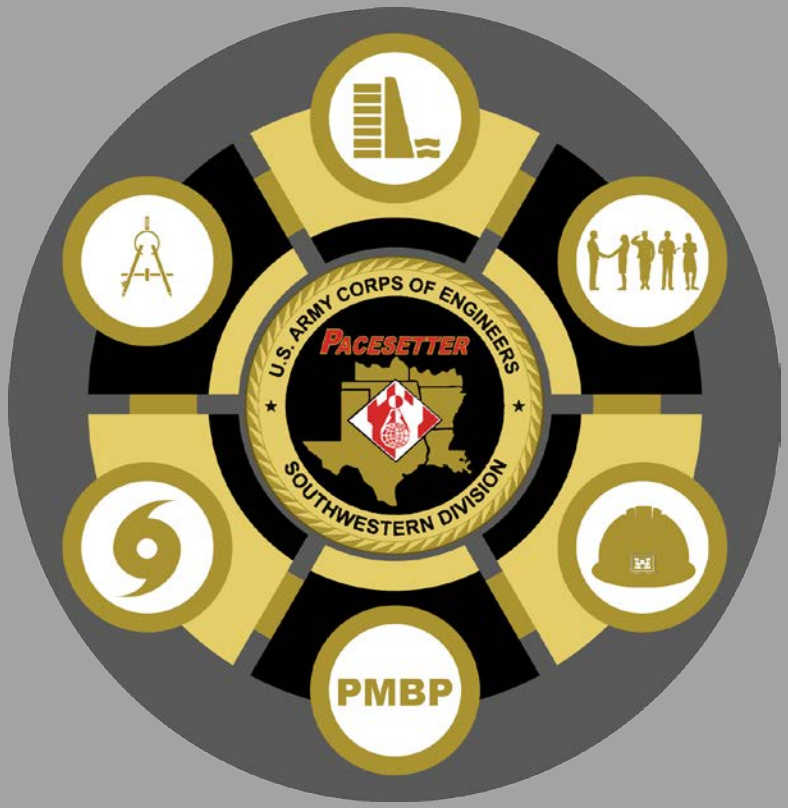
SWT HYDROPOWER PROGRAM OVERVIEW



Dan Brueggenjohann

Hydropower Capital Reinvestment Program and Project Manager

Programs and Project Management Div.

18 September, 2018

Discussion Topics

- Hydropower 101
- The Corps History in Hydropower
- Power Marketing Administrations (PMAs)
- Tulsa District Rehabilitation Projects
- Trends in the Hydropower Industry
- Hydropower Environment in the Future

US Army Corps of Engineers ®

U.S.ARMY

HYDROPOWER 101

- People have a long history of using the force of water flowing in streams and rivers to produce mechanical energy.

- Hydropower was one of the first sources of energy used for electricity generation and is the largest single renewable energy source for electricity generation in the United States.

- In 2017, hydroelectricity accounted for about 7.5% of total U.S. utility-scale electricity generation and 44% of total utility-scale electricity generation from renewable energy sources. Hydroelectricity's share of total U.S. electricity generation has decreased over time, mainly because electricity generation from other sources has increased.

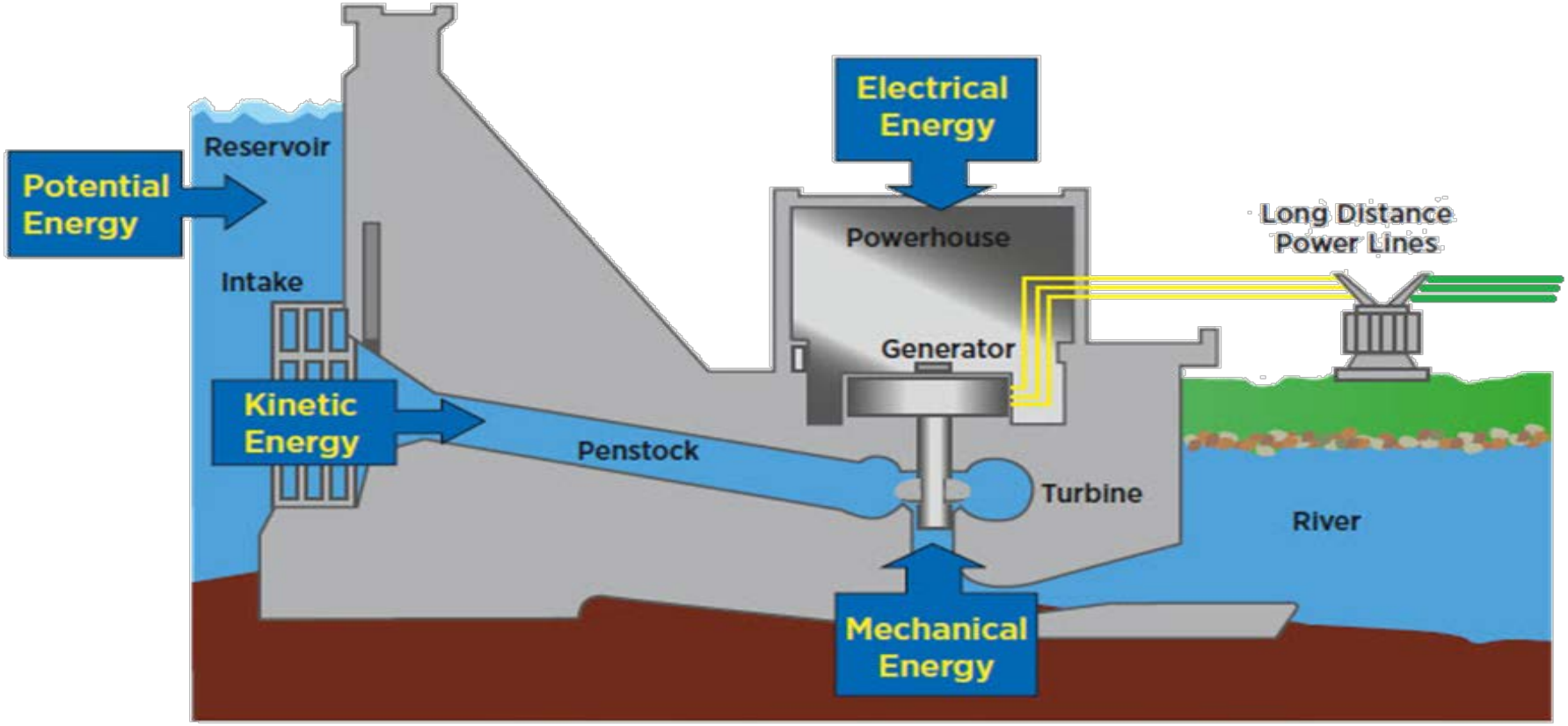
US Army Corps of Engineers ®

U.S.ARMY

NOTIONAL HYDROPOWER PLANT

The first law of thermodynamics, aka Law of Conservation of Energy, states that energy can neither be created nor destroyed; energy can only be transferred or changed from one form to another

