

hydroAMP

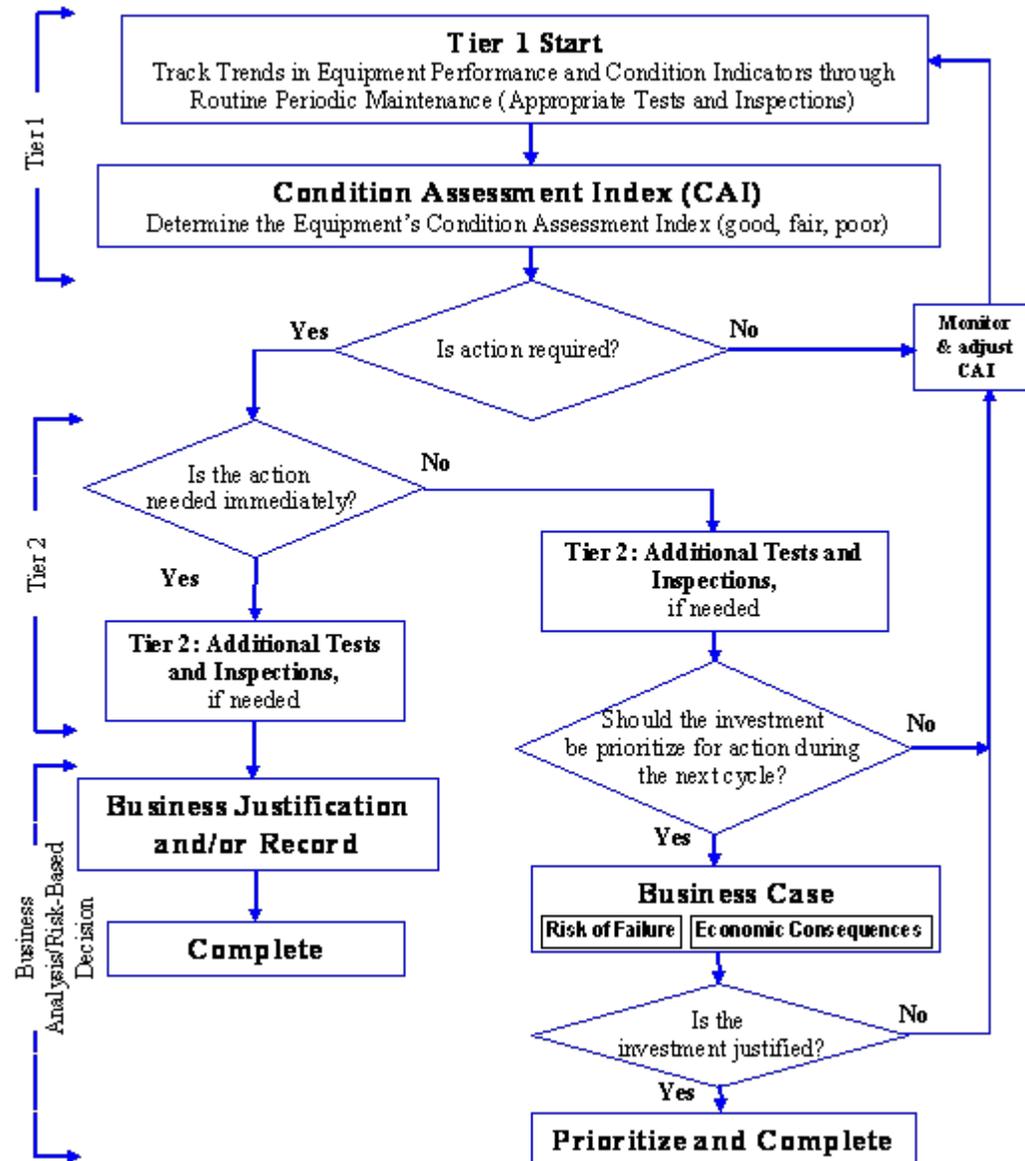
equipment condition assessments

USACE Asset Management Risk & Reliability Workshop
Alexandria, VA
August 15-18, 2006

Presented by Lori Rux, PhD, PE
Hydroelectric Design Center



hydroAMP Framework



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

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

Tier 1 Condition Assessment

-
-
- Appropriate **Condition Indicators** have been identified for each type of equipment.
 - Condition Indicators are scored based on tests, measurements, and inspections that are normally performed during routine O&M activities.
 - Results are combined into a **Condition Index** with a scale of 1-10; higher is better.
 - Mid- to low-range values may trigger actions such as a repair or Tier 2 evaluation.

