hydroAMP:
Condition Assessment Tools

U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

Hydro Québec

US Army Corps of Engineers

Bonneville Power Administration

hydroAMP: The Partnership

In 2001, the following four organizations joined together to create a framework to improve the evaluation of hydroelectric equipment and prioritization of hydropower investments:

- Bureau of Reclamation
- Hydro-Québec
- Corps of Engineers
- Bonneville Power Administration

hydroAMP: Condition Assessments

- Component condition is a key driver of maintenance and investment needs because the likelihood of failure increases as component condition degrades.
- Even with effective maintenance, condition will eventually deteriorate to the point at which sustained outages will result.
- To reduce the risk of unexpected failure and forced outages, it is imperative that the condition of major components be understood and managed.

hydroAMP: The Methodology

Employs a two-tiered methodology for deriving condition ratings.

- Tier 1 indicators rely on test results and/or inspections that are normally obtained during routine maintenance activities.
- These Condition Indicators are weighed together to compute an equipment Condition Index.
- The index ranges from 10 to 0 and equates to a Good, Fair, Marginal or Poor rating.
- Tier 2 assessments are used to refine or adjust the Tier 1 Condition Index.

hydroAMP: The Principles

- Objective results
- Developed from routine tests and inspections
- Simplified process
- Easy interpretation
- Technically sufficient (valid though not necessarily perfect)
- Consistent and repeatable results
- Guided by multi-agency team effort
- Start small, expand with time
- Open to improvement

Condition Assessment Guides

Multi-agency technical teams have developed or are developing condition assessment guides for:

- Turbines
- Generators
- Transformers
- Circuit Breakers
- Governors
- Exciters
- Surge Arresters
- Emergency Closure Gates & Valves
- Cranes
- Compressed Air Systems
- Station Batteries

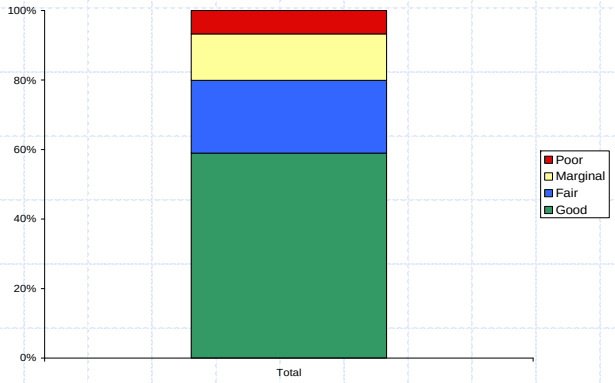
Asset Management: Building a Business Case

Analysis tools are being developed to facilitate resource allocation decisions based on material condition and other business factors, e.g.,

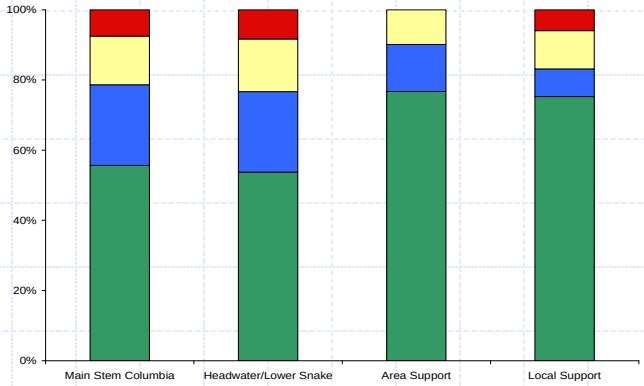
- Risk assessment
- Condition profile analysis
- Age profile analysis

