

# The 'Subset' Issue . . .



. . . Correcting a Common  
Psychometric Flaw

Michael K. Meeks  
USNRC Region II

# The 'Subset' Issue . . .



*Please*

**SILENCE**  
Cell Phones  
And Pagers

. . . Correcting a Common  
Psychometric Flaw

Michael K. Meeks  
USNRC Region II



# Naval Nuclear Power...



August 2, 2011

The 'Subset' Issue . . .  
Correcting a Common Psychometric Flaw

Michael K. Meeks

# Indian Point 3 SRO...



August 2, 2011

The 'Subset' Issue . . .  
Correcting a Common Psychometric Flaw

Michael K. Meeks

# NRC



- NRC Region II – August 2008
- Operations Engineer
- Qualified on Westinghouse and Babcock & Wilcox



# Mathematics 101

---

$$A = \{ 1 \}$$

# Mathematics 101

---

$$A = \{ 1 \}$$

$$B = \{ 1, 2 \}$$

# Mathematics 101

---

$$A = \{ 1 \}$$

$$B = \{ 1, 2 \}$$

$$A \subset B$$



# Mathematics 101

---

$$A = \{ 1 \}$$

$$B = \{ 1, 2 \}$$

$$C = \{ \mathbf{x} \}$$

# Mathematics 101

---

$$A = \{ 1 \}$$

$$B = \{ 1, 2 \}$$

$$C = \{ x \}$$

$$D = \{ x, y \}$$

# Mathematics 101

$$A = \{ 1 \}$$

$$B = \{ 1, 2 \}$$

$$C = \{ x \}$$

$$D = \{ x, y \}$$

$$C \subset D$$

# 'Subset' Issue 101

---

Our Hypothetical Plant:

Low Pressure Rx Trip = 1900 psig

Low Pressure SI = 1800 psig



# 'Subset' Issue 101

---

Rx Trip = 1900 psig

SI = 1800 psig

Which ONE of the following  
Pressurizer pressure values results in  
an automatic Reactor trip?

# 'Subset' Issue 101

---

Rx Trip = 1900 psig

SI = 1800 psig

Which ONE of the following Pressurizer pressure values results in an automatic Reactor trip?

A. 1800 psig

# 'Subset' Issue 101

---

Rx Trip = 1900 psig

SI = 1800 psig

Which ONE of the following Pressurizer pressure values results in an automatic Reactor trip?

A. 1800 psig

B. 1900 psig

# 'Subset' Issue 101

Rx Trip = 1900 psig

SI = 1800 psig

Which ONE of the following Pressurizer pressure values results in an automatic Reactor trip?

A. 1800 psig

B. 1900 psig



# 'Subset' Issue 101

---

Rx Trip = 1900 psig

SI = 1800 psig

Which ONE of the following Pressurizer pressure values results in an automatic Reactor trip?

A. 1800 psig

B. 1900 psig

# 'Subset' Issue 101

Rx Trip = 1900 psig

SI = 1800 psig

Which ONE of the following Pressurizer pressure values results in an automatic Reactor trip?

A. 1800 psig

B. 1900 psig

$$A \subset B$$

# 'Subset' Issue 101

Rx Trip = 1900 psig

SI = 1800 psig

Which ONE of the following is the automatic plant response for a low Pressurizer pressure of 1800 psig?

# 'Subset' Issue 101

---

Rx Trip = 1900 psig

SI = 1800 psig

Which ONE of the following is the automatic plant response for a low Pressurizer pressure of 1800 psig?

C. Reactor Trip



# 'Subset' Issue 101

---

Rx Trip = 1900 psig

SI = 1800 psig

Which ONE of the following is the automatic plant response for a low Pressurizer pressure of 1800 psig?

C. Reactor Trip

D. Reactor Trip and SI

# 'Subset' Issue 101

Rx Trip = 1900 psig

SI = 1800 psig

Which ONE of the following is the automatic plant response for a low Pressurizer pressure of 1800 psig?

C. Reactor Trip

D. Reactor Trip and SI

# 'Subset' Issue 101

Rx Trip = 1900 psig

SI = 1800 psig

Which ONE of the following is the automatic plant response for a low Pressurizer pressure of 1800 psig?

