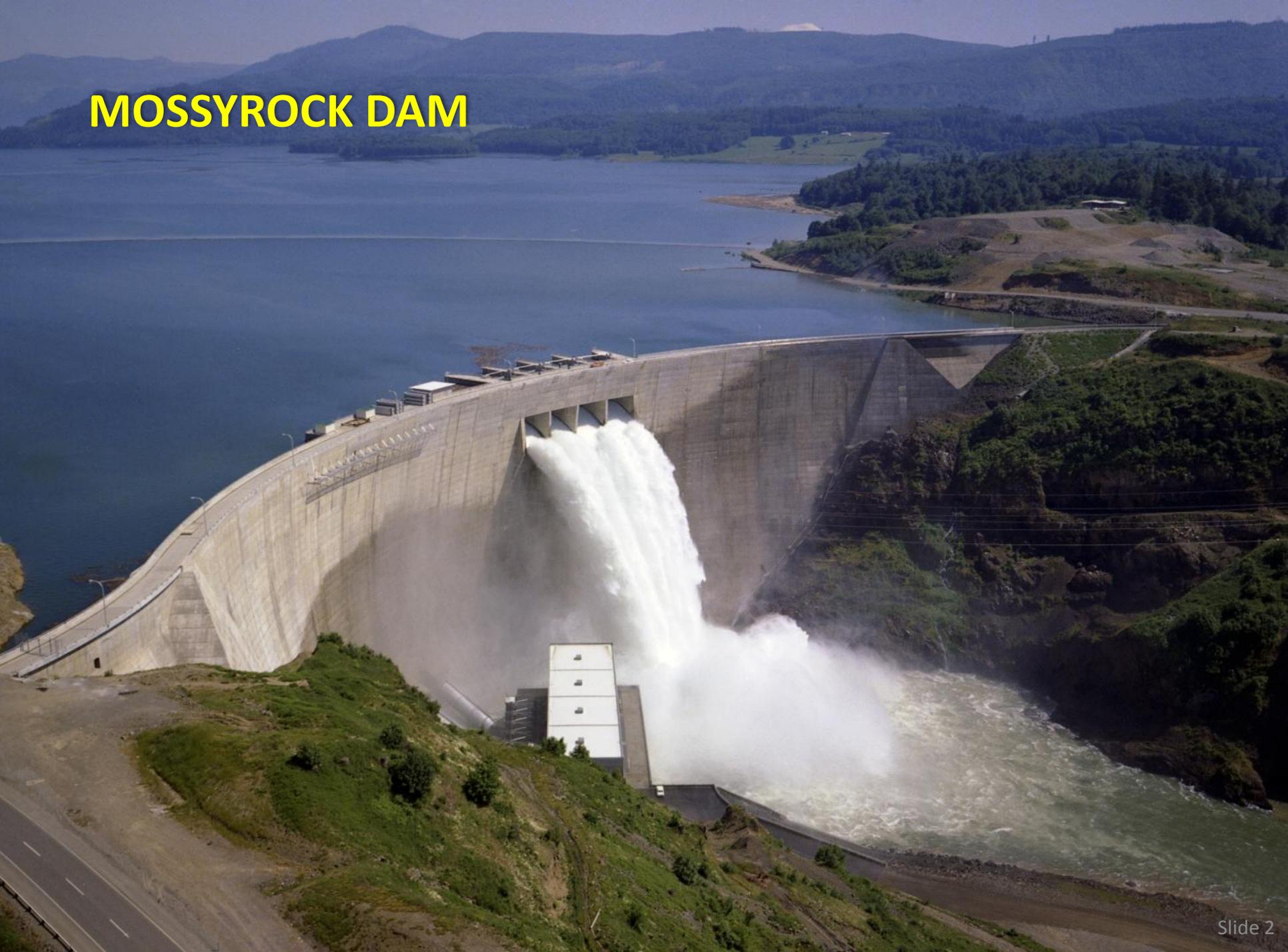


# UPGRADES AT MOSSYROCK POWERHOUSE

MARK HAMMER  
TACOMA POWER



# MOSSYROCK DAM





# SCOPE OF WORK

- 1. SITE PREPARATIONS & CRANE TESTING**
- 2. TURBINES**
- 3. GENERATORS**
- 4. GOVERNORS**
- 5. EXCITERS**
- 6. GSUs & ISO-PHASE**
- 7. PLANT CONTROL SYSTEM**
- 8. HAZARDOUS MATERIALS REMOVAL**