Analysis of Condition Ratings

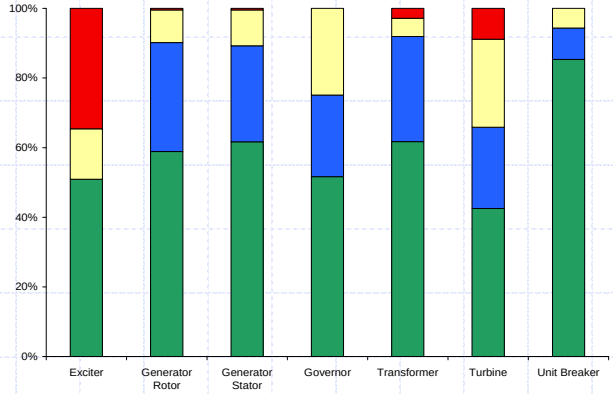
System



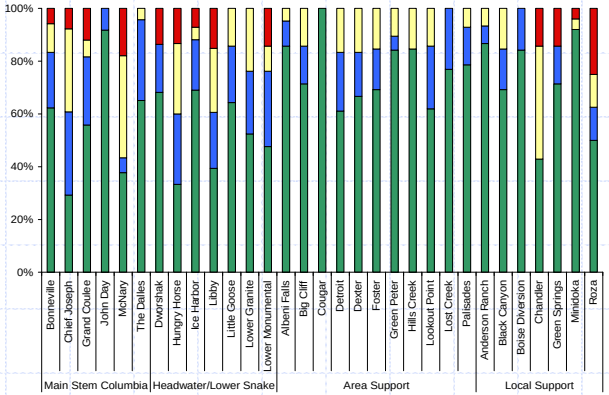
Strategic Class



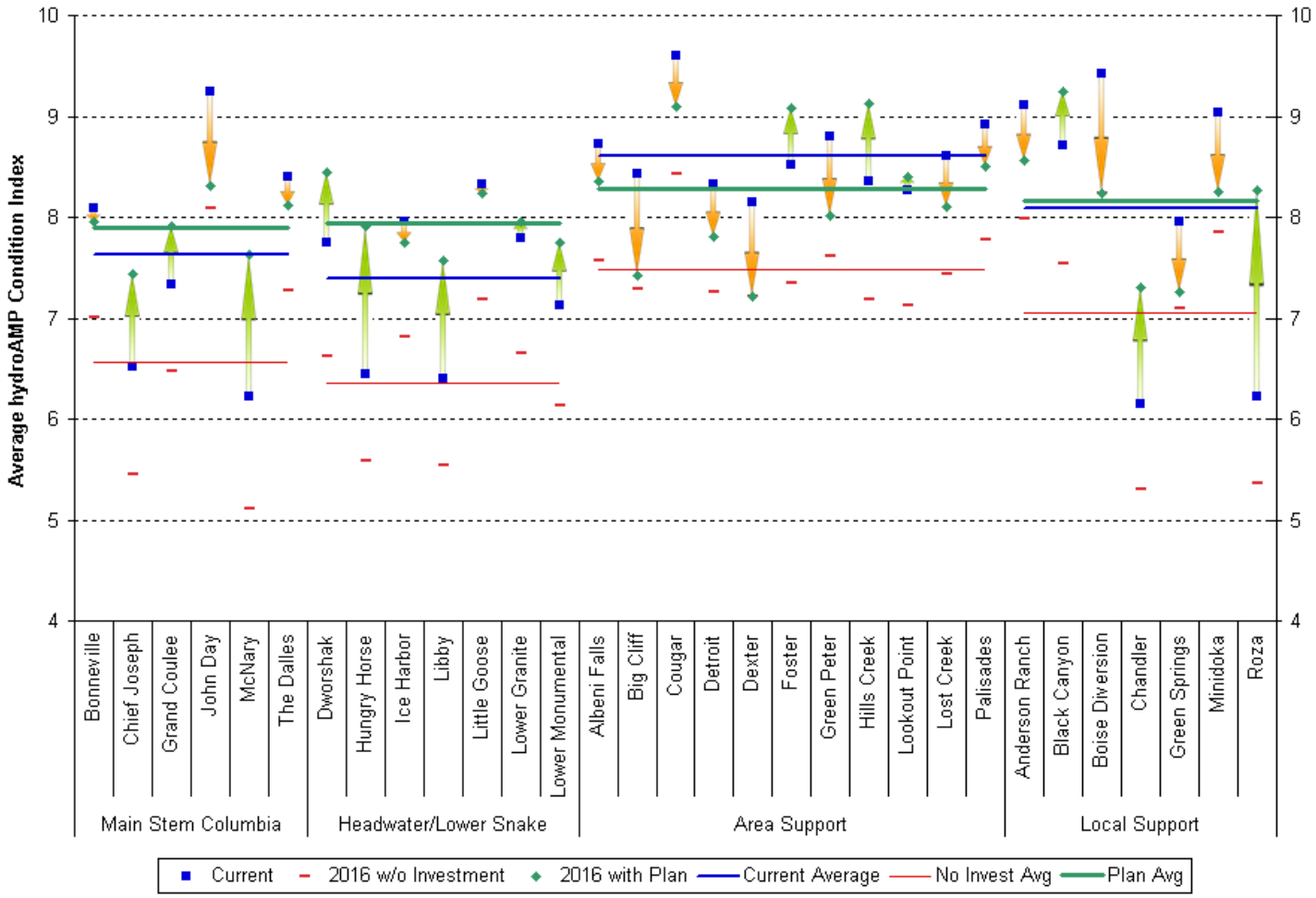
Equipment Type



Project



Condition Ratings: Current versus With and Without Investment



Buying Down the Risk

Current Risk Profile

Likelihood	Insignificant	Minor	Moderate	Major	Extreme	hydroAMP Index	
	< $ 10K	$ 10K to $ 100K	$ 100K to $ 1 M	$ 1 M to $ 10 M	> $ 10 M		
Almost Certain		2 Non-Power Train	2 Turbine 9 Non-Power Train	1 Transformer 3 Turbine 7 Non-Power Train	5 Transformer 3 Non-Power Train	0 to 0.9 1 to 1.9	Poor
Likely	1 Non-Power Train	1 Governor 25 Non-Power Train	14 Exciter 1 Generator Rotor 4 Governor 4 Turbine 34 Non-Power Train	3 Exciter 1 Generator Stator 1 Transformer 12 Turbine 1 Unit Breaker 19 Non-Power Train	1 Transformer 4 Non-Power Train	2 to 2.9 3 to 3.9	Poor Marginal
Possible		10 Governor 23 Non-Power Train	17 Exciter 20 Generator Rotor 6 Generator Stator 38 Governor 1 Transformer 25 Turbine 7 Unit Breaker 79 Non-Power Train	1 Exciter 14 Generator Stator 5 Transformer 27 Turbine 4 Unit Breaker 32 Non-Power Train	2 Generator Stator 5 Transformer 18 Non-Power Train	4 to 4.9 5 to 5.9	Marginal
Unlikely		2 Generator Rotor 34 Governor 3 Turbine 26 Non-Power Train	59 Generator Rotor 14 Generator Stator 16 Governor 7 Transformer 37 Turbine 19 Unit Breaker 26 Non-Power Train	6 Generator Rotor 45 Generator Stator 54 Transformer 10 Turbine 18 Non-Power Train	6 Transformer 21 Non-Power Train	6 to 6.9 7 to 7.9	Marginal Fair
Rare		35 Exciter 33 Generator Rotor 46 Governor 35 Unit Breaker 7 Non-Power Train	61 Exciter 92 Generator Rotor 31 Generator Stator 57 Governor 1 Transformer 78 Turbine 128 Unit Breaker 2 Non-Power Train	13 Exciter 1 Generator Rotor 98 Generator Stator 7 Governor 128 Transformer 13 Turbine 18 Unit Breaker 15 Non-Power Train	3 Generator Stator 18 Transformer 3 Non-Power Train	8 to 8.9 9 to 10	Fair Good

