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Managing Water in the West

Implications of Lower Lake Levels

Hoover Dam



U.S. Department of the Interior
Bureau of Reclamation

Project Purposes

- Flood Control
- Storage of Water to meet downstream deliveries
- Power Generation
- Recreation
- Fish & Wildlife

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Project Purposes - continued

- On the power generation side we provide ancillary services such as:
 - Voltage control
 - System restoration
 - Blackstart power

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Lake Mead Reservoir

- **Full Lake Elevation –**
 - Elevation 1221.4 top of Spillway Gates
 - 28, 537,000 acre feet
 - 2074 mw
- **Current Lake Elevation –**
 - Elevation of 1099.25
 - 122 ft down (44% of capacity)
 - 11, 429,000 acre feet
 - 1688 mw (76%)

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Impacts of Lower Lake Elevations

- Loss of total generation capacity
- Loss of regulation capacity
- Decreased energy supplied to the customers
- Increased rough zones
- Increased Maintenance (cavitation) concerns

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Impacts of Lower Lake Elevation - continued

- 2009 power generation was 3.7 billion KWH
- 10 year average (1999 – 2008) was 4.2 billion KWH
- 1999 power generation was 5.5 billion KWH

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Efficiency and Capacity Improvements at Hoover Dam

- Major Overhauls of Turbine Components
- Stainless Steel Wicket Gates
- Opening Existing Wicket Gates beyond 100%
- Unit Controls Modernization
 - Hoover Load Following
- Wide Head Range Turbine

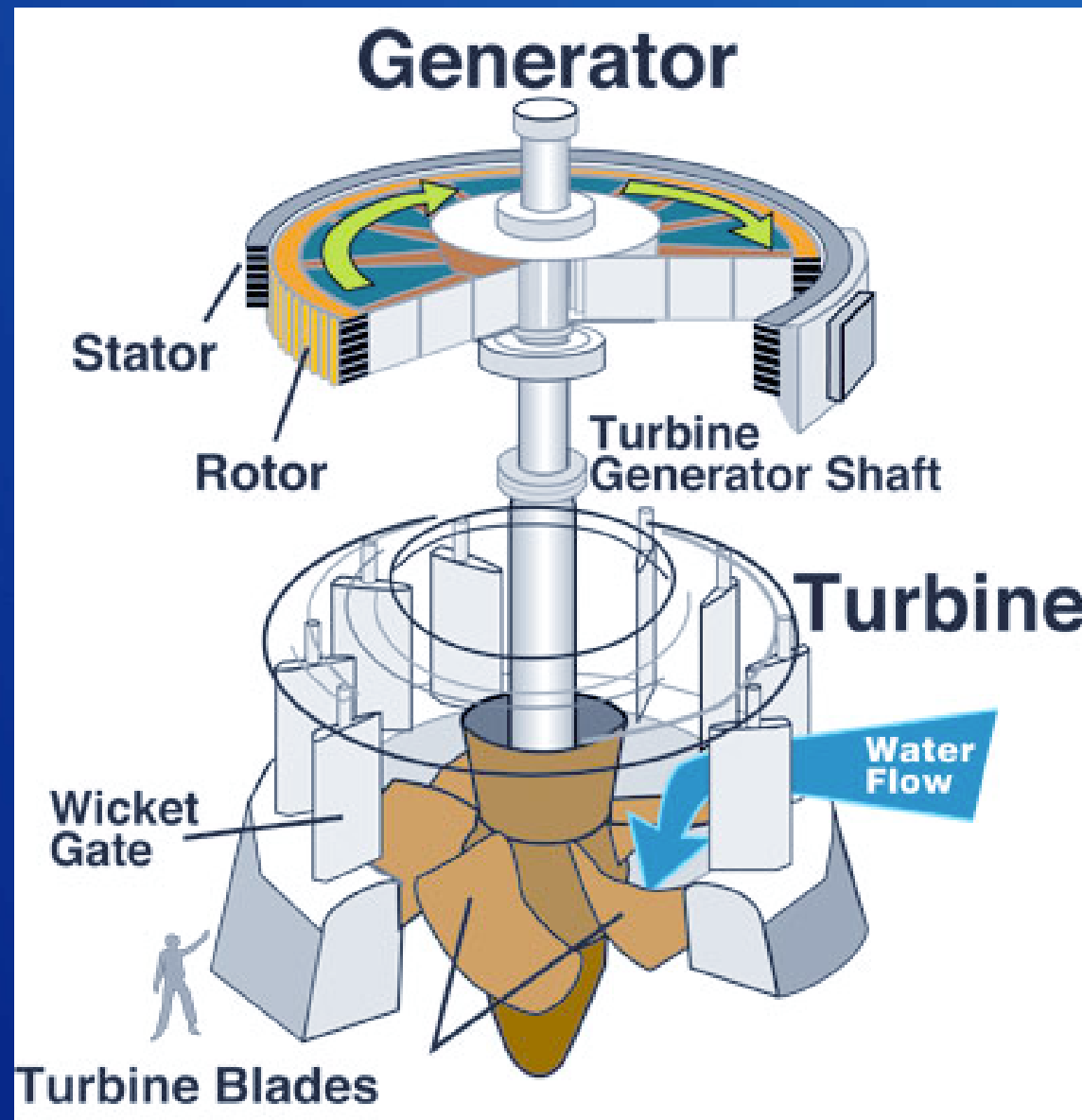
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Turbine Overhaul Work