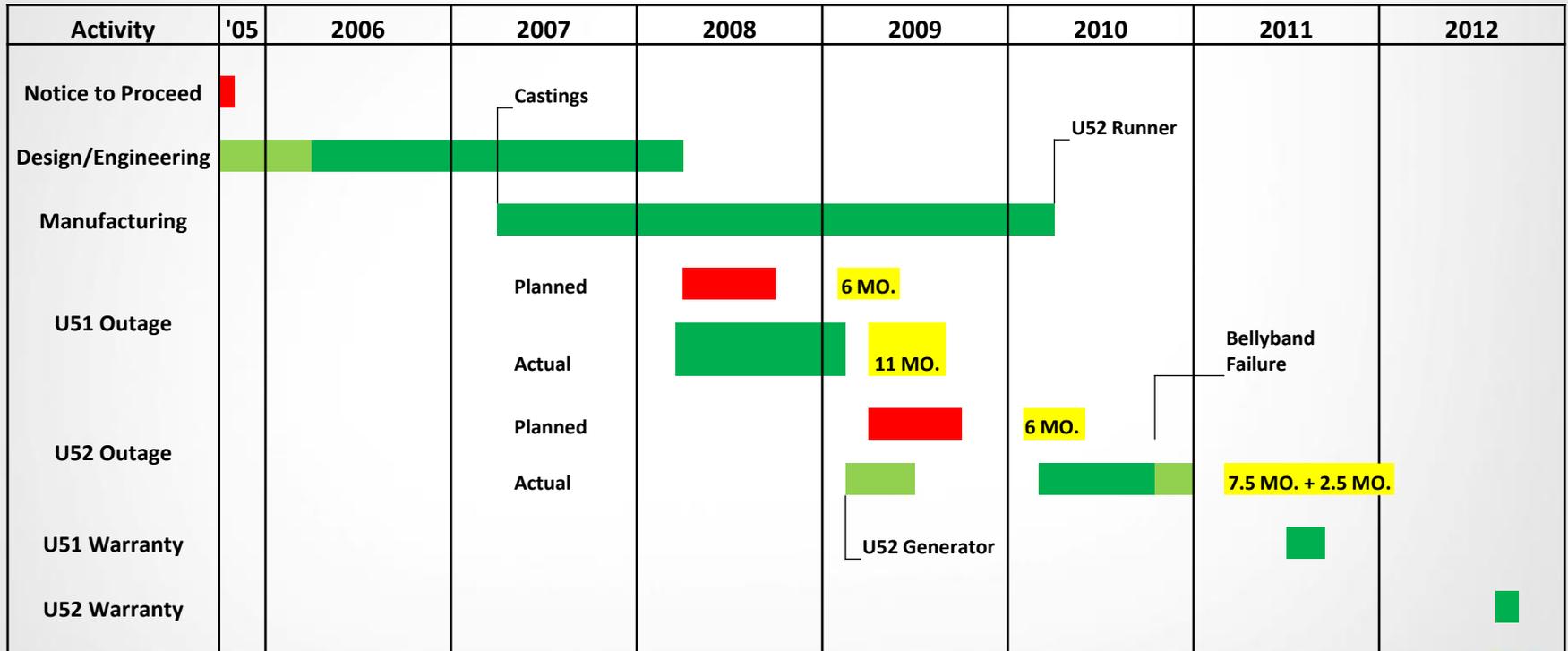


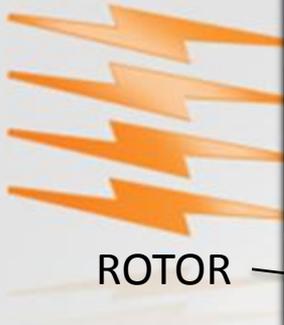
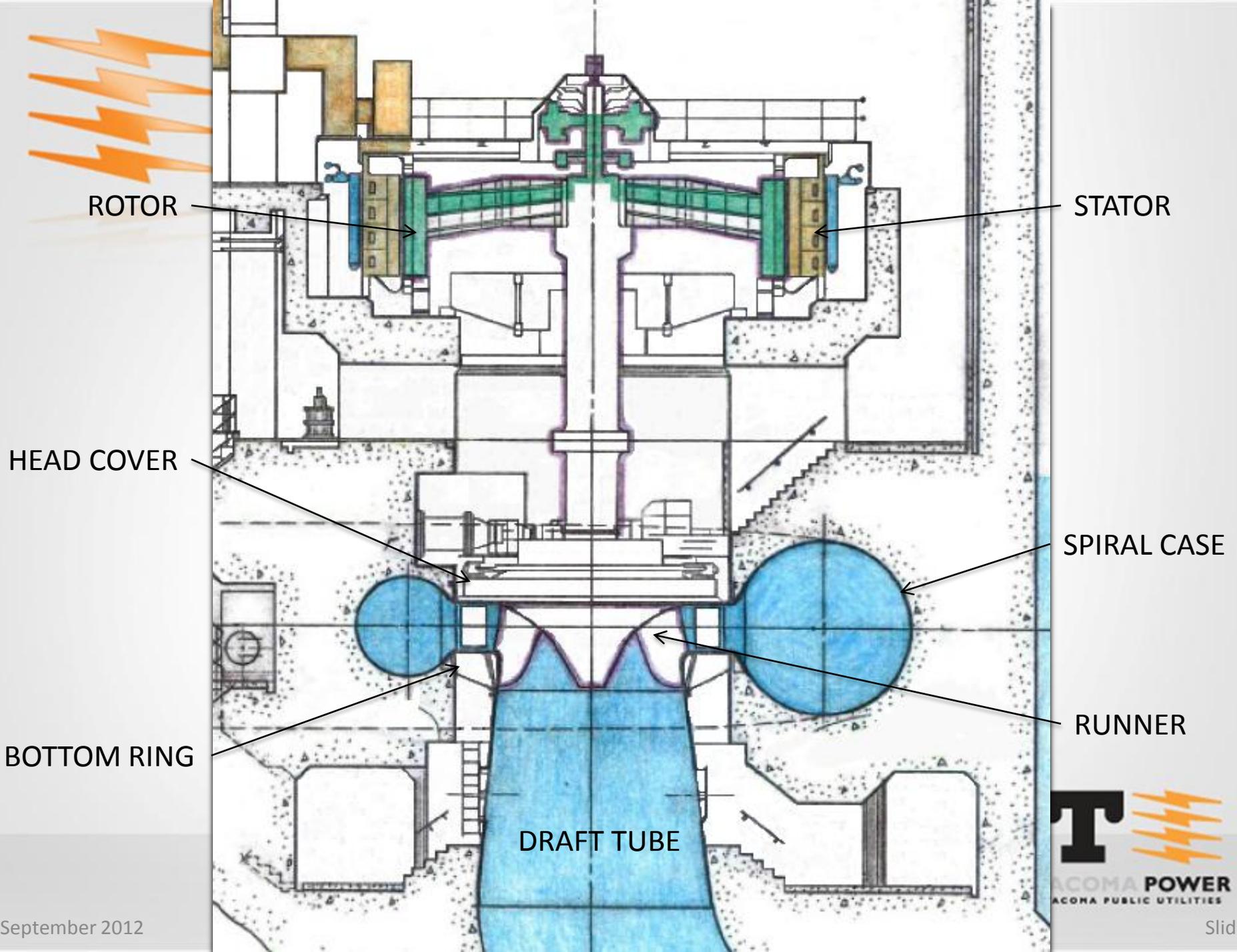
# COST OF REBUILD

DESCRIPTION	COST
TURBINES / GENERATORS / EXCITERS / GOVERNORS	\$39.1M
GSUs	\$11.4M
ISO-PHASE	\$1.0M
SITE PREPARATIONS	\$2.4M
AUTOMATION & CONTROLS	\$7.1M
TOTAL	\$61.0M



# TIMELINE







# FIELD MACHINING BOTTOM RING





# RUNNER



# GENERATOR PIT DEMOLITION



WINDING  
TRENCH

# STATOR LIFT



LIFTING  
BEAMS

STATOR  
ASSEMBLY



# CHALLENGES

- **GE-to-ANDRITZ TRANSITION**
- **SHOP WORKMANSHIP**
- **DESIGN ISSUES**
- **U51 ROUGH ZONE & AIR ADMISSION**
- **U52 BELLYBAND FAILURE**
- **TIME CONSTRIANTS**
- **WARRANTY ITEMS**



# REBUILD DETAILS

- **MODEL TESTING**
- **WICKET GATE SEALING SYSTEMS**
- **WICKET GATE STEM SEALS**
- **WICKET GATE THRUST WASHERS**
- **AIR ADMISSION**



# TURBINE/RUNNER HIGHLIGHTS

## ➤ TWO (2) RUNNER DESIGNS

- WINTER UNIT (Lower Head, Higher Flow)
- SUMMER UNIT (Higher Head, Lower Flow)