Consequence

Risk Level	Low	Medium	Medium High	High

Risk After Investment

Likelihood	Insignificant	Minor	Moderate	Major	Extreme	hydroAMP Index	
	< $ 10K	$ 10K to $ 100K	$ 100K to $ 1 M	$ 1 M to $ 10 M	> $ 10 M		
Almost Certain			28 Exciter 1 Generator Rotor 1 Turbine	1 Generator Stator 1 Unit Breaker	3 Transformer	0 to 0.9 1 to 1.9	Poor
Likely			7 Exciter 5 Generator Rotor 2 Governor 3 Turbine	1 Exciter 7 Turbine 4 Unit Breaker	3 Transformer	2 to 2.9 3 to 3.9	Poor Marginal
Possible			20 Generator Rotor 5 Generator Stator 5 Transformer 12 Turbine 16 Unit Breaker	9 Generator Stator 10 Transformer 7 Turbine	6 Transformer	4 to 4.9 5 to 5.9	Marginal
Unlikely		22 Exciter 10 Generator Rotor 3 Governor 3 Turbine 3 Unit Breaker	8 Exciter 65 Generator Rotor 20 Generator Stator 1 Governor 4 Transformer 38 Turbine 26 Unit Breaker	13 Exciter 6 Generator Rotor 37 Generator Stator 49 Transformer 5 Turbine	4 Transformer	6 to 6.9 7 to 7.9	Marginal Fair
Rare	1 Non-Power Train	13 Exciter 25 Generator Rotor 88 Governor 32 Unit Breaker 83 Non-Power Train	113 Exciter 81 Generator Rotor 26 Generator Stator 112 Governor 92 Turbine 112 Unit Breaker 150 Non-Power Train	9 Exciter 1 Generator Rotor 111 Generator Stator 7 Governor 130 Transformer 46 Turbine 18 Unit Breaker 91 Non-Power Train	5 Generator Stator 19 Transformer 49 Non-Power Train	8 to 8.9 9 to 10	Fair Good

Consequence

Risk Level	Low	Medium	Medium High	High

Conclusions

- hydroAMP assessment guides provide consistent techniques for evaluating component condition.
- Condition ratings provide an important tool for evaluating performance risk of hydropower equipment and can be correlated with the likelihood of equipment failing to perform as expected within a planning window.
- hydroAMP ratings support Risk Assessments, Condition Profile Analysis, and Age Profile Analysis for different investment scenarios.

The End

Questions?