- Purpose of this work is to restore the machinery to a more efficient operating condition
- Major Overhauls of Turbine Components
 - Installation of new seal rings improves the efficiency of turbine energy conversion.
 - \$290K per unit per year.
 - Installation of new wicket gates prevent water leakage when units are shut down by restoring gate tolerances.
 - \$200K per unit per year

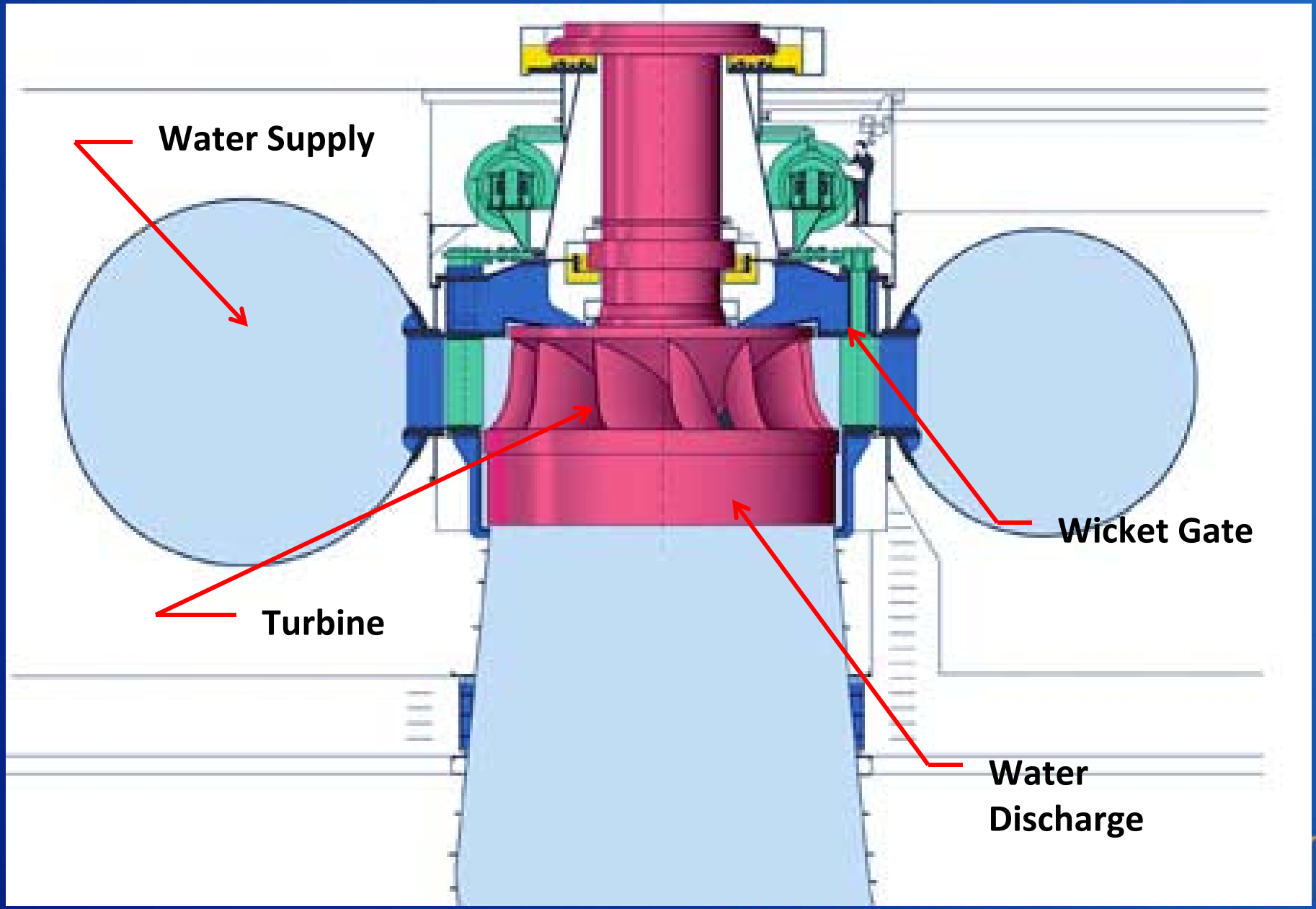
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Typical Hydro Turbine and Generator



