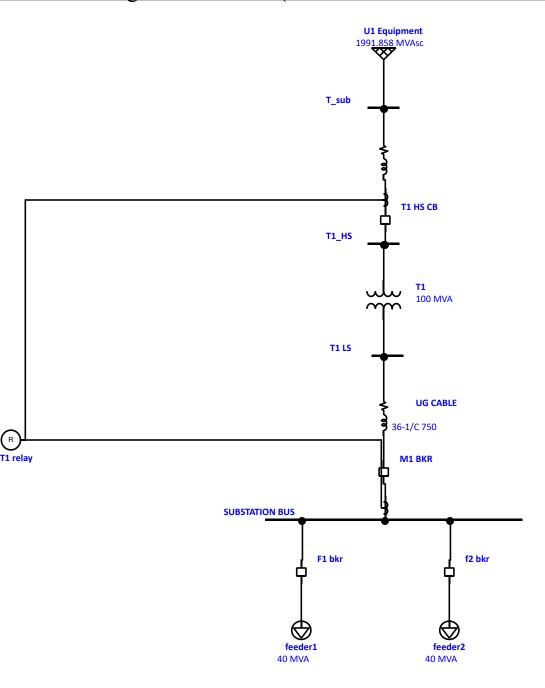
# One-Line Diagram - OLV1 (Star - Protection & Coordination)



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# **Utility Specifications**

Nominal Voltage 230kV

3LG fault current 5000A , X/R=10 SLG fault current 7000A, X/R=12

# **Transmission Line**

Length 0.1miles
Type Pelican

## Transformers

Primary nominal voltage 230kV **Secondary Nominal Voltage** 13.8kV Rated OA apparent power 100 impedance 10% X/R 34.1 High side tap Nominal Low side tap Nominal Connection Dyn1

## **Underground Cables**

Size 230kV Length 13.8kV Conductors per phase 12

Rated voltage 15kV

Type Aluminium

## Feeder Loads

Load nominal voltage 13.8kV
Load power factor 0.8
connection Delta

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#### **Electrical Transient Analyzer Program**

#### **Load Flow Analysis**

Loading Category (1): Design

Generation Category (1): Design

Load Diversity Factor: None

	Swing	V-Control	Load	Total
Number of Buses:	1	0	3	4
				Line/Cable/
	XFMR2	XFMR3	Reactor	Busway

Method of Solution: Adaptive Newton-Raphson Method

Maximum No. of Iteration: 99

Number of Branches:

Precision of Solution: 0.0001000

System Frequency: 60.00 Hz
Unit System: English

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## Adjustments

Tolerance	Apply Adjustments	Individual /Global	Percent
Transformer Impedance:	Yes	Individual	
Reactor Impedance:	Yes	Individual	
Overload Heater Resistance:	No		
Transmission Line Length:	No		
Cable / Busway Length:	No		
Temperature Correction	Apply Adjustments	Individual /Global	Degree C
Transmission Line Resistance:	Yes	Individual	
Cable / Busway Resistance:	Yes	Individual	

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## **Bus Input Data**

					Load								
Bus	Bus		Initial Voltage		Constar	Constant kVA		ant Z	Cons	tant I	Generic		
ID	kV	Sub-sys	% Mag.	Ang.	MW	Mvar	MW	Mvar	MW	Mvar	MW	Mvar	
SUBSTATION BUS	13.800	1	100.0	0.0	51.200	38.400	12.800	9.600					
T1 LS	13.800	1	100.0	0.0									
T1_HS	230.000	1	100.0	0.0									
T_sub	230.000	1	100.0	0.0									
Total Number of Buses: 4					51.200	38.400	12.800	9.600	0.000	0.000	0.000	0.000	

Ge	Generation Bus						MW     Mvar     % PF     Max     Min			
ID	kV	Type	Sub-sys	% Mag.	Angle	MW	Mvar	% PF	Max	Min
T_sub	230.000	Swing	1	100.0	0.0					
						0.000	0.000			

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#### **Line/Cable/Busway Input Data**

#### ohms or siemens/1000 ft per Conductor (Cable) or per Phase (Line/Busway)

Line/Cable/Busway	_		Length						
ID	Library	Size	Adj. (ft)	% Tol.	#/Phase	T (°C)	R	X	Y
UG CABLE	15MALS1	750	300.0	0.0	12	75	0.036570	0.049700	
Linel		477	528.0	0.0	1	75	0.044604	0.157749	0.0000010

Line / Cable / Busway resistances are listed at the specified temperatures.