Tier 2 Condition Assessment

-
-
- In-depth, non-routine tests or inspections that may be invasive and/or require specialized equipment and expertise not normally found at the project.
 - Results are used to adjust the Condition Index score (either up or down).
 - When performed, adds confidence to the assessment results and conclusions.

Data Quality Indicator

- A stand-alone indicator used to reflect the quality of information available for performing the condition assessment.
- Recognizes that data may be missing, out of date, or of questionable integrity.
- Poor data could affect the accuracy of individual condition indicator scores as well as the validity of the overall Condition Index.
- Provides a means to evaluate and record confidence in the final Condition Index.

Condition-based Alternatives

<i>Condition Index</i>	<i>Suggested Action</i>
≥ 7.0 and ≤ 10 (Good)	Continue O&M without restriction.
≥ 3.0 and < 7.0 (Fair)	Continue operation but reevaluate O&M practices. Consider Tier 2 tests.
≥ 0 and < 3.0 (Poor)	Immediate evaluation including Tier 2 testing. Consultation with experts. Adjust O&M as prudent.

Unit and Station Indices

- Individual equipment condition assessment results can be combined to develop aggregated assessments.
 - Unit Index – Complete power train
 - Station Index – Entire generating station

Generator Example

Tier 1 Condition Indicators (stator and field windings):

- O&M history
- Physical inspection
- Insulation resistance and polarization index
- Winding age

Condition Indicators are scored. Results are weighted and summed to calculate the Condition Index.

Data Quality Indicator is scored.

Summary of Tier 1 Stator Assessment

Condition Indicator	Score	Weighting Factor	Total Score
O&M History (0,1,2,or 3)	2	1.18	2.36
Physical Inspection (0,1,2,or 3)	3	1.18	3.54
Insulation Resistance and Polarization Index (0,1,2,or 3)	3	0.58	1.74
Winding Age (0,1,2,or 3)	0	0.39	0
Stator Condition Index (0 – 10)			7.6
Data Quality Indicator (0, 4, 7, or 10)			7

Tier 2 Tests

Tier 2 Toolbox (stator, rotor, and core):

- DC ramp
- High-pot
- PDA
- PF measurements
- Ozone
- Pole drop
- Blackout
- Loop
- EL CID
- Wedge tightness
- Other specialized tests

Results are used to refine the Tier 1 score.

Data Quality Indicator may be adjusted also.

Tier 1 Condition Indicator Scoring

Condition assessment guides provide instructions for scoring Tier 1 Condition Indicators.

Table 1 – Stator Winding Operation & Maintenance History Scoring	
Results	Stator Condition Indicator Score
Operation and maintenance normal.	3
Some abnormal operating conditions experienced and/or additional maintenance above normal occurring.	2
Significant operation outside normal and/or significant additional maintenance is required; forced outage occurs; outages are regularly extended due to maintenance problems; similar units are problematic.	1
Repeated forced outages; maintenance not cost effective; major electrical or mechanical failures; similar units have reached end-of-life.	0

Tier 2 Tests and Condition Index Adjustments

Condition assessment guides also provide criteria for using Tier 2 test results.

Table 14 – Ozone Scoring	
Test Results	Adjustment to Stator Condition Index
Ozone levels less than 0.05 ppm.	Add 0.5
Ozone levels between 0.05 and 0.1 ppm.	No Change
Ozone levels between 0.1 and 1.0 ppm.	Subtract 1.0
Ozone levels above 1.0 ppm.	Subtract 2.0

Data is stored in a secure web-accessible database.