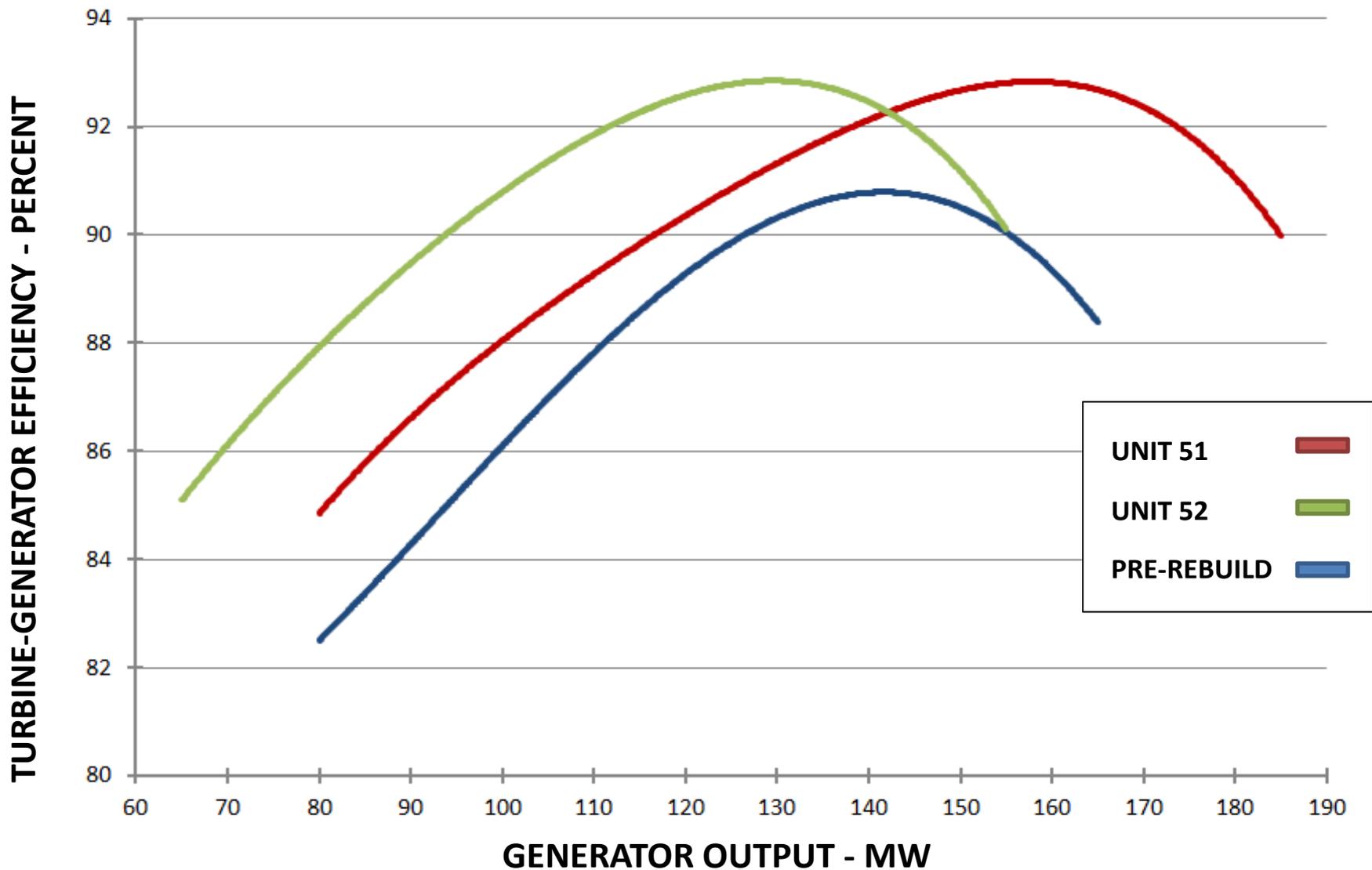
## ➤ MODEL TESTING

- CFD NEEDED REFINEMENTS (U51)
- ROUGH ZONE DIDN'T APPEAR IN MODEL (U51)
- AIR ADMISSION HAD OPPOSITE AFFECT IN MODEL

## ➤ RUNNER PASSIVATION (U52)

## ➤ RUNNER PERFORMANCE

# EFFICIENCY @ 310 FT





# UNIT PERFORMANCE SUMMARY

## ➤ INCREASED RANGE OF OUTPUTS

- Higher Top End (U51 – Winter Unit)
- Lower Low End (U52 – Summer Unit)
- **350MW** (Pre-Rebuild) / **375MW** (Post-Rebuild) @ Max Pool