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## **2-Winding Transformer Input Data**

	Transformer				Rating			Z Variation			% Tap Setting		Adjusted	Phase S	Shift
	ID	Phase	MVA	Prim. kV	Sec. kV	% Z1	X1/R1	+ 5%	- 5%	% Tol.	Prim.	Sec.	% Z	Туре	Angle
T1		3-Phase	100.000	230.000	13.800	10.00	34.10	0	0	0	0	0	10.0000	Dyn	0.000

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## **Branch Connections**

CKT/Bra	nch	Cor	nnected Bus ID	% Impe	% Impedance, Pos. Seq., 100 MVA Base					
ID	Туре	From Bus	To Bus	R	X	Z	Y			
T1	2W XFMR	T1_HS	T1 LS	0.29	10.00	10.00				
UG CABLE	Cable	T1 LS	SUBSTATION BUS	0.05	0.07	0.08				
Linel	Line	T sub	T1 HS	0.00	0.02	0.02	0.0271987			

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## LOAD FLOW REPORT

Bus		Volt	age	Gener	ration	Lo	ad	Load Flow				XFMR	
ID	kV	% Mag.	Ang.	MW	Mvar	MW	Mvar	ID	MW	Mvar	Amp	%PF	%Тар
SUBSTATION BUS	13.800	94.552	-3.7	0.000	0.000	62.643	46.983	T1 LS	-62.643	-46.983	3464.8	80.0	
T1 LS	13.800	94.616	-3.7	0.000	0.000	0.000	0.000	SUBSTATION BUS	62.676	47.027	3464.8	80.0	
								T1_HS	-62.676	-47.027	3464.8	80.0	
T1_HS	230.000	99.989	0.0	0.000	0.000	0.000	0.000	T_sub	-62.877	-53.883	207.9	75.9	
								T1 LS	62.877	53.883	207.9	75.9	
* T_sub	230.000	100.000	0.0	62.880	53.866	0.000	0.000	T1_HS	62.880	53.866	207.8	75.9	

<sup>\*</sup> Indicates a voltage regulated bus ( voltage controlled or swing type machine connected to it)

<sup>#</sup> Indicates a bus with a load mismatch of more than 0.1 MVA

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## **Bus Loading Summary Report**

					Di	rectly Con			Total Bus Load					
В	Bus KV Poted				Constant Z		Constant I		Generic					Percent
ID	kV	Rated Amp	MW	Mvar	MW	Mvar	MW	Mvar	MW	Mvar	MVA	% PF	Amp	Loading
SUBSTATION BUS	13.800		51.200	38.400	11.443	8.583					78.304	80.0	3464.8	
T1 LS	13.800										78.357	80.0	3464.8	
T1_HS	230.000										82.806	75.9	207.9	
T sub	230.000										82.798	75.9	207.8	

<sup>\*</sup> Indicates operating load of a bus exceeds the bus critical limit (100.0% of the Continuous Ampere rating). # Indicates operating load of a bus exceeds the bus marginal limit (95.0% of the Continuous Ampere rating).

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## **Branch Loading Summary Report**

CIVIE ( D		Busway / Cable & Reactor				Transformer								
CKT / Brand	Ampacity Loading			Capability	Loading (	input)	Loading (output)							
ID	Туре	(Amp)	Amp	%	(MVA)	MVA	%	MVA	%					
UG CABLE	Cable	6144.38	3464.76	56.39										
T1	Transformer				166.670	82.806	49.7	78.357	47.0					

<sup>\*</sup> Indicates a branch with operating load exceeding the branch capability.

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## **Branch Losses Summary Report**

	From-To	Bus Flow	To-From	Bus Flow	Los	ses	% Bus \	Vd % Drop	
Branch ID	MW	Mvar	MW	Mvar	kW	kvar	From	То	in Vmag
Line1	-62.877	-53.883	62.880	53.866	3.1	-16.4	100.0	100.0	0.01
T1	-62.676	-47.027	62.877	53.883	201.0	6855.5	94.6	100.0	5.37
UG CABLE	-62.643	-46.983	62.676	47.027	32.9	44.7	94.6	94.6	0.06
					237.0	6883.9			

<sup>\*</sup> This Transmission Line includes Series Capacitor.