Potential → Kinetic → Mechanical → Electrical →$$$$$

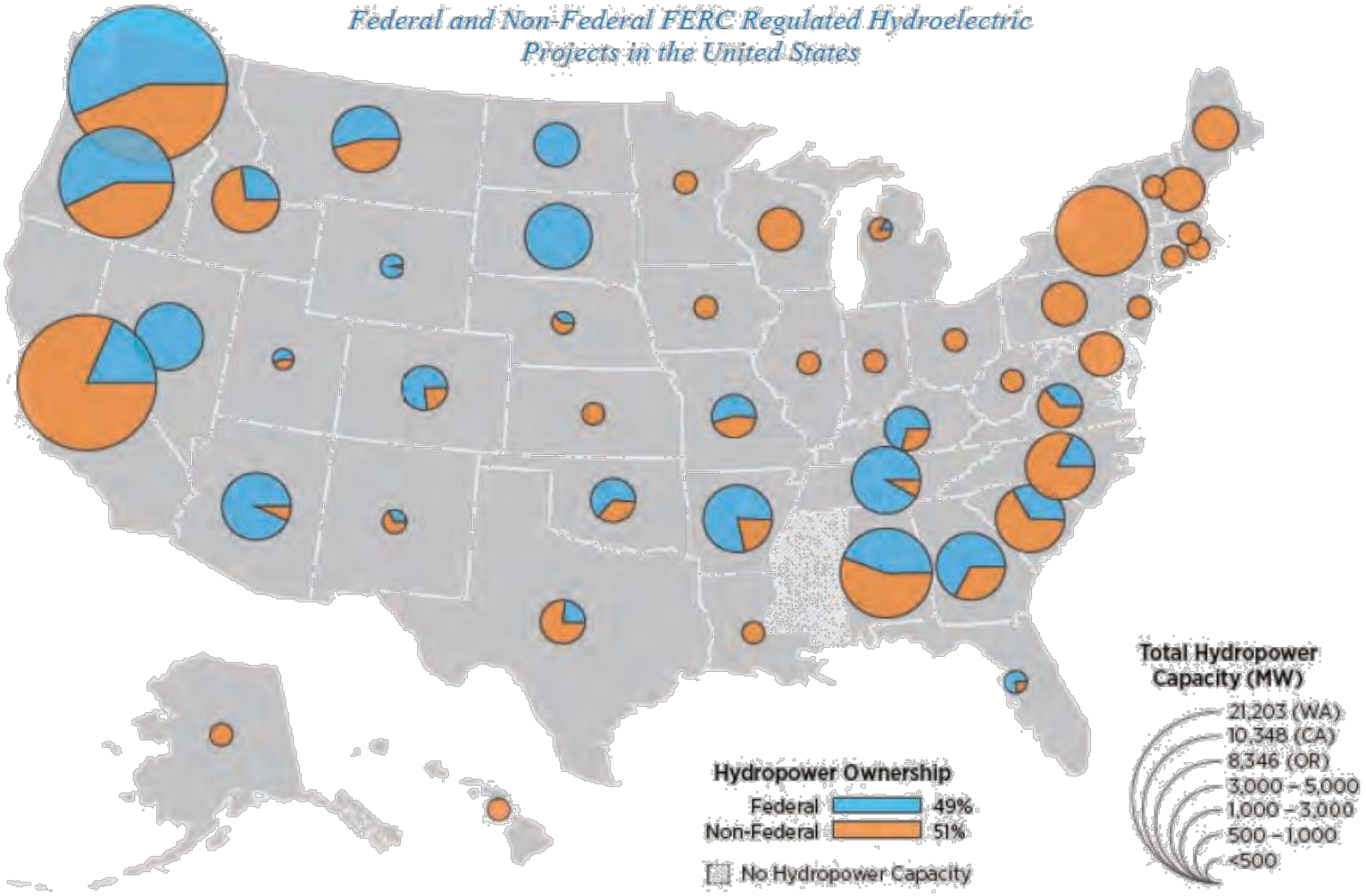


US Army Corps of Engineers ®

U.S.ARMY

NATIONAL HYDROPOWER

Federal and Non-Federal FERC Regulated Hydroelectric Projects in the United States



Source: U.S. Department of Energy, 2016

US Army Corps of Engineers ®

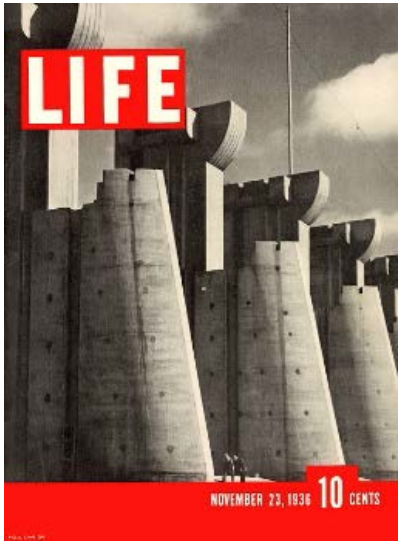
U.S.ARMY

USACE HYDROPOWER

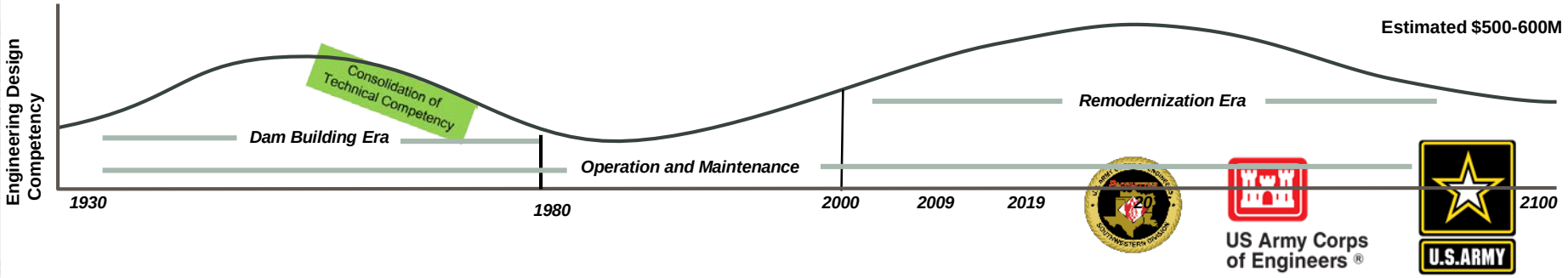
READY TODAY, WHILE SETTING THE CONDITIONS FOR FUTURE SUCCESS

– **1925 Rivers and Harbors Act**
USACE authorized to explore cost and feasibility of identifying navigable rivers for power generation

– **1934 Bonneville Dam, Columbia River**
First USACE project to include hydropower, 40 miles east of Portland, OR



Today
- 375 generating units at 75 dams
- 21,000 MW total capacity
- 25% of U.S. hydropower
- 3% of U.S total electric capacity
- 5th largest U.S. electric supplier
- 70 Billion KWH annually



POWER MARKETING AGNECIES (OUR PARTNERS IN HYDROPOWER)

USACE produces the power & works closely with all four DOE Power Market Administrations (PMA) across the country. PMAs have contracts to sell the power to customers, receive receipts, and send funds to the treasury.

Partners in the Hydropower Modernization Initiative

- **Southwestern Power Administration (SWPA)**
- **Southeastern Power Administration (SEPA)**
- **Western Area Power Administration (WAPA)**
- **Bonneville Power Administration (BPA)**

Bonneville POWER ADMINISTRATION

SEPA SouthEastern Power Administration

SOUTHWESTERN POWER ADMINISTRATION

Western Area Power Administration

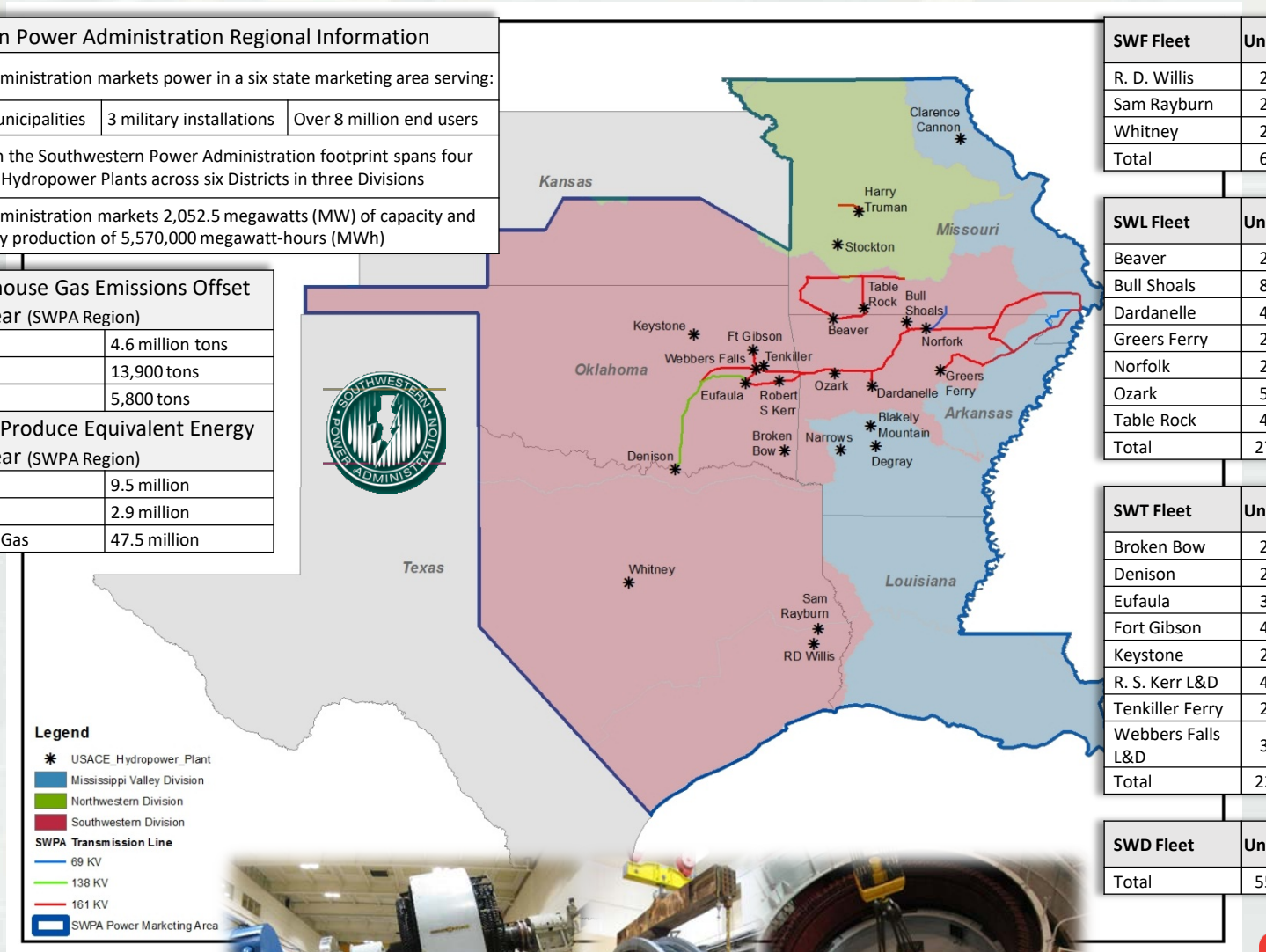
US Army Corps of Engineers ®

U.S.ARMY

Southwestern Power Administration Region

Southwestern Power Administration Regional Information			
Southwestern Power Administration markets power in a six state marketing area serving:			
21 cooperatives	78 municipalities	3 military installations	Over 8 million end users
USACE operations within the Southwestern Power Administration footprint spans four states and consists of 24 Hydropower Plants across six Districts in three Divisions			
Southwestern Power Administration markets 2,052.5 megawatts (MW) of capacity and an average annual energy production of 5,570,000 megawatt-hours (MWh)			