## ➤ IMPROVED EFFICIENCIES

## ➤ REDUCED WICKET GATE LEAKAGE

- U51 – **90 cfs** to **7 cfs**
- U52 – **90 cfs** to less than **5 cfs**

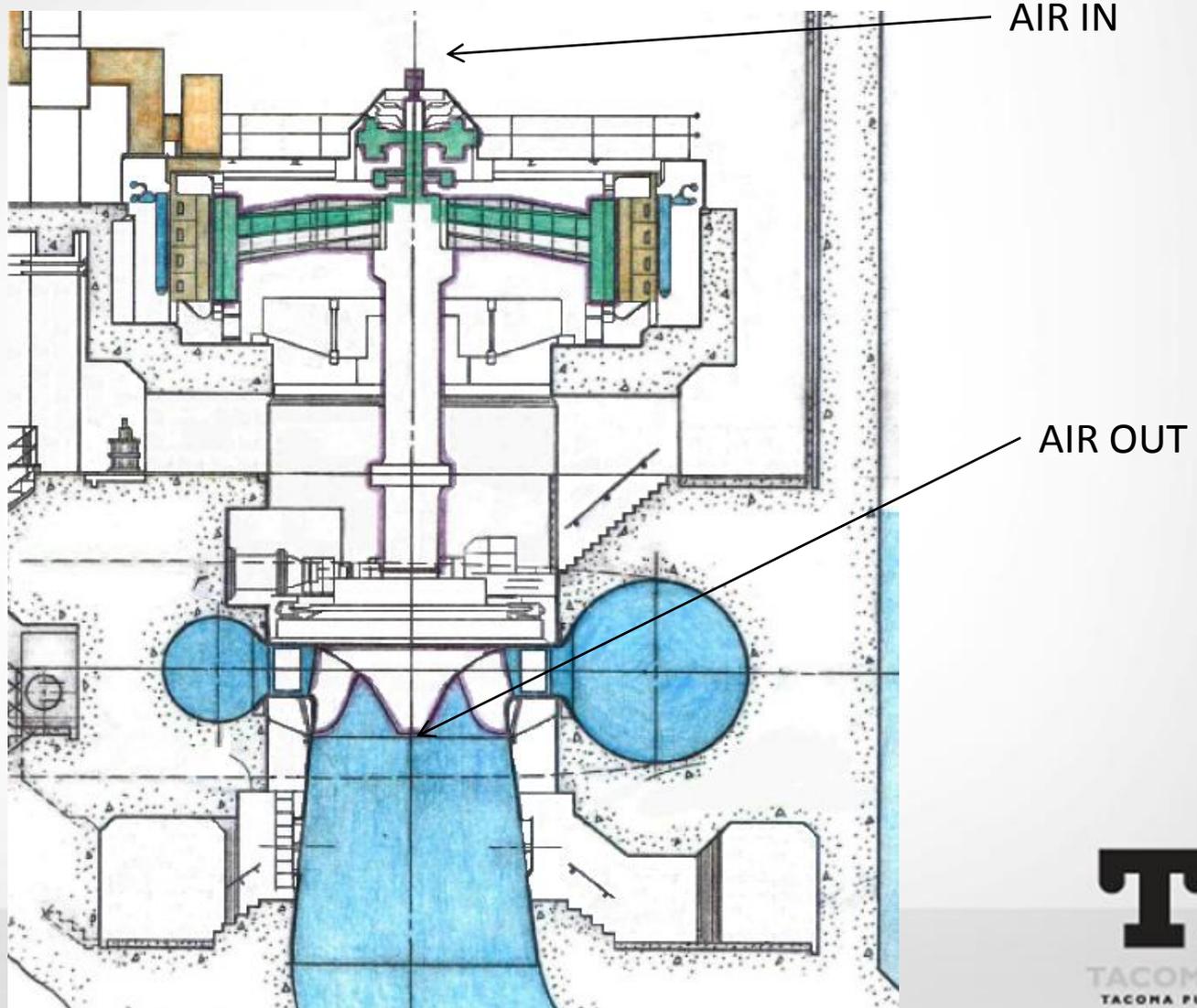
## ➤ IMPROVED CAVITATION BEHAVIOR



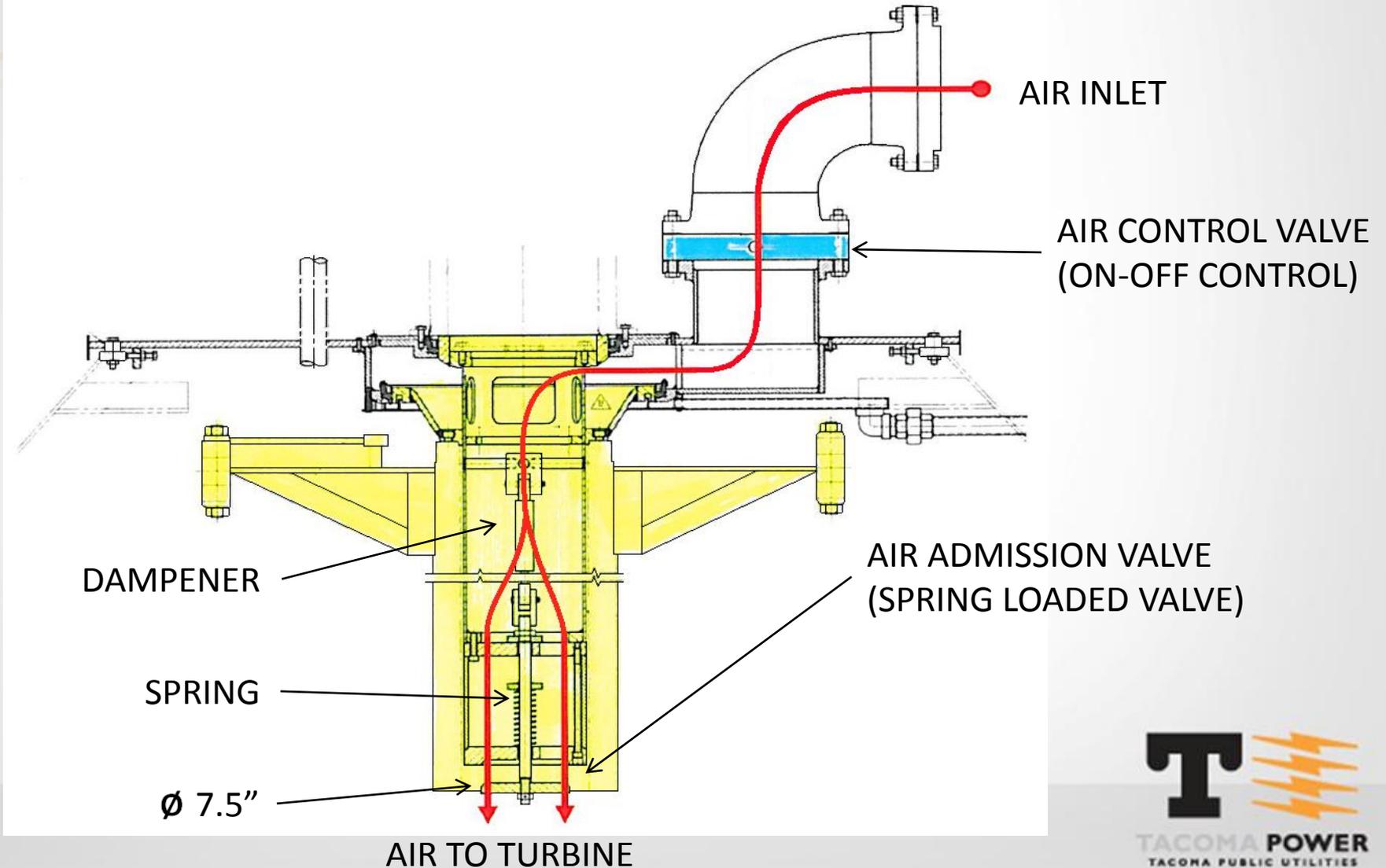
# DESIGN DETAILS & ISSUES

- **ROUGH ZONE & AIR ADMISSION**
- **WG END SEALS**
- **WG STEM SEALS**
- **WG THRUST WASHERS**
- **SERVO CLEVIS REPAIRS**
- **FIELD POLE BELLYBANDS**

