

# *Leveraging the Lessons Learned from AP1000 Qualification Testing*



**ASCO**  
**NUMATICS™**

**EMERSON™**  
Industrial Automation

# Agenda

Solenoid Valve Fundamentals

AP1000 Challenges & Solutions

Evolution of ASCO Nuclear Solenoids

Qualification Lessons

Next Step

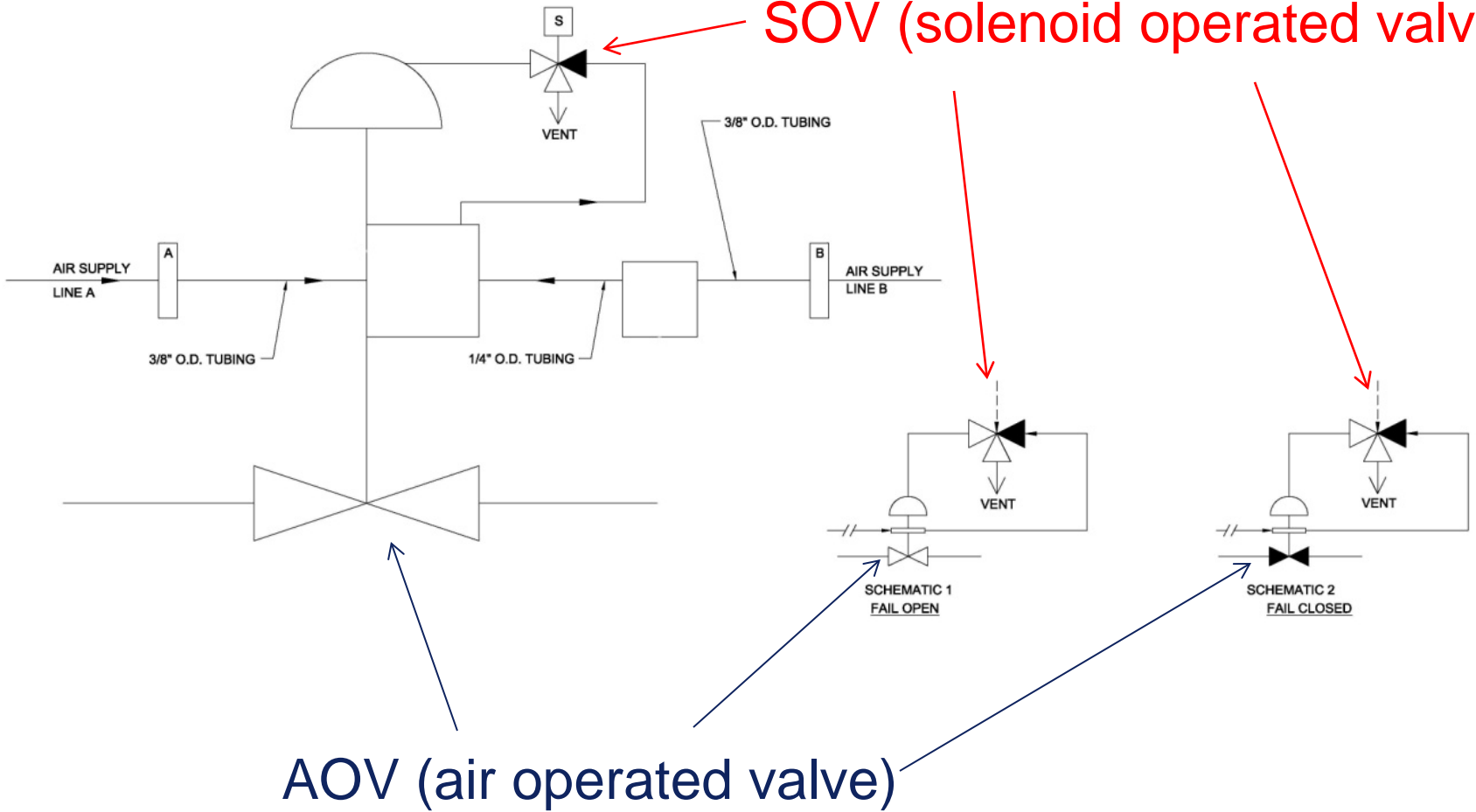
# *Function of Solenoids in Air Operated Valve*