Estimated Greenhouse Gas Emissions Offset Per Year (SWPA Region)	
Carbon Dioxide	4.6 million tons
Sulfur Dioxide	13,900 tons
Nitrogen Oxides	5,800 tons
Estimated Fuel to Produce Equivalent Energy Per Year (SWPA Region)	
Barrels of Fuel Oil	9.5 million
or Tons of Coal	2.9 million
or Cubic Feet of Natural Gas	47.5 million



SWF Fleet	Units	Year	Capacity (MW)
R. D. Willis	2	1989	7.4
Sam Rayburn	2	1965	60
Whitney	2	1953	42
Total	6		109.4

SWL Fleet	Units	Year	Capacity (MW)
Beaver	2	1965	112
Bull Shoals	8	1953	340
Dardanelle	4	1965	140
Greers Ferry	2	1964	96
Norfolk	2	1944	80.5
Ozark	5	1973	100
Table Rock	4	1959	200
Total	27		1068.5

SWT Fleet	Units	Year	Capacity (MW)
Broken Bow	2	1970	100
Denison	2	1945	70
Eufaula	3	1965	90
Fort Gibson	4	1953	45
Keystone	2	1968	70
R. S. Kerr L&D	4	1971	110
Tenkiller Ferry	2	1954	39.1
Webbers Falls L&D	3	1974	60
Total	22		584.1

SWD Fleet	Units	Avg. Age	Capacity (MW)
Total	55	52	1762

U.S.ARMY

BUILDING STRONG®

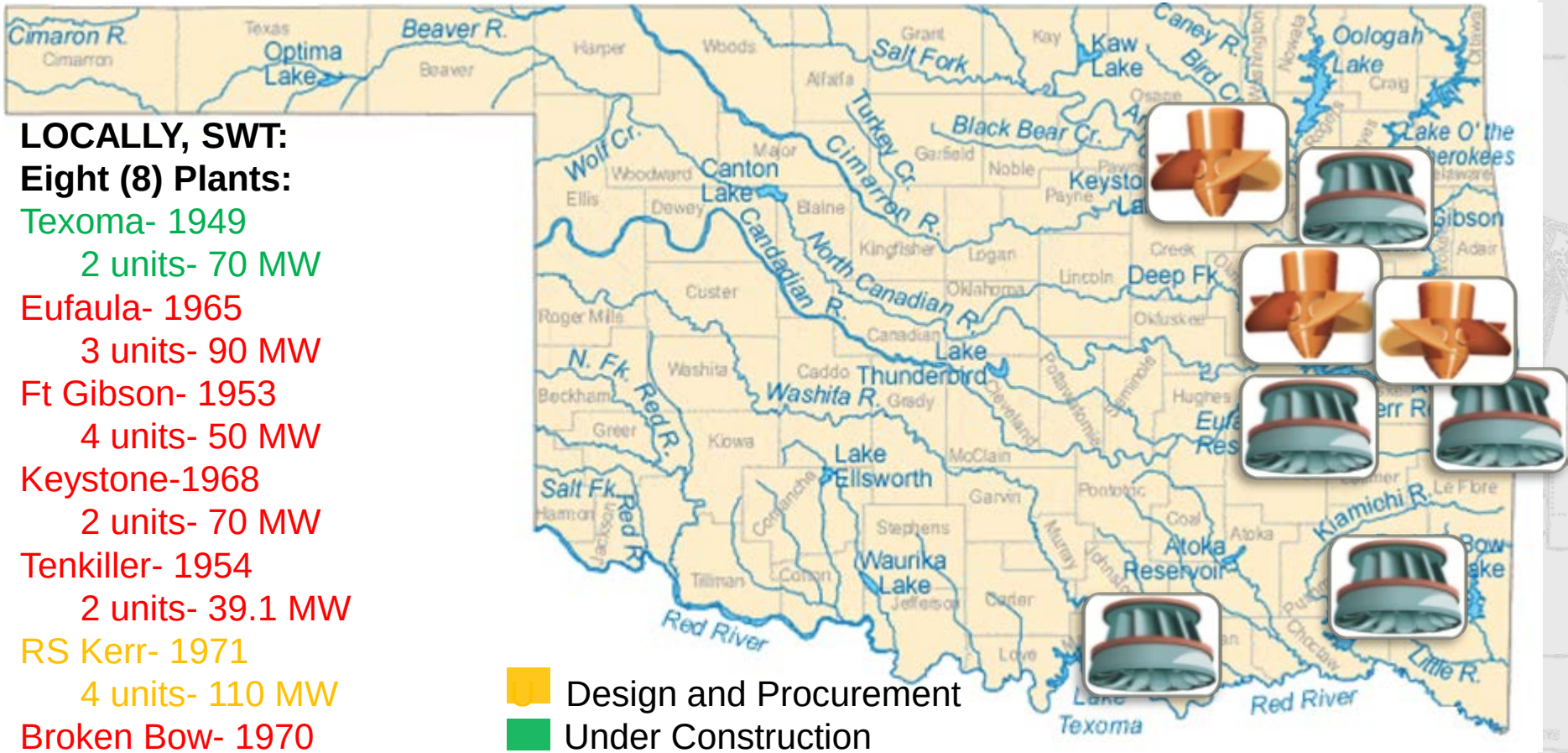
CUTOMER FUNDING PROCESS

- **A Memorandum of Agreement (MOA) was signed in 1999 by the USACE, Southwestern Power Administration, and the City of Jonesboro, AR (Southwestern Power Resource Association), to allow Southwestern customers to fund non-routine maintenance at Corps projects by diverting power receipts that would normally be returned to the treasury back to the power plant for rehabilitation.**
- **A collaboration among the hydropower customers, the Corps, and Southwestern allows the prioritization of maintenance to provide the greatest benefit.**
- **To date, 135 Sub-agreements have been executed to perform work in Tulsa District.**
- **The total amount approved for funding is approximately $360M.**

US Army Corps of Engineers ®

U.S.ARMY

Tulsa District Hydropower



LOCALLY, SWT:
Eight (8) Plants:

Texoma- 1949
- 2 units- 70 MW

Eufaula- 1965
- 3 units- 90 MW

Ft Gibson- 1953
- 4 units- 50 MW

Keystone-1968
- 2 units- 70 MW

Tenkiller- 1954
- 2 units- 39.1 MW

RS Kerr- 1971
- 4 units- 110 MW

Broken Bow- 1970
- 2 units- 100 MW

Webbers Falls- 1974
- 3 units- 60 MW

Approx. 600 Megawatts of capacity
Customers are Rural Electric Coops

- Design and Procurement
- Under Construction
- Planned Future Program

US Army Corps of Engineers ®

U.S.ARMY

HYDROPOWER PLANT REHABILITATION

1 Bridge Crane

2 Tailrace Crane

3 Intake Crane

4 Intake Roller Gates, Intake Bulkheads, Tailrace Bulkheads

5 Transformer

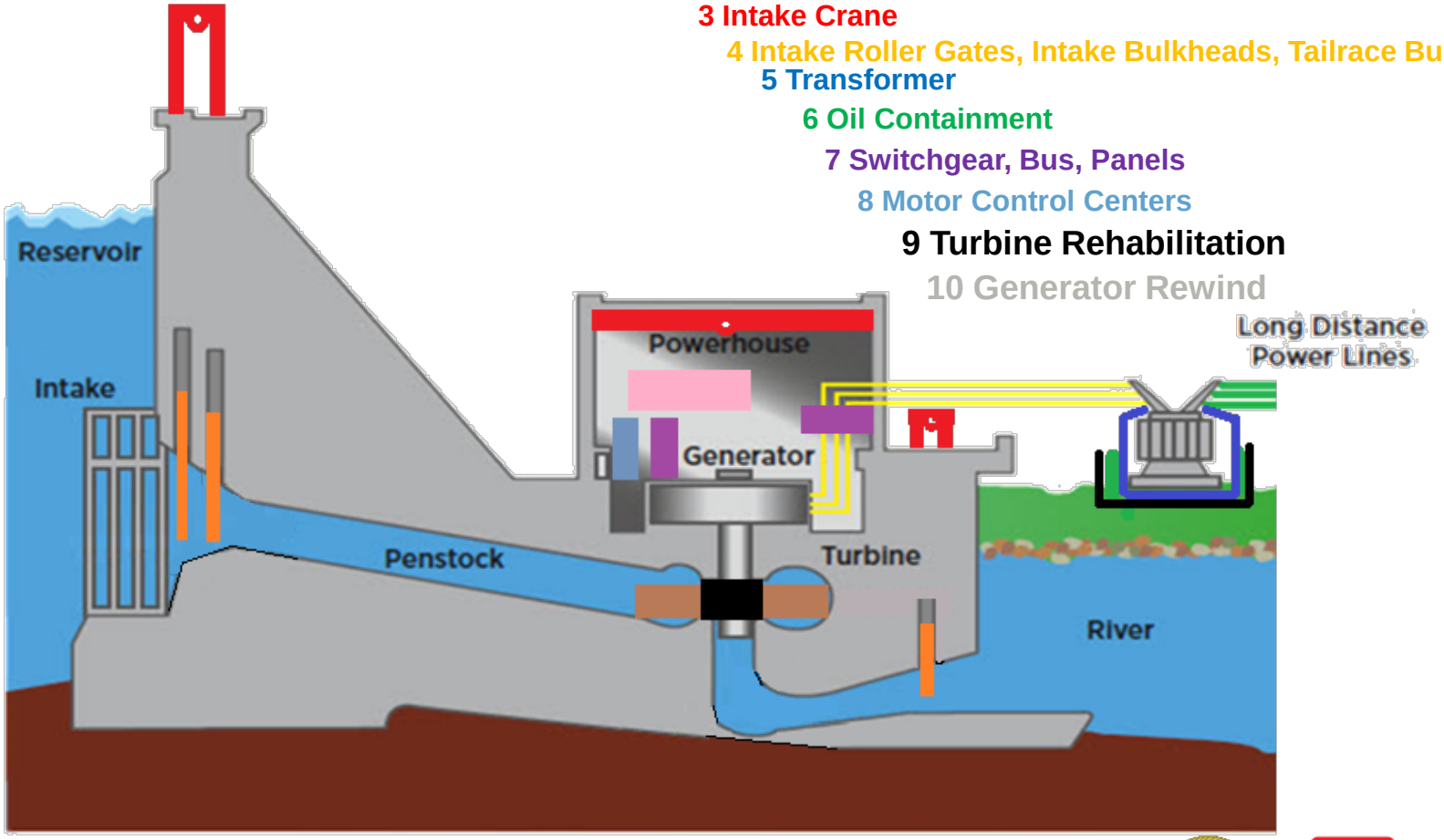
6 Oil Containment

7 Switchgear, Bus, Panels

8 Motor Control Centers

9 Turbine Rehabilitation

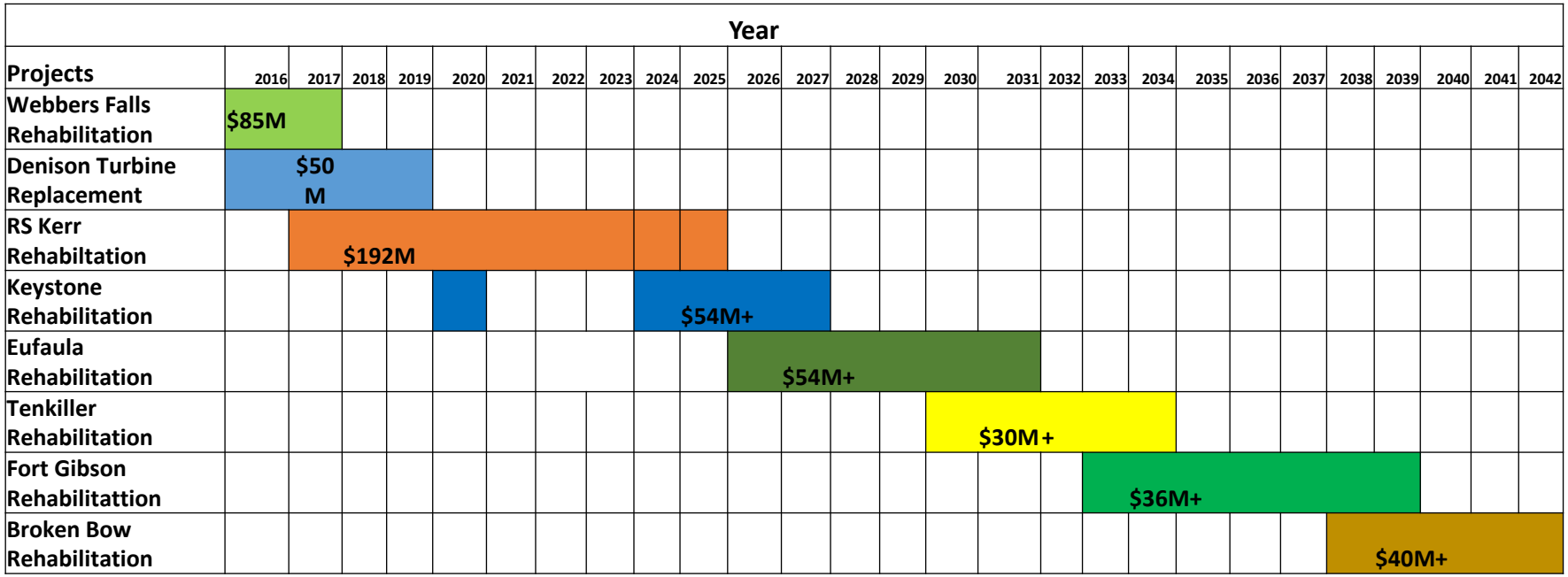
10 Generator Rewind



US Army Corps of Engineers ®

U.S.ARMY

TULSA DISTRICT TURBINE/GENERATOR PROJECTED TIMELINES AND PROGRAM ESTIMATE



Cost for turbine/generator; Does not include balance of plant.