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Francis Hydro Turbine





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Stainless Steel Wicket Gates and Over stroke of Wicket Gates

- **Stainless Steel Wicket Gates**
 - Thinner gates and larger gate openings increase capacity available at low lake levels.
 - 52 MW of additional capacity
- **Opening Existing Wicket Gates beyond 100%**
 - Increase hydro unit capacity available at low lake levels.
 - 36 MW of additional capacity

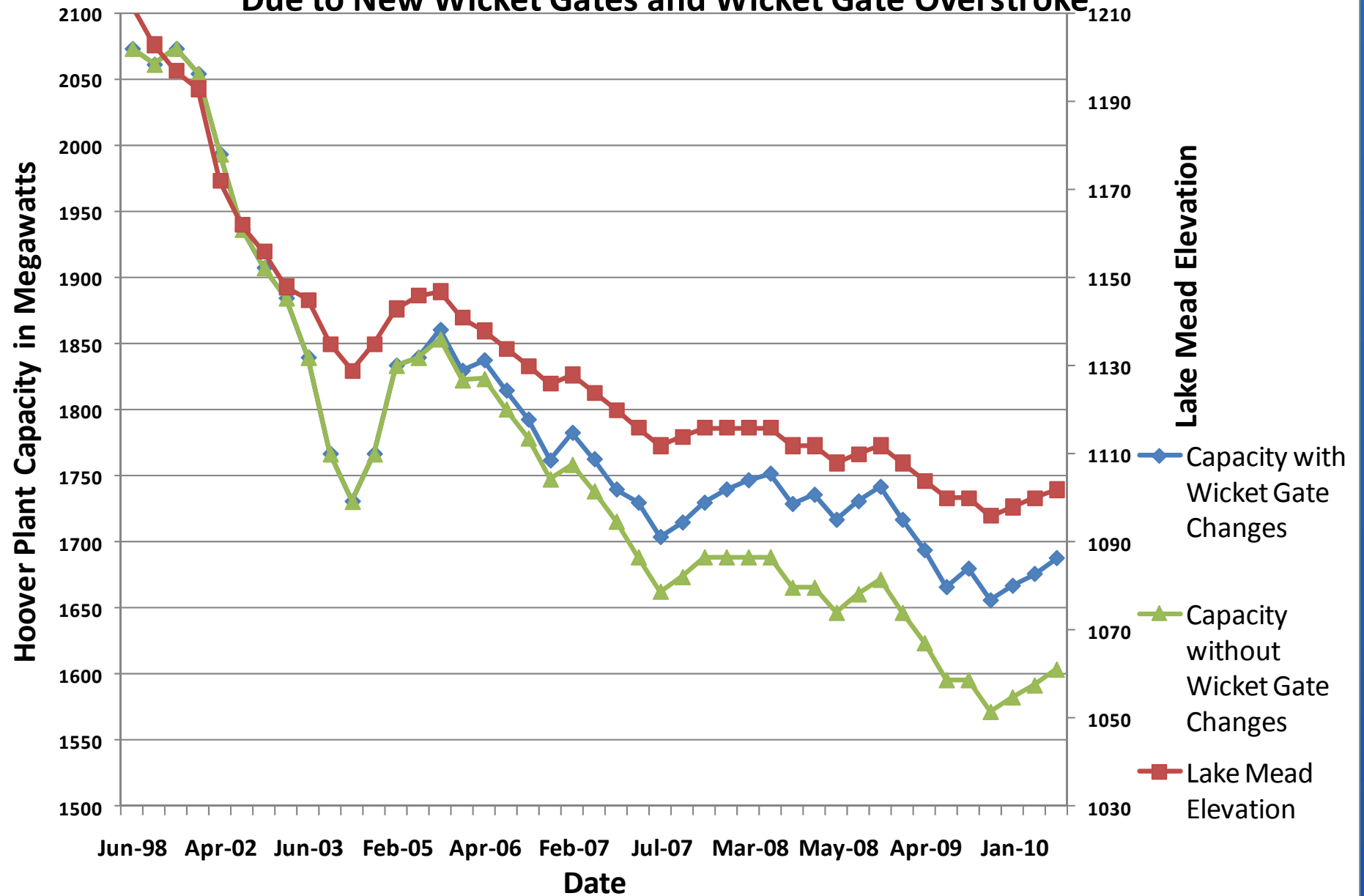
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Stainless Steel Wicket Gates and Over stroking Wicket Gates