C. Reactor Trip

D. Reactor Trip and SI

# 'Subset' Issue 101

Rx Trip = 1900 psig

SI = 1800 psig

Which ONE of the following is the automatic plant response for a low Pressurizer pressure of 1800 psig?

C. Reactor Trip

D. Reactor Trip and SI

$$C \subset D$$

# 'Subset' Issue Theorem 101

---

- If you can recognize  
a 'Subset' Issue,  
you can correct  
a 'Subset' Issue.

# 'Subset' Issue Theorem 101

---

- If you can recognize a 'Subset' Issue, you can correct a 'Subset' Issue.
- There are multiple valid ways to correct a 'Subset' Issue.



# ‘Subset’ Issue Theorem 101

---

- If you can **RECOGNIZE** a ‘Subset’ Issue, you can correct a ‘Subset’ Issue.
- There are multiple valid ways to correct a ‘Subset’ Issue.

# Example Question #1

## 3.4 REACTOR COOLANT SYSTEM (RCS)

### 3.4.13 RCS Operational LEAKAGE

LCO 3.4.13 RCS operational LEAKAGE shall be limited to:

- a. No pressure boundary LEAKAGE,
- b. 1 gpm unidentified LEAKAGE,
- c. 10 gpm identified LEAKAGE,
- d. 1 gpm total primary to secondary LEAKAGE through all steam generators (SGs), and
- e. [500] gallons per day primary to secondary LEAKAGE through any one SG.

APPLICABILITY: MODES 1, 2, 3, and 4.

#### ACTIONS

| CONDITION | REQUIRED ACTION | COMPLETION TIME |
|-----------|-----------------|-----------------|
|-----------|-----------------|-----------------|

# Example Question #1

The plant is in MODE 3.

Which ONE of the following is the  
Reactor Coolant System (RCS)  
UNIDENTIFIED leak rate that results in  
LCO 3.4.13, RCS Operational  
LEAKAGE, to be NOT MET?

# Example Question #1

The plant is in MODE 3. Which ONE of the following is the Reactor Coolant System (RCS) UNIDENTIFIED leak rate that results in LCO 3.4.13, RCS Operational LEAKAGE, to be NOT MET?

A. Any nonzero leak rate

# Example Question #1

The plant is in MODE 3. Which ONE of the following is the Reactor Coolant System (RCS) UNIDENTIFIED leak rate that results in LCO 3.4.13, RCS Operational LEAKAGE, to be NOT MET?

A. Any nonzero leak rate

B. 0.2 gpm

# Example Question #1

The plant is in MODE 3. Which ONE of the following is the Reactor Coolant System (RCS) UNIDENTIFIED leak rate that results in LCO 3.4.13, RCS Operational LEAKAGE, to be NOT MET?

- A. Any nonzero leak rate
- B. 0.2 gpm

C. 1.1 gpm

# Example Question #1

The plant is in MODE 3. Which ONE of the following is the Reactor Coolant System (RCS) UNIDENTIFIED leak rate that results in LCO 3.4.13, RCS Operational LEAKAGE, to be NOT MET?

- A. Any nonzero leak rate
- B. 0.2 gpm
- C. 1.1 gpm
- D. 10.1 gpm

# Example Question #1

---

- A. Any nonzero leak rate
- B. 0.2 gpm
- C. 1.1 gpm
- D. 10.1 gpm



# Example Question #1

---

A. Any nonzero leak rate

B. 0.2 gpm

C. 1.1 gpm

D. 10.1 gpm

# Example Question #1

---

A. Any nonzero leak rate

B. 0.2 gpm

C. 1.1 gpm

D. 10.1 gpm

# Example Question #1

---

A. Any nonzero leak rate

B. 0.2 gpm

C. 0.6 gpm

D. 1.1 gpm

# Example Question #1

---

- A. Any nonzero leak rate
- B. 0.2 gpm
- C. 0.6 gpm
- D. 1.1 gpm [now, only one correct]