# AIR ADMISSION DETAILS



# AIR ADMISSION SYSTEM

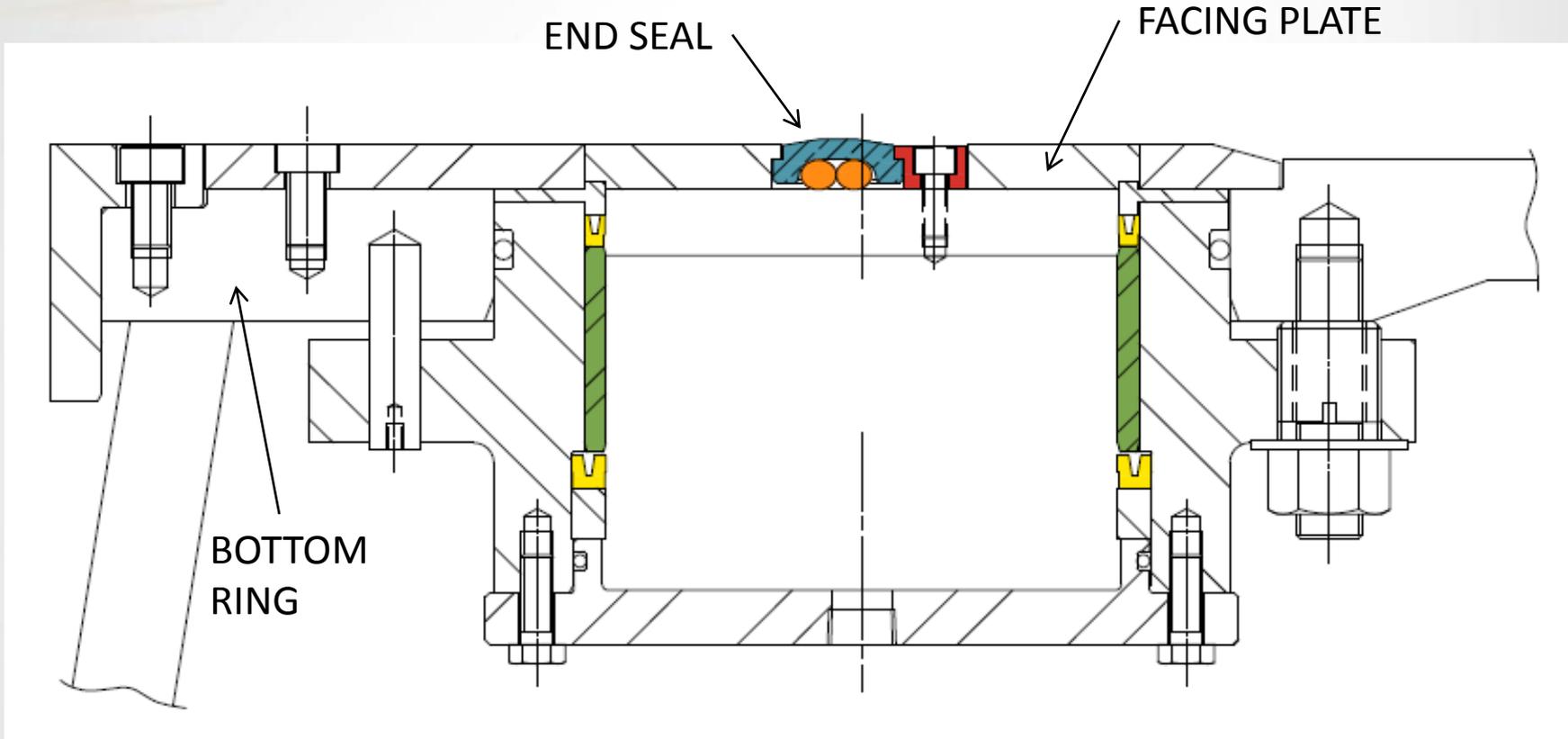


# AIR ADMISSION VALVE

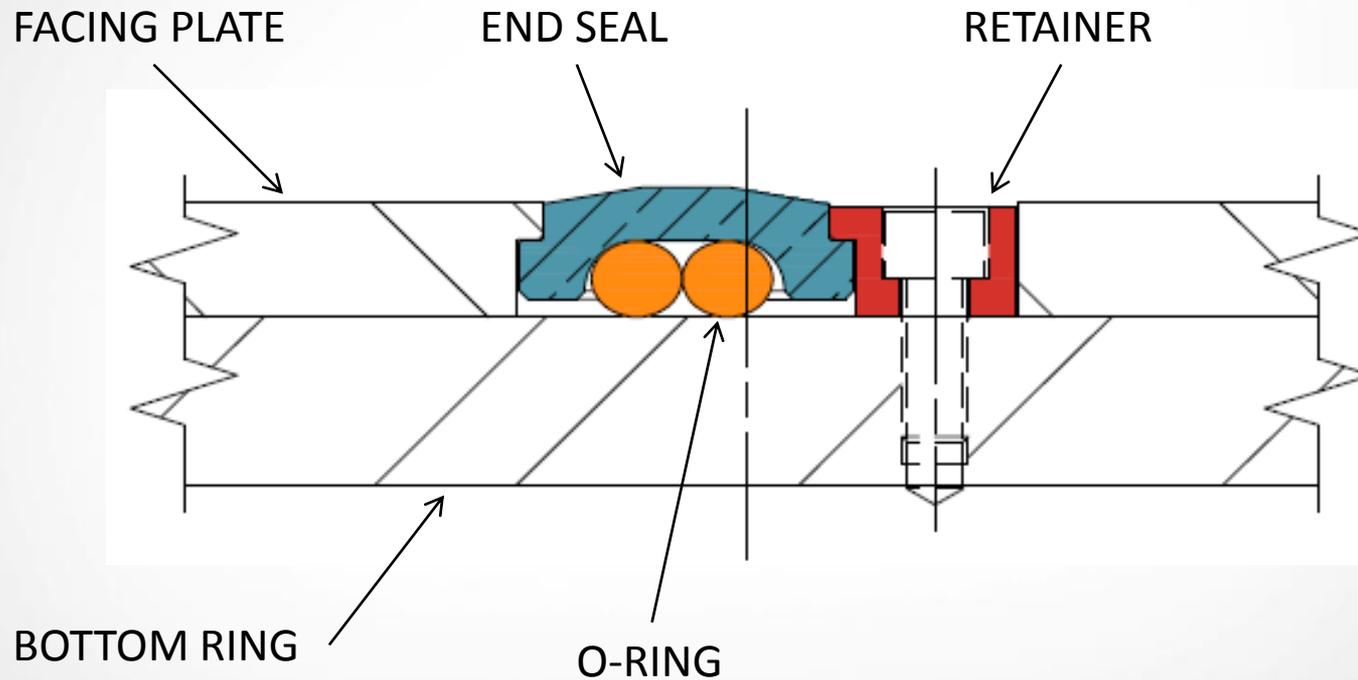




# BOTTOM WICKET GATE POT & LOWER END SEAL



# LOWER END SEAL



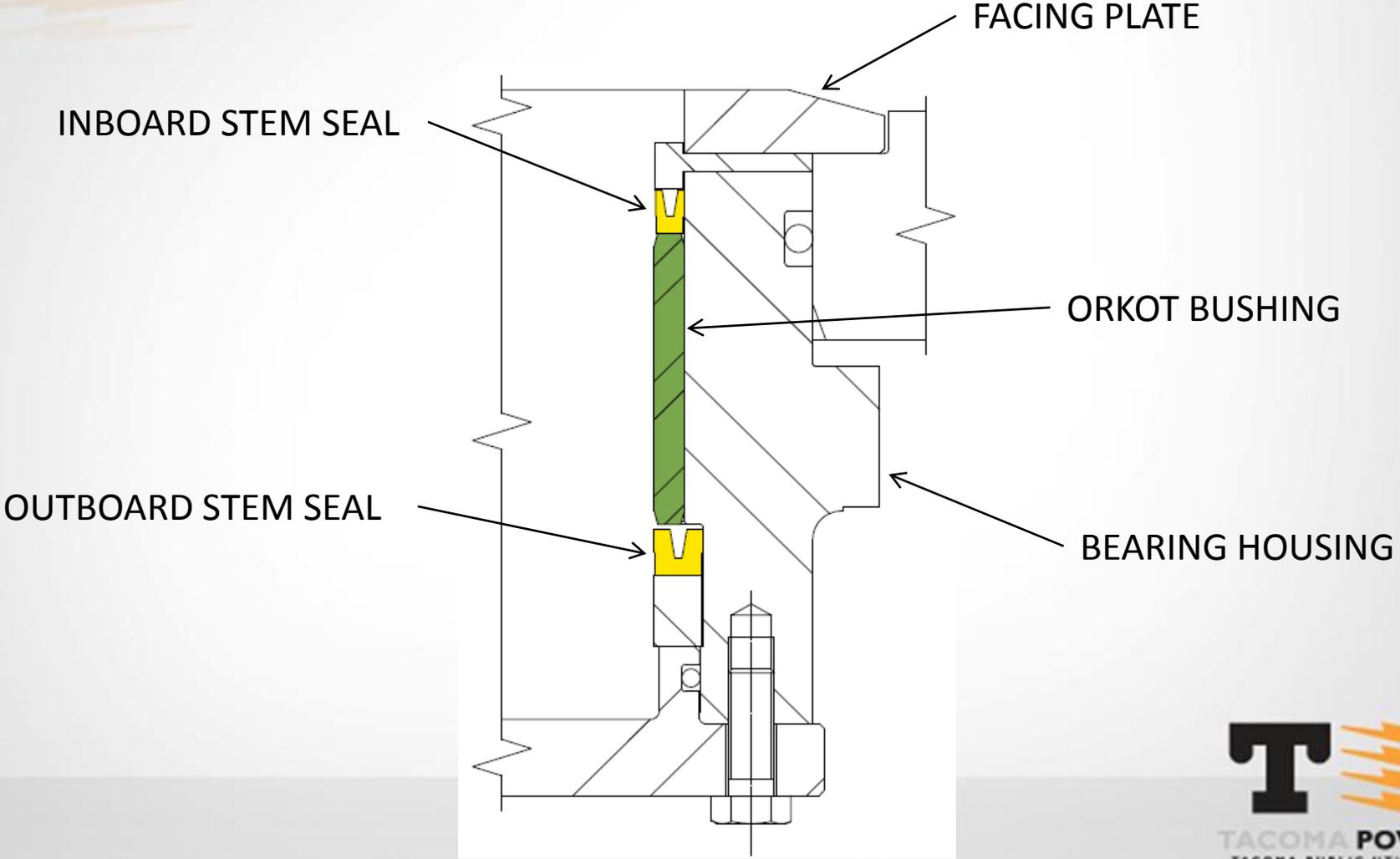