- Total Project Cost for these efforts is \$6.2M
- Benefits result from the 88 MW of capacity added at lower lake levels as of April 2010.
- Additional 17 MW are scheduled over the next 2 years
- When the lake is below elevation 1145, the benefit of the added capacity is \$2.8 M per year
 - 88MW x \$2660 per MW month x 12 months

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Hoover Capacity Improvements Due to New Wicket Gates and Wicket Gate Overstroke



Unit Controls Modernization Benefits

- The role of Hoover is Regulation, Ramping, and Reserves
- UCM improves efficiency while units are providing regulation for the power system.
 - Faster operating mode transitions such as starting and stopping a unit
 - Faster changing from condense mode to generate mode
 - Faster transition/loading through the unit rough zones
 - Faster load-following response.
- UCM improves maximum capacity available to the market

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Benefits Gained from UCM (Speed)

	Before UCM	After UCM
Unit Loading Rate	30 MW/min	100 MW/min
Condense to Generate Time	80 seconds	20 seconds
Shutdown to Generate Time	4-7 Minutes	2-3 Minutes

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UNIT CONTROLS MODERNIZATION (UCM)

Local Control Panels



PRIOR TO CHANGES

Relays for unit control, solid state relay protection, analogue meters, pistol grip manual controls, and “window” type annunciator for alarms.



AFTER CHANGES

Programmable logic controller for unit control, digital relay protection, touch screen for manual control, monitoring, and alarms. Typical of 26 control panels

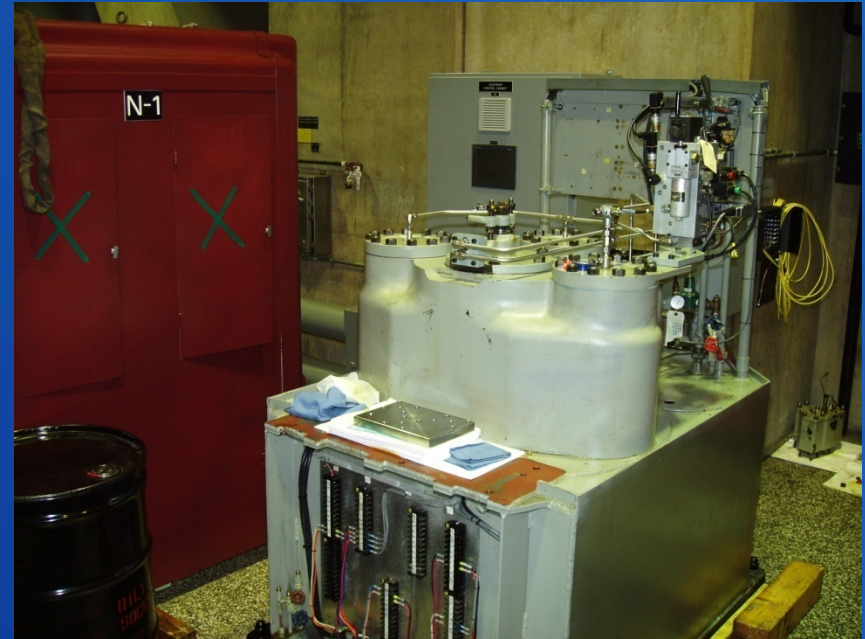
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Unit Controls Modernization (UCM) Digital Governor Conversion



PRIOR TO CHANGES

Mechanical Hydraulic Governor with Servo feedback based on cable and pulleys, flyballs for speed sensing, and many gears, springs, and levers for control.