# Example Question #1

---

A. Any nonzero leak rate

B. 0.2 gpm

C. 0.6 gpm

D. 1.1 gpm

# Example Question #1

---

A. Any nonzero leak rate

B. 0.2 gpm

C. 0.6 gpm

D. 1.1 gpm

# Example Question #1

---

A. Any nonzero leak rate

B. 0.2 gpm

C. 0.6 gpm

D. 1.1 gpm

# Example Question #1

---

A. Any nonzero leak rate

B. 0.2 gpm

C. 0.6 gpm

D. 1.1 gpm



# Example Question #1

---

A. ~~Any nonzero leak rate~~

B. 0.2 gpm

C. 0.6 gpm

D. 1.1 gpm

# Example Question #1

---

A. ~~Any nonzero leak rate~~

B. ~~0.2 gpm~~

C. 0.6 gpm

D. 1.1 gpm

# Example Question #1

A. ~~Any nonzero leak rate~~

B. ~~0.2 gpm~~

C. ~~0.6 gpm~~

D. 1.1 gpm

# Example Question #1

The plant is in MODE 3.

Which ONE of the following is the **MINIMUM** Reactor Coolant System (RCS) UNIDENTIFIED leak rate that results in LCO 3.4.13, RCS Operational LEAKAGE, to be NOT MET?

# Example Question #1

---

- A. Any nonzero leak rate
- B. 0.2 gpm
- C. 0.6 gpm
- D. 1.1 gpm [only one correct]

# Example Question #1

---

- A. Any nonzero leak rate
- B. 0.2 gpm
- C. 1.1 gpm [only one correct]
- D. 10.1 gpm

# Correcting the 'Subset' Issue

---

- 1. Choose an 'Appropriate' Modifier to Eliminate the 'Subset.'

# Correcting the 'Subset' Issue

---

- 1. Choose an 'Appropriate' Modifier to Eliminate the 'Subset.'
- MINIMUM, LOWEST, LEAST, SMALLEST



# Correcting the 'Subset' Issue

- 1. Choose an 'Appropriate' Modifier to Eliminate the 'Subset.'
- MINIMUM, LOWEST, LEAST, SMALLEST
- MAXIMUM, LARGEST, MOST, BIGGEST

# Correcting the 'Subset' Issue

- 1. Choose an 'Appropriate' Modifier to Eliminate the 'Subset.'
- MINIMUM, LOWEST, LEAST, SMALLEST
- MAXIMUM, LARGEST, MOST, BIGGEST
- EARLIEST, SOONEST

# Correcting the 'Subset' Issue

- 1. Choose an 'Appropriate' Modifier to Eliminate the 'Subset.'
- MINIMUM, LOWEST, LEAST, SMALLEST
- MAXIMUM, LARGEST, MOST, BIGGEST
- EARLIEST, SOONEST
- LATEST, LAST