US Army Corps of Engineers ®

U.S.ARMY

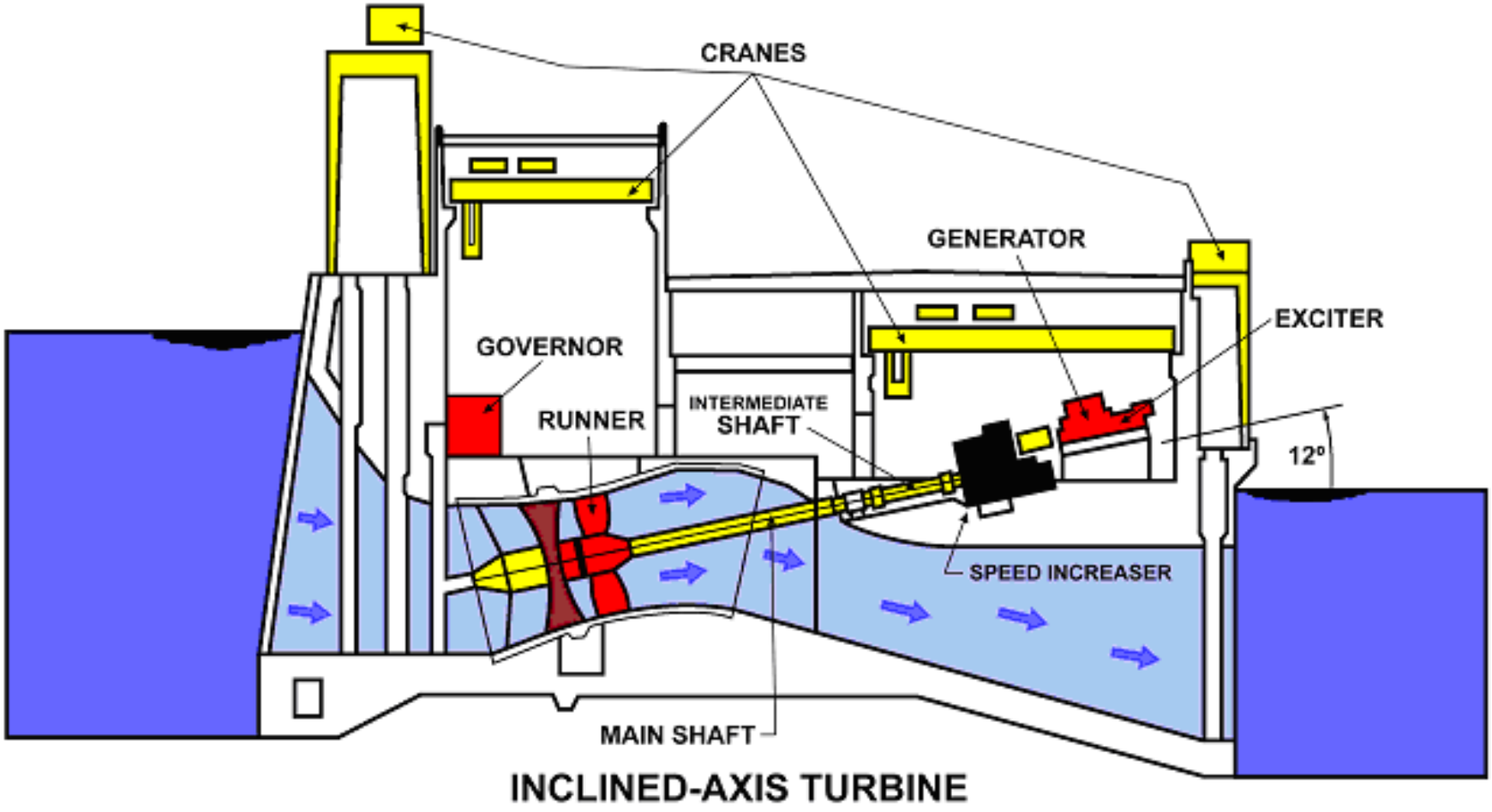
Webbers Falls Major Rehabilitation

- **Project Scope: Replace three turbines, rewind three generators and rehabilitate all cranes, tailrace and intake gates and bulkheads.**
- **Total Project cost, including turbines, generator, gates, cranes, governors and misc: $88.2M ($83.8M customer funded)**
- **2 MW per unit (8.5%) increase by up-rating.**
- **Anticipated Turbine Completion Date: 19 September 2018**
- **Commence Rewind of the last generator October 2018**

