U.S.NRC

United States Nuclear Regulatory Commission

Protecting People and the Environment

NRC Inspector

Field Observation Best Practices

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PHONE NUMBERS

INSPECTOR NAME _____

INSPECTOR PHONE NUMBER _____

HEADQUARTERS OPERATIONS OFFICE _____

CONTROL ROOM _____

RADIATION PROTECTION CONTROL POINT _____

SECURITY OFFICE _____

RESIDENT OFFICE _____

REGIONAL DUTY OFFICE _____

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PURPOSE

The U.S. Nuclear Regulatory Commission (NRC) developed this booklet for new inspectors. In user-friendly language, this booklet provides guidance and contains tips for an effective inspection. In writing this booklet, the author sought to combine information from veteran inspectors with best practices from all four NRC regions

NOTE: ***This guidance is not intended to be all inclusive, but rather to supplement existing inspection procedures, to heighten inspector awareness of some common inspection attributes, and to improve the effectiveness of plant walkdowns. Official agency guidance or policy is promulgated in NRC's Inspection Manual.***

GUIDANCE ON PLANT INSPECTIONS

The following plant observation opportunities are a compilation of issues identified in generic correspondence, such as generic letters and information notices, as well as other correspondence, such as value added findings (VAFs).

Personnel Performance

In addition to plant equipment issues, inspectors should also be aware of the activities of licensee personnel working around them. Particular attention should be given to the following areas:

- **Radiation protection standards and practices:** Verify that plant workers are adhering to proper radiation protection standards and practices at the facility. For example, verify that plant workers are wearing radiation dosimetry in conformance with facility-specific requirements and maximizing the use of low-dose waiting areas. During containment and other contaminated area entries, observe plant workers and verify that they are properly donning anticontamination clothing before entering the area and properly removing their protective clothing upon exiting the area. Verify that workers passing tools

and other equipment across contaminated area boundaries are following good radiation protection practices and do not violate or compromise radiation boundaries.

- **Fitness-for-duty:** Note whether plant workers are exhibiting indications that they may not be fit for duty (e.g., slurred speech, alcohol on the breath, lethargy, closed eyes, fatigue). Immediately report any observations of fitness-for-duty issues to licensee management.

- **Horseplay:** Look out for physically rough, playful behavior among plant personnel that might compromise safety. Report any observations immediately to licensee management.

- **In-hand procedures:** Verify that operators using in-hand procedures in the field follow the instructions in those procedures. Also verify that the procedures are current.

- **Unauthorized operator aids:** Operator aids are instructions, cautions, labels, or other markings on or near plant equipment to help a plant worker perform an activity. Some operator aids have been formally reviewed and approved for use, but most have not and are therefore unauthorized. Unauthorized operator aids are relatively easy to identify since most are handwritten on the equipment. Look out for potentially unauthorized aids and report them to licensee management.

- **Clearance (tagging) activities:** Improper performance of clearance (tagging) activities can lead to personnel safety hazards such as

electrical shock and increase plant risk by causing internal flooding, increasing ignition sources, and compromising defense-in-depth. During routine plant entries, watch for clearance tags on equipment associated with maintenance or modifications and verify that the clearance tags have been properly hung by comparing the information on the tags with the configuration of the equipment. (NOTE: DO NOT manipulate equipment! Verify equipment configuration by visual observation or seek the assistance of a plant operator.)

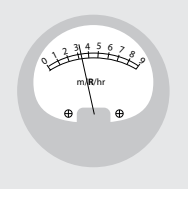
Stop - Look - Listen - Learn
Stop and stand in an area for 5 to 15 minutes. It's amazing what will stand out or who will walk by with an interesting story.

- **Foreign material exclusion (FME) controls:** The introduction of undesired (foreign) material in plant systems, areas, and components can have a significant negative impact. Licensees must therefore have adequate foreign material exclusion (FME) controls in place to ensure that foreign material is not introduced into systems during maintenance or other activities in which system boundaries are breached. During routine tours near maintenance activities, verify that licensee personnel are taking precautions to properly control foreign material. Verify that piping and system components that would otherwise be open are covered or plugged with a prefabricated FME device. In some more strict cases, such

as during work on the main turbine during an outage, licensee controls may include roping off the work area and logging tools and other equipment in and out of the area to avoid leaving anything behind. If this type of activity is taking place, verify that it is being carried out effectively and consistently and that other uncontrolled entry points do not exist. Well-defined areas of the refueling floor or fuel handling building should have strict FME controls around the spent fuel pool. Review the FME control log to ensure that the licensee is maintaining appropriate controls.