- The solenoid valve is an electromechanical device that converts electric control signal converted to mechanical energy to actuate the AOV
- The solenoid valve is located between control instrumentation and actuator
- The solenoid valve is a specific safety related device
- The solenoid valve initiates the safety function by venting air from the actuator



# SOVs on Main AOV

SOV (solenoid operated valve)



# Operational testing of Air Operated Valve with Solenoid Valve

Solenoid Valve



# Agenda

Solenoid Valve Fundamentals

AP1000 Challenges & Solutions

Evolution of ASCO Nuclear Solenoids

Qualification Lessons

Next Step

# *AP1000 Solenoid Valve Challenges*

## **AP 1000 Requirements**

- All solenoid valves require suppression diode
- 200 C rated lead wire 30 ft lead wire
- Coil must be removable
- Non 1E and 1E different coating to distinguish
- Increased seismic loads

## **ASCO NT solution**

- Integrate diode into one piece molded coil
- PEEK lead wire from NS qualification
- Red Hat II with molded in QDC
- Red Hat II coils Black- 1E  
Green non-1E
- Stronger mounting bracket

# AP1000 Qualification Challenges

## AP1000

- Rapid LOCA curves
- High HELB Temps
- Chemical Spray variation
- Mission Time w margin vs actual time

## Solutions

- Labs can't meet
  - Monitor component temps for Thermal lag
- Can materials function
  - Screening / Simulation
- Verify with customer & Lab – every parameter
- Understand safety function



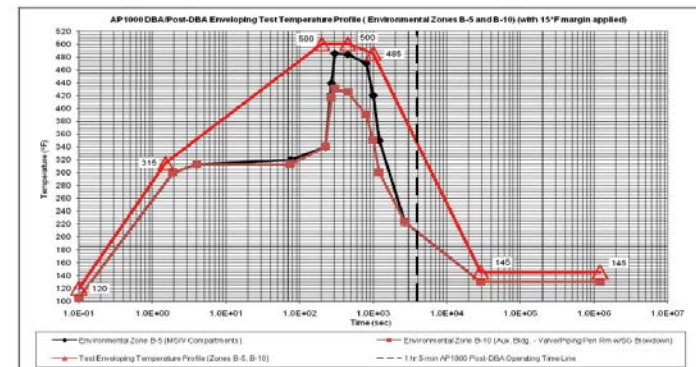
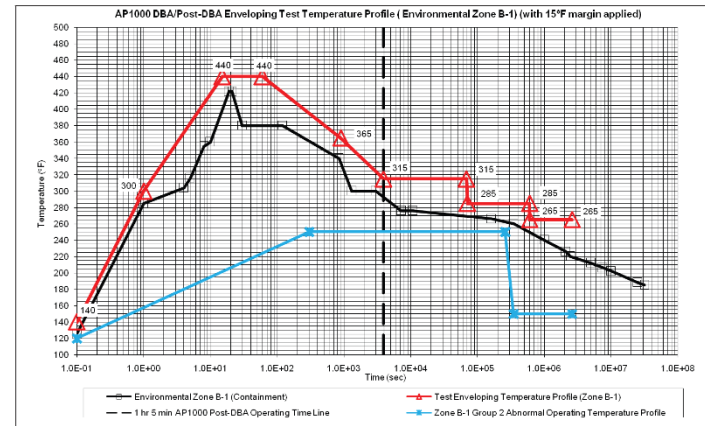
# NT Qualification Levels

## LOCA:

- 450°F(232°C), Zone 1 profile.

## HELB:

- 500°F(260°C) Zone 5 and zone10 profile



# SOV – NT 8316 Safety Related AP1000



- NT 8316 is used for safety related (1E) on AP 1000
- Quick Disconnect (QDC)
- RHII Encapsulated Coil
- Internal Diode
- High Temp Radiation Resistant elastomers
- Zero Minimum Pressure

# NUCLEAR VALVE EVOLUTION



NP8316

Developed 1978  
First SOV in Nuclear for Safety

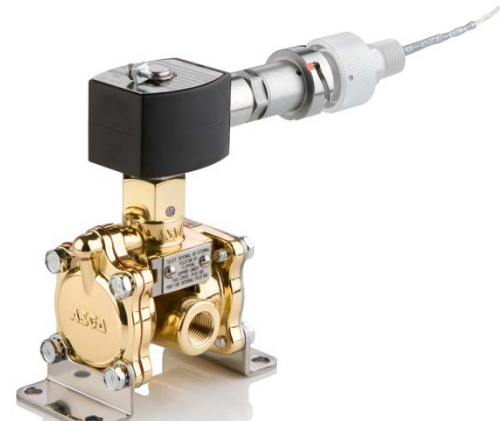
- EPDM/FKM elastomers
- Non-molded varnish
- impregnated coils.



