



# EHC Fluid Contamination D.C. Cook – Unit 2

# EHC Fluid Contamination Background

- The main turbine and both main feedwater pump turbines share a common EHC fluid system.
- EHC fluid quality has typically been better than OEM and INPO guidelines for particulate, resistivity, etc.
- The servos are replaced every refueling outage.

# EHC Fluid Contamination Background

- During the U2C21 cycle the resistivity was decreasing regardless of the continuous use of the conditioning filter.
- It was elected to replace the entire charge of 700 gallons during the U2C22 refueling outage in the spring of 2015.

# EHC Fluid Contamination

## U2C22 Refueling Outage

- The new EHC fluid was transferred from the drums to the reservoir using a pump with a filter ( $\beta=200$  for particles  $\geq 5 \mu\text{m}$  or 99.5% efficient)
- Operations performed the transfer in the same manner when a single 55 gallon drum is added or 8.5% of the reservoir volume.

# EHC Fluid Contamination

## Post U2C22 Operation

- Approximately a month after entering service from U2C22 a noticeable drifting of all 4 control valves was observed with the control valves receiving a constant signal from the distributed control system (DCS).
- Typical pre-U2C22 drift was  $<0.25\%$  but after the new EHC fluid was introduced drifting  $>0.50\%$  was typical for all 4 valves that was effecting the reactivity.  $T_{avg}$  was drifting  $\sim 1^\circ$  F and main steam pressure was changing  $\sim 1$  psig causing Level 4 Precursor Reactivity Events.
- A troubleshooting exercise of the situation was performed in effort to determine the problem



# EHC Fluid Contamination

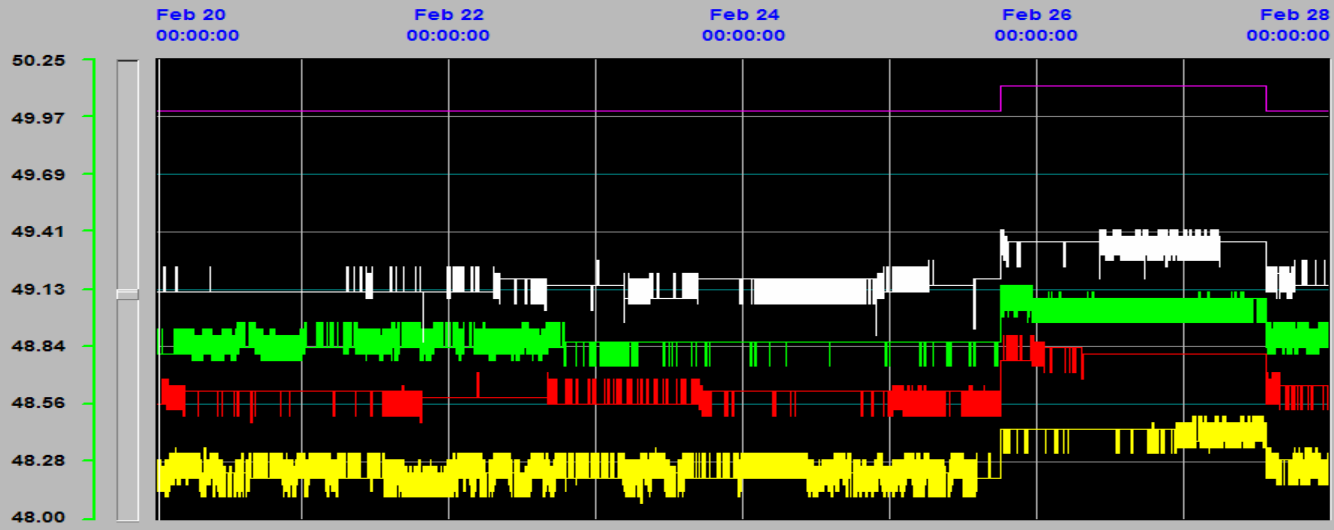
## Pre-U2C22 Operation

Megawatts:	0 MW	Speed:	0 rpm	CVD:	0.0 %	MW:	OUT
Target:	0 MW	Target:	0 rpm	CVA:	0.0 %	Impulse:	OUT
Rate:	0.00 MW/min	Rate:	0 rpm/min	CVB:	0.0 %	SPP-302:	0.0 in Hg
Reference:	0.00 MW	Reference:	0 rpm	CVC:	0.0 %		

Turbine Status: **TURBINE TRIPPED (0)**

### Main Turbine Historical Trending

= Enable / Disable  
*i* = Information Box  
 ! Be sure tag is enabled before assigning new tagname.



