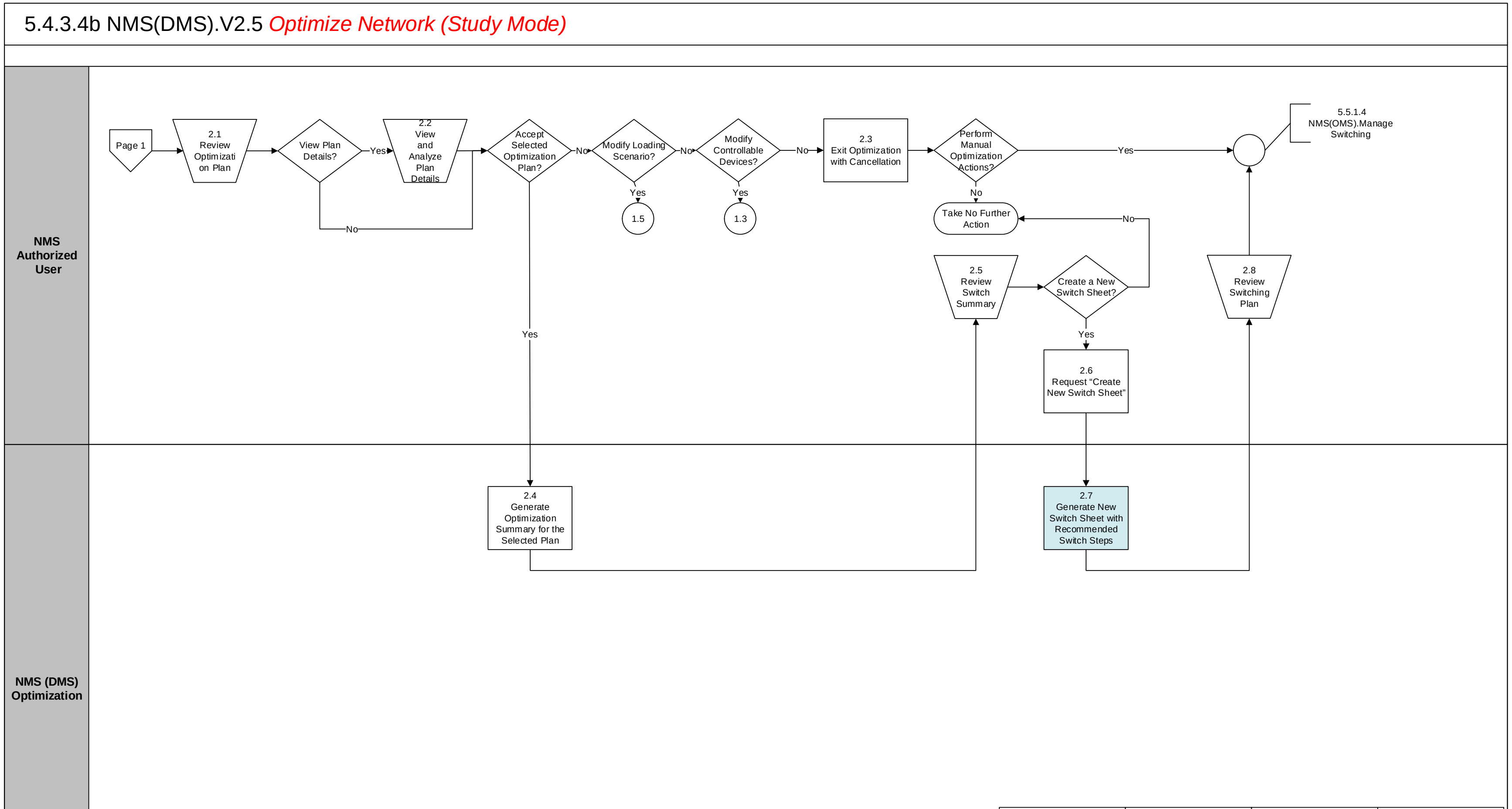
Business Process Model Page 2


5.4.3.4b NMS(DMS).V2.5 Optimize Network (Study Mode)
NMS Authorized User
NMS (DMS) Optimization
Page 1
2.1 Review Optimizati on Plan
View Plan Details?
Yes
No
2.2 View and Analyze Plan Details
Accept Selected Optimization Plan?
No
Yes
Modify Loading Scenario?
No
Yes
1.5
Modify Controllable Devices?
No
Yes
1.3
2.3 Exit Optimization with Cancellation
Perform Manual Optimization Actions?
Yes
No
Take No Further Action
5.5.1.4 NMS(OMS).Manage Switching
2.4 Generate Optimization Summary for the Selected Plan
2.5 Review Switch Summary
Create a New Switch Sheet?
No
Yes
2.6 Request "Create New Switch Sheet"
2.7 Generate New Switch Sheet with Recommended Switch Steps
2.8 Review Switching Plan

