HydroAMP:
Hydropower Asset Management

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Hydroelectric Design Center
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What is HydroAMP?

Asset management tools developed to improve

- Evaluation of hydroelectric equipment
- Prioritization of investments
Objectives

- Background
- Goals, methodology, and principles
- Condition assessments
- Business analyses
- Current status
- What’s next
- Conclusions
In 2001, four organizations began creating an asset management framework.

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

- Aging infrastructure
- Generation availability and reliability
- Objective, consistent, and valid assessments
- Strengthen prioritization processes
- Available tools too complex and costly
Goals

- Streamlined condition assessments
- Justify investigations, repairs, and refurbishments
- Strategic business decisions
- Long-term viability and reliability
Methodology

- Assessment tools for major powerhouse equipment
- Field validation
- Computerized data collection, trending, and reporting
- Management tools based on condition, risk, and other factors
Principles

- Objective results
- Developed from routine tests and inspections
- Simple process
- Easy interpretation
- Technically sufficient (not necessarily perfect)

- Consistent and repeatable results
- Multi-agency team effort
- Start small, expand with time
- Open to improvement
Condition Assessments

Tier 1:

- Information and guidelines
- Condition Indicators for each type of equipment
- Scored using routine tests and inspections
- Results in Condition Index on scale of 1-10; higher is better
- Mid- to low-range values may trigger Tier 2 evaluation
Tier 2:

- In-depth, non-routine tests or inspections
- Invasive and/or require specialized equipment and expertise
- Adjust Condition Index up or down
- Add confidence to results and conclusions
## Tier 1:

<table>
<thead>
<tr>
<th>Condition Indicator</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>0 – 3.0</td>
</tr>
<tr>
<td>Physical Condition</td>
<td>0 – 4.0</td>
</tr>
<tr>
<td>Operating Restrictions</td>
<td>0 – 1.5</td>
</tr>
<tr>
<td>Maintenance History</td>
<td>0 – 1.5</td>
</tr>
<tr>
<td><strong>Turbine Condition Index</strong></td>
<td>0 – 10.0</td>
</tr>
<tr>
<td><strong>Data Quality Indicator</strong></td>
<td>0, 4, 7, or 10</td>
</tr>
</tbody>
</table>
### Example: Turbine Assessment (cont.)

#### Tier 2:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Adjustment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Efficiency</td>
<td>+/- 1.0</td>
</tr>
<tr>
<td>Capacity</td>
<td>+/- 0.5</td>
</tr>
<tr>
<td>Surface Roughness</td>
<td>+/- 0.5</td>
</tr>
<tr>
<td>Cracking</td>
<td>+/- 1.0</td>
</tr>
<tr>
<td>Cavitation</td>
<td>+/- 0.5</td>
</tr>
<tr>
<td>Environmental Improvements</td>
<td>+/- 0.5</td>
</tr>
<tr>
<td>Off-Design Conditions</td>
<td>+/- 0.5</td>
</tr>
<tr>
<td><strong>Total Adjustment to Condition Index</strong></td>
<td>+/- x.x</td>
</tr>
</tbody>
</table>
## Condition-Based Alternatives

<table>
<thead>
<tr>
<th>Condition Index</th>
<th>Suggested Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\geq 7.0$ and $\leq 10$ (Good)</td>
<td>Continue O&amp;M without restriction.</td>
</tr>
<tr>
<td>$\geq 3.0$ and $&lt; 7.0$ (Fair)</td>
<td>Continue operation but reevaluate O&amp;M practices. Consider Tier 2 tests.</td>
</tr>
<tr>
<td>$\geq 0$ and $&lt; 3.0$ (Poor)</td>
<td>Immediate evaluation including Tier 2 testing. Consultation with experts. Adjust O&amp;M as prudent.</td>
</tr>
</tbody>
</table>
Example: Generator Assessment

Tier 1: (Stator and field windings)
- Insulation resistance and PI
- O&M history
- Physical inspection
- Age