# LOWER END SEAL





# WICKET GATE STEM SEALS





# TYPES OF SEALS IN USE

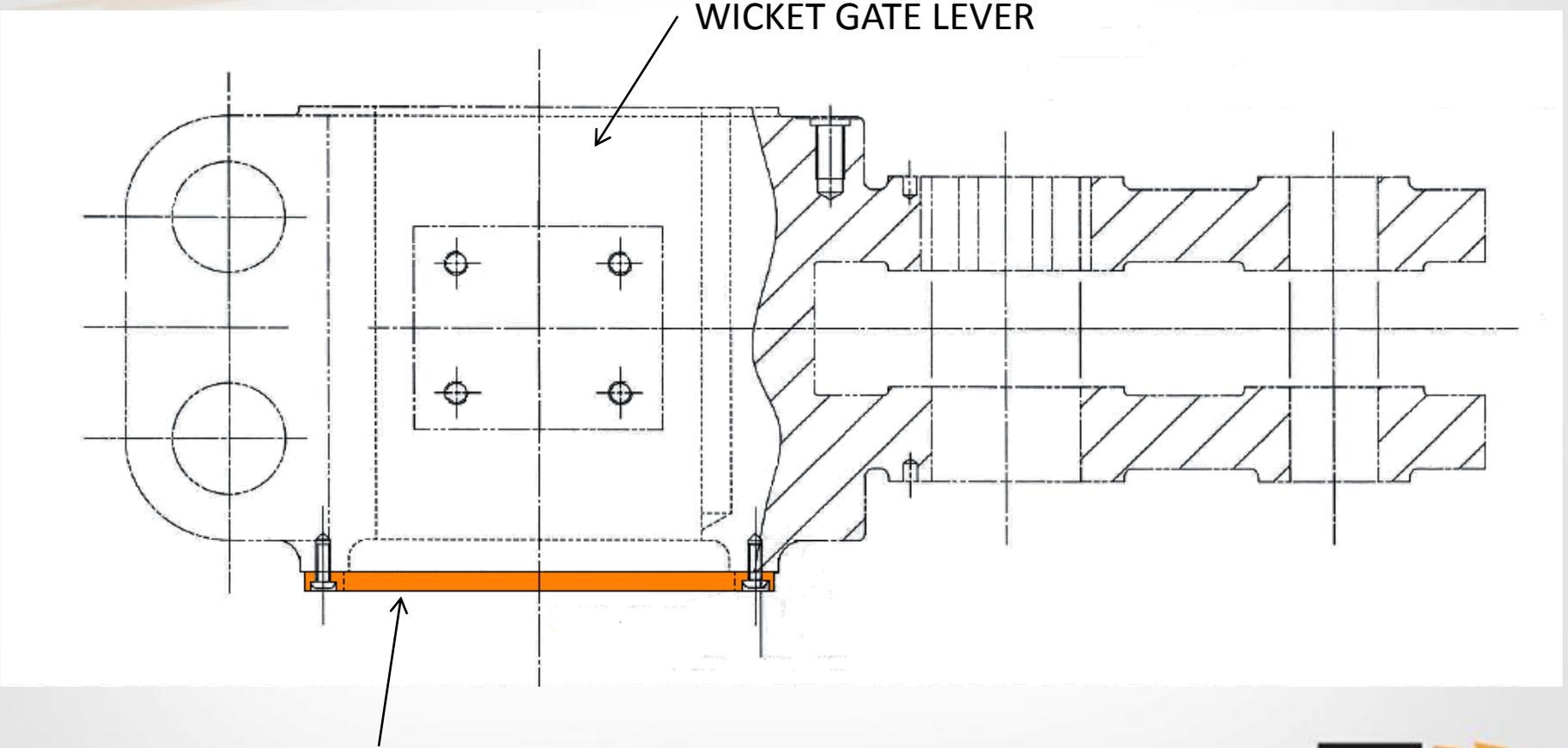
## ➤ INBOARD STEM SEALS

- Chesterton 22KN5RM / AWC800
- Trelleborg Variseal
- James Walker Solosele Type G - to be installed Sept/Oct 2012