PROCESS 5.4.3.4b NMS(DMS) Optimize Network (Study Mode)	**PRODUCT FAMILY** UGBU	**CREATED BY** PM URM Team	**FILENAME** 5.4.3.4b NMS(DMS)v2.5 Optimize Network Study.vsd
SUB-PROCESS	**PRODUCT LINE/RELEASE** NMS v2.5	**BPE APPROVAL**	**Page Number** Page-2
ACTIVITY	**PRODUCTS** ________	**PRODUCT LINE APPROVAL** ________	**REVISED** 10/27/2021

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Detail Business Process Model Description

1.0 Analyze Network

Actor/Role: NMS Authorized User

Description:

This will be the basis of starting a run of Optimization and will be triggered by user needing to evaluate a particular objective, for a chosen spot within the model, with specific load conditions that need to be analyzed.

1.1 Select Device and Initiate Optimization Application

Actor/Role: NMS Authorized User

Description:

The users selects a device within the area that needs to be evaluated. Please note the analysis optimizes the area at and below a Low Voltage (LV) bus within a substation. Therefore a user could pick any device within the LV bus or feeder fed by the LV bus and achieve the same results.

1.2 Identify Controllable Devices

Actor/Role: NMS (DMS) Optimization

Description:

Based on the area of the model the user selected, the system will look for candidate devices that could be used within the optimization. If a device inherits from pf_opf_enabled_devices, it will be used as a candidate device and will be selected by default. If a device inherits from pf_opf_excluded_devices, it will not be considered at all as a candidate device. If a regulation device inherits from neither class it will be shown as a candidate device buy not selected by default.

Task Customizable (Y) **Available Rule(s):**

Mechanism	Rule
Inheritance	pf_opf_enabled_devices
Inheritance	pf_opf_excluded_devices

Configuration required (Y) **Entities to Configure:**

Inheritance

1.3 Select Controllable Devices

Actor/Role: NMS Authorized User

Description:

The NMS user can select the regulation devices they would like to consider within the optimization analysis dialog. The list of devices presented here will be DERs, Power Transformers, Voltage Regulators, and Capacitors.

1.4 Select Optimization Objective

Actor/Role: NMS Authorized User

Description:

After the controllable devices have been selected the user can then chose the optimization objective they would like to use within the analysis (e.g. Conservation Voltage Reduction).

1.5 Select and Modify Loading Scenario

Actor/Role: NMS Authorized User

Description:

After the user has chosen the candidate devices and objective to be used within the analysis they must next setup the loading conditions. The user has multiple options that can be selected within this page of the optimization analysis dialog. The user can select a copy of real-time or a copy of a future specific date for which forecast data has been provided for. Alternatively, a user can setup custom conditions by selecting the type and hour of a load profile (e.g. Weekday at 5pm). In addition to setting the load for this option, the user can also choose the behavior for the various DER technology types (e.g. Windy and Sunny to alter weather affected DER units)

1.6 Set Control and Constraint Configuration for Objective

Actor/Role: NMS (DMS) Optimization

Description:

Determine the control and constraint weighting for the selected objective. The optimization has configuration which allows projects to specify which constraints and controls should be considered within each of the available objective functions. In addition the weight at which each control/constraint can also be configured. For example a project could specify they would not like to use DER controls for the CVR objective.

Task Customizable (Y) **Available Rule(s):**

Mechanism	Rule
SRS Rules	opfConstraintLine
SRS Rules	opfConstraintSwitch
SRS Rules	opfConstraintVolt
SRS Rules	opfConstraintXfmr
SRS Rules	opfControlCapPos
SRS Rules	opfControlDistGen
SRS Rules	opfControlTapPos

Configuration required (Y) **Entities to Configure:**

SRS Rules

1.7 Perform Optimization Analysis

Actor/Role: NMS (DMS) Optimization

Description:

Perform the actual optimization analysis to determine how to optimize the controllable devices given the constraints and control objective. The results of this analysis should be the optimal device positions/outputs for the objective that was configured for the optimization area.

1.8 Review Error

Actor/Role: NMS Authorized User

Description:

If the optimization objective could not be achieved a dialog message will appear stating an error condition. The user can then review this and decide if they want to modify any of the options altered earlier such as loading, candidate devices, or the objective.

1.9 Initialize Before and After Plan Summaries, Violations, and Graphs

Actor/Role: NMS (DMS) Optimization

Description:

The Optimization will determine what the before and after results look like as a part of executing the plan. This involves calculating power flow results, voltage profile graphs, and violation counts for before and after plan execution. This will help operators determine the benefit of the particular plan that was generated. For example in with a CVR plan they will see the savings in real-power, the new minimum feeder voltage, and the shift in the voltage profile for each feeder.