# Correcting the 'Subset' Issue

---

- 1. Choose an 'Appropriate' Modifier to Eliminate the 'Subset.'
- ONLY

# Correcting the 'Subset' Issue

---

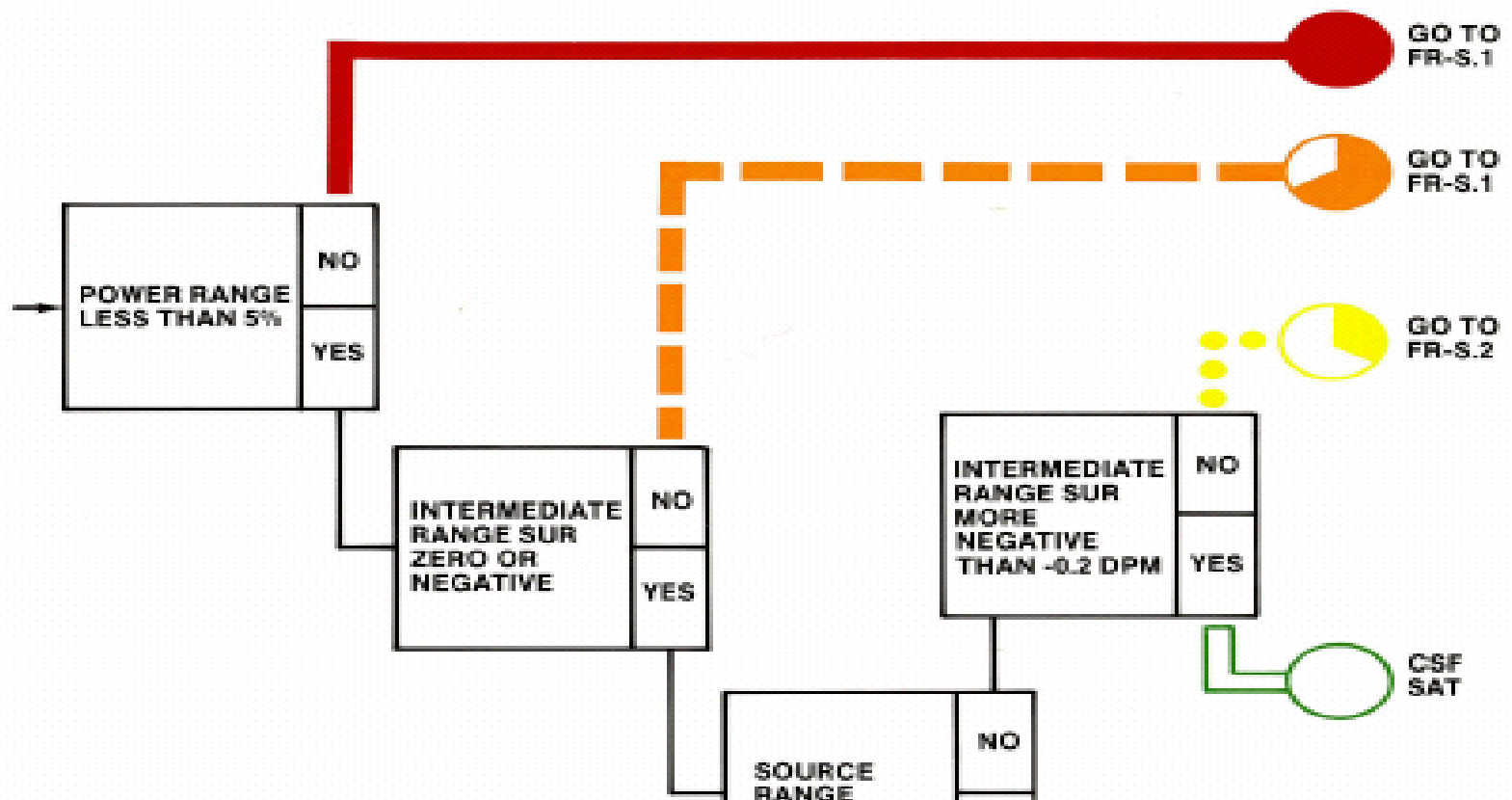
- 1. Choose an 'Appropriate' Modifier to Eliminate the 'Subset.'
- ONLY
- NEXT

# Correcting the 'Subset' Issue

- 1. Choose an 'Appropriate' Modifier to Eliminate the 'Subset.'
- ONLY
- NEXT (ACTION REQUIRED BY PROCEDURE ... )

# Example Question #2

|                 |                         |   |
|-----------------|-------------------------|---|
| Number<br>F-0.1 | Title<br>SUBCRITICALITY | Rev. Issue/Date:<br>HP/LP, Rev. 2<br>04/30/2005 |
|-----------------|-------------------------|---|



## Example Question #2

---

Which ONE of the following is the Intermediate Range (IR) Start Up Rate (SUR) value that requires entry to FR-S.1 based on an ORANGE path transition?



## Example Question #2

Which ONE of the following is the Intermediate Range (IR) Start Up Rate (SUR) value that requires entry to FR-S.1 based on an ORANGE path transition?

A. -0.2 dpm

## Example Question #2

Which ONE of the following is the Intermediate Range (IR) Start Up Rate (SUR) value that requires entry to FR-S.1 based on an ORANGE path transition?