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**Alert Summary Report** 

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% Alert Settings

	Critical	Marginal
Loading		
Bus	100.0	95.0
Cable / Busway	100.0	95.0
Reactor	100.0	95.0
Line	100.0	95.0
Transformer	100.0	95.0
Panel	100.0	95.0
Protective Device	100.0	95.0
Generator	100.0	95.0
Inverter/Charger	100.0	95.0
Bus Voltage		
OverVoltage	105.0	102.0
UnderVoltage	95.0	98.0
<b>Generator Excitation</b>		
OverExcited (Q Max.)	100.0	95.0
UnderExcited (Q Min.)	100.0	

## **Critical Report**

Device ID	Type	Condition	Rating/Limit	Unit	Operating	% Operating	Phase Type	
SUBSTATION BUS	Bus	Under Voltage	13.800	kV	13.048	94.6	3-Phase	
T1 LS	Bus	Under Voltage	13.800	kV	13.057	94.6	3-Phase	

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## SUMMARY OF TOTAL GENERATION, LOADING & DEMAND

	MW	Mvar	MVA	% PF
Source (Swing Buses):	62.880	53.866	82.798	75.94 Lagging
Source (Non-Swing Buses):	0.000	0.000	0.000	
Total Demand:	62.880	53.866	82.798	75.94 Lagging
Total Motor Load:	51.200	38.400	64.000	80.00 Lagging
Total Static Load:	11.443	8.583	14.304	80.00 Lagging
Total Constant I Load:	0.000	0.000	0.000	
Total Generic Load:	0.000	0.000	0.000	
Apparent Losses:	0.237	6.884		
System Mismatch:	0.000	0.000		

Number of Iterations: 4

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#### **Electrical Transient Analyzer Program**

## **Short-Circuit Analysis**

#### **ANSI Standard**

## 3-Phase, LG, LL, & LLG Fault Currents

## 1/2 Cycle Network

	Swing	V-Control	Load	Total			
Number of Buses:	1	0	3	4			
				Line/Cable/			
	XFMR2	XFMR3	Reactor	Busway	Impedance	Tie PD	Total
Number of Branches:	1	0	0	2	0	0	3
	Synchronous	Power	Synchronous	Induction	Lumped		
	Generator	Grid	Motor	Machines	Load	Total	
Number of Machines:	0	1	0	0	2	3	

System Frequency: 60.00
Unit System: English

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## Adjustments

Tolerance	Apply Adjustments	Individual /Global	Percent
Transformer Impedance:	Yes	Individual	
Reactor Impedance:	Yes	Individual	
Overload Heater Resistance:	No		
Transmission Line Length:	No		
Cable / Busway Length:	No		
	Apply	Individual	
Temperature Correction	Adjustments	/Global	Degree C
Transmission Line Resistance:	Yes	Individual	
Cable / Busway Resistance:	Yes	Individual	

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## **Bus Input Data**

	Bus									
ID	Туре	Nom. kV	Base kV	Sub-sys	%Mag.	Ang.				
SUBSTATION BUS	Load	13.800	13.800	1	100.00	-30.00				
T1 LS	Load	13.800	13.800	1	100.00	-30.00				
T1_HS	Load	230.000	230.000	1	100.00	0.00				
T_sub	SWNG	230.000	230.000	1	100.00	0.00				

4 Buses Total

All voltages reported by ETAP are in % of bus Nominal kV. Base kV values of buses are calculated and used internally by ETAP.

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#### **Line/Cable/Busway Input Data**

## ohms or siemens per 1000 ft per Conductor (Cable) or per Phase (Line/Busway)

Line/Cable/Busway	_		Leng	ţth								
ID	Library	Size	Adj. (ft)	% Tol.	#/Phase	T (°C)	R1	X1	Y1	R0	X0	Y0
UG CABLE	15MALS1	750	300.0	0.0	12	75	0.03657	0.0497		0.11519	0.12226	
Linel		477	528.0	0.0	1	75	0.0446045	0.1577493	0.000001	0.0956523	0.4853866	0.0000005

Line / Cable / Busway resistances are listed at the specified temperatures.

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## 2-Winding Transformer Input Data

Transformer			Z Variation			% Tap Setting		Adjusted Phase S		hift				
ID	MVA	Prim. kV	Sec. kV	% Z	X/R	+ 5%	- 5%	% Tol.	Prim.	Sec.	% Z	Туре	Angle	
T1	100.000	230.000	13.800	10.00	34.10	0	0	0	0	0	10.00	Dyn	30.00	

## **2-Winding Transformer Grounding Input Data**

## Grounding

SN:

Transformer	Rating			Conn.		Primary	Secondary					
ID	MVA	Prim. kV	Sec. kV	Type	Type	kV	Amp	ohm	Туре	kV	Amp	ohm
Γ1	100.000	220,000	12 800	D/V					Solid			