2.0 Generate and Store Optimization Steps

Actor/Role: NMS (DMS) Optimization

Description:

The analysis will determine the before/after positions of the devices and calculate any regulation set points that need to be applied. The steps found for the optimization analysis will be written to the database and associated to the event.

2.1 Review Optimization Plan

Actor/Role: NMS Authorized User

Description:

The NMS user can view the high level information related to the plan generated by the optimization. This dialog will show pertinent information related to the plan such as the controllable device settings, violation counts, power flow results, and voltage profile graphs before and after plan execution.

2.2 View and Analyze Plan Details

Actor/Role: NMS Authorized User

Description:

If needed the user can access the plan details to see detailed power flow results, violation counts, and a voltage profile graph for each feeder involved in the plan.

2.3 Exit Optimization with Cancellation

Actor/Role: NMS Authorized User

Description:

If the user does not accept the plan or wants to generate their own steps manually they may hit the cancel button at this point to exit the optimization analysis user interface completely.

2.4 Generate Optimization Summary for the Selected Plan

Actor/Role: NMS (DMS) Optimization

Description:

If a user accepts the steps that were generated as part of the optimization they can request to generate the summary.

2.5 Review Switch Summary

Actor/Role: NMS Authorized User

Description:

This will be the last page within the optimization user interface that will display the steps that will be added to the Switch Plan as well as including a button that allows a user to create an actual switch plan within the NMS.

2.6 Request "Create New Switch Sheet"

Actor/Role: NMS Authorized User

Description:

After the user has had a final chance to review the steps that will be added to the switch sheet they can now choose to press the button to create the switch plan within NMS.

2.7 Generate New Switch Sheet with Recommended Steps

Actor/Role: NMS (DMS) Optimization

Description:

The optimization analysis steps will be placed into an actual Switching Management Sheet that can then be executed in study mode to analyze the effects of the plan on the electrical network.

The following SRS rules define the configuration for which control actions will be placed in the Switching Sheet for the various steps. The rules should be setup properly such that the rules are mapped to the proper SCADA control actions for controlling the regulation device.

Task Customizable (Y) **Available Rule(s):**

Mechanism	Rule
SRS Rule	voltVarSwitchPlanType
SRS Rule	voltVarTemplateBase
SRS Rule	voltVarTemplateCapAuto
SRS Rule	voltVarTemplateCapPosition
SRS Rule	voltVarTemplateCapOnThreshold
SRS Rule	voltVarTemplateCapOffThreshold
SRS Rule	voltVarTemplateXfmrAuto
SRS Rule	voltVarTemplateXfmrPosition
SRS Rule	voltVarTemplateXfmrPositionA
SRS Rule	voltVarTemplateXfmrPositionB
SRS Rule	voltVarTemplateXfmrPositionC
SRS Rule	voltVarTemplateXfmrTarget
SRS Rule	voltVarTemplateDistGenKw
SRS Rule	voltVarTemplateDistGenKvar

Configuration required (Y) **Entities to Configure:**

SRS Rules

2.8 Review Switching Plan

Actor/Role: NMS Authorized User

Description:

After the NMS has generated the switching plan the user can review the plan within Switching Management before plan execution. At this point, if anything needs be altered, the user has the ability to modify the plan as needed.