- The database stores and reports Tier 1 condition assessments.
- The database can import data from FEMS/MAXIMO.
- It is expandable to include new plants and equipment and Tier 2 data.

hydroAMP Database: Main Page

Thursday, July 20, 2006

HydroAMP

[Home](#) | [Condition Assessments](#) | [Equipment](#) | [Reports](#) | [My Account](#) | [Help](#)

Logout: lori.rux@usace.army.mil

Welcome to HydroAMP!

Aging and deteriorating equipment poses significant risk to hydroelectric equipment reliability and may result in low generating unit availability. Significant investment in replacing, repairing or refurbishing existing generation and support equipment within hydroelectric projects is required to assure the continued viability of hydropower assets. The four organizations involved in hydroAMP, the Bureau of Reclamation (BOR), Hydro-Québec (HQ), the US Army Corps of Engineers (COE) and the Bonneville Power Administration (BPA), joined together to develop a common framework or process to streamline, simplify and improve the evaluation and documentation of the condition of hydroelectric equipment and facilities in order to support condition-based prioritization of hydropower asset business decision-making.

A two-tiered approach for assessing equipment condition and risk of failure for hydropower equipment was developed. Tier 1 of the condition assessment process incorporates test results and/or inspections that are normally obtained during routine operation and maintenance activities. These condition indicators are combined to compute an equipment Condition Index. Tier 2 of the assessment relies on more in-depth, non-routine test results and inspections requiring specialized knowledge to further refine the equipment Condition Index.

This website represents an additional effort that was developed in order to allow plants and agencies to input their equipment condition data into a single database in a common format. It also allows for individual plant/utility analysis and reporting.

Please select an option from the list below:



Condition Assessments

Input equipment condition data for tier 1 assessment.



Equipment

Add, update and delete equipment for specific plants.



Reports

View and export condition assessment reports.



My Account

View and make changes to your account.



Help

Need help? Have comments?

What's New

- 12/30/2005 - HydroAMP is now live and ready for use. Please take some time to familiarize yourself with the menu options at the top. Please contact the System Administrator for any questions or concerns.

Assessment Guides

- [Turbine \(pdf\)](#)
- [Generator \(pdf\)](#)
- [Circuit Breaker \(pdf\)](#)
- [Governor \(pdf\)](#)
- [Excitation System \(pdf\)](#)
- [Transformer \(pdf\)](#)
- [Battery \(pdf\)](#)
- [Compressed Air System \(doc\)](#)
- [Crane \(doc\)](#)
- [Surge Arrester \(pdf\)](#)
- [Emergency Closure Gates and Valves \(pdf\)](#)

Tier 1 Generator Stator Assessment

Thursday, July 20, 2006

HydroAMP

Home | Condition Assessments | Equipment | Reports | My Account | Help

Logout: lori.rux@usace.army.mil

Tier 1 Condition Assessment

Generator Stator

Plant: **Chief Joseph** Unit:

Stator Winding Manufacturer: Stator Insulation Type:

Rated Capacity: (MVA) Power Factor:

Voltage Rating: (kV)

Tier 1 Generator Stator Condition Assessment

(For Instructions on indicator scoring, please refer to the [condition assessment guide](#).)

No.	Condition Indicator	Score	x Weighting Factor	=	Total Score
1	Operation & Maintenance History <input type="text" value="Significant abnormal Operation or Maintenance"/>	1	1.18		1.18
2	Physical Inspection <input type="text" value="Inspection Shows some deterioration"/>	2	1.18		2.36
3	Insulation Resistance and Polarization Index <input type="text" value="Results are Normal and similar to Previous tests"/>	3	0.58		1.74
4	In Service Date: <input type="text" value="1985"/>	2	0.39		0.78
Stator Condition Index					6.1
					Fair

Data Quality Indicator **10**

Note: Your Condition Assessment is not completed until you save!

Certification Information

Last Assessment Date: **9/30/2005**

Last Approval Date: **9/30/2005**

Comment on Update:

hydroAMP Database: Generator Summary

Thursday, July 20, 2006

HydroAMP

[Home](#) | [Condition Assessments](#) | [Equipment](#) | [Reports](#) | [My Account](#) | [Help](#)

Logout: lori.rux@usace.army.mil

View and export reports.