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## **Branch Connections**

CKT/Branch			Connect	ted Bus ID	% Impedance, Pos. Seq., 100 MVAb					
	ID	Туре	From Bus	To Bus	R	X	Z	Y		
	T1	2W XFMR	T1_HS	T1 LS	0.29	10.00	10.00			
	UG CABLE	Cable	T1 LS	SUBSTATION BUS	0.05	0.07	0.08			
	Line1	Line	T_sub	T1_HS	0.00	0.02	0.02	0.0271987		

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## Power Grid Input Data

Power Grid	Connected Bus	Ra	ting	% Zero Sea. Impedance 100 MVA Base						
ID	ID ID		kV	X/R	R	X	Type	X/R	R0	X0
U1 Equipment	T_sub	1991.858	230.000	10.00	0.49955	4.99552	Wye - Solid	12.00	0.059568	0.71482

Total Power Grids (= 1 ) 1991.858 MVA

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## **Lumped Load Input Data**

Lumped Load Motor Loads

						Impedance								
Lumped Load	Lumped Load Rating		<u>%</u>	% Load Loading		ding	X/R Ratio		(Machine Base)		se)	Grounding		g
ID	kVA	kV	MTR	STAT	kW	kvar	X"/R	X'/R	% R	% X"	% X'	Conn.	Type	Amp.
feeder1	40000.0	13.800	80	20	25600.0	19200.0	10.00	10.00	1.538	15.38	23.08	Delta		
feeder2	40000.0	13.800	80	20	25600.0	19200.0	10.00	10.00	1.538	15.38	23.08	Delta		

Total Connected Lumped Loads ( = 2 ): 80000.0 kVA

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## SHORT- CIRCUIT REPORT

Fault at bus: SUBSTATION BUS

 $Prefault\ voltage\ =\ 13.800\ kV \\ \hspace*{1.5cm} =\ 100.00\ \%\ of\ nominal\ bus\ kV\ (\ 13.800\ kV)$ 

= 100.00 % of base kV ( 13.800 kV)

Cont	3-Phas	se Fault		Line-	Fo-Ground	Fault	Positive & Zero Sequence Impedances  Looking into "From Bus"						
From Bus	From Bus To Bus		kA	% Voltage at From Bus			kA Symm. rms		% Impedance on 100 MVA base				
ID	ID	From Bus	Symm. rms	Va	Vb	Vc	Ia	310	R1	X1	R0	X0	
SUBSTATION BUS	Total	0.00	45.022	0.00	102.40	100.70	43.658	43.658	6.76E-001	9.27E+000	4.44E-001	1.02E+001	
T1 LS	SUBSTATION BUS	0.54	27.714	1.11	102.51	100.13	32.468	43.658	8.45E-001	1.51E+001	4.44E-001	1.02E+001	
feeder1	SUBSTATION BUS	100.00	8.659	100.00	100.00	100.00	5.598	0.000	4.81E+000	4.81E+001			
feeder2	SUBSTATION BUS	100.00	8.659	100.00	100.00	100.00	5.598	0.000	4.81E+000	4.81E+001			

<sup>#</sup> Indicates fault current contribution is from three-winding transformers

<sup>\*</sup> Indicates a zero sequence fault current contribution (310) from a grounded Delta- Y transformer

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## **Short-Circuit Summary Report**

1/2 Cycle - 3-Phase, LG, LL, & LLG Fault Currents

Prefault Voltage = 100 % of the Bus Nominal Voltage

Bus		3-Phase Fault			Line-to-Ground Fault			Line-to-Line Fault			*Line-to-Line-to-Ground		
ID	kV	Real	Imag.	Mag.	Real	Imag.	Mag.	Real	Imag.	Mag.	Real	Imag.	Mag.
SUBSTATION BUS	13.800	3.275	-44.903	45.022	2.728	-43.573	43.658	38.887	2.836	38.990	37.768	23.992	44.744

All fault currents are symmetrical (1/2 Cycle network) values in rms kA.

<sup>\*</sup> LLG fault current is the larger of the two faulted line currents.

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## Sequence Impedance Summary Report

Bus		Positive Seq. Imp. (ohm)			Negative Seq. Imp. (ohm)			Zero Seq. Imp. (ohm)			Fault Zf (ohm)		
ID	kV	Resistance	Reactance	Impedance	Resistance	Reactance	Impedance	Resistance	Reactance	Impedance	Resistance	Reactance	Impedance
SUBSTATION BUS	13.800	0.01287	0.17650	0.17697	0.01287	0.17650	0.17697	0.00846	0.19341	0.19360	0.00000	0.00000	0.00000