- a2\_OME90\_LI\_CV\_POSA *i*  
48.81 48.93
- a2\_OME90\_LO\_CV\_POSA *i*  
48.57 48.66
- a2\_OME90\_RI\_CV\_POSA *i*  
48.26 48.32
- a2\_OME90\_RO\_CV\_POSA *i*  
49.11 49.15
- \_\_\_\_\_ *i*
- r2\_CVA\_SPCA\_OUT *i*  
50.00 50.00
- FALSE *i*  
Unavail Unavail
- FALSE *i*  
Unavail Unavail

00:28:48 | 00:00:00

Refreshing

Left Extend | 00:00:00 | Left Shrink | Zoom In | 8d | Chart Length | Zoom Out | Right Shrink | 00:00:00 | Right Extend

Pan Or Extend/Shrink Chart By Desired Time  
 4 hours | 1 hour | Double Pan | Single Pan | Minutes | Single Pan | Double Pan | 30 minutes | 10 minutes | Current Time

# EHC Fluid Contamination

## Post-U2C22 Operation

Megawatts:	0 MW	Speed:	0 rpm	CVD:	0.0 %	MW:	OUT
Target:	0 MW	Target:	0 rpm	CVA:	0.0 %	Impulse:	OUT
Rate:	0.00 MW/min	Rate:	0 rpm/min	CVB:	0.0 %	SPP-302:	0.0 in Hg
Reference:	0.00 MW	Reference:	0 rpm	CVC:	0.0 %		

Turbine Status: **TURBINE TRIPPED (0)**

### Main Turbine Historical Trending

= Enable / Disable  
*i* = Information Box  
 ! Be sure tag is enabled before assigning new tagname.



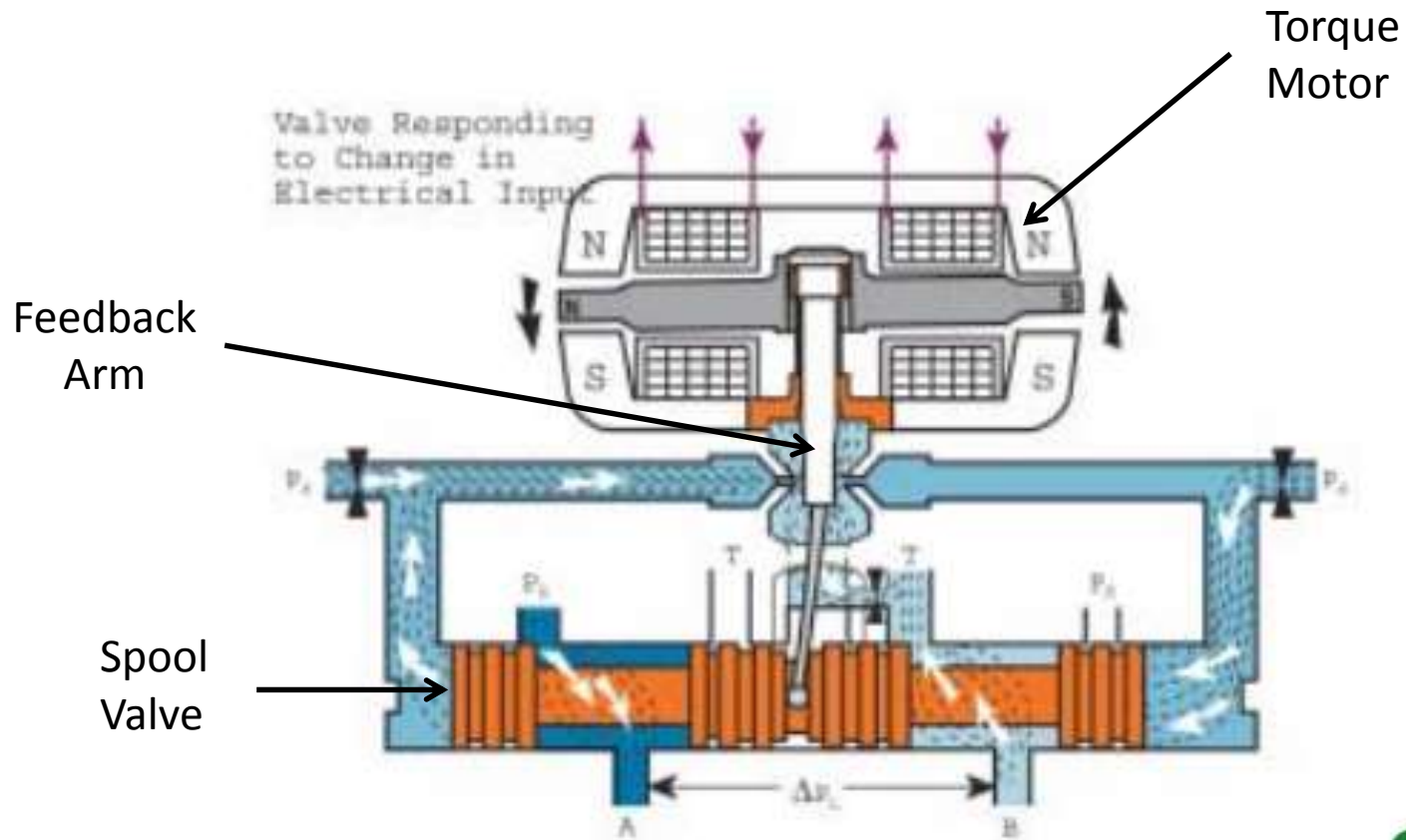
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  - a2\_OME90\_RI\_CV\_POSA *i*  
50.21 49.73
  - a2\_OME90\_RO\_CV\_POSA *i*  
49.97 50.03
  - \_\_\_\_\_ *i*
  - r2\_CVA\_SPCA\_OUT *i*  
50.52 50.40
  - FALSE *i*  
Unavail Unavail
  - FALSE *i*  
Unavail Unavail
- 49%