AFTER CHANGES

Conversion to Digital Hydraulic Governor
Typical of 26 governors

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Unit Controls Modernization (UCM) Pilot Exciter Replacement



PRIOR TO CHANGES

Pilot Exciter with motor operated rheostats for automatic and manual voltage control.



AFTER CHANGES

New digitally controlled pilot exciter integrated into UCM control and protection

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Unit Controls Modernization Cost

- UCM total cost for 17 Hoover units is \$11M:
 - Equipment Contract Cost is \$5,211,674.07 (L&S contract)
 - Labor Cost is \$5,693,000.00 (including labor contract cost for installation; Hoover labor cost for design, integration, installation, testing and commissioning; and regional non-contract cost for procurement and inspection)

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Load Following Benefit from Unit Controls Modernization (UCM)

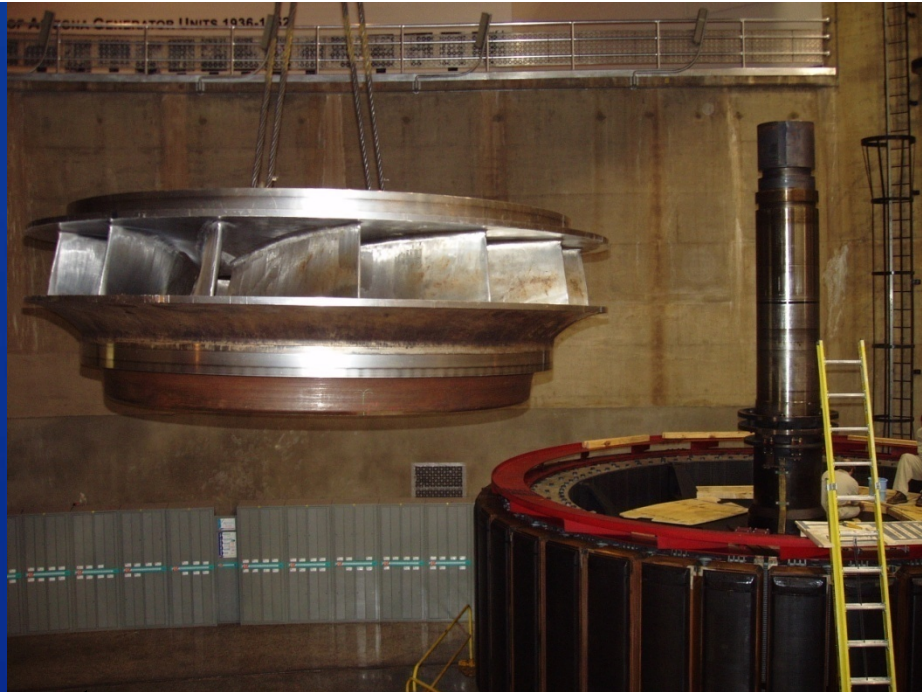
- UCM results in condensing 2 additional units compared to running these units at low loads.
 - Condensing a Hoover Unit results in an energy cost of 3 MW
 - Running a unit at low load results in a water power cost which results from water flow (325 cfs) used to spin a unit at rated speed. The flow of 325 cfs is equivalent to 10 MW of power.
 - The benefit from condensing 2 units compared to running the units at low load is \$2.3M per year per unit.
 - $7\text{MW} \times 75\% \text{ of the time} \times 2 \text{ units} \times 8760 \text{ hours} \times \35 per hour

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Wide Head Turbine Installation

- The primary goal of purchasing a Wide Head Turbine is to maintain the capability and value of regulation at Hoover as the Lake Mead elevation falls below 1100
- Installation of a Wide Head Turbine also creates a plan to insure that Hoover units are capable of operating if Lake Mead falls below elevation 1050

