NRC GENERIC FUNDAMENTALS EXAMINATION

NRC/NEI Meeting
August 16, 2001

Ivan Kingsley
Sonalysts, Inc.

ATTACHMENT 6

NEW TEST ITEM DEVELOPMENT/ADMINISTRATION

- Select GFE K/A.
- Research GFE references.
- Develop draft new test item.
- Review by Sonalysts SMEs.
- Review by NRC SMEs.
- Administer on GFE.
- Sonalysts review item statistics and facility comments.
- Sonalysts recommend answer key changes.
- NRC review recommended answer key changes.
- Only valid test items retained or added to GFE question banks. Others deleted from GFE question banks.

FACILITY FEEDBACK ON GFE

Some questions on the GFE are inappropriate because the questions:

- **Require knowledge of plant systems.**
- **Require knowledge of plant operations.**

COMMENT: REQUIRES SYSTEM KNOWLEDGE

"There are many GFE K/As that directly or indirectly require some basic knowledge of power plant systems.....such as the reactor, reactor coolant system, control rod drive system, main turbine, and main generator. Without some assumed basic system knowledge, we would have to limit fundamentals knowledge testing to theoretical facts alone. By assuming some basic plant systems knowledge, we are able to move from theoretical fact testing into the real, or physical domain where our exams are more operationally valid."

NRC Response To
FAQ #4, ES-205
April 2001

SYSTEM-RELATED TERMS USED IN GENERIC K/As

Systems/Components	Implies System Knowledge
• Reactor vessel, jet pump	• Condensate depression
• Fuel pellet, rod, bundle	• Reflux boiling
• Control rod	• Natural circulation
• Main condenser	• Forced core recirculation
• MSR, feedwater heaters	• Secondary system
• Turbine, generator	• Overexcited/underexcited
• Steam bypass valves	• Steam cycle
• ECCS	• Heat balance

Expected GFE Knowledge: Major Steam Cycle Flowpaths and Basic Functions of Systems and Major Components--BWR

- Reactor core, reactor vessel, and safety valves
- Fuel bundles, control rods, and burnable poisons
- Reactor recirculation pumps and jet pumps
- Steam bypass control system
- Main turbine (incl. HP unit, LP units, and MSR)
- Main generator (incl. voltage and frequency control)
- Main condensate system
- Main feedwater system
- Emergency coolant injection systems
- Emergency diesel generator (incl. voltage and frequency control)

Expected GFE Knowledge: Major Primary and Secondary System Flowpaths and Basic Functions of Systems and Major Components--PWR

- Reactor core, reactor vessel, and reactor coolant pumps
- Fuel assemblies, control rods, and burnable poisons
- Pressurizer and safety/relief valves
- Steam generators and safety/relief valves
- Steam dump/bypass system
- Main turbine (incl. HP unit, LP units, and MSR)
- Main generator (incl. voltage and frequency control)
- Main condensate system
- Main feedwater system
- Emergency coolant injection systems
- Emergency diesel generator (incl. voltage and frequency control)

COMMENT: REQUIRES SYSTEM KNOWLEDGE

EXAMPLE OF ACCEPTABLE GFE QUESTION

PWR K/A: Define or explain the following term: pressure spike.

A plant is recovering from a loss of offsite power that caused all reactor coolant pumps (RCPs) to be lost. Pressurizer level indication is off-scale high.

Prior to starting an RCP, the steam generator (S/G) temperatures should be equal to or less than the associated reactor coolant system (RCS) loop temperature to avoid:

A. localized water hammer in the RCS.
B. pressurized thermal shock to the S/Gs.
C. a large pressure spike throughout the RCS.
D. inadvertently lifting a S/G atmospheric relief valve.

Answer: C.

Analysis: Question requires basic knowledge of RCS, pressurizer, and S/Gs that is expected of GFE examinees.

COMMENT: REQUIRES SYSTEM KNOWLEDGE

EXAMPLE OF DELETED GFE QUESTION

PWR K/A: Operation of venturis and orifices

A common method used in emergency cooling water systems to reduce the rate of flow through a pipe rupture, while allowing design cooling flow capability during normal operation, is the installation of:

A. venturis.
B. orifices.
C. redundant pumps.
D. pipe hangers.

Answer: B.

Analysis: Question "crosses the line" for system knowledge because GFE examinees are not expected to know specific ECCS system applications of orifices.

COMMENT: REQUIRES OPERATIONAL KNOWLEDGE

"The operational validity of a GFE question does not require that the applicant be able to operate the plant. However, an operationally valid GFE question does assess understanding and application of components, reactor theory, and thermodynamics within a realistic, job-related context. Therefore, the fundamental knowledge addressed by a K/A will often be tested by requiring the applicant to apply the knowledge in the context of a realistic, or operational, setting."

NRC Response To
FAQ #4, ES-205
April 2001

COMMENT: REQUIRES OPERATIONAL KNOWLEDGE

EXAMPLE OF ACCEPTABLE GFE QUESTION

BWR K/A: Calculate core thermal power using a simplified heat balance.

