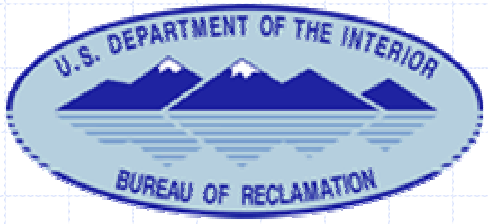
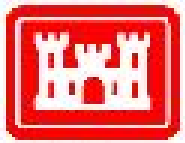
HydroAMP:
Hydropower Asset Management





US Army Corps
of Engineers

Presented by Lori Rux, Ph.D., P.E.
Hydroelectric Design Center
Tri-Service Infrastructure Systems Conference - August 2005

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

Background

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

Condition Assessments (cont.)

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

Example: Turbine Assessment

Tier 1:

Condition Indicator	***Score***
Age	0 – 3.0
Physical Condition	0 – 4.0
Operating Restrictions	0 – 1.5
Maintenance History	0 – 1.5
Turbine Condition Index	0 – 10.0
Data Quality Indicator	0, 4, 7, or 10

Example: Turbine Assessment (cont.)

Tier 2:

Efficiency	+/- 1.0
Capacity	+/- 0.5
Surface Roughness	+/- 0.5
Cracking	+/- 1.0
Cavitation	+/- 0.5
Environmental Improvements	+/- 0.5
Off-Design Conditions	+/- 0.5
Total Adjustment to Condition Index	+/- x.x

Condition-Based Alternatives

Condition Index	***Suggested Action***
≥ 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.

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

Building the Business Case (cont.)

Analyses may vary in complexity:

- **Simple:** Condition/Trend → Decision

  Example – Failing compressor

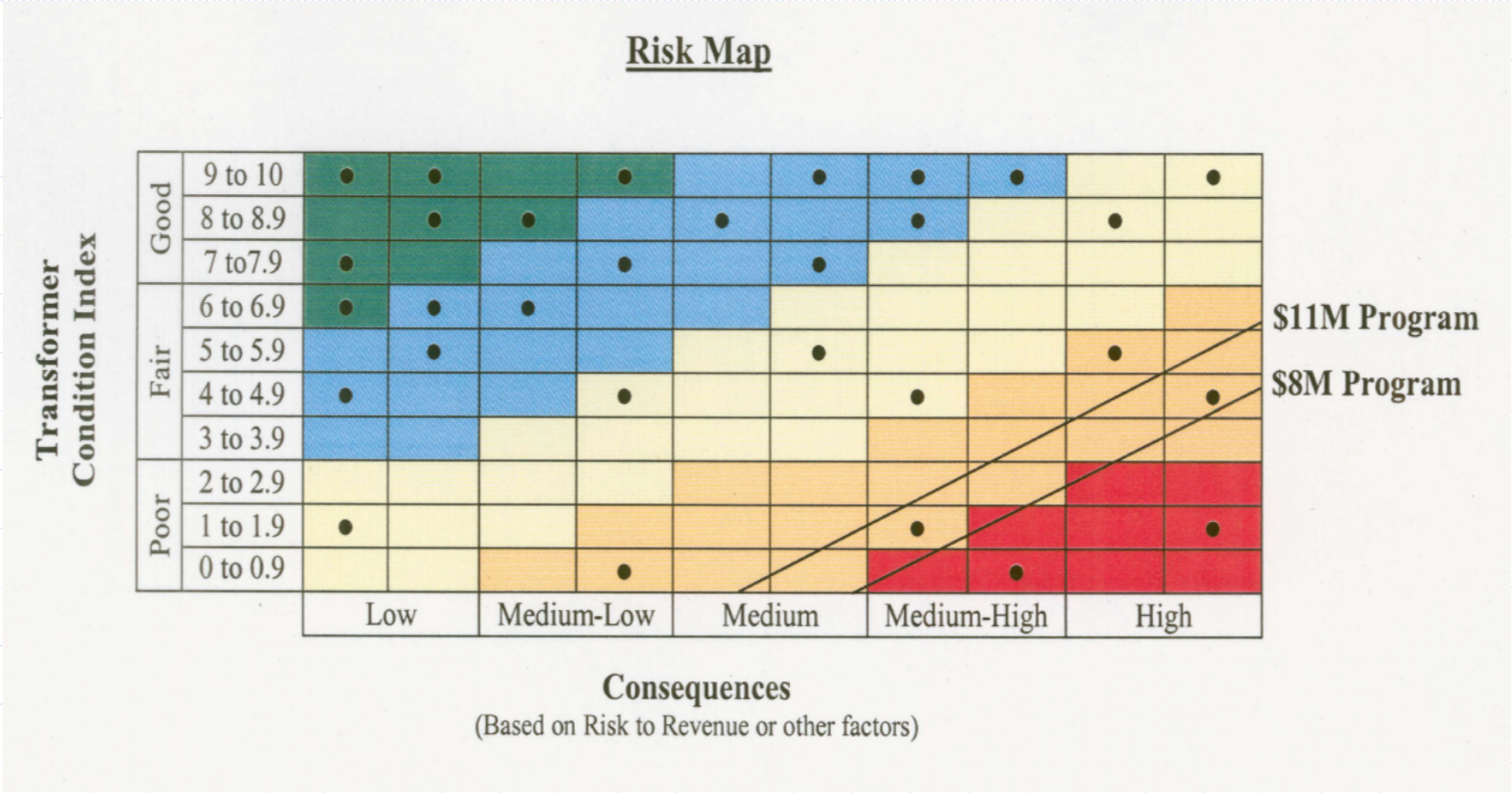
- **Comparative:** Condition/Trend → Value → Decision