A. -0.2 dpm

B. -0.1 dpm

## Example Question #2

Which ONE of the following is the Intermediate Range (IR) Start Up Rate (SUR) value that requires entry to FR-S.1 based on an ORANGE path transition?

A. -0.2 dpm

B. -0.1 dpm

C. +0.1 dpm

## Example Question #2

Which ONE of the following is the Intermediate Range (IR) Start Up Rate (SUR) value that requires entry to FR-S.1 based on an ORANGE path transition?

- A. -0.2 dpm
- B. -0.1 dpm
- C. +0.1 dpm

**D. +0.2 dpm**

## Example Question #2

---

A. -0.2 dpm

B. -0.1 dpm

C. +0.1 dpm

D. +0.2 dpm

## Example Question #2

---

A. -0.2 dpm

B. -0.1 dpm

C. +0.1 dpm

D. +0.2 dpm

# Example Question #2

---

A. -0.2 dpm

B. -0.1 dpm

C. +0.1 dpm

D. +0.2 dpm

## Example Question #2

---

A. -0.33 dpm

B. -0.2 dpm

C. -0.1 dpm

D. +0.1 dpm



## Example Question #2

---

A. -0.33 dpm

B. -0.2 dpm

C. -0.1 dpm

D. +0.1 dpm

## Example Question #2

---

Which ONE of the following is the **MINIMUM** Intermediate Range (IR) Start Up Rate (SUR) value that requires entry to FR-S.1 based on an ORANGE path transition?

## Example Question #2

---

A. -0.2 dpm

B. -0.1 dpm

C. +0.1 dpm

D. +0.2 dpm

## Example Question #2

---

Based on the given data, which ONE of the following is the **EARLIEST** time entry to FR-S.1 was required based on an ORANGE path transition?

## Example Question #2

Based on the given data, which ONE of the following is the EARLIEST time entry to FR-S.1 was required based on an ORANGE path transition?

- A. -0.2 dpm
- B. -0.1 dpm
- C. +0.1 dpm
- D. +0.2 dpm

## Example Question #2

Based on the given data, which ONE of the following is the EARLIEST time entry to FR-S.1 was required based on an ORANGE path transition?

| <u>Time</u> | <u>IR SUR</u> |
|-------------|---------------|
| 0404        | -0.2 dpm      |
| 0405        | -0.1 dpm      |
| 0407        | +0.1 dpm      |
| 0409        | +0.2 dpm      |

## Example Question #2

Based on the given data, which ONE of the following is the EARLIEST time entry to FR-S.1 was required based on an ORANGE path transition?

| <u>Time</u> | <u>IR SUR</u> |         |
|-------------|---------------|---------|
| 0404        | -0.2 dpm      | A. 0404 |
| 0405        | -0.1 dpm      | B. 0405 |
| 0407        | +0.1 dpm      | C. 0407 |
| 0409        | +0.2 dpm      | D. 0409 |

## Example Question #3

---

Another Hypothetical Plant: SIAS  
Actuation and injection results in  
EAL upgrade

Unit 1 SIAS = 1600 psia

Unit 2 SIAS = 1736 psia



## Example Question #3

---

Unit 1 is at 100% power. [...]

Which ONE of the following states

- 1) ...
- 2) What condition would result in Escalation of the EAL?

# Example Question #3

- A. 1)
  - 2) Unit trips, RCS pressure stable at 1690 psia
- B. 1)
  - 2) Unit trips, RCS pressure stable at 1550 psia
- C. 1)
  - 2) Unit trips, RCS pressure stable at 1690 psia
- D. 1)
  - 2) Unit trips, RCS pressure stable at 1550 psia

## Example Question #3

Unit 1 is at 100% power. [...]

Which ONE of the following states

- 1) ...
- 2) Following a unit trip, what is the EARLIEST time conditions are met that requires an escalation of the EAL?

# Example Question #3

Unit 1 is at 100% power. [...]