Component Related Issues

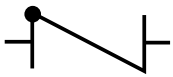
- **Gauges:** Verify that gauge indications are appropriate for the equipment's current condition. For example, a gauge that is "pegged" high could warrant additional discussion with the licensee to verify that the associated equipment is functioning properly and that the gauge itself is not damaged. Similarly, a gauge with a bent needle could indicate an extreme over-range condition, potentially impacting the calibration of the gauge.



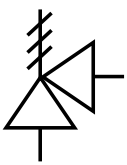
- **Thread engagement:** Inspectors have frequently identified issues involving the thread engagement of fasteners or missing fasteners. This type of issue can impact the seismic qualification of the associated equipment and therefore overall operability.

For nut/bolt arrangements, verify that all portions of a fastening nut are fully engaged with its associated fastening bolt. Verify that screws and similar fasteners are in place and appear to be tight.

- **Check valves:** Check valves commonly have an arrow or some other marking stamped on them to indicate the proper direction of fluid flow. Based on the arrangement of piping and other equipment such as pumps, verify that the orientation of a check valve appears correct.



- **Relief valves:** Similar to check valves, relief valves can be installed backwards. Look at the marking to verify that these valves are properly installed. Verify that relief valves are not artificially or mechanically held closed (gagged) when in service. Relief valves often have vendor-supplied nameplate data indicating design rating (i.e., lift pressure). The rating should be consistent with the design basis pressure of the system.



- **Welds:** Be aware of the potential impact of fatigue on piping welds that are subjected to constant or frequent vibration. Visually check that piping welds are structurally sound with no obvious cracks. Some obvious signs of a failed weld would be steam or water issuing from the crack or boric acid buildup at the weld location.

- **Pumps:** Pumps cavitate when fluid pressure near the eye of a pump is reduced to the point that cavities form in the fluid. When this happens, the cavities or bubbles collapse when they pass through the regions of higher pressure at the pump discharge resulting in noise, vibration, and sometimes erratic discharge pressure. Cavitation can damage internal pump components, including the pump impeller. Over time, the efficiency and capacity of the pump decreases, sometimes to the point that the pump is no longer able to perform adequately. Be aware of this condition and look and listen for the symptoms of pump cavitation. Another problem associated with standby pumps that discharge into hot, high-pressure systems (such as AFW pumps) is back-leakage of hot fluid into the pump through its associated discharge piping resulting in steam binding. Look for symptoms of steam binding by checking the temperature of pump casings and nearby discharge and suction piping. They should all be at ambient room temperature when the pump is idle.

- **Oil reservoirs:** Verify that oil reservoirs and other lubricating oil containers are sufficiently full for the associated equipment to operate as designed. If the reservoirs have high/low marks, verify that the oil level is where it should be. A piece of equipment may have a placard to instruct personnel on the proper oil level. Question an empty or nearly empty oil reservoir on an otherwise operable piece

of equipment. Observe the color of the oil in the oil reservoir and verify that the color is consistent with the color of the oil in the oil reservoir in a redundant piece of equipment. Excessive oil leakage on a component exhibited by saturated rags or oil puddles may be masked by equipment operators who frequently provide makeup oil to the component. This excessive leakage may prevent the component from operating without makeup and the leaked oil could also present a fire hazard.

- **Variable spring pipe supports:** Also known as spring cans, this type of pipe support allows a pipe to move due to thermal expansion while still providing dead weight support. Verify that spring cans associated with operable equipment do not have pins or locking devices installed to prevent their operation. This issue is of particular concern following a refueling outage or system overhaul activity where spring cans may have been pinned prior to the draining of system piping and components. Connections should have all fasteners in place with proper thread engagement.

- **Snubber pipe supports:** This type of pipe support allows a pipe to move gradually due to thermal expansion but rigidly locks to arrest any sudden pipe movement due to causes such as earthquake, waterhammer, or relief valve blowoff. There are two basic

types of snubbers: hydraulic and mechanical. Some operability aspects of hydraulic snubbers can be inspected visually (e.g., fluid levels/leakage, needle valve settings). However, operability for all snubber types can only be fully determined through physical bench testing. The material condition of a snubber, like any other pipe support, can be inferred by looking at the overall installation. Any misalignment of the pipe clamp and the snubber may indicate a problem. Any deformation or other sign of overloading may also indicate a problem, such as a previous waterhammer.