Tier 2: (Stator, Rotor, Core)
- DC ramp
- High-pot
- Partial discharge
- Power factor
- Ozone
- Blackout
- Rated flux (loop)
- EL CID
- Wedge tightness
- Pole drop
Example: Transformer Assessment

**Tier 1:**
- Oil analysis
- Doble tests
- O&M history
- Age

**Tier 2:**
- Turns ratio
- Short circuit impedance
- Core ground
- Winding resistance
- Vibration analysis
- Frequency response
- Internal inspection
- Polymerization
Available Guides

Power train and auxiliary systems:

- Turbines
- Generators
- Transformers
- Circuit Breakers
- Governors
- Exciters

- Surge Arresters
- Emergency Closure Gates & Valves
- Cranes
- Compressed Air Systems
- Station Batteries
Building the Business Case

- Allocations based on condition, risk, economics, other factors
- Component, unit, and plant summaries
- Open and flexible analysis tools
- Fit into existing maintenance, planning, budgeting, and decision-making processes
Analyses may vary in complexity:

- **Simple:** Condition/Trend $\rightarrow$ Decision
  
  *Example – Failing compressor*

- **Comparative:** Condition/Trend $\rightarrow$ Value $\rightarrow$ Decision
  
  *Example – Crane repair*

- **In-Depth:** Condition/Trend $\rightarrow$ Value $\rightarrow$ Risk and Economics $\rightarrow$ Decision
  
  *Example – Generator uprate*
Example: Influence Diagram (Risk Map) for a Population of Transformers
Overall Process

**Tier 1 - Start**
Track trends in equipment performance and condition indicators through routine periodic maintenance

**Condition Index (CI)**
Determine equipment’s Condition Index (Good, Fair, Poor)

- **Yes**
  - Is action required?
- **No**
  - Monitor & Adjust CI

**Tier 2 - Additional tests and inspections, if needed**

- **Yes**
  - Business Justification and/or Record
  - Complete
- **No**
  - Is the action needed immediately?
    - **Yes**
      - Business Justification and/or Record
      - Complete
    - **No**
      - Should investment be considered for action during the next cycle?
        - **Yes**
          - Business Case
          - (Risk of Failure, Economic Consequences, Etc.)
        - **No**
          - Is the investment justified?
            - **Yes**
              - Prioritize and Complete
            - **No**
Intended Users

- O&M Field Staff
- Technical Support Staff & HDC
- Plant Managers
- District & Division Management
- Investment Decision-Makers
Current Status

COE – Within FCRPS:
- Transformer spare study (FY04)
- Tier 1 on all generators (FY05)
- Completing Tier 1 of turbines, governors, exciters, and circuit breakers.
  - PI goal is 95% completion of power train in FY05
Current Status

**COE – Outside FCRPS:**
- Planning pilot tests
- Using HydroAMP nationally to meet PART
- Nationwide transformer assessments in FY05 and FY06 (USACE-funded)
Current Status (cont.)

BPA & COE:

- Excel spreadsheet for FCRPS assessment data
  - Calculates unit and plant condition summaries
- Developing web-based application
  - Improved data collection, tracking, reporting
  - Accommodate all Corps plants
What’s Next?

- Complete asset management tools
  - Equipment assessment guides
  - Guidebook

- Implement nationwide
  - On-site training/orientation outside of FCRPS
  - Make tools available

- Evaluate and improve
  - Assess, update, clarify
What’s Next? (cont.)

- USACE Workshop on Asset Management (August ’05)
  - Describe HydroAMP program
  - Relate to other CW business lines
- Special panel session planned for *HydroVision 2006* (with HydroAMP partners).
Conclusions

HydroAMP supports

- Repair, replacement, monitoring
- Comparisons and prioritization
- Budget coordination at multiple levels
- Long-term investment strategies
- Performance goals
End of Presentation

Questions?