AVISTA CORP.
RESPONSE TO REQUEST FOR INFORMATION

JURISDICTION:	WASHINGTON	DATE PREPARED:	06/18/2021
CASE NO.:	UE-200900 & UG-200901	WITNESS:	DiLuciano/La Bolle
REQUESTER:	Public Counsel	RESPONDER:	Larry La Bolle
TYPE:	Data Request	DEPT:	Transm Ops/System Planning
REQUEST NO.:	PC – 361	TELEPHONE:	(509) 495-4710
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SUBJECT: Availability Workbench Modeling with Public Counsel

REQUEST:
Please refer to the conference call between Public Counsel and Avista on 6-7-21 regarding Avista's Availability Workbench Modeling.
In this call, Avista used the terms "failure in service" and "functional failure". A list of potential reasons for equipment replacement is provided below. For each potential reason, please identify which of the following classifications Avista would apply: (i) "Failure in service"; (ii) "Functional failure"; (iii) "neither failure in service nor functional failure (meaning, not included in equipment failure rate calculations):

a) Equipment failed in service.
b) Equipment failed to pass a routine inspection.
c) Equipment age was in excess of the economic end-of-life for that particular equipment type.
d) Equipment condition appeared poor in the qualitative assessment of field personnel.
e) Equipment was damaged by lightning, weather, animal or a third party.
f) Equipment was part of a wholesale replacement program (such as the replacement of cutouts manufactured by AB Chance company, or transformers likely to be contaminated with PCBs).
g) Equipment was replaced because the pole on which it was installed was replaced.
h) Equipment was replaced for some other reason.

RESPONSE:

For a more complete description of the Company's classifications of failures, please see our response to PC-DR-360, a portion of which is excerpted below.

Foundation is Known Age Historic Failure Data – For our June 7, 2021 online meeting, Avista provided all of the life[1] data for overhead transformers and equipment used in developing the Weibull failure curves for the equipment. As we have noted repeatedly in response to numerous specific requests, the foundation of our failure analysis for all assets is actual historic failures of equipment of known age experienced by the Company.[2] This actual historic failure data collected by Avista is the starting place for the identification of failure modes, manufacturer (as applicable), condition and age. As we have also explained in responses to data requests, the condition of assets is also evaluated as part of the early failure mode analysis to help determine whether visual or other indicators of asset condition, in addition to age, can be useful in predicting the likelihood of asset failures over time, and the determination of functional failures. This actual failure data continues to be collected and used for a variety of additional purposes including the determination of consequence probabilities associated with each different failure mode, consequence costs associated with each different consequence type, and providing the annual rates of failure for given assets that are used to validate and calibrate the subsequent Weibull failure function.

[1] Life data includes assets of known ages from inspections that are still functioning and in service, as well as assets of known ages that have failed in service.
[2] Early on, the failure data is based on units that completely failed in service and were replaced as a result.

Failure Data is Based on Failures and Functional Failures[3] – When available, as we discussed for Wood Pole management and overhead transformers and equipment, results of inspections are added to the foundational data of known-aged failures of assets in the life database, which includes assets of known ages that failed in service, assets of known age that were inspected and deemed fit for duty and left in service, and assets that had functionally failed and were repaired or replaced. After our meeting discussion with Public Counsel, we confirmed that transformer "failures" in the database include only complete failures and functional failures. Avista determines a transformer has functionally failed only when it is physically damaged (lid, tank, bushings, etc.) and/or is leaking oil.[4] Other external characteristics, such as generally poor appearance, including substantial rust, even over the entire unit, do not constitute any imminent failure, and consequently, those units are left in service. In this program, overhead transformers are only replaced if they are deemed to have functionally failed, by the criteria described above, and if they are confirmed as such by follow-up inspection during design, installation, and final inspection (as we noted in our online meeting). Avista has provided confirming evidence of this operating practice in the transformer data used for the Weibull analysis, as part of its response to PC-DR-318 and PC-DR-336 Revised/Supplemental, where many hundreds of units over 60 years in age, and ranging up to 97 years in age, were left in service upon inspection because they did not meet the strict requirements of having functionally failed.

Weibull Function is Carefully Fit to the Data – When Weibull failure analysis is applied to this life data the result is much more than a plot of failures with age. The process of selecting the parameters that best represent the failure data can result in a single Weibull function or curve, to two or more as needed, to best describe the failure properties of an asset over its service life. The Weibull function provided by Avista for overhead transformers is a bi-Weibull curve reflecting the differences in failure rates and patterns over the mid-life and later life of the asset. The Beta 2 value of 1.0 represents a period of random failures, while the Beta 1 value of 6.7 represents a strong tendency toward failure by "wearing out." The same type patterns are evident in the Weibull failure curves presented in the transformer study provided as Exh. PADS-19, on pages 9-12. Once the parameters are initially estimated, the Weibull function is tested by Monte Carlo simulations and is adjusted to remove any bias in the parameters until it reasonably predicts the failure rates in the population over time represented by the actual data.[5]

Weibull Curve is Calibrated to Actual Failures Experienced by Avista – Finally, as we attempted to explain our meeting, Avista compares the annual number of failures predicted for the asset population from the Weibull analysis with the actual number of asset failures we experience on our system. The comparison of this failure prediction with the results of actual failures allows the Company to calibrate the Weibull function so it is neither underrepresenting actual failures nor overrepresenting them. This calibration process has two components: 1) forecast of individual asset failures with the equipment used for year in our work and asset management system, and 2) forecast of customer outages resulting from equipment failures with the actual number of such outages we experience on our system. This calibration is central to the discussion we were having about whether or not including functional failures in the Weibull analysis had the potential to underestimate the actual life expectancy of a transformer, as an example. This failure curve calibration, along with the detection error correction process in Availability Workbench (discussed below), ensures the failure models for our assets are accurately predicting the failures we experience on our system.

[3] In our online meeting with Public Counsel, Avista described the circumstance for wood poles that had functionally failed, where the pole may still be standing at inspection, but where it no longer meets the performance requirement of having the strength needed to be fit for duty.

[4] In practice, assets are regularly removed from service and are properly included in failure analysis when designated by inspection to be functional failures, or "potential failures," which latter condition indicates that functional failure is imminent (such as noted in Exh. PADS-19, page 15).

[5] For many years Weibull analysis has been the leading method in the world for fitting life data (Abernathy, Robert. The New Weibull Handbook Fifth Edition, Reliability and Statistical Analysis for Predicting Life, Safety, Supportability, Risk, Cost and Warranty Claims. 2006).

a) Failed in service.

b) Functional Failure.

c) Neither, not included in equipment failure rate determination.

d) Neither, not included in equipment failure rate determination.

e) Failed in service.

f) Neither, not included in equipment failure rate determinations.[6]

g) Neither, only individual pieces of equipment that have been determined to have functionally failed are included in failure rate determination.

h) Neither, only equipment failures and functional failures are included in equipment failure rate determination.

[6] Results of such equipment that actually failed in service is used to perform the failure and lifecycle analysis to determine such economic end of life. Actual failures are included in the failure analysis.