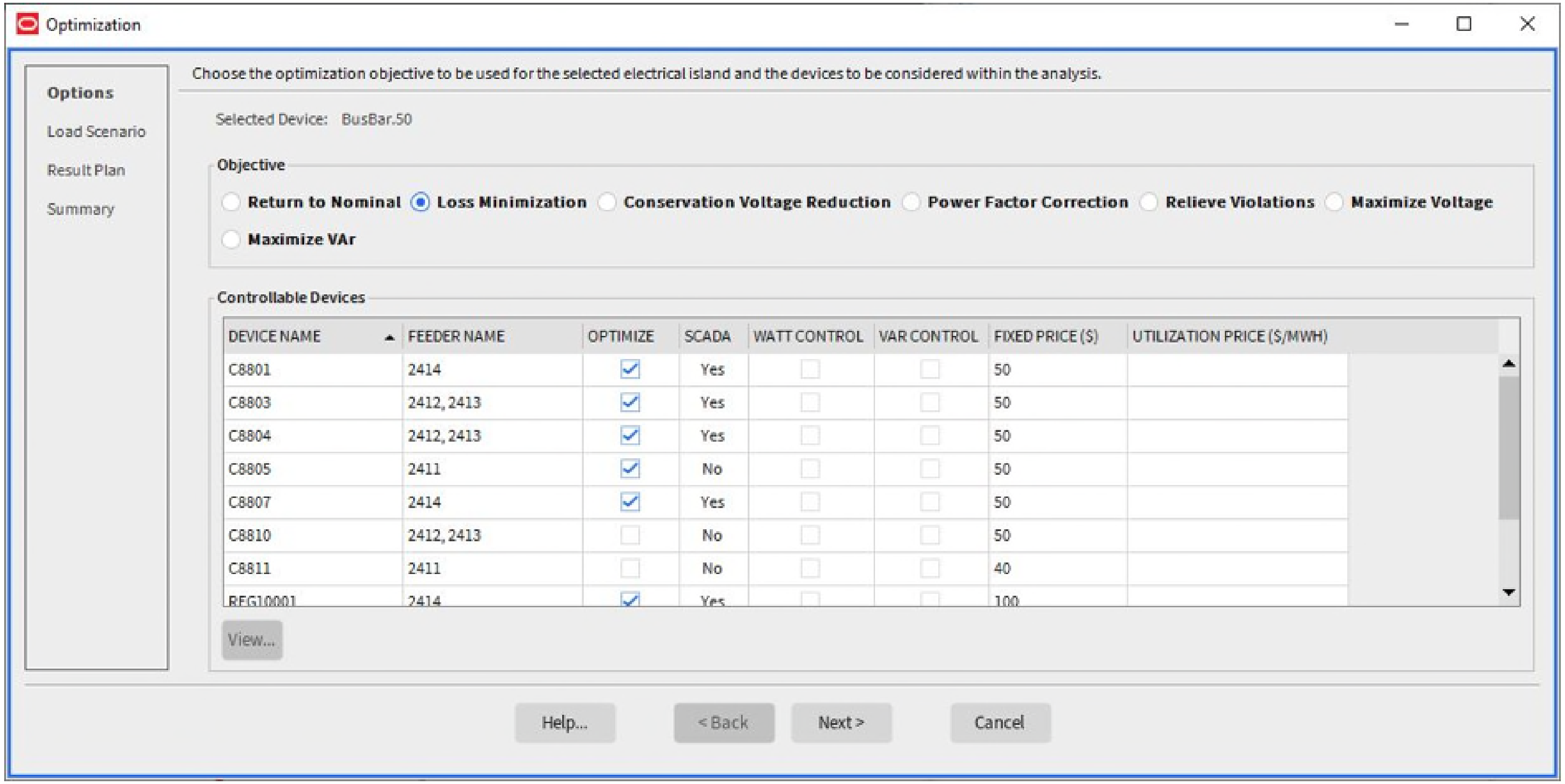
Document Control

Change Record

Date	Author	Version	Change Reference
05/07/2021	Andrew Neddermeyer	1.0	Initial Version for NMS v2.5.0.1
07/01/2021	Andrew Neddermeyer	1.1	Finalized Changes for NMS v2.5.0.1
07/08/2021	Saurabh Gupta	1.1	Reviewed
07/08/2021	Ian Hoogendam	1.1	Reviewed
08/17/2021	Palak Jain	1.1	Reviewed
08/17/2021	Mike Langford	1.1	Reviewed
08/26/2021	Galina Polonsky		Reviewed, Approved

Attachments

Optimization Dialog Pg. 1


Optimization
Options
Load Scenario
Result Plan
Summary
View...
Help...
< Back
Next >
Cancel

Choose the optimization objective to be used for the selected electrical island and the devices to be considered within the analysis.