US Army Corps of Engineers ®

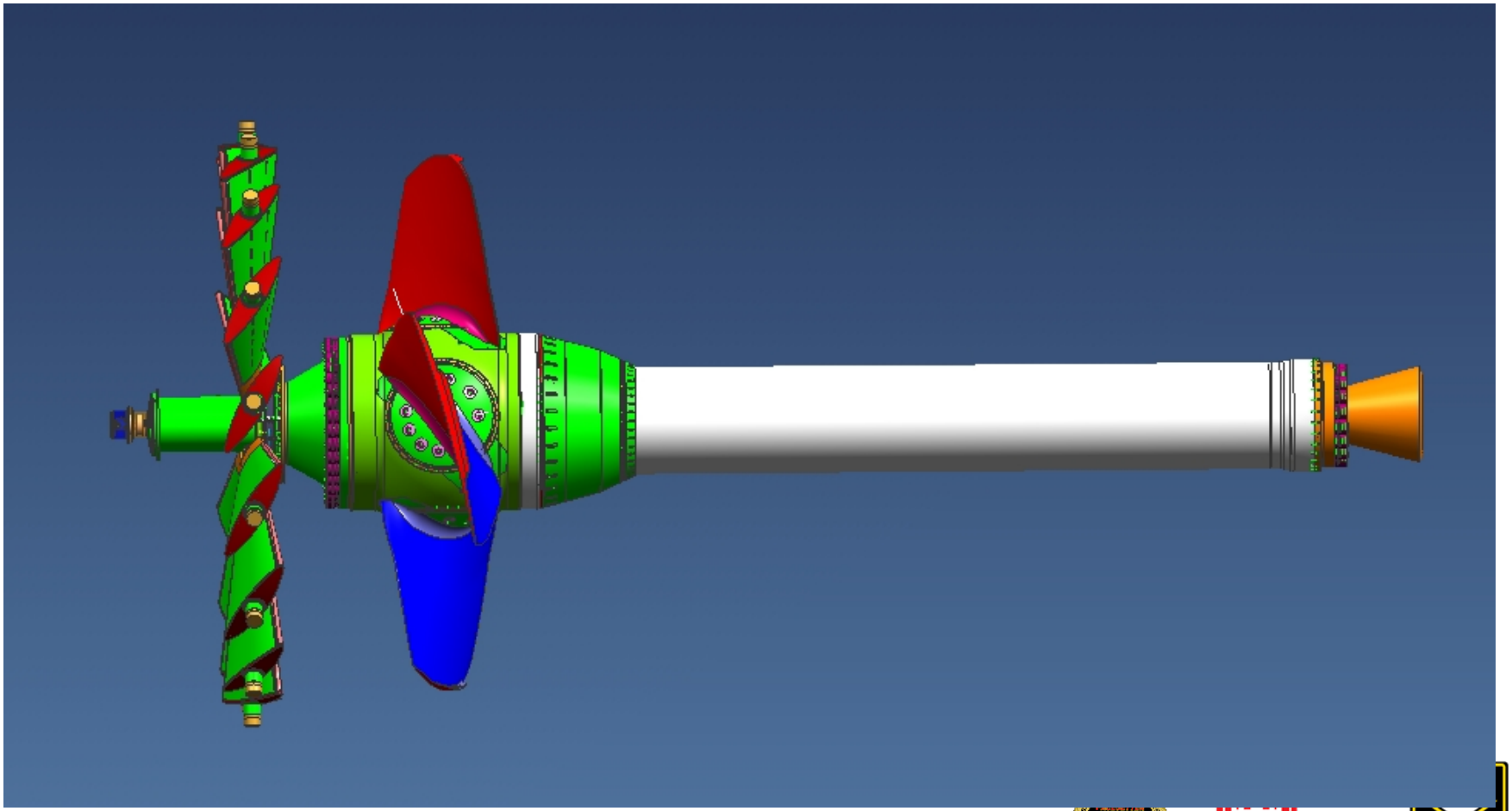
U.S.ARMY

POWERHOUSE CUTVIEW



INCLINED-AXIS TURBINE

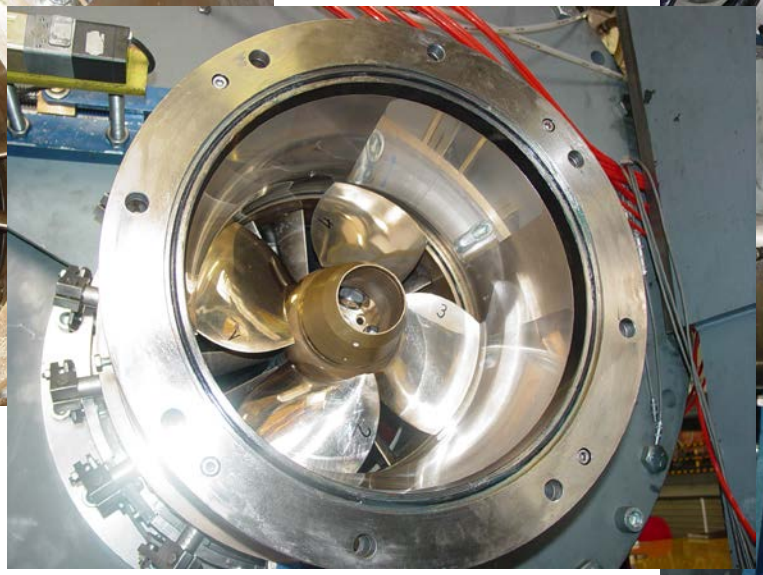
NEW RUNNER DESIGN

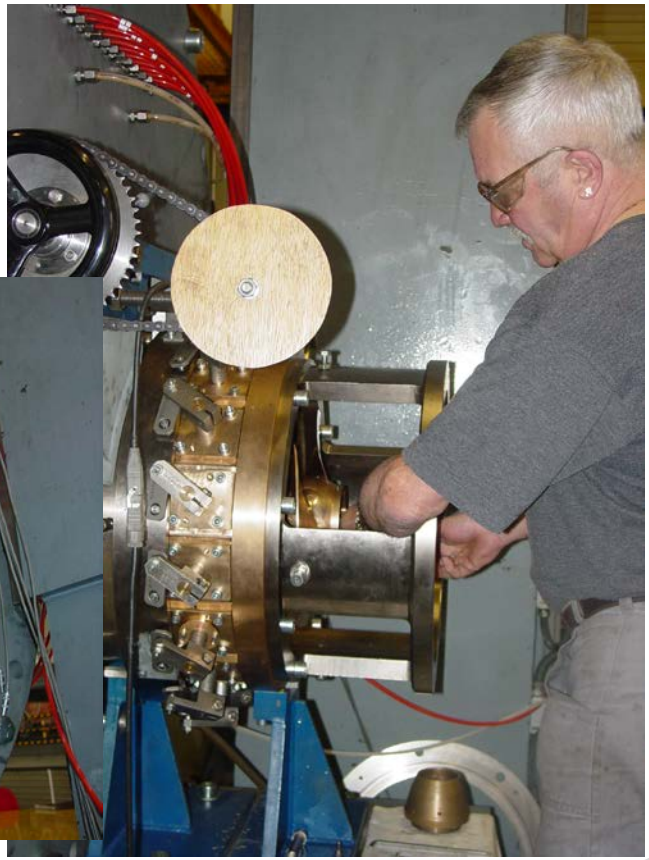


US Army Corps of Engineers ®

U.S.ARMY

MODEL TEST, AUSTRIA - 2006





KAPLAN RUNNER CONFIGURATION
OLD VS. NEW

US Army Corps of Engineers ®

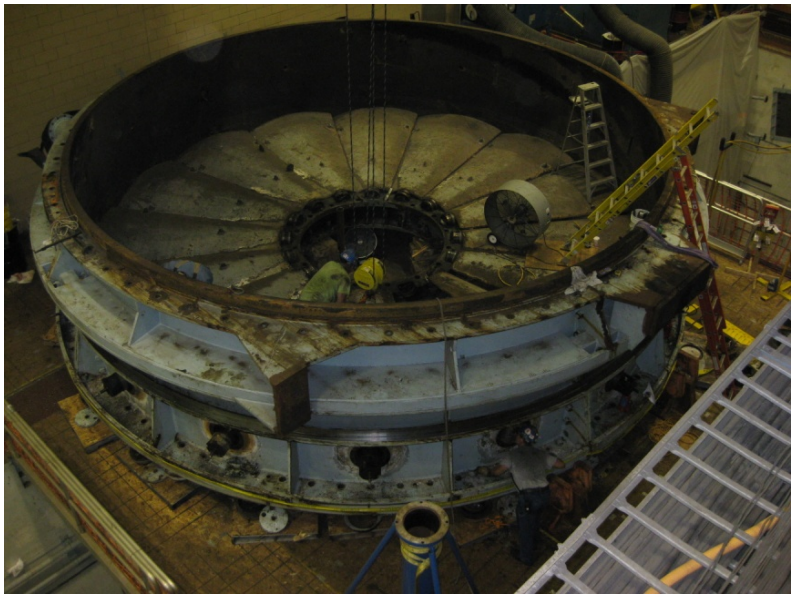
U.S.ARMY

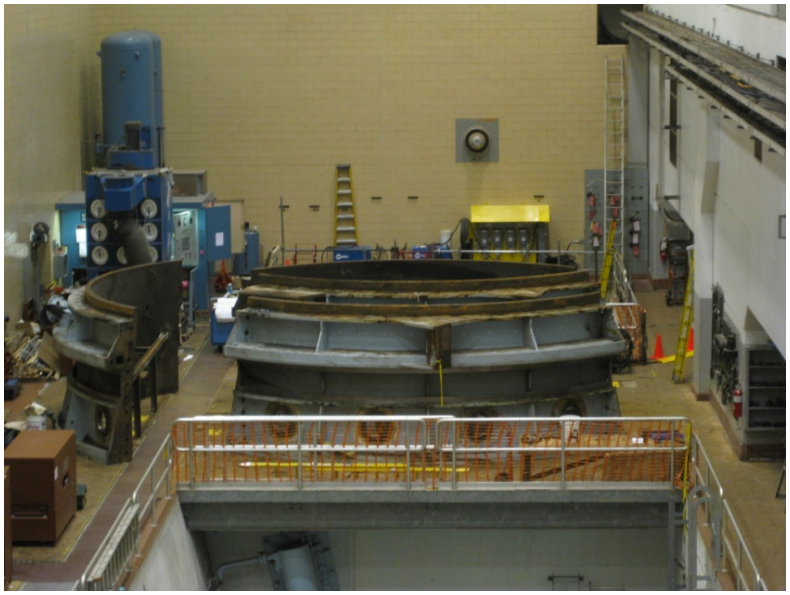
GATE BARREL REMOVAL

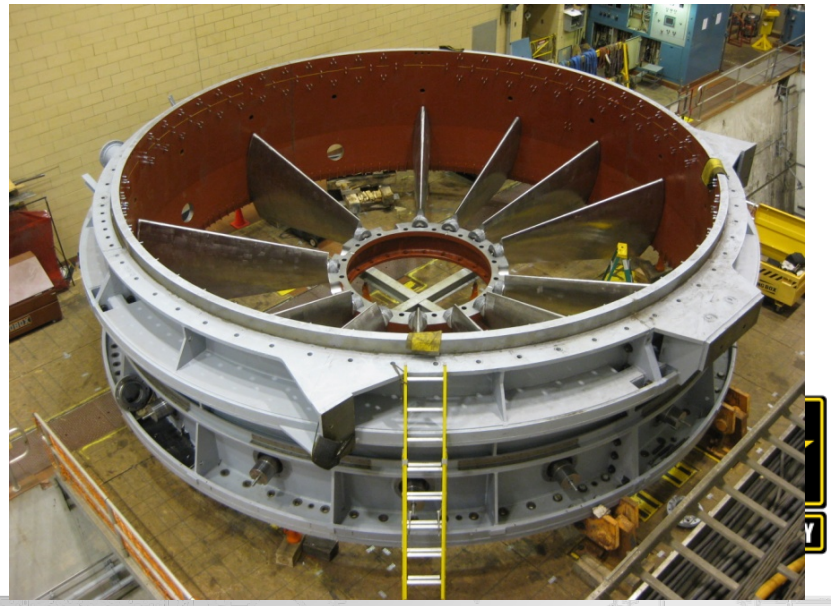
US Army Corps of Engineers ®

U.S.ARMY

WICKET GATES