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Existing Turbine at Hoover



New Wide Head Turbine at Hyatt



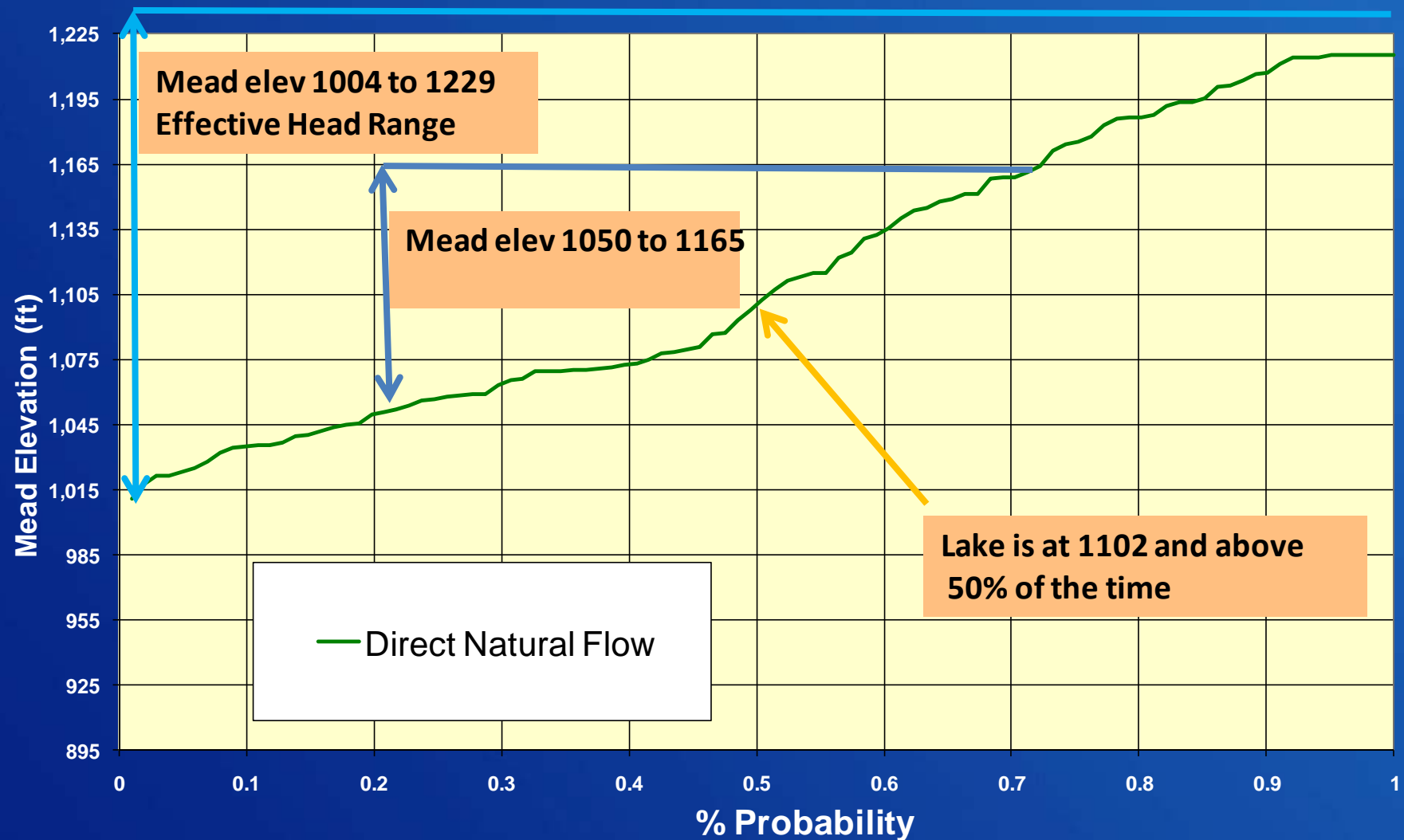
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Wide Head Turbine Project Update

- On 4/14/10, Hoover awarded a \$3.4 M contract for the purchase of a new “wide head range” turbine to replace the Unit N8 turbine.
- The new N8 turbine will be installed in March 2012.
- 3 Additional Turbines may be ordered if the new turbine performs as expected, and installations will be planned in 2014, 2015, and 2016. The additional turbines will cost \$8.16 M

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Lake Mead Elevation Probabilities and Wide Head Turbine Operating Ranges
CRSS Projection of Lake Mead Pool Elevation for December 31, 2025
Operations According to the Interim Guidelines



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In Closing -

- **Note: Lake Mead has never been below elevation 1083 since 1937.**
- **Elevations of interest to Hoover Operations:**
 - 1075.00 initiates shortage conditions
 - 1050.00 concerns for operating generating outside their performance curves
- **Reclamation continues to work with our power customers in identifying and completing major projects to recover plant generating capacity and efficiency in the face of a declining reservoir.**

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Questions?

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