  Example – Crane repair

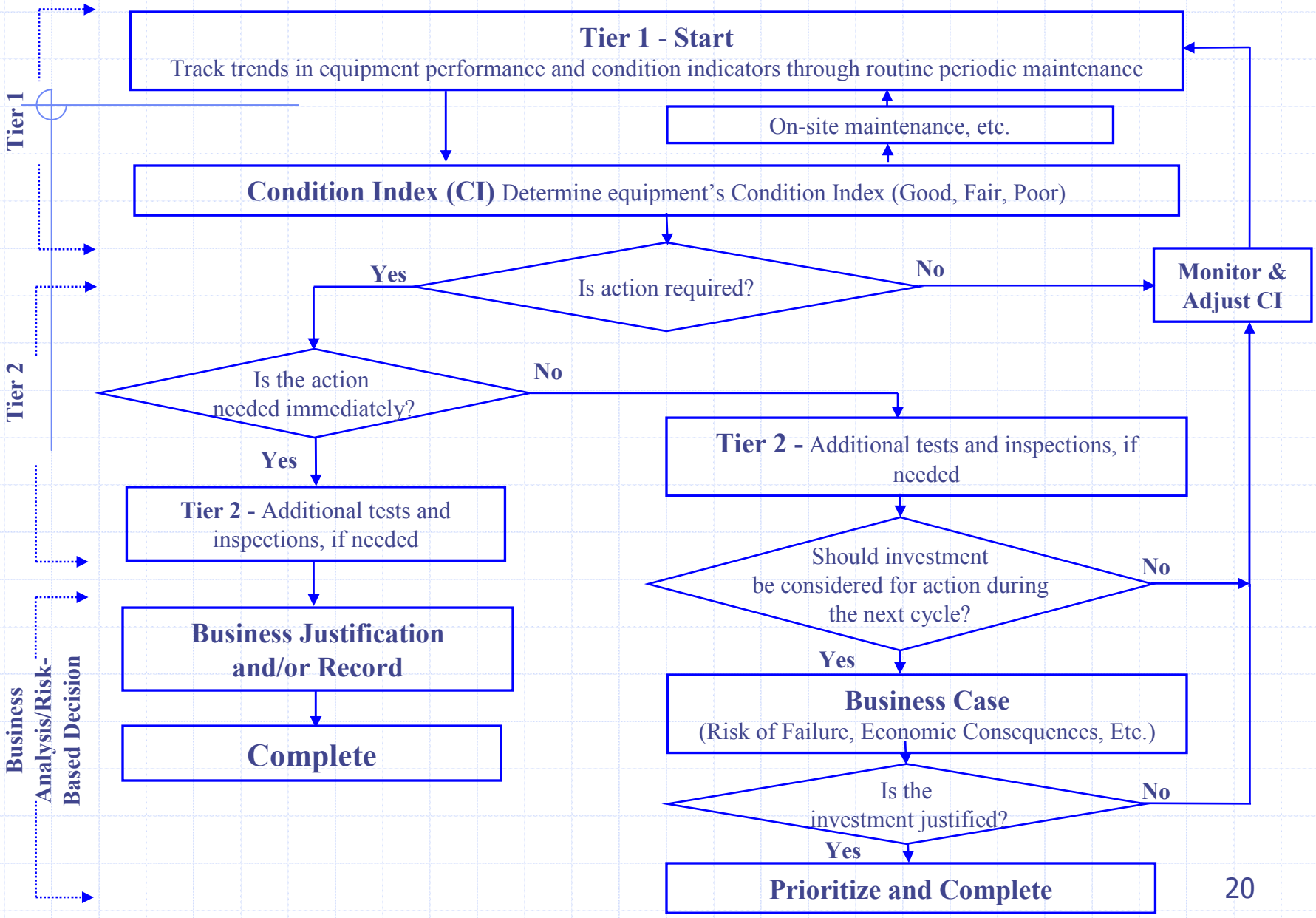
- **In-Depth:** Condition/Trend → Value → Risk and Economics → Decision

  Example – Generator uprate

Example: Influence Diagram (Risk Map) for a Population of Transformers



Overall Process



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?