Which ONE of the following states

- 1) ...
- 2) Following a unit trip, what is the EARLIEST time conditions are met that requires an escalation of the EAL?

| <u>Time</u> | <u>RCS Pressure</u> |
|-------------|---------------------|
| 1234        | 1690 psia           |
| 1236        | 1550 psia           |

# Example Question #3

A. 1)  
2) 1234

B. 1)  
2) 1236

C. 1)  
2) 1234

D. 1)  
2) 1236

# Correcting the 'Subset' Issue

---

- 1. Choose an 'Appropriate' Modifier to Eliminate the 'Subset.'
- 2. Substitute a Sequence of Times as Answers to Eliminate the 'Subset.'

# Example Question #4

## Unit 1 Initial Conditions:

- 
- {power level, line-ups, controls, etc...}
- 

## Current Conditions:

- 
- 
-

# Example Question #4

## Unit 1 Initial Conditions:

- 
- {power level, line-ups, controls, etc...}
- 

## Current Conditions:

- 
- {after something happens}
-



## Example Question #4

Based on the current conditions,  
which ONE of the following is the  
correct status of the 'A' and 'B'  
Component Cooling Water (CCW)  
Pumps?  
(consider no operator actions  
occurred)

# Example Question #4

Based on the current conditions, which ONE of the following is the correct status of the 'A' and 'B' Component Cooling Water (CCW) Pumps? (consider no operator actions occurred)

A. 'A' CCW Pump is running.

## Example Question #4

Based on the current conditions, which ONE of the following is the correct status of the 'A' and 'B' Component Cooling Water (CCW) Pumps? (consider no operator actions occurred)

A. 'A' CCW Pump is running.

B. 'B' CCW Pump is running.

## Example Question #4

Based on the current conditions, which ONE of the following is the correct status of the 'A' and 'B' Component Cooling Water (CCW) Pumps? (consider no operator actions occurred)

A. 'A' CCW Pump is running.

B. 'B' CCW Pump is running.

C. BOTH 'A' AND 'B' CCW Pumps are running.

## Example Question #4

Based on the current conditions, which ONE of the following is the correct status of the 'A' and 'B' Component Cooling Water (CCW) Pumps? (consider no operator actions occurred)

- A. 'A' CCW Pump is running.
- B. 'B' CCW Pump is running.
- C. BOTH 'A' AND 'B' CCW Pumps are running.
- D. NEITHER 'A' NOR 'B' CCW Pumps are running.**

# Example Question #4

---

- A. 'A' CCW Pump is running.
- B. 'B' CCW Pump is running.
- C. BOTH 'A' AND 'B' CCW Pumps are running.
- D. NEITHER 'A' NOR 'B' CCW Pump is running.

# Example Question #4

---

- A. 'A' CCW Pump is running.
- B. 'B' CCW Pump is running.
- C. BOTH 'A' AND 'B' CCW Pumps are running.
- D. NEITHER 'A' NOR 'B' CCW Pump is running.

# Example Question #4

---

- A. 'A' CCW Pump is running.
- B. 'B' CCW Pump is running.
- C. BOTH 'A' AND 'B' CCW Pumps are running.
- D. NEITHER 'A' NOR 'B' CCW Pump is running.



# Example Question #4

---

- A. ONLY 'A' CCW Pump is running.
- B. ONLY 'B' CCW Pump is running.
- C. BOTH 'A' AND 'B' CCW Pumps are running.
- D. NEITHER 'A' NOR 'B' CCW Pump is running.

# Example Question #4

- A. 'A' CCW Pump is running. 'B' CCW Pump is NOT running.
- B. 'A' CCW Pump is NOT running. 'B' CCW Pump is running.
- C. 'A' CCW Pump is running. 'B' CCW Pump is running.
- D. 'A' CCW Pump is NOT running. 'B' CCW Pump is NOT running.

# Example Question #4

- A. 'A' CCW Pump is running.  
'B' CCW Pump is NOT running.
- B. 'A' CCW Pump is NOT running.  
'B' CCW Pump is running.
- C. 'A' CCW Pump is running.  
'B' CCW Pump is running.
- D. 'A' CCW Pump is NOT running.  
'B' CCW Pump is NOT running.

