



Stakeholder Comments Template

Variable Operations and Maintenance Cost Review Working Group – Hydro Resources

This template has been created for submission of stakeholder comments on the VOM Cost Review working group for Hydro resources that was held on July 19, 2019. The workshop, stakeholder meeting presentations, and other information related to this initiative may be found on the initiative webpage at:

<http://www.caiso.com/informed/Pages/StakeholderProcesses/VariableOperations-MaintenanceCostReview.aspx>.

Upon completion of this template, please submit it to initiativecomments@caiso.com. Submissions are requested by close of business on **August 2, 2019**.

Note: Upon submission, please indicate if you would like your comments to be confidential.

Submitted by	Organization	Date Submitted
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Please provide your organization's comments on the following topics and questions.

- Appendix A to this template contains a list of maintenance activities for Hydro resources. What maintenance activities are missing from this list that should be included for consideration?**

Please see CDWR's Appendix B for typical hydro resources maintenance activities. CDWR cross referenced its lists to CAISO's Appendix A list. Please note that Appendix B lists are preliminary and may not be complete.

- Appendix A also allocates the maintenance activities to three cost components (Major Maintenance [green], Other Maintenance – Variable**

[yellow], Other Maintenance – Fixed [red]). Please review and note whether you disagree with our proposed allocation and why.

Please see Appendix A and B for CDWR's comments.

3. Please provide any comments or updates you may have to the definitions of Major Maintenance Costs, Variable Operations Costs, and General and Administrative Costs, if any, listed in the July 2, 2019 report found on the stakeholder initiative website.

In general, CDWR would like to clarify terms used in Appendix A, B, and throughout its comments.

- A **turbine** is the prime mover that converts moving water to mechanical energy.
 - **Substantial components**: shaft, runner, servomotors, wicket gates, stay ring, headcover, bearings, and spiral case.
- A **generator** converts mechanical energy to electrical power.
 - **Substantial components**: rotor, stator, armature, field windings, water cooling coils, and exciter.
- **Important appurtenances**: penstock, turbine shut-off valve, draft tube, switchgear, transformer, circuit breakers, unit control, and protection systems.
- **Critical auxiliaries**: fire suppression, plant electrical systems, lubrication systems, compressed air systems, hydraulic systems, water cooling systems, turbine piping, and communication systems.

Substantial components and critical auxiliaries for the most part could be considered as appurtenances to the turbine, generator, penstock, turbine shut-off valve, draft tube, switchgear, transformer, circuit breakers, unit control, or protection systems.

Major maintenance (MM) would be reactive repair, replacement, or rehabilitation of substantial components and important appurtenances to restore the unit to its full capability. By its nature this work would require considerable equipment disassembly or a lengthy outage, weeks to months, to complete the work.

Routine (minor) maintenance would be inspections, corrective and predictive activities to substantial components and important appurtenances to ensure reliable operation as well as all work on critical auxiliaries. For substantial components and important appurtenances, the differentiation between major maintenance and this work is that this is of short duration and requires minor disassembly of equipment. For critical auxiliaries, these systems tend to have redundancies or manual workarounds that will allow the unit to remain operable (at full or reduced capability and/or availability) during the work, or of a nature that

major work can be completed in a relatively short time, is typically completed in 1 to 5 days.

Note 1: The key here is unit downtime, the extent of substantial component disassembly and unit outage time. If the work does require an extensive outage, then it can be escalated to its parent substantial component and that can be made unavailable.

Note 2: Other maintenance (OM) should be such that it does not impact generation and as it is transparent to the market.

Element	Major Maintenance (MM)	Routine (Minor) Maintenance “Other Maintenance - Fixed”	“Other Maintenance - Variable”
Unit	penstock, turbine shut-off valve (TSV), TSV actuator, draft tube, switchgear, transformer, circuit breakers, unit control, and protection systems	fire suppression, plant electrical systems, compressed air systems, hydraulic systems, water systems, turbine piping, communication systems, <i>[relay testing, unit inspection, and unit testing]</i>	Energy for cooling transformer
Turbine	shaft, runner, servomotors, wicket gates, stay ring, headcover, bearings, and spiral case, high pressure lift system, governor system, oil lubricating system,	runner and wicket gate surface refurbishment, shaft seals, turbine seals, <i>[turbine preventative maintenance]</i>	Raw water and energy for cooling bearing oil
Generator	rotor, stator, armature, field windings, water cooling coils, and exciter	brush replacement, Doble testing, <i>[generator preventative maintenance]</i>	Raw water and energy for cooling generator Generator self-excitation

The table above has been formatted to align with CAISO’s Appendix A – Cost Component Allocation table, in this document. Items in [xxx] can be considered “Other Maintenance Costs (Variable)” in order to align with CAISO’s Figure 1 – Breakdown of Cost Components (see 7/2/19 VOM Cost Definitions Report, page 3). The “Other Maintenance – Variable” column above is equivalent to “Variable Operations Costs” in CAISO’s Figure 1 – Breakdown of Cost Components.

- 4. Please provide any comments or updates to the categories/sub-categories of generation technologies for VOM adders. Should the categories currently found in the CAISO BPM for Market Instruments be further disaggregated into sub-categories (e.g. Solar PV and Solar Thermal)?**

Variable Operations (VO) costs, as defined by CAISO in page 5 of its 7/2/19 VOM Definitions Report, exist for hydro resources but are not directly measured by CDWR. The VO costs identified by CDWR are the electrical energy and raw water used for cooling the turbine and the generator bearings and the generator housing, the electrical energy for cooling the transformer, and the electrical energy required for the generator's self-excitation. More energy and raw water are used to maintain proper operating temperatures as electrical energy production increases. More generator self-excitation energy is used as electrical energy production increases.