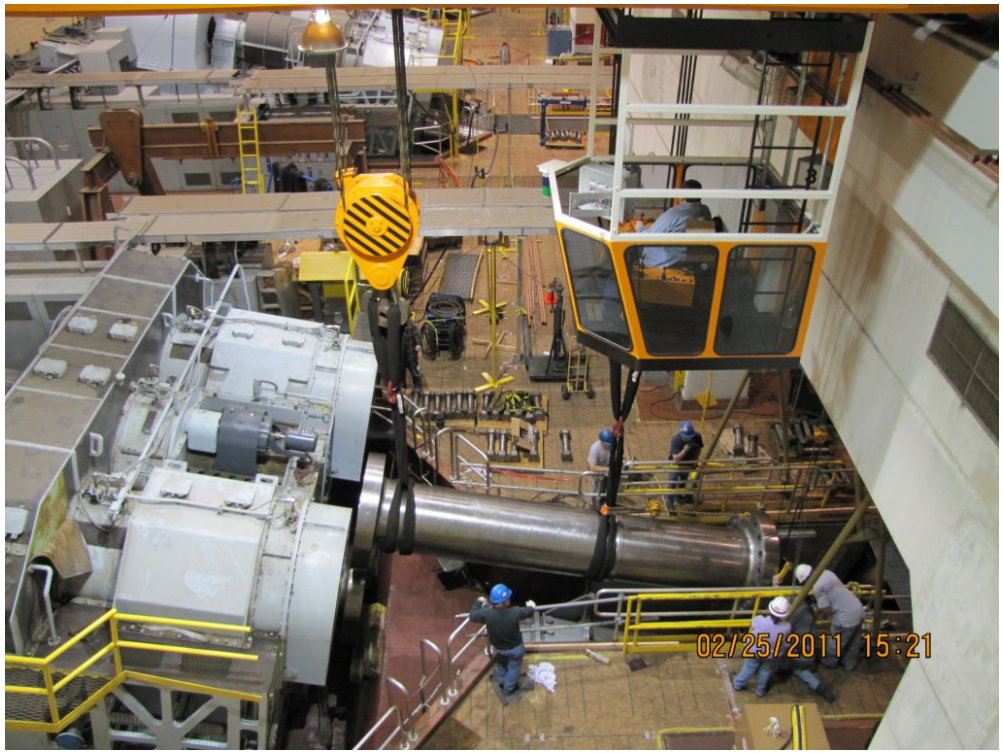
RUNNER INSTALLATION

LOWER MAIN SHAFT

US Army Corps of Engineers ®

U.S.ARMY

INTERMEDIATE SHAFT

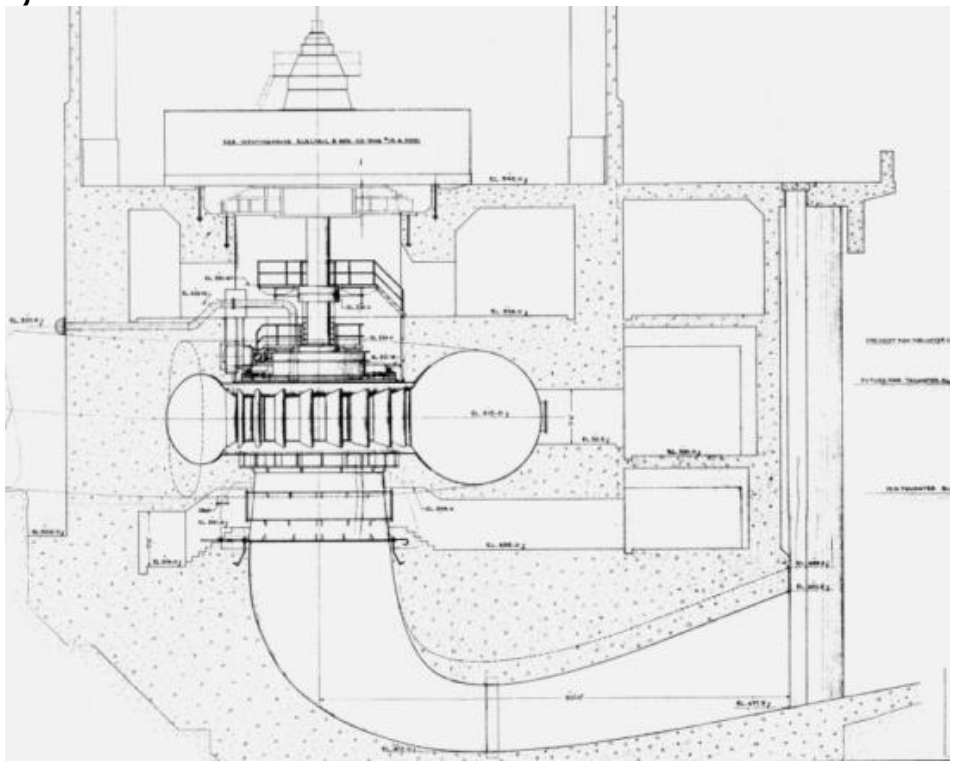


US Army Corps of Engineers ®

U.S.ARMY

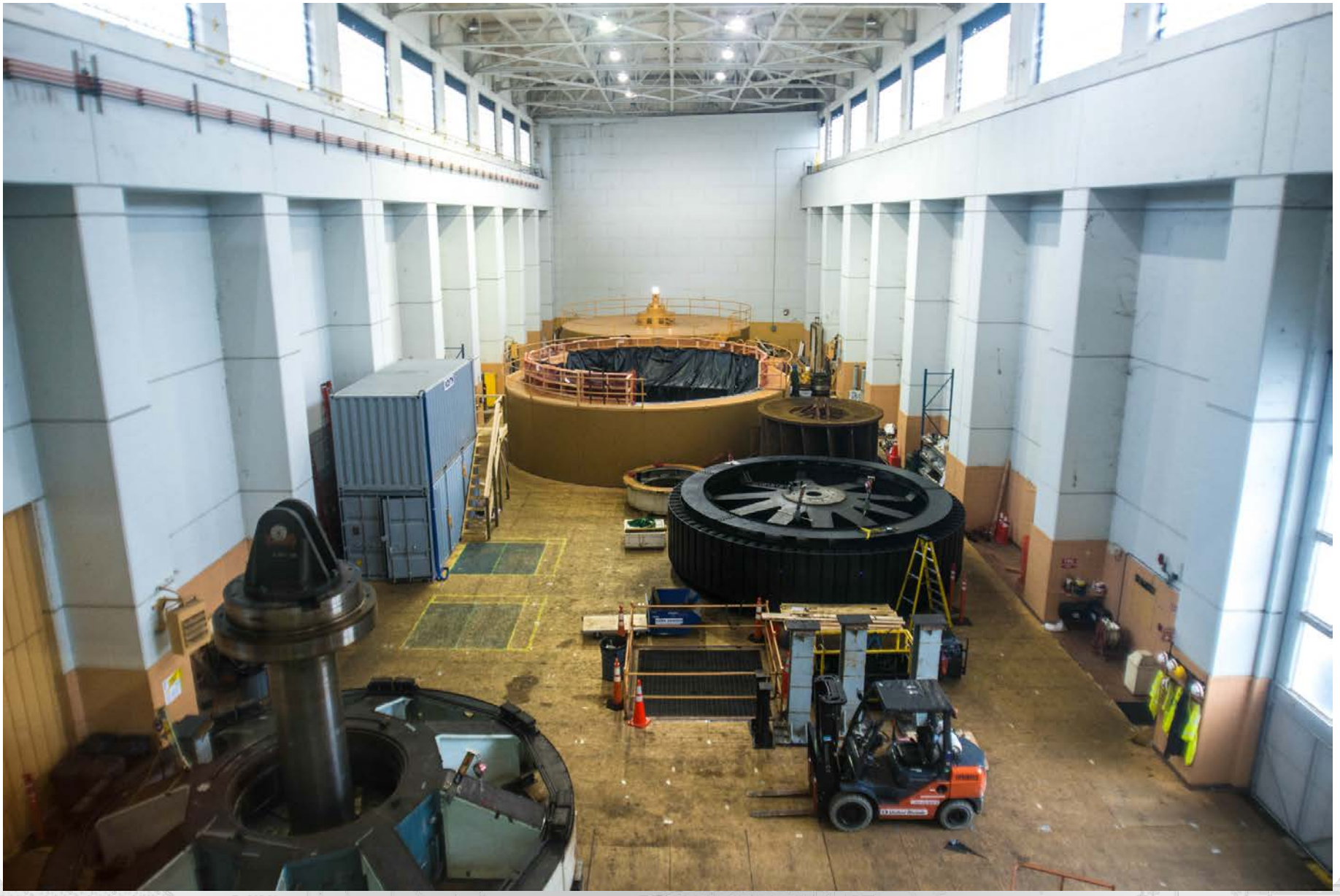
DENISON TURBINE REPLACEMENT SCOPE AND BUDGET

- **Project Scope: Replacement of two francis turbines, installation of new digital governors, gas insulated 3 phase transformers, switchgear, bus and rehabilitation of the bridge crane.**
- **Turbine efficiency increase from 40 MW to 50 MW**
- **Total Customer Funding - $50,295,000**