00:28:48 | 00:00:00

Refreshing

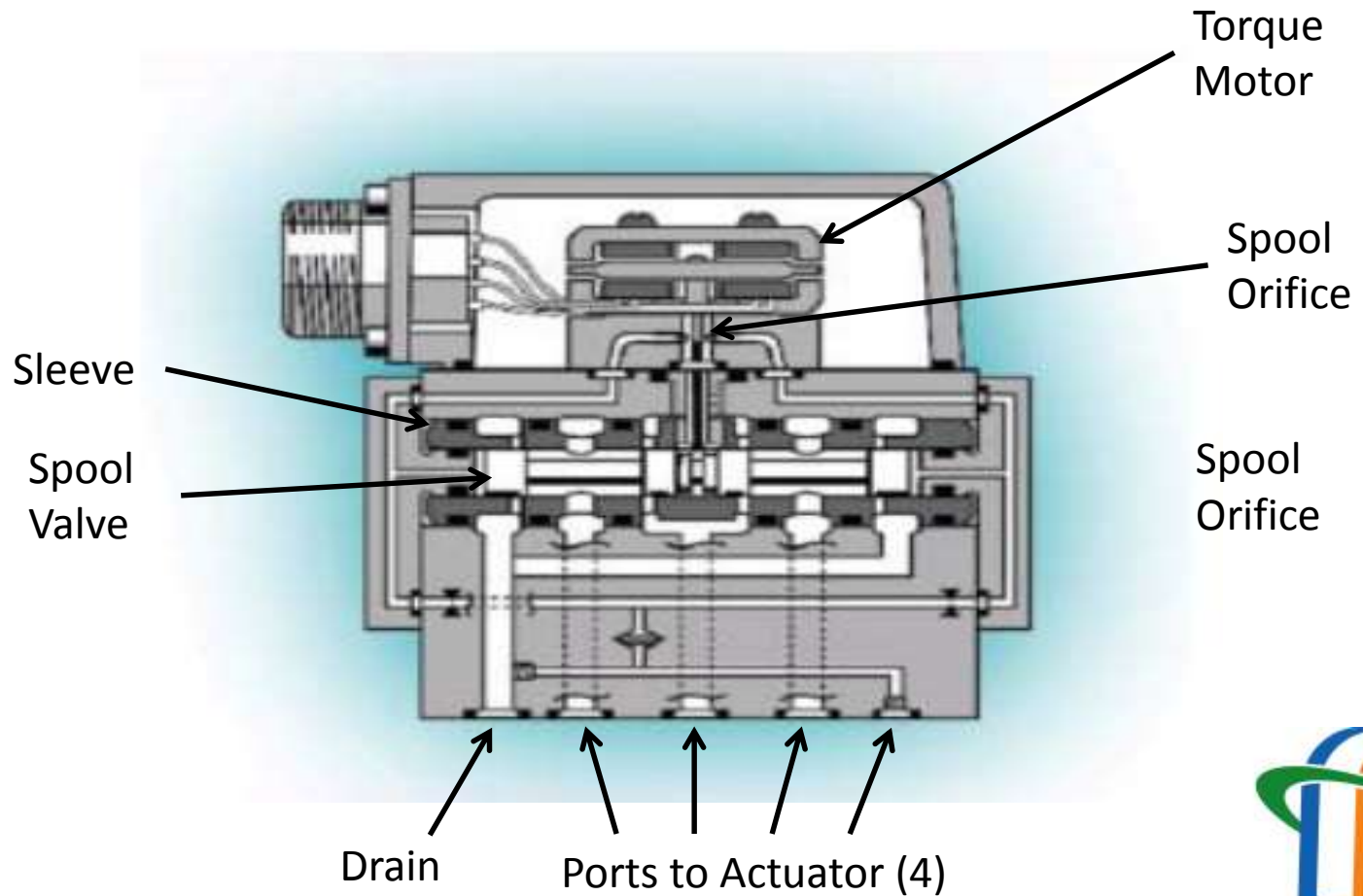
00:00:00      00:00:00

# EHC Fluid Contamination Servo Operation





# EHC Fluid Contamination Servo Operation



# EHC Fluid Contamination Servo Operation



# EHC Fluid Contamination

## Post U2C22 Operation

- Drifting was also observed on the 3 left side intercept valve (IV) but was not affecting electrical load due to being a butterfly style valve and by virtue of the location of the IVs in the cycle.
- All actuators and valves are direct coupled with no linkages or pivots to introduce hysteresis and this includes the feedback mechanism (LVDT).
- Verified that operating mode of the DCS is outputting a constant signal to the control valves.
- The MFPT control valves and LVDT are direct coupled as well BUT were not exhibiting any drifting or other anomalies.
- Conducted a conference call with our group (USA Alliance) and survey via a GE turbine user group (GETURBGEN) regarding this condition.



# EHC Fluid Contamination Troubleshooting

- Reviewed two documents of merit:
  - EPRI: TR-1004554: EHC Fluid Maintenance
  - MOOG White Paper: Contamination Control - A Hydraulic OEM Perspective.
- Utilizing a Support/Refute table the only likely cause was that we introduced a large volume of silt/sub-micron particles that passed through the filter of the transfer pump when the new fluid was added.
- The drifting of the control valves is the sticking of the servo spool valve due to small changes in position. When the servos are in a constant position the silt accumulates in the “lands” or grooves in the spool. As EHC fluid bleeds through the spool valve the pressure difference across the spool valve will change and cause the actuator to move, but because the signal to the torque motor is small it is not sufficient to overcome sticking in the spool valve.