- **Circuit breakers:** With breakers in any position other than the seismically qualified racked-in position, the Class 1E switchgear might not function as required for a design basis seismic event. The term "racked out" is defined to include any breaker position other than the fully connected operating position. There are several intermediate positions, depending on the manufacturer and model of the switchgear. Some of these intermediate positions include the following: the "test" position in which the primary contacts are disengaged but the secondary contacts are in place so the breaker can be tested; the "disconnect" position in which both the primary and secondary contacts are disengaged, but the breaker is still in the switchgear cabinet, and in some cases, restrained; and the "removed" position, which is similar to the "disconnect" position, but the breaker is not restrained. These intermediate positions may not be seismically qualified. Question the qualification of Class 1E

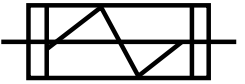
switchgear whenever the breakers in the switchgear room are observed to be in any position other than the "racked in" position. Take notice of any flags or tags and compare the position with other breakers to identify abnormal positions. Breakers free of the cabinet and any other loose equipment on wheels should have the wheels blocked to prevent movement.

Follow the string, extension cord, temporary label, or anything out of the ordinary. There's usually a story.

- **Tape and markings containing chlorides:** Although seemingly harmless, tape or markings on stainless steel piping can cause transgranular stress corrosion cracking as a result of the leeching of chlorides and can result in piping failure. Watch out for tape or markings on stainless steel piping and report observations to licensee personnel.
- **Lighting:** Verify that areas are illuminated properly through the use of permanently installed, operable lighting. Verify that lighting installed on chains or other devices allow lighting to swing freely and cannot adversely impact safety-related equipment during a seismic event. At some sites, a restraining chain or rod is used to prevent overhead light fixtures from swinging in one direction or another in the vicinity of safety-related equipment. Verify that such devices are properly installed. Verify that emergency lighting will illuminate and that the units are maintaining charge.

- **Scaffolding:** Verify that scaffolding is erected in accordance with the licensee's scaffolding erection procedures. Pay particular attention to scaffolding installed in safety-related areas. Verify scaffolding is not directly attached to instrument racks or piping supports, does not interfere with the operation of equipment such as ventilation dampers and valves, and does not block access to fire protection equipment such as hose reels, fire extinguishers, and fire doors. Scaffolding should not "shadow" overhead sprinklers. In other words, scaffolding should not block sprinkler water from reaching potentially combustible hazards below or adjacent to the scaffolding.

- **Heat exchangers:** A significant amount of industry operating experience exists regarding the clogging of heat exchangers and coolers. Observe the flow of coolant through this equipment by local indication and identify any low-flow condition through a comparison with flow indication from a redundant heat exchanger. Compare the orientation of the end bell of one heat exchanger to the orientation of a similar redundant train heat exchanger end bell to confirm proper configuration (an improper end bell orientation can significantly reduce or isolate flow to an otherwise functional heat exchanger). If you have an opportunity to observe the reassembly of a heat exchanger, verify that gaskets are properly installed such that the cooling water flowpath is not blocked



or restricted. When open, visually verify the absence of silting, biological growth, and tube plugging.

- **Electrical panels:** Confirm that electrical panels are in good material condition. Verify that electrical panels have all bolts and/or thumbscrews securely in place to ensure seismic qualification is maintained. Verify that there is not an excessive amount of dust or debris on the panels. Verify that electrical panels and cabinets do not have holes or other openings that could allow moisture to penetrate the outside of the cabinet. Other signs of electrical cabinet degradation are excessive heat outside the cabinet and abnormal sounds or smells.

- **Conduit seals:** Verify that conduit seals are properly installed and are in good material condition. Verify that conduit seals are properly attached to conduits that contain instrumentation (signal) cables associated with the reactor protection system. These seals, if improperly installed, can allow interference signals from radios or other devices to initiate a reactor trip signal.

- **Seal leakage:** During operation of raw water systems (such as service water that can have varying amounts of seal leakage), verify that any seal leakage is not spraying on the adjacent electrical components or bearing housings. Significant water intrusion into the bearing housing can occur in certain conditions. Spray shields can also inadvertently direct the leakage to the bearing housing.

- **Motors:** Verify the material condition of motors when in operation. A motor that is operating with degraded windings or some other material condition issue can frequently be detected by resting the back of a hand (for personal safety) on the casing of the motor and comparing the temperature to the temperature of a similar operating motor. Motors can also overheat if the motor vents are blocked or clogged by an accumulation of grease and dust. Verify that motor vents are free of such debris.

Watch for and take advantage of opportunities to tour normally inaccessible areas. (Also see IMC-2515, Appendix D.)

- **Freeze seals:** Freeze seals are used to isolate components during maintenance in locations that cannot otherwise be isolated. The seal is created and maintained by applying a cooling agent such as liquid nitrogen to the exterior of the piping. The cooling agent freezes the water