# Example Question #4

- A. (1) 'A' CCW Pump is running.  
(2) 'B' CCW Pump is NOT running.
- B. (1) 'A' CCW Pump is NOT running.  
(2) 'B' CCW Pump is running.
- C. (1) 'A' CCW Pump is running.  
(2) 'B' CCW Pump is running.
- D. (1) 'A' CCW Pump is NOT running.  
(2) 'B' CCW Pump is NOT running.

# Example Question #4

‘A’ CCW Pump is \_\_\_\_ (1) \_\_\_\_.

‘B’ CCW Pump is \_\_\_\_ (2) \_\_\_\_.

- A. (1) running  
(2) NOT running
- B. (1) NOT running  
(2) running
- C. (1) running  
(2) running
- D. (1) NOT running  
(2) NOT running

# Example Question #4

'A' CCW Pump

'B' CCW Pump

- |    |             |             |
|----|-------------|-------------|
| A. | Running     | NOT Running |
| B. | NOT Running | Running     |
| C. | Running     | Running     |
| D. | NOT Running | NOT Running |

# Correcting the 'Subset' Issue

- 1. Choose an 'Appropriate' Modifier to Eliminate the 'Subset.'
- 2. Substitute a Sequence of Times as Answers to Eliminate the 'Subset.'
- 3. Use a Favorite Format to Eliminate the 'Subset.'

# Example Question #5

## Unit 1 Initial Conditions:

- 
- {low reactor power level}
- 

## Current Conditions:

- 
- {problems with Reactor Coolant Pumps}
-



## Example Question #5

---

Based on the current conditions,  
which ONE of the following is (1)  
the NEXT operator action(s)  
required by procedure ..., AND (2)  
the reason(s) for the action(s)?

# Example Question #5

Based on the current conditions, which ONE of the following is (1) the NEXT operator action(s) required by procedure ..., AND (2) the reason(s) for the action(s)?

A. (1) Stop the 'B' RCP.  
(2) ...

# Example Question #5

Based on the current conditions, which ONE of the following is (1) the NEXT operator action(s) required by procedure ..., AND (2) the reason(s) for the action(s)?

A. (1) Stop the 'B' RCP.

(2) ...

B. (1) Manually trip the Reactor,  
then stop the 'B' RCP.

(2) ...

# Example Question #5

---

A. (1) Stop the 'B' RCP.  
(2) ...

B. (1) Manually trip the Reactor, then stop the  
'B' RCP.  
(2) ...

# Example Question #5

---

A. (1) Stop the 'B' RCP.  
(2) ...

B. (1) Manually trip the Reactor, then stop the  
'B' RCP.  
(2) ...

# Example Question #5

---

A. (1) Stop the 'B' RCP.  
(2) ...

B. (1) Manually trip the Reactor, then stop the  
'B' RCP.  
(2) ...

# Example Question #5

---

A. (1) Stop the 'B' RCP ONLY.  
(2) ...

B. (1) Manually trip the Reactor, then stop the  
'B' RCP.  
(2) ...

# Example Question #4

---

A. (1) Stop the 'B' RCP. An immediate Reactor trip is NOT required.

(2) ...

B. (1) Manually trip the Reactor, then stop the 'B' RCP.

(2) ...



# Example Question #4

---

- A. (1) An immediate Reactor trip is NOT required.  
(2) ...
  
- B. (1) An immediate Reactor trip is required.  
(2) ...

# Correcting the 'Subset' Issue

- 1. Choose an 'Appropriate' Modifier to Eliminate the 'Subset.'
- 2. Substitute a Sequence of Times as Answers to Eliminate the 'Subset.'
- 3. Use a Favorite Format to Eliminate the 'Subset.'
- 4. Re-Verify other Attributes  
( K/A Match, RO/SRO level, etc...)

# 'Subset' Issue Theorem 101

---

- If you can recognize a 'Subset' Issue, you can correct a 'Subset' Issue.
- There are multiple valid ways to correct a 'Subset' Issue.

# The End



WARNER BROS. - FIRST NATIONAL  
PICTURE

August 2, 2011

The 'Subset' Issue . . .  
Correcting a Common Psychometric Flaw

Michael K. Meeks