- The MFPT control valves did not exhibit drifting due to these servos are constantly modulating causing the silt to be constantly dislodged.

# EHC Fluid Contamination

## Apparent Cause

- New EHC fluid is typically higher in particle count than the existing fluid in the reservoir!!!
- This higher particle is more at the range that is NOT normally analyzed -  $< 5 \mu\text{m}$ .
- Worse of all.....
- We did this to ourselves!!

# EHC Fluid Contamination Resolution

- 6/28/15: Stroked or exercised the control valves in a effort cause the accumulation of silt to be dislodged but drifting reoccurred in three weeks
- The magnitude of the drifting worsened.
- 8/28/15: Stroked or exercised the control valves in a effort cause the accumulation of silt to be dislodged but drifting reoccurred in three weeks.

# EHC Fluid Contamination Resolution

- 9/19/15: Stroked or exercised the control valves as part of quarterly turbine valve testing.
- Drifting reoccurred in three weeks. Since the EHC Fluid cleanliness had greatly improved it was thought that as each occasion that the control valves were exercised would provide longer periods until the drifting would reoccur. This was not the case.
- 10/29/15: Replaced two of the worse performing servos.



# EHC Fluid Contamination Resolution

- Drifting reoccurred within three weeks for the two older servos but did not reoccur in the newly replaced servos.
- Thermal power did not drift as much but Level 4 Reactivity Precursors were still occurring.
- 12/5/15: Replaced two remaining servos.
- To date (1/15/16) three of the four servos are performing as expected and the fourth has acceptable minor drifting but no Level 4 Reactivity Precursors are occurring.





# ECR Skid

- Electrostatic Contamination Removal
- Removes sub-micron insoluble material
- improves resistive & air release properties.

