

1 Q. The Western Avalon Terminal Station 230kV expansion is proposed to be by GIS
2 (gas insulated switchgear) due to a \$2.5M lower capital cost. GIS equipment can be
3 O&M cost intensive over time due to the repair of SF6 gas leaks and regular
4 maintenance on devices that require the removal and replacement of the SF6 gas.
5 What is the approximate difference in O&M costs over 30 years between GIS and
6 open-air designs?

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9 A. Gas Insulated Switchgear (GIS) for Western Avalon would be based on a Siemens
10 8DN9 design. The following table provides a maintenance cost comparison for GIS
11 verses Hydro's costs for an Air Insulated Substation (AIS) design of equipment
12 providing the same functionality, using a schedule based on a 35 year period¹. As
13 indicated in the table, the costs for maintenance of GIS would be less than the costs
14 for maintenance of AIS (\$3,600/year vs. \$18,900/year). Detailed spreadsheets for
15 the maintenance activities and costs for both the GIS and AIS designs are attached
16 as CA-NLH-016 Attachment 1 and CA-NLH-016 Attachment 2, respectively.

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Maintenance Cost Comparison of GIS versus AIS Designs Western Avalon Terminal Station		
Equipment ²	GIS Maintenance Cost Per 35 Years	AIS Maintenance Cost Per 35 Years
GIS	\$125,350	
AIS		\$661,820
Average Annual Maintenance Cost Per Year	\$3,580	\$18,910

¹ A 35 year period was chosen for consistency since costs for maintenance of the Siemens GIS 8DN9 are based on their 35 year schedule.

² The designs are similar based on the following major equipment: four breakers, eight disconnect switches, and required numbers of associated potential and current transformers (PTs and CTs).

**Maintenance Costs of an Gas Insulated Substation (GIS) design for Termination of Third Line at Western Avalon
Siemens GIS 8DN9**

Year	Maintenance Type	Hrs/visit at visit	Cost	Inspection Kits	Comments on Applicable Maintenance activities	Hrs Rate 2014
1	SK	4	\$ 860.00		4 hrs at site (1 hr inspection per bay of GIS base on Avalon layouts 4 bays); travelling , travelling time , expenses and taxes not included	\$ 215.00
2	SK	4	\$ 860.00			
3	SK	4	\$ 860.00			
4	SK	4	\$ 860.00			
5	SK	4	\$ 860.00			
6	SK	4	\$ 860.00			
7	SK	4	\$ 860.00			
8	SK	4	\$ 860.00			
9	SK	4	\$ 860.00			
10	SK	4	\$ 860.00			
11	SK	4	\$ 860.00			
12	SK	4	\$ 860.00			
13	SK	4	\$ 860.00			
14	SK	4	\$ 860.00			
15	SK	4	\$ 860.00			
16	SK	4	\$ 860.00			
17	ESK	8	\$ 1,720.00		8 hrs at site (2 hrs inspection per bay of GIS base on Avalon layouts 4 bays) if reach CB 6000 operation and or disconnect reach 2000 operations; travelling , travelling time , expenses and taxes not included.	
18	SK	4	\$ 860.00			
19	SK	4	\$ 860.00			
20	SK	4	\$ 860.00			
21	SK	4	\$ 860.00			
22	SK	4	\$ 860.00			
23	SK	4	\$ 860.00			
24	SK	4	\$ 860.00			
25	REV	150	\$ 35,250.00	\$ 60,000.00	3 Siemens Field Representative 5 days at site 10 hrs per day for first opening (if required) depending of number of operations as per Gis manual section 6 and 7. Work to be consider is as per document REV with 1 full revision kit. Travelling , travelling time , expenses and taxes not included	
26	SK	4	\$ 860.00			
27	SK	4	\$ 860.00			
28	SK	4	\$ 860.00			
29	SK	4	\$ 860.00			
30	SK	4	\$ 860.00			
31	SK	4	\$ 860.00			
32	SK	4	\$ 860.00			
33	SK	4	\$ 860.00			
34	SK	4	\$ 860.00			
35	SK	4	\$ 860.00			
Total			\$ 65,350.00	\$ 60,000.00		

SK Visual check, gas compartments need not be opened

ESK Visual check extended version after 17 years when Mechanical operation reach 3000 cycle, gas compartments need not be opened

REV Revision or Major inspection depending of the contact conditions

KK Contact Inspections after cycle of operations

Maintenance Costs of an Air Insulated Substation (AIS) design for Termination of Third Line at Western Avalon