- 5. Please offer your feedback on structure of this stakeholder initiative and working groups.**

Additional comments

Please offer any other feedback your organization would like to provide on the topics discussed during the working group.

Appendix A:

Cost Component Allocation		
Major Maintenance	Other Maintenance - Variable	Other Maintenance - Fixed

Maintenance Activity	Please note if you disagree and why
Inspections, Repairs and Overhauls, and Replacements:	
1) Bearings and Bushings	Disagree. See Appendix B.
2) Communication Systems	Agree.
3) Distributed Control Systems	Disagree. See Appendix B.
4) Exciter Water Wheels and Turbines	Disagree. See Appendix B.
5) Generator Cooling System	Agree.
6) Generator Field Rewinds	Agree.
7) Lubricating Systems	Disagree. See Appendix B.
8) Main Penstock Valves and Appurtenances	Agree.
9) Main Turbines and Water Wheels	Disagree. See Appendix B.
10) Plant Electrical Systems	Agree.
11) Runner Seals	Disagree. See Appendix B.
12) Servomotors	Agree.
13) Shaft Sleeves and Seals	Disagree. See Appendix B.
14) Valves	Disagree. See Appendix B.
15) Wicket Gate Seals	Disagree. See Appendix B.

Other	
16) Balance-of-Plant	Agree.

Materials	
17) Instruments	Agree.
18) Safety Equipment	Agree.
19) Shop Supplies	Agree.
20) Tools	Agree.

Appendix B:

Major Maintenance				
Hydro Nomenclature	Criticality	Next level Up	ISO #	CAISO
Circuit Breakers	Important Appurtenance	Unit		
Draft Tube	Important Appurtenance	Unit		
Penstock	Important Appurtenance	Unit		
Protection Systems	Important Appurtenance	Unit		
Switchgear	Important Appurtenance	Unit		
Transformer	Important Appurtenance	Unit		
Unit Control (Governor)	Important Appurtenance	Unit	3	Distributed Control Systems
Generator	Substantial Component	Unit	4	Exciter Water Wheel
Thrust & Guide Bearings	Substantial Component	Unit	1	Bearings
Turbine	Substantial Component	Unit	9	Turbines
Unit (generator and turbine)	Substantial Component	Unit	4	Exciter Water Wheels and Turbines
Headcover and Spiral Case	Substantial Component	Turbine		
Runner	Substantial Component	Turbine	9	Water Wheels
Servomotors	Substantial Component	Turbine	12	Servomotors
Shaft	Substantial Component	Turbine		
Stay Ring	Substantial Component	Turbine		
Turbine	Substantial Component	Turbine	9	Main Turbine
Turbine Shut-off Valve	Substantial Component	Turbine	8	Main Penstock Valves (large dia.)
Wicket Gates	Substantial Component	Turbine		
Armature	Substantial Component	Generator		
Exciter	Substantial Component	Generator		
Field Windings	Substantial Component	Generator	6	Generator Field Rewinds
Generator Cooling System	Substantial Component	Generator	5	Generator Cooling System
Bearings Cooling System	Substantial Component	Turbine		
Rotor	Substantial Component	Generator		
Stator	Substantial Component	Generator		

Routine (Minor) Maintenance				
Hydro Nomenclature	Criticality	Next level Up	ISO #	CAISO
Lubricating Systems	Critical Auxiliary	Unit	7	Lubricating Systems
Plant Electrical Systems	Critical Auxiliary	Unit	10	Plant Electrical Systems
Communication Systems	Critical Auxiliary	Unit	2	Communication Systems
Compressed Air Systems	Critical Auxiliary	Unit		
Fire Suppression	Critical Auxiliary	Unit		
Hydraulic Systems	Critical Auxiliary	Unit		
Turbine Piping	Critical Auxiliary	Unit		
TSV Seals or Seats	Critical Auxiliary	Unit		
Unit Testing	Critical Auxiliary	Unit		
Unit Inspection	Critical Auxiliary	Unit		
Unit PMs	Critical Auxiliary	Unit		
Water Systems	Critical Auxiliary	Unit		
Turbine Seals	Critical Auxiliary	Turbine	11 & 15	Runner Seals & Wicket Gate Seals
Shaft Guide Bearing	Critical Auxiliary	Shaft	15	Bushings
Balance-of-Plant	Auxiliary	Unit	16	Balance-of-Plant
Shaft Sleeves and Seals	Auxiliary	Shaft	13	Shaft Sleeves and Seals

Note:

Turbine Seals include Headcover, Wicket Gate Shaft, and Spiral Case seals

8 Main Penstock Valves Appurtenances are included in hydraulic system and turbine piping

#14 Valves are covered by component or auxiliary systems or turbine piping (small dia.)

Materials				
Hydro Nomenclature	Criticality	Next level Up	ISO #	CAISO
Instruments	Auxiliary	Unit	17	Instruments
Safety Equipment	Auxiliary	Unit	18	Safety Equipment
Shop Supplies	Auxiliary	Unit	19	Shop Supplies
Tools	Auxiliary	Unit	20	Tools