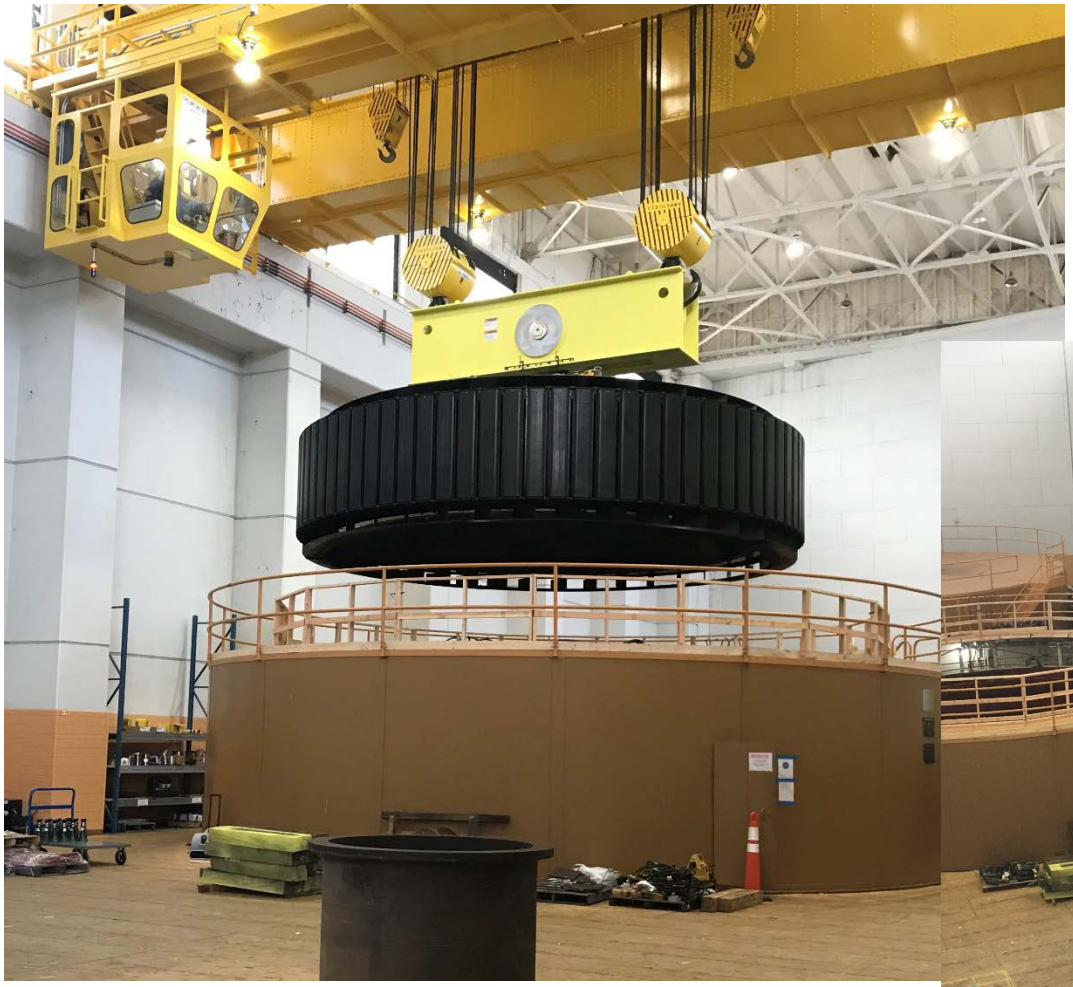


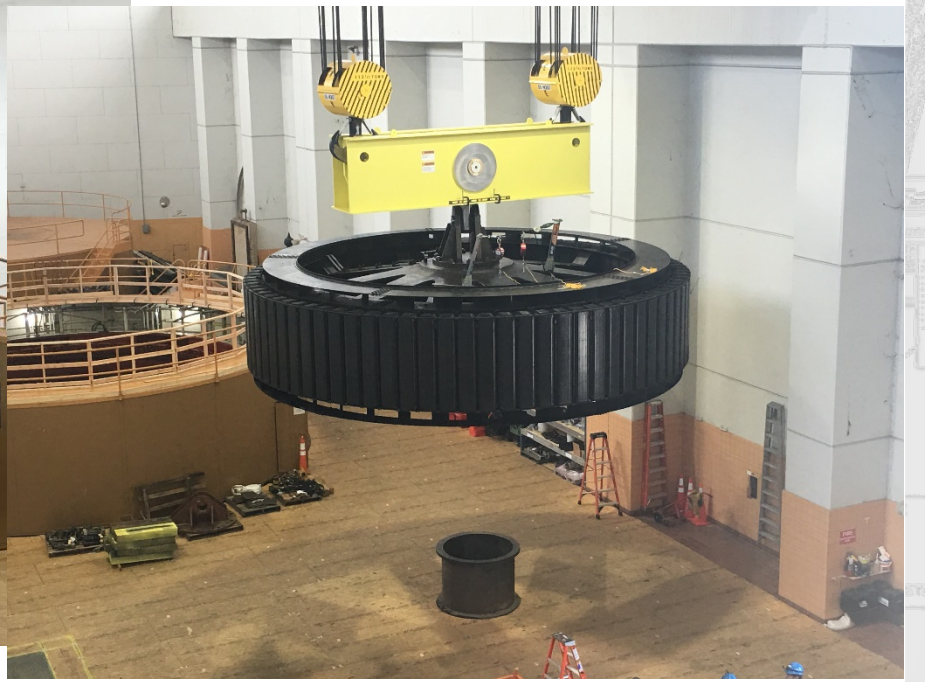
DENISON 1944 CONSTRUCTION

DENISON 2018 – TURBINE REPLACEMENT



Denison Rotor Removal

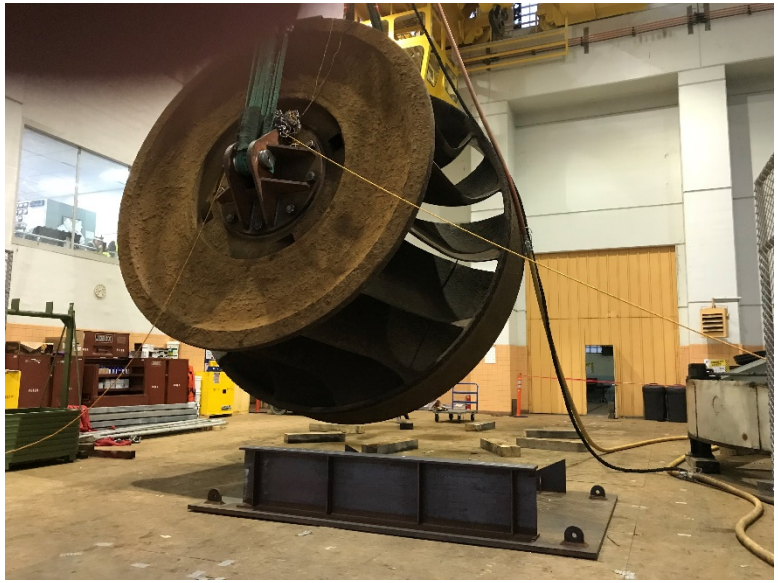




US Army Corps of Engineers ®

U.S.ARMY

Old Runner Removal/New Runner Delivery



of Engineers ®

U.S.ARMY

Removed on 2 Feb 2018

Inner Head Cover (Bearing Housing) Condition

US Army Corps of Engineers ®

U.S.ARMY

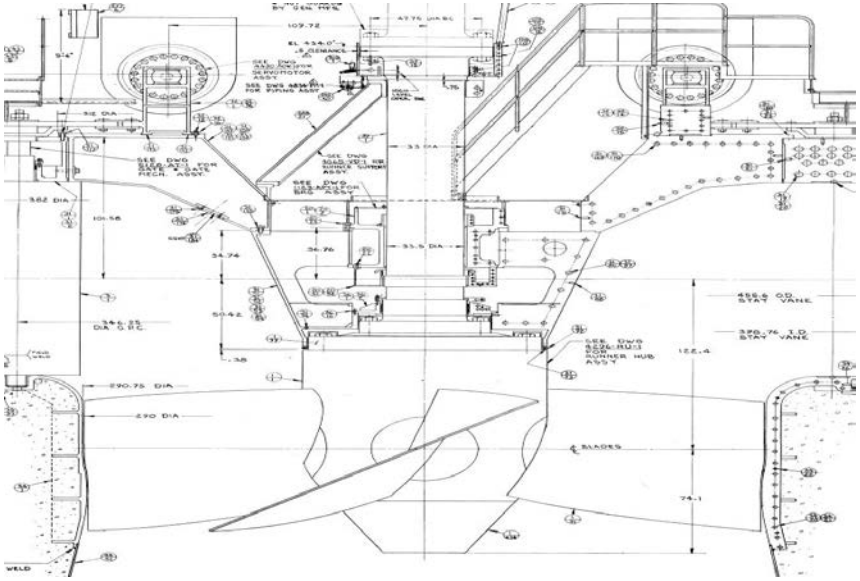
R. S. Kerr Major Rehabilitation

Scope, Cost and Agreements

- Replace four Kaplan turbines, rewind four generators, refurbish governors and exciters, rehabilitate bridge and intake crane, replace tail race crane, replace transformers, rehabilitate draft tube and roller gates and construct new roller gate and draft tube gates.
- Energy Output 36MVA/unit
- Total Project Cost: $192,144,000

R. S. Kerr Major Component Award Schedule

- New Draft Tube Crane Award – 6 Dec 2018
- Transformer Award – 2 Dec 2018
- Bridge Crane Rehab Award – 15 Dec 2018
- Modernization of Electrical Infrastructure Award – 28 Mar 2019
- New Gates and Bulkhead Award – 7 Mar 2019
- Exisiting Gates and Bulkhead Minor Repair Award – 7 Mar 2019
- Turbine & Generator Award – 26 Oct 2019



R. S. Kerr Turbine Generator Schedule

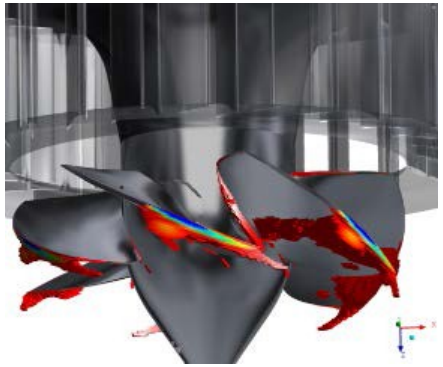
Turbine Generator Design Completion: 16 July 2018
Turbine Generator Contract Award: 26 Oct 2019
Model Test, Design, and Fabrication: Jan 2019 to Dec 2020
Unit 1 Construction Period: 26 Oct 21 to 26 Sep 2022
Unit 2 Construction Period: 26 Sep 2022 to 25 Oct 2023
Unit 3 Construction Period: 25 Oct 2023 to 24 Oct 2024
Unit 4 Construction Period: 24 Oct 2023 to 24 Oct 2025

US Army Corps of Engineers ®

U.S.ARMY

HYDRO TRENDS TODAY

- Unit and Plant optimization
- New Technologies/Digital Equipment
- Cyber Protection, GDACS/SCADA, Instrumentation for the Corps & Others
- Renewable Energy Integration
- Investing in Modernization/Rehabilitation of our Infrastructure



US Army Corps of Engineers ®

U.S.ARMY

THE HYDROPOWER ENVIRONMENT IN THE NEXT 30-50 YEARS

- High Certainty of increasing Large Capital Investment to Remodernize Corps' hydropower fleet.
- High value energy resource; Base, Peak, Voltage Support, Frequency Response/Regulation, major integrator of other renewables
- Increased Emergency Response, Aging Fleet, Forced Outages, Trouble shooting, Emergency Repairs, Forensics
- SCADA & Industrial Control System Emerging Requirements, Compliance and Reliability burden, cyber security assurance

US Army Corps of Engineers ®

U.S.ARMY

Questions ?

US Army Corps of Engineers ®

U.S.ARMY