## ➤ OUTBOARD STEM SEALS

- Parker Polypak
- SKF S-ELOPUR / Profile S01-P

# WICKET GATE THRUST WASHER



WICKET GATE LEVER

ORKOT THRUST WASHER



# THRUST WASHER FAILURE

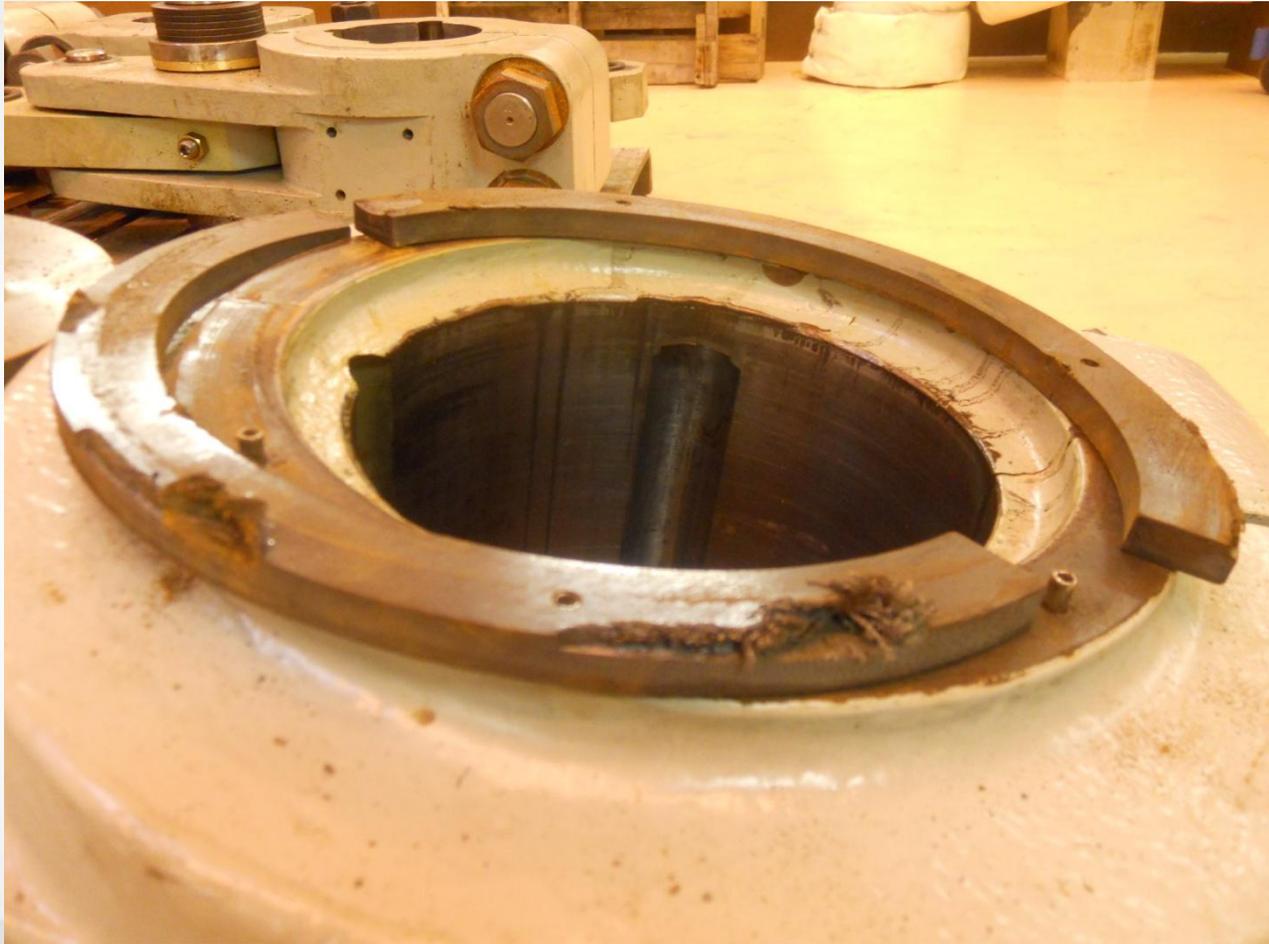


SHEARED  
SPRING  
PIN

SHEARED  
BRASS  
SCREWS



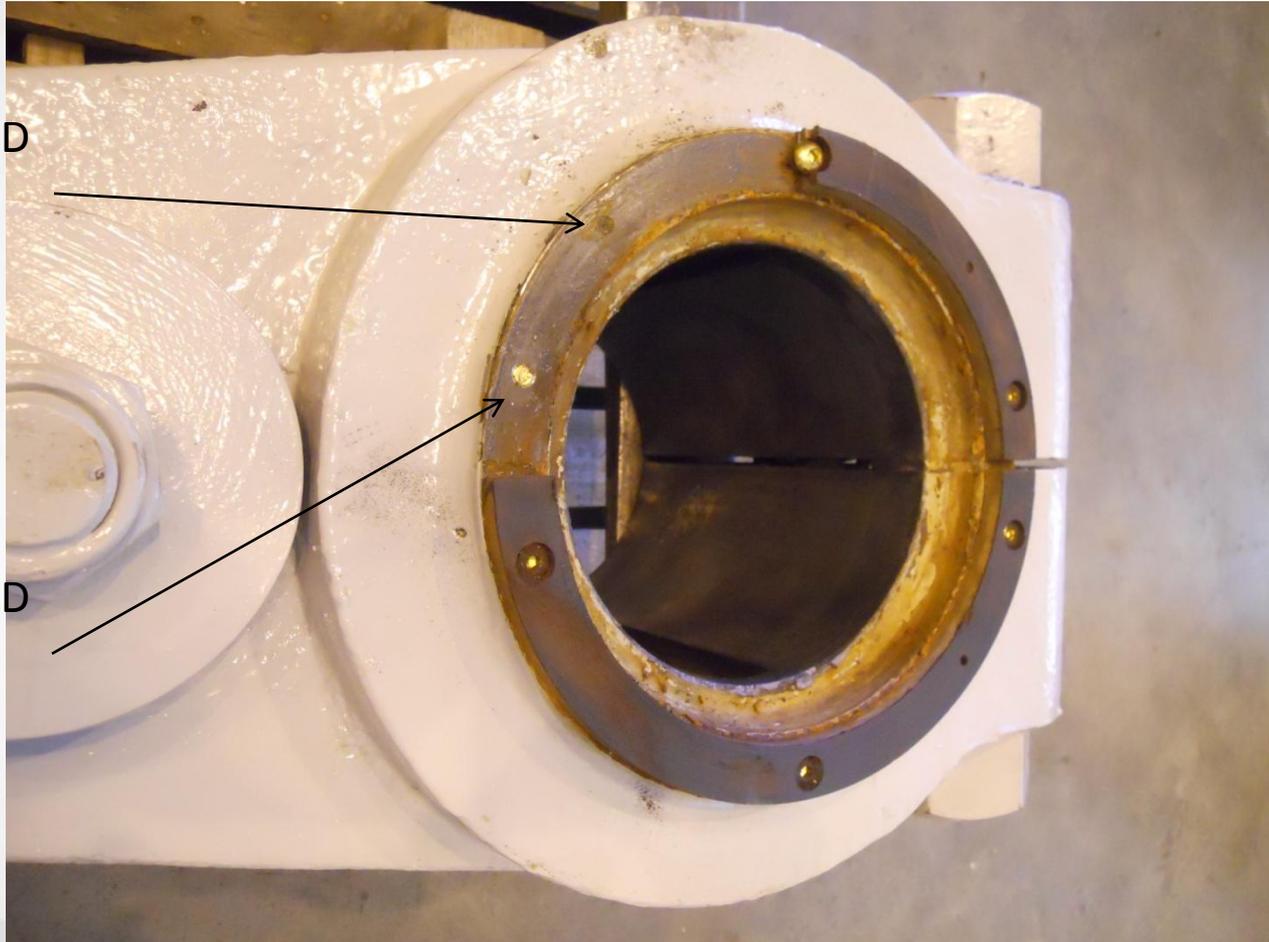
# THRUST WASHER DAMAGE



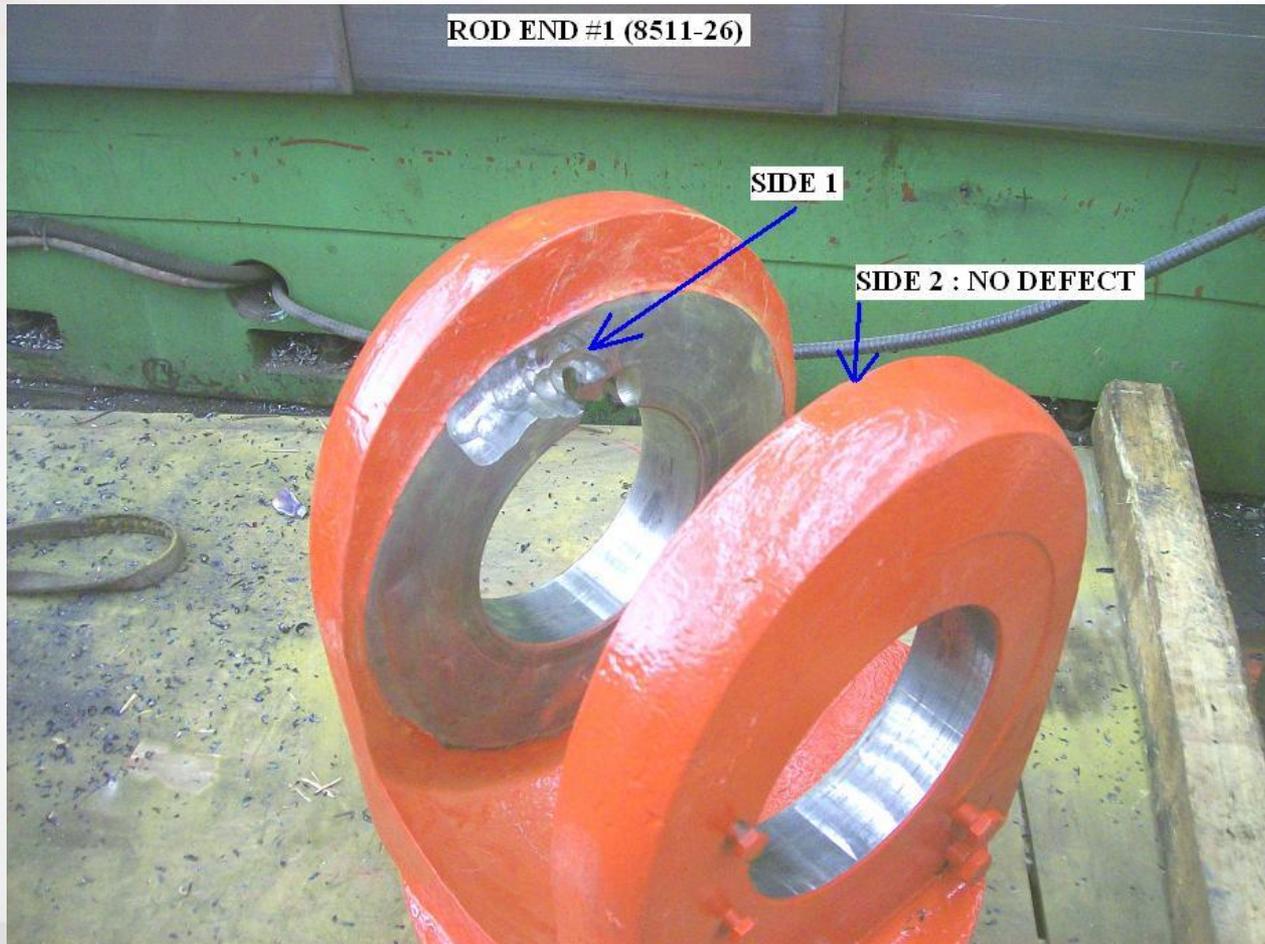
# THRUST WASHER FAILURE

SHEARED  
SPRING  
PIN

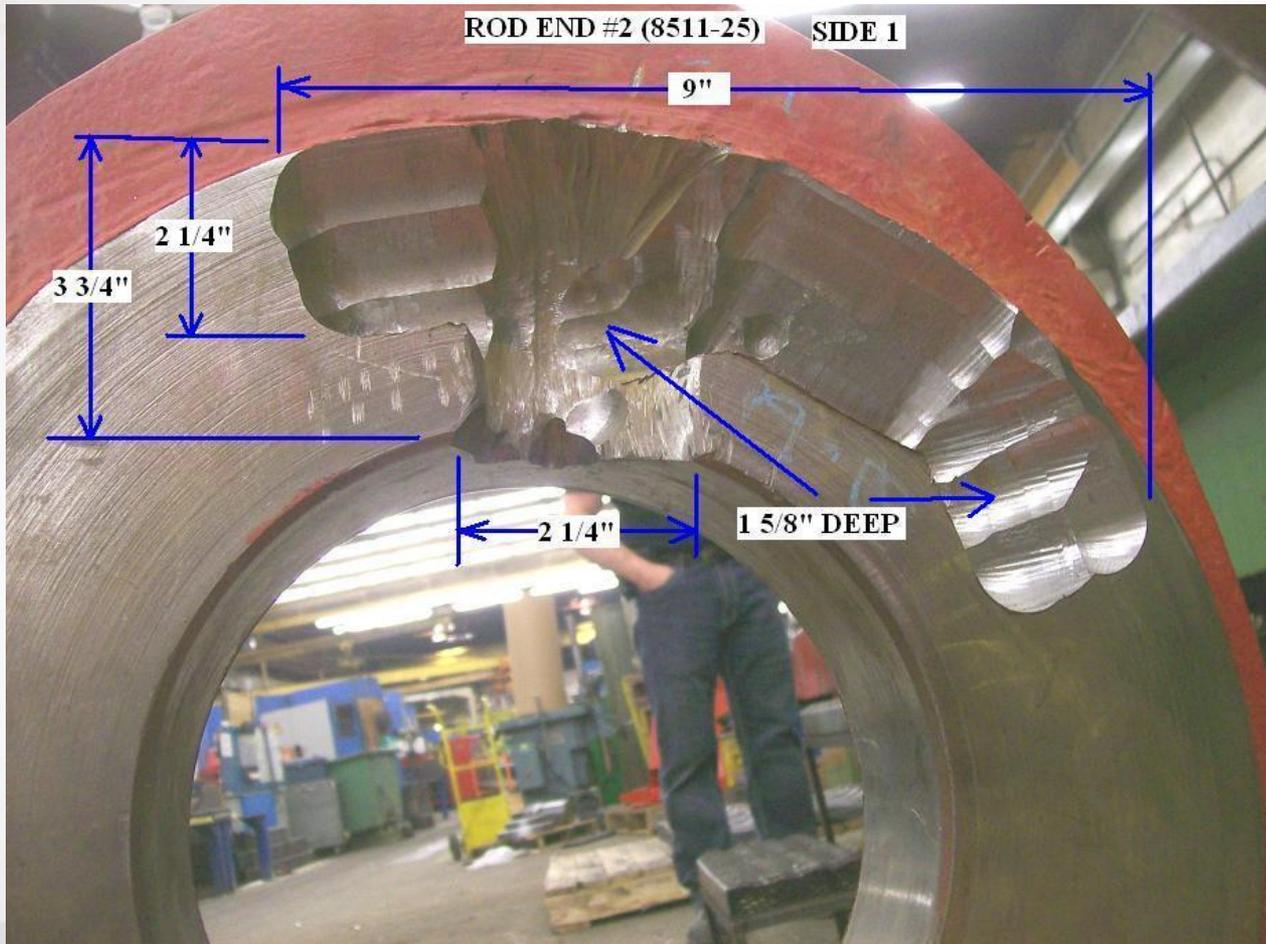
SHEARED  
BRASS  
SCREW



# CLEVIS CRACK EXCAVATION



# CLEVIS CRACK EXCAVATION



# BELLYBAND FAILURE



ROTOR  
FIELD POLES  
56 TOTAL

BROKEN  
BELLYBAND  
Pole #32



# BELLYBAND FAILURE



POINT OF  
BELLYBAND  
FAILURE

# STATOR CORE DAMAGE



DAMAGED  
WEDGES

DAMAGED  
LAMINATIONS



# WINDING DAMAGE



DAMAGED  
WINDING

REPLACED\*\*  
15 BARS

3% OF 480  
SLOTS



# HIGHLIGHTS & BENEFITS

- **IMPROVED PERFORMANCE & EXTENDED SERVICE LIFE**
  - Efficiency / Leakage / Cavitation
- **IMPROVED OPERATIONAL FLEXIBILITY**
  - Expanded Range (Higher High & Lower Low)
- **BENEFITS FROM CREBs & RECs**
- **GREASELESS BUSHINGS & NO LEAD PAINT**
- **PLANT CONTROL SYSTEM**
  - Modern / Expanded Capabilities



# KEYS TO SUCCESS

- **COLLABORATION**
- **COMMUNICATION**
- **BACKUP PLANS**
- **PROACTIVE**
- **TEAMWORK**

**QUESTIONS?**