Year	SF6 Breaker Preventative Maintenance per 6 year term x 4	SF6 Breaker Corrective Maintenance per year x 4	Disconnect Preventative Maintenance per 6 year term x 8	Disconnect Corrective Maintenance per year x 8	CT/PT Preventative Maintenance per 6 year term x 4	CT/PT Corrective Maintenance per year x 4	Station Visual Inspection per year	SF6 Breaker 20 year overhaul * 4	Total AIS Cost of Preventative and Corrective Maintenance per year
1		\$ 5,080.00		\$ 800.00		\$ 200.00	\$ 916.00		\$ 6,996.00
2		\$ 5,080.00		\$ 800.00		\$ 200.00	\$ 916.00		\$ 6,996.00
3		\$ 5,080.00		\$ 800.00		\$ 200.00	\$ 916.00		\$ 6,996.00
4		\$ 5,080.00		\$ 800.00		\$ 200.00	\$ 916.00		\$ 6,996.00
5		\$ 5,080.00		\$ 800.00		\$ 200.00	\$ 916.00		\$ 6,996.00
6	\$ 30,000.00	\$ 5,080.00	\$ 8,928.00	\$ 800.00	\$ 4,464.00	\$ 200.00	\$ 916.00		\$ 50,388.00
7		\$ 5,080.00		\$ 800.00		\$ 200.00	\$ 916.00		\$ 6,996.00
8		\$ 5,080.00		\$ 800.00		\$ 200.00	\$ 916.00		\$ 6,996.00
9		\$ 5,080.00		\$ 800.00		\$ 200.00	\$ 916.00		\$ 6,996.00
10		\$ 5,080.00		\$ 800.00		\$ 200.00	\$ 916.00		\$ 6,996.00
11		\$ 5,080.00		\$ 800.00		\$ 200.00	\$ 916.00		\$ 6,996.00
12	\$ 30,000.00	\$ 5,080.00	\$ 8,928.00	\$ 800.00	\$ 4,464.00	\$ 200.00	\$ 916.00		\$ 50,388.00
13		\$ 5,080.00		\$ 800.00		\$ 200.00	\$ 916.00		\$ 6,996.00
14		\$ 5,080.00		\$ 800.00		\$ 200.00	\$ 916.00		\$ 6,996.00
15		\$ 5,080.00		\$ 800.00		\$ 200.00	\$ 916.00		\$ 6,996.00
16		\$ 5,080.00		\$ 800.00		\$ 200.00	\$ 916.00	\$ 200,000.00	\$ 206,996.00
17		\$ 5,080.00		\$ 800.00		\$ 200.00	\$ 916.00		\$ 6,996.00
18	\$ 30,000.00	\$ 5,080.00	\$ 8,928.00	\$ 800.00	\$ 4,464.00	\$ 200.00	\$ 916.00		\$ 50,388.00
19		\$ 5,080.00		\$ 800.00		\$ 200.00	\$ 916.00		\$ 6,996.00
20		\$ 5,080.00		\$ 800.00		\$ 200.00	\$ 916.00		\$ 6,996.00
21		\$ 5,080.00		\$ 800.00		\$ 200.00	\$ 916.00		\$ 6,996.00
22		\$ 5,080.00		\$ 800.00		\$ 200.00	\$ 916.00		\$ 6,996.00
23		\$ 5,080.00		\$ 800.00		\$ 200.00	\$ 916.00		\$ 6,996.00
24	\$ 30,000.00	\$ 5,080.00	\$ 8,928.00	\$ 800.00	\$ 4,464.00	\$ 200.00	\$ 916.00		\$ 50,388.00
25		\$ 5,080.00		\$ 800.00		\$ 200.00	\$ 916.00		\$ 6,996.00
26		\$ 5,080.00		\$ 800.00		\$ 200.00	\$ 916.00		\$ 6,996.00
27		\$ 5,080.00		\$ 800.00		\$ 200.00	\$ 916.00		\$ 6,996.00
28		\$ 5,080.00		\$ 800.00		\$ 200.00	\$ 916.00		\$ 6,996.00
29		\$ 5,080.00		\$ 800.00		\$ 200.00	\$ 916.00		\$ 6,996.00
30	\$ 30,000.00	\$ 5,080.00	\$ 8,928.00	\$ 800.00	\$ 4,464.00	\$ 200.00	\$ 916.00		\$ 50,388.00
31		\$ 5,080.00		\$ 800.00		\$ 200.00	\$ 916.00		\$ 6,996.00
32		\$ 5,080.00		\$ 800.00		\$ 200.00	\$ 916.00		\$ 6,996.00
33		\$ 5,080.00		\$ 800.00		\$ 200.00	\$ 916.00		\$ 6,996.00
34		\$ 5,080.00		\$ 800.00		\$ 200.00	\$ 916.00		\$ 6,996.00
35		\$ 5,080.00		\$ 800.00		\$ 200.00	\$ 916.00		\$ 6,996.00
Total AIS Cost of Preventative and Corrective Maintenance per 35 years									\$ 661,820.00

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