Selected Device: BusBar.50

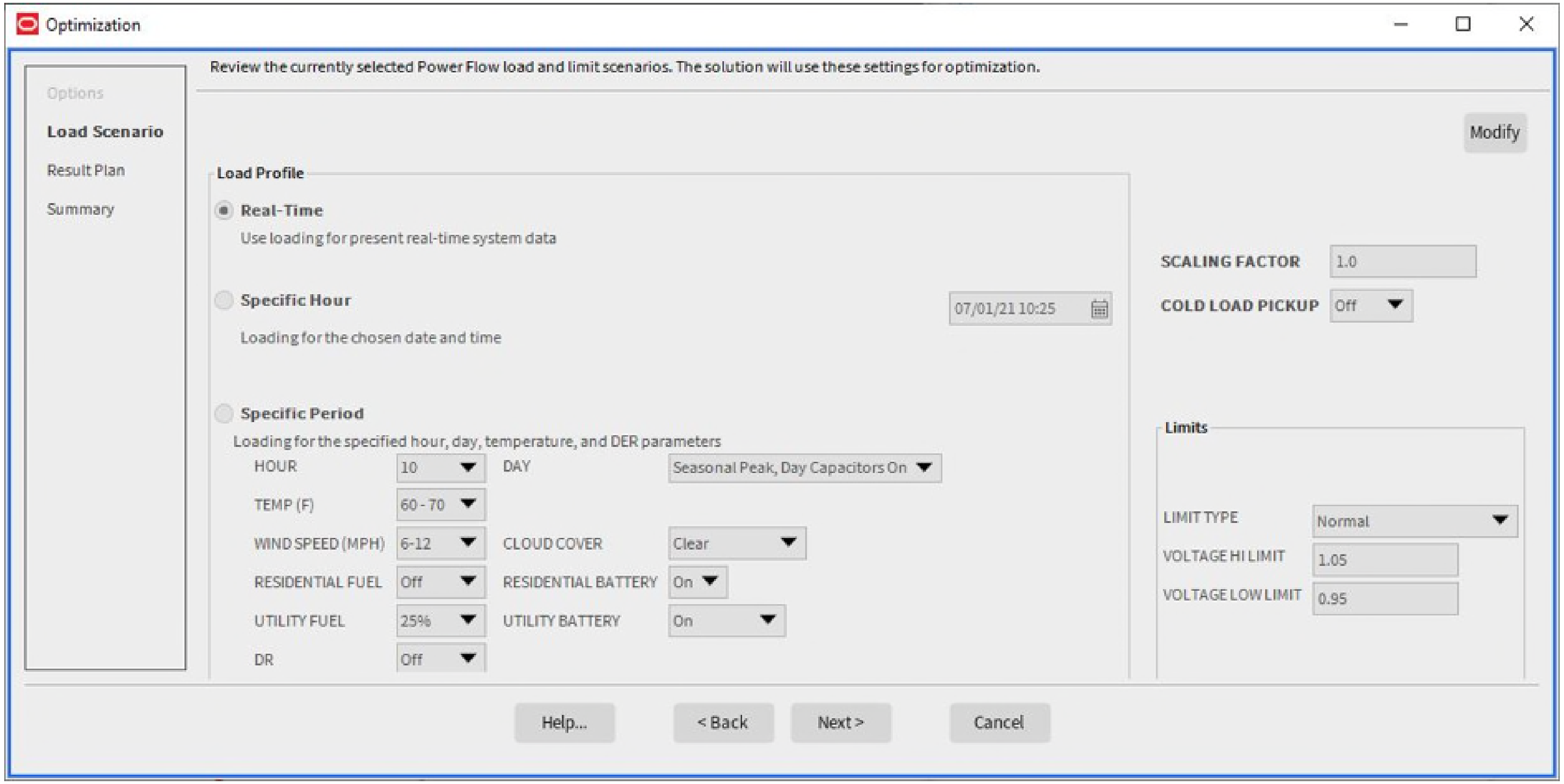
Objective

○ Return to Nominal ● Loss Minimization ○ Conservation Voltage Reduction ○ Power Factor Correction ○ Relieve Violations ○ Maximize Voltage ○ Maximize VAr

Controllable Devices

DEVICE NAME	FEEDER NAME	OPTIMIZE	SCADA	WATT CONTROL	VAR CONTROL	FIXED PRICE ($)	UTILIZATION PRICE ($/MWH)
C8801	2414	☑	Yes	☐	☐	50	
C8803	2412, 2413	☑	Yes	☐	☐	50	
C8804	2412, 2413	☑	Yes	☐	☐	50	
C8805	2411	☑	No	☐	☐	50	
C8807	2414	☑	Yes	☐	☐	50	
C8810	2412, 2413	☐	No	☐	☐	50	
C8811	2411	☐	No	☐	☐	40	
REG10001	2414	☑	Yes	☐	☐	100	

Optimization Dialog Pg. 2


Optimization
Options
Load Scenario
Result Plan
Summary
Modify
Help...
< Back
Next >
Cancel

Review the currently selected Power Flow load and limit scenarios. The solution will use these settings for optimization.

Load Profile

● **Real-Time**
Use loading for present real-time system data

○ **Specific Hour** 07/01/21 10:25
Loading for the chosen date and time

○ **Specific Period**
Loading for the specified hour, day, temperature, and DER parameters