Report Viewer

[New Report](#)

Printing: For best results, export and print from Adobe Acrobat or Microsoft Excel

Zoom: Export:

Report Date: 7/20/2006

Generator Stator

Plant Name	Unit #	Data Quality Score	Condition Index	Condition Rating
Chief Joseph	1	10.0	7.6	Good
Chief Joseph	2	10.0	7.6	Good
Chief Joseph	3	10.0	7.6	Good
Chief Joseph	4	10.0	7.6	Good
Chief Joseph	5	10.0	6.1	Fair
Chief Joseph	6	10.0	7.6	Good
Chief Joseph	7	10.0	6.5	Fair
Chief Joseph	8	10.0	4.9	Fair
Chief Joseph	9	10.0	7.6	Good
Chief Joseph	10	10.0	6.1	Fair
Chief Joseph	11	10.0	7.2	Good
Chief Joseph	12	10.0	7.2	Good
Chief Joseph	13	10.0	7.2	Good
Chief Joseph	14	10.0	7.6	Good
Chief Joseph	15	10.0	7.6	Good
Chief Joseph	16	10.0	7.2	Good
Chief Joseph	17	10.0	7.2	Good
Chief Joseph	18	10.0	6.1	Fair

hydroAMP Database: Station Summary Report

HydroAMP | Reports | Report Viewer

HydroAMP

Thursday, July 20, 2006

Home Condition Assessments Equipment Reports My Account Help

Logout: lori.rux@usace.army.mil

View and export reports.

Report Viewer

[New Report](#)

Printing: For best results, export and print from Adobe Acrobat or Microsoft Excel

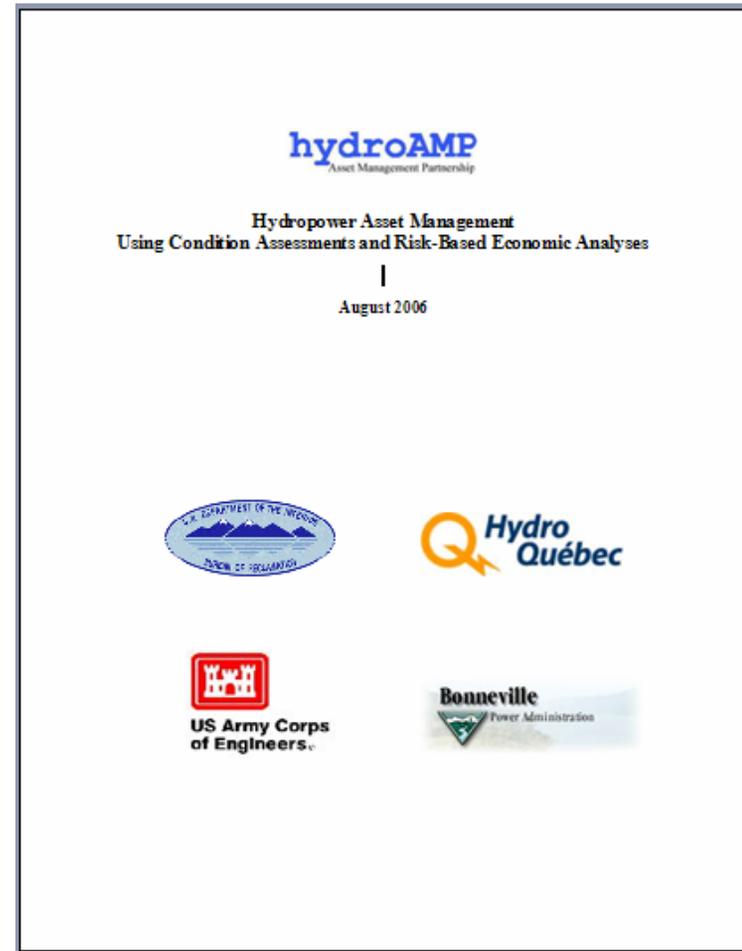
Zoom: Report 7/20/2006
Date:

Summary of Condition Index Scores

		Generator		Transformer		Turbine		Governor		Exciter		Unit Breaker		Unit Index Rating		Station Index Rating																	
Power Train Component Weight		0.30		0.25		0.20		0.10		0.10		0.06		<table border="1"> <tr><td>Rating for score ></td><td></td></tr> <tr><td>0.85</td><td>Good</td></tr> <tr><td>0.75</td><td>Fair</td></tr> <tr><td>0.00</td><td>Poor</td></tr> </table>		Rating for score >		0.85	Good	0.75	Fair	0.00	Poor	<table border="1"> <tr><td>Rating for score ></td><td></td></tr> <tr><td>0.75</td><td>Good</td></tr> <tr><td>0.25</td><td>Fair</td></tr> <tr><td>0.00</td><td>Poor</td></tr> </table>		Rating for score >		0.75	Good	0.25	Fair	0.00	Poor
Rating for score >																																	
0.85	Good																																
0.75	Fair																																
0.00	Poor																																
Rating for score >																																	
0.75	Good																																
0.25	Fair																																
0.00	Poor																																
Plant Name	Unit ID	Condition Index	Condition Rating	Unit Condition Index	Unit Condition Rating	Station Condition Index	Station Condition Rating																										
Chief Joseph	1	7.6	Good	10.0	Good	3.0	Fair	8.0	Good	6.0	Fair	9.1	Good	1.00	Good	1.00	Good																
Chief Joseph	2	7.6	Good			5.0	Fair	8.0	Good	6.0	Fair	8.7	Good	1.00	Good																		
Chief Joseph	3	7.6	Good			3.0	Fair	8.0	Good	6.0	Fair	8.7	Good	1.00	Good																		
Chief Joseph	4	7.6	Good			5.0	Fair	8.0	Good	6.0	Fair	7.4	Good	1.00	Good																		
Chief Joseph	5	6.1	Fair			5.0	Fair	7.5	Good	6.0	Fair	8.7	Good	1.00	Good																		
Chief Joseph	6	7.6	Good			5.0	Fair	7.5	Good	6.0	Fair	8.7	Good	1.00	Good																		
Chief Joseph	7	6.5	Fair			5.0	Fair	7.5	Good	6.0	Fair	8.4	Good	1.00	Good																		
Chief Joseph	8	4.9	Fair			5.0	Fair	7.5	Good	2.0	Poor	7.4	Good	0.90	Good																		
Chief Joseph	9	7.6	Good			5.0	Fair	8.0	Good	6.0	Fair	8.7	Good	1.00	Good																		
Chief Joseph	10	6.1	Fair			4.0	Fair	8.0	Good	6.0	Fair	8.7	Good	1.00	Good																		
Chief Joseph	11	7.2	Good	3.0	Fair	7.5	Good	5.0	Fair	8.7	Good	1.00	Good																				
Chief Joseph	12	7.2	Good	5.0	Fair	7.5	Good	2.0	Poor	7.4	Good	0.90	Good																				
Chief Joseph	13	7.2	Good	5.0	Fair	7.5	Good	5.0	Fair	7.4	Good	1.00	Good																				
Chief Joseph	14	7.6	Good	5.0	Fair	8.0	Good	6.0	Fair	8.0	Good	1.00	Good																				
Chief Joseph	15	7.6	Good	5.0	Fair	8.0	Good	6.0	Fair	9.1	Good	1.00	Good																				
Chief Joseph	16	7.2	Good	5.0	Fair	7.5	Good	3.0	Fair	7.8	Good	1.00	Good																				
Chief Joseph	17	7.2	Good	8.9	Good	9.0	Good	7.5	Good	1.0	Poor	10.0	Good	0.90	Good																		
Chief Joseph	18	6.1	Fair	9.0	Good	7.5	Good	1.0	Poor	10.0	Good	0.90	Good																				

Assessment Guides and Guidebook

- A guidebook was developed to facilitate asset management decisions using equipment condition assessments.
- The asset management tools are open and flexible to fit into the existing structure of each utility's maintenance, planning, budgeting and decision-making processes.