NS8316

Developed 1995  
Harsh environment, long life

- Special elastomeric compound developed by ASCO
- Better radiation resistance, longer thermal life
- Increase resistance to high temperatures



NT8316

Developed 2011  
Digital & more features (AP1000)

- Red Hat II Coil with built in diode for digital applications.
- Quick Disconnect
- Zero Minimum PSID
- PEEK Leads

# Agenda

Solenoid Valve Fundamentals

AP1000 Challenges & Solutions

Leveraging to NT Line Extension

Qualification Lessons

Next Step

## *NT line extension*

- Leveraged lessons from NT AP1000 testing
  - Molded coil
  - Internal diode
  - QDC
  - Reverse flow – NT 8316 ( 3/8 to 1 inch) 8320 -1/4 inch
  - Increased qualified thermal life



# NP vs NT Qualification Levels

Comparison items		NP (AQR 67368)	NT (ATR 35115-3)
Elastomer		EPDM or Viton	Gamma +
Coil	DC	RHI w/ enclosure	RH II w/ diode
	AC	RHI w/ enclosure	RH II
QDC option		N/A	Yes
Thermal aging for qualify life <u>at 50C</u> ambient		Coil 2 year, valve 4 & 7 years	15 years
Radiation (total)		167 Mrads	32 Mrads for HELB; 170 Mrads for LOCA
Vibration & Seismic		15g input	6.6g input -RIM (>50G response)
HELB & LOCA		30 days; Double peak, Max 420F,	HELB: 14 days; max 500F, LOCA: 30 days; Double peak, Max 440F,

# NUCLEAR VALVE EVOLUTION



**NT8316**  
 Developed 2011  
 Digital & more feature (AP1000)

- Red Hat II Coil with built in diode for digital applications.
- Quick Disconnect
- Zero Minimum PSID
- PEEK Leads



**NT8316 & NT8320**  
 Developed 2014

- Red Hat II Coil with built in diode for digital applications
- 8316 -3/8-1 & 8320 qualified to increased levels
- Quick Disconnect
- Reverse flow
- Peek or Silicone leads



**NP G Series**  
 Available 2016

- Extended to NP series
- Red Hat II Coil with built in diode for digital applications
- Coils to increased levels
- Quick Disconnect
- Peek or Silicone leads

# *NT line Extension applied to NP & NS valves*

## NT Upgrade

- 3 way Std Flow
  - NT 8320
- 3 way Hi Flow
  - NT8316

## NP RH II

- 3 way
  - NP8300G
  - NP8321G
- 4-Way
  - NP8342G
  - NP8344G



# Agenda

Solenoid Valve Fundamentals

AP1000 Challenges & Solutions

Evolution of ASCO Nuclear Solenoids

Qualification Lessons

Next Step

# ***Lessons Learned Solenoid Valves***

---

- Leverage existing knowledge base
  - Red Hat II – Commercial line
  - Peek Lead Wire – NS
  - Gamma Plus Elastomers - NS
  - Don't reinvent the wheel – use qualified materials
- Prequalification Screening
  - Establish Thermal & Radiation limits
    - diodes, elastomers, coils, lead wires
  - Verify designs prior to qual testing
    - Try several variations of materials / processes

## ***Other EQ lessons learned***

---

- Back up test samples
  - Run in parallel 2 phases behind –
- Separate options/variations
  - Increases sample size but minimizes risk
- Separate zones – aging isn't cumulative across zones
  - Zone 1 equipment doesn't have to work in Zone 5
- Age in phases with sacrificial parts to establish limits
  - Thermal – spread out into 5 year increments /wear aging
  - Radiation- phased based on performance of sac parts
  - Wear- integrate into thermal aging

# Questions