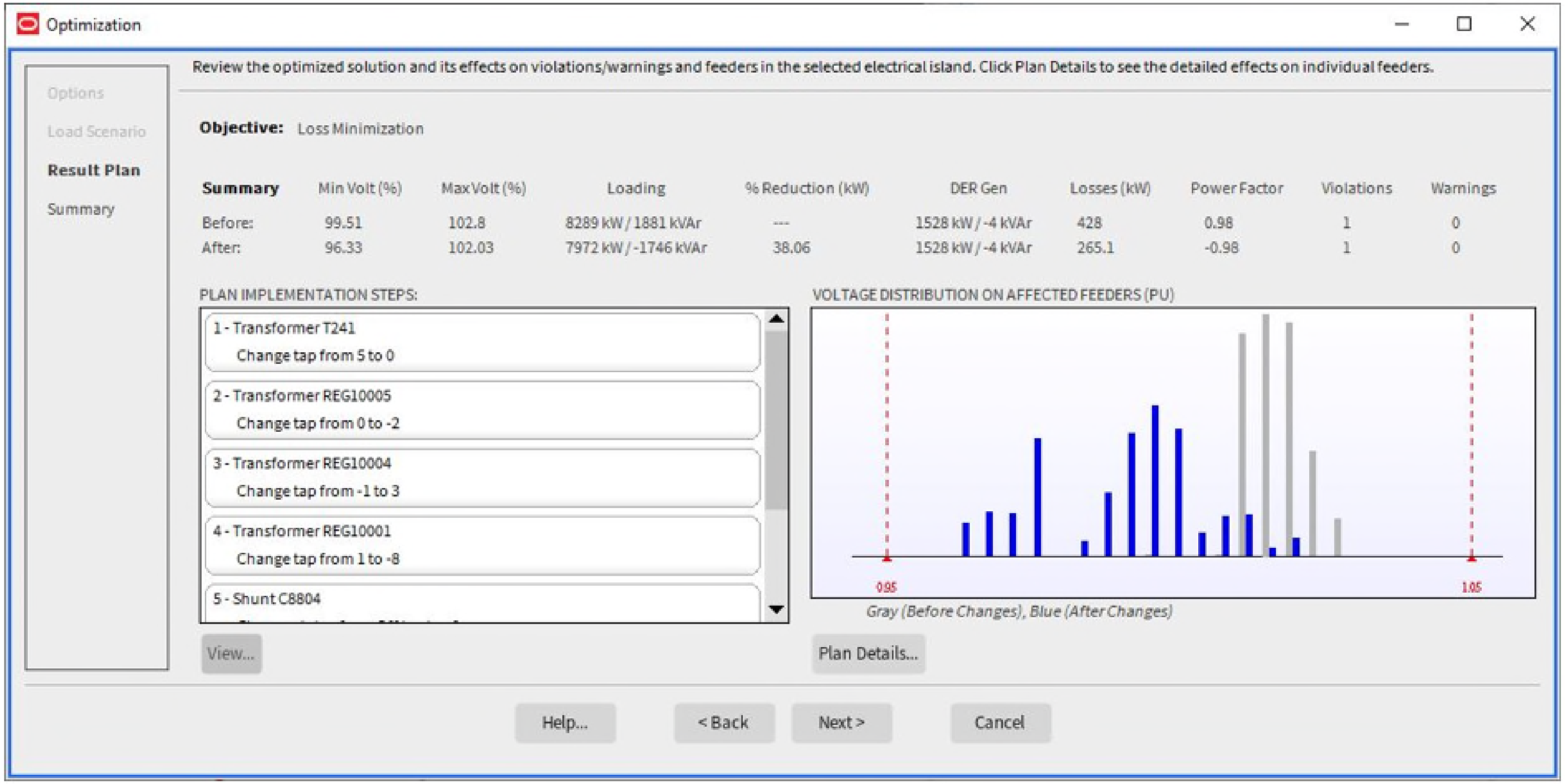
HOUR: 10
DAY: Seasonal Peak, Day Capacitors On
TEMP (F): 60 - 70
WIND SPEED (MPH): 6-12
CLOUD COVER: Clear
RESIDENTIAL FUEL: Off
RESIDENTIAL BATTERY: On
UTILITY FUEL: 25%
UTILITY BATTERY: On
DR: Off

SCALING FACTOR: 1.0
COLD LOAD PICKUP: Off

Limits

LIMIT TYPE: Normal
VOLTAGE HI LIMIT: 1.05
VOLTAGE LOW LIMIT: 0.95

Optimization Dialog Pg. 3


Optimization
Options
Load Scenario
Result Plan
Summary

Review the optimized solution and its effects on violations/warnings and feeders in the selected electrical island. Click Plan Details to see the detailed effects on individual feeders.

Objective: Loss Minimization

Summary	Min Volt (%)	Max Volt (%)	Loading	% Reduction (kW)	DER Gen	Losses (kW)	Power Factor	Violations	Warnings
Before:	99.51	102.8	8289 kW / 1881 kVAr	---	1528 kW / -4 kVAr	428	0.98	1	0
After:	96.33	102.03	7972 kW / -1746 kVAr	38.06	1528 kW / -4 kVAr	265.1	-0.98	1	0

PLAN IMPLEMENTATION STEPS:

1 - Transformer T241
Change tap from 5 to 0

2 - Transformer REG10005
Change tap from 0 to -2

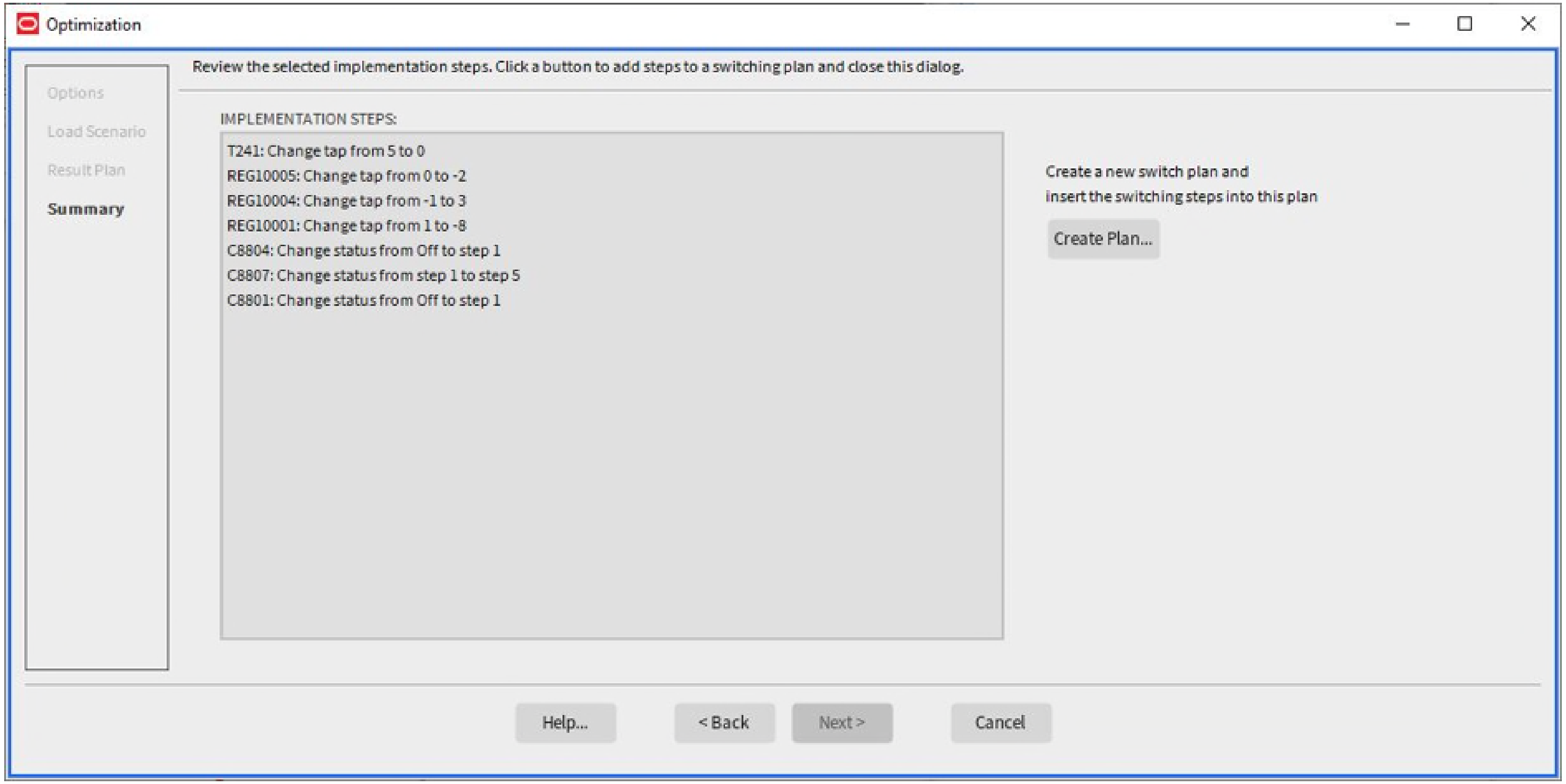
3 - Transformer REG10004
Change tap from -1 to 3

4 - Transformer REG10001
Change tap from 1 to -8

5 - Shunt C8804

VOLTAGE DISTRIBUTION ON AFFECTED FEEDERS (PU)
0.95
1.05
Gray (Before Changes), Blue (After Changes)
View...
Plan Details...
Help...
< Back
Next >
Cancel

Optimization Dialog Pg. 4


Optimization
Options
Load Scenario
Result Plan
Summary
Create Plan...
Help...
< Back
Next >
Cancel