US Army Corps
of Engineers ®

Hydropower Gateway

[Home](#) [Visitors](#) [People](#) [Forums](#) [Learning](#) [BMPs](#) [Tools](#) [News/Events](#) [Submit](#) [Search](#)

[Help](#) * [Contact Us](#) * [Make Hydropower your home page](#)

Communities of Practice

- [USACE CoPs](#)
 - [Operations & Regulatory](#)
 - [Blue Collar](#)
 - [Hydropower](#)
 - [Inland Navigation Infrastructure](#)
 - [Natural Resources Management](#)
 - [Navigation](#)
 - [Operations Project Managers](#)
 - [Regulatory](#)
 - [Safety](#)

Business Processes

- [Headquarters](#)
- [Acquisition](#)
- [Administration](#)
- [Budget](#)
- [Communication & Marketing](#)
- [Environment](#)
- [Financial Management](#)
- [Human Resources](#)
- [PMP & PgMP](#)
- [Policy & Procedures](#)
- [Programs & Partnerships](#)
- [Related Sites](#)
- [Research & Development](#)
- [Safety, Security & Risk Management](#)
- [Teams](#)
- [Tools/AIS](#)

Hydropower Notes

FY2005 Strategic Planning Workshop Proposals

Mission Statement

Provide reliable hydroelectric power services, including power system stabilization, to benefit the nation's electrical power consumers in partnerships with federal power marketing administrations.

Vision

Be the premier steward of entrusted hydropower resources.

Strategic Objectives

1. Provide power services at the lowest sustainable cost.
2. Optimize hydropower as a renewable resource that does not contribute to greenhouse gases.
3. Meet or exceed industry standards for reliability and availability.
4. Develop and implement a hydropower asset management strategy.
5. Identify and implement opportunities to standardize equipment, processes, and services in coordination with other related federal hydropower agencies.
6. Sustain a skilled hydropower workforce.
7. Strengthen and sustain hydropower partnerships with power marketing administrations, preference customers, and federal power agencies.
8. Manage the hydropower program through sound project management principles.
9. Optimize hydropower resources within authorized project purposes and environmental laws.

[Meeting Notes](#)



US Army Corps
of Engineers ®

Hydropower Gateway

[Home](#) [Visitors](#) [People](#) [Forums](#) [Learning](#) [BMPs](#) [Tools](#) [News/Events](#) [Submit](#) [Search](#)

[Help](#) * [Contact Us](#)

Communities of Practice

- [USACE CoPs](#)
 - [Operations & Regulatory](#)
 - [Blue Collar](#)
 - [Hydropower](#)
 - [Inland Navigation Infrastructure](#)
 - [Natural Resources Management](#)
 - [Navigation](#)
 - [Operations Project Managers](#)
 - [Regulatory](#)
 - [Safety](#)

Business Processes

- [Headquarters](#)
- [Acquisition](#)
- [Administration](#)
- [Budget](#)
- [Communication & Marketing](#)
- [Environment](#)
- [Financial Management](#)
- [Human Resources](#)
- [PMP & PgMP](#)
- [Policy & Procedures](#)
- [Programs & Partnerships](#)
- [Related Sites](#)
- [Research & Development](#)
- [Safety, Security & Risk Management](#)
- [Teams](#)
- [Tools/AIS](#)

Best Management Practices - BMPs

- [U.S. Bureau of Reclamation website for Facilities Instructions Standards and Techniques \(FIST\) documents](#)
- Condition Assessment Guides
 - [A Strategic Approach to Making Hydropower Investment Decisions Based on Equipment Condition and Risk Management Principles](#)
 - [Plant Battery](#)
 - [Circuit Breakers](#)
 - [Excitation System](#)
 - [Generator](#)
 - [Governor](#)
 - [Surge Arrester](#)
 - [Transformer](#)
 - [Turbine](#)
- [Electric Utility Cost Group \(EUCG\)](#)



Item is restricted to U.S. Army Corps of Engineers and will open in a new window.

Conclusion

hydroAMP condition assessments support:

- Need for further investigation.
- Repair and/or replacement decisions.
- Development and prioritization of long-term capital investments.
- Coordination of O&M practices at Regional, District, and Project levels.
- Identification and tracking of performance goals.

Thank you!