The power range nuclear instruments have been adjusted to 100% based on a calculated heat balance. Which one of the following will result in indicated reactor power being lower than actual reactor power?

A. The reactor recirculation pump heat input term was omitted from the heat balance calculation.
B. The feed water temperature used in the heat balance calculation was 20°F lower than actual feed water temperature.
C. The steam and feed water flow rates used in the heat balance calculation were 10% higher than actual flow rates.
D. The reactor vessel pressure used in the heat balance calculation was 30 psia higher than actual reactor vessel pressure.

Answer: D.

Analysis: Question tests the K/A in an operational setting.

COMMENT: REQUIRES OPERATIONAL KNOWLEDGE

EXAMPLE OF DELETED GFE QUESTION

PWR K/A: List reactivity control mechanisms which exist for plant conditions during the approach to criticality.

A reactor is currently subcritical with a normal reactor startup in progress. Control rod withdrawal has just been initiated. Which one of the following contains the parameter(s) that will be adjusted by the operator to make the reactor critical?

A. Control rod position only
B. RCS boron concentration and control rod position only
C. RCS flow rate, RCS boron concentration, and control rod position
D. Moderator temperature, RCS boron concentration, and control rod position

Answer: A.

Analysis: Question "crosses the line" for operational knowledge because GFE examinees are not expected to know the procedure for reactivity addition during a normal reactor startup.

SAMPLE QUESTIONS FOR TESTING AT DIFFERENT COGNITIVE LEVELS FOR IDENTICAL K/A--BWR

BWR K/A: **Calculate core thermal power using a simplified heat balance.**

Which one of the following expressions can be used to calculate core thermal power (Q_{core})?

A. $Q_{core} = Q_{Feedwater} - Q_{Steam} - Q_{CRD} - Q_{Recirc} + Q_{Ambient} + Q_{RWCU}$
B. $Q_{core} = Q_{Steam} - Q_{Feedwater} + Q_{CRD} + Q_{Recirc} - Q_{Ambient} - Q_{RWCU}$
C. $Q_{core} = Q_{Steam} - Q_{Feedwater} - Q_{CRD} - Q_{Recirc} + Q_{Ambient} + Q_{RWCU}$
D. $Q_{core} = Q_{Steam} - Q_{Feedwater} - Q_{CRD} - Q_{Recirc} - Q_{Ambient} - Q_{RWCU}$

Answer: C.

Analysis: Requires only simple memory

BWR K/A: Calculate core thermal power using a simplified heat balance.

The power range nuclear instruments have been adjusted to 100% based on a calculated heat balance. Which one of the following will result in indicated reactor power being lower than actual reactor power?

A. The reactor recirculation pump heat input term was omitted from the heat balance calculation.
B. The feed water temperature used in the heat balance calculation was 20°F lower than actual feed water temperature.
C. The steam and feed water flow rates used in the heat balance calculation were 10% higher than actual flow rates.
D. The reactor vessel pressure used in the heat balance calculation was 30 psia higher than actual reactor vessel pressure.

Answer: D.

Analysis: Requires application/analysis level of knowledge.

SAMPLE QUESTIONS FOR TESTING AT DIFFERENT COGNITIVE LEVELS FOR IDENTICAL K/A--PWR

PWR K/A: Describe CHF (critical heat flux).

The heat transfer rate that causes departure from nucleate boiling is the:

A. critical heat flux.
B. nucleate heat flux.
C. transition heat flux.
D. departure heat flux.

Answer: A.

Analysis: Requires only simple memory.

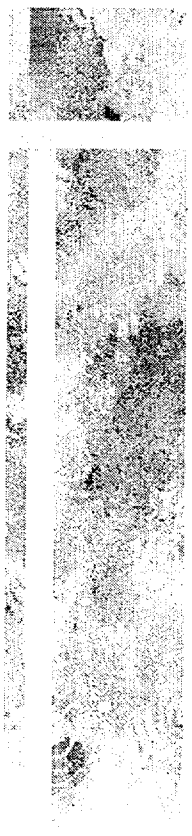
PWR K/A: Describe CHF (critical heat flux).

A reactor is operating at steady-state 75% power. Which one of the following parameter changes will cause the core to operate closer to the critical heat flux? (Assume reactor power does not change unless stated.)

A. Decrease reactor power by 10%.
B. Decrease reactor coolant flow rate by 5%.
C. Decrease reactor coolant temperature by 3°F.
D. Increase pressurizer pressure by 20 psia.

Answer: B.

Analysis: Requires comprehension level of knowledge.



"I enjoyed going through the [GFE] bank and working the problems. It helped a lot and increased my understanding of the subject matter. The way the problems used realistic examples of power plant operation helps make the connection between fundamentals and future control room operation."

Email from Reactor Operator in Training -- June 2001