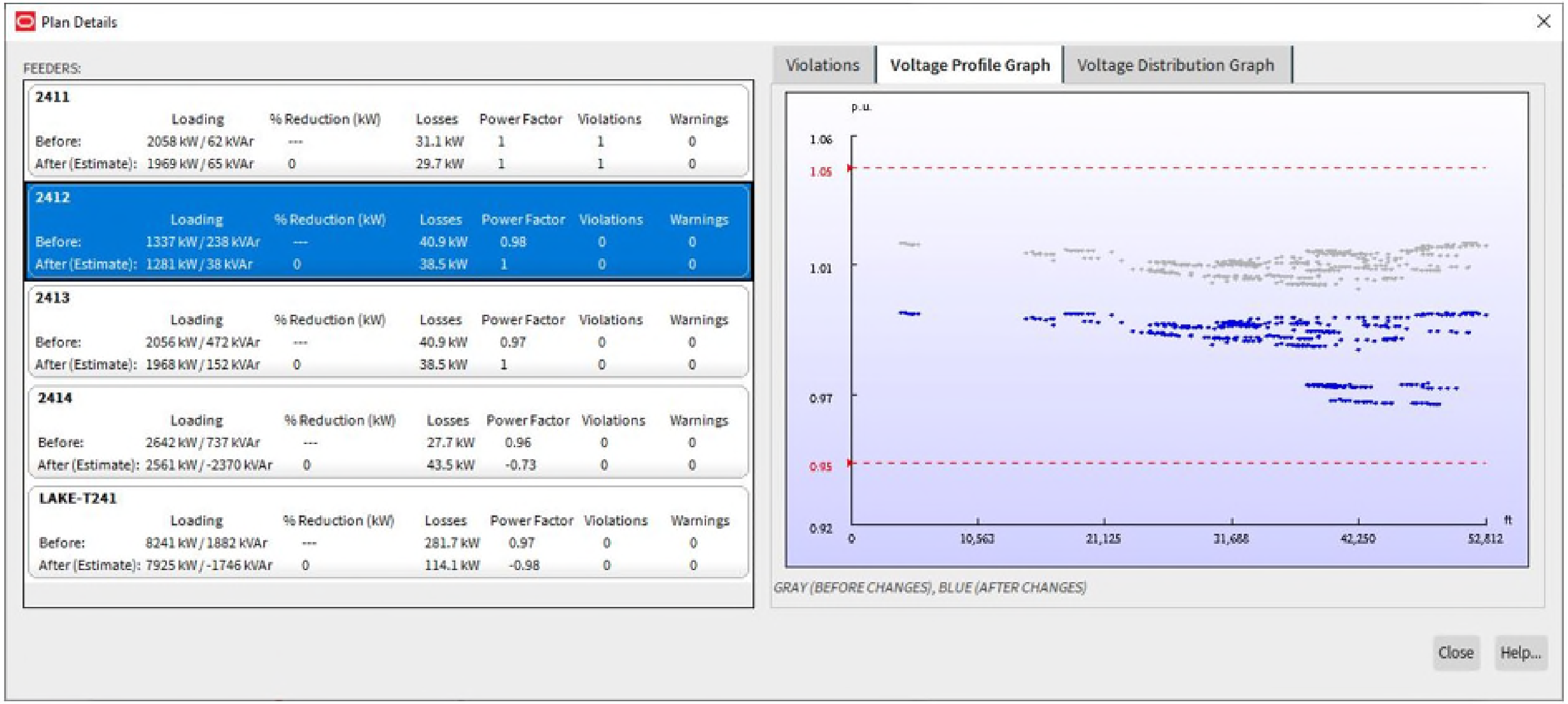
Review the selected implementation steps. Click a button to add steps to a switching plan and close this dialog.

IMPLEMENTATION STEPS:

T241: Change tap from 5 to 0
REG10005: Change tap from 0 to -2
REG10004: Change tap from -1 to 3
REG10001: Change tap from 1 to -8
C8804: Change status from Off to step 1
C8807: Change status from step 1 to step 5
C8801: Change status from Off to step 1

Create a new switch plan and
insert the switching steps into this plan

Optimization Plan Details


Plan Details
Violations
Voltage Profile Graph
Voltage Distribution Graph
p.u.
1.06
1.05
1.01
0.97
0.95
0.92
0
10,563
21,125
31,688
42,250
52,812
ft
Close
Help...

FEEDERS:

2411	Loading	% Reduction (kW)	Losses	Power Factor	Violations	Warnings
Before:	2058 kW / 62 kVAr	---	31.1 kW	1	1	0
After (Estimate):	1969 kW / 65 kVAr	0	29.7 kW	1	1	0

2412	Loading	% Reduction (kW)	Losses	Power Factor	Violations	Warnings
Before:	1337 kW / 238 kVAr	---	40.9 kW	0.98	0	0
After (Estimate):	1281 kW / 38 kVAr	0	38.5 kW	1	0	0

2413	Loading	% Reduction (kW)	Losses	Power Factor	Violations	Warnings
Before:	2056 kW / 472 kVAr	---	40.9 kW	0.97	0	0
After (Estimate):	1968 kW / 152 kVAr	0	38.5 kW	1	0	0

2414	Loading	% Reduction (kW)	Losses	Power Factor	Violations	Warnings
Before:	2642 kW / 737 kVAr	---	27.7 kW	0.96	0	0
After (Estimate):	2561 kW / -2370 kVAr	0	43.5 kW	-0.73	0	0

LAKE-T241	Loading	% Reduction (kW)	Losses	Power Factor	Violations	Warnings
Before:	8241 kW / 1882 kVAr	---	281.7 kW	0.97	0	0
After (Estimate):	7925 kW / -1746 kVAr	0	114.1 kW	-0.98	0	0

GRAY (BEFORE CHANGES), BLUE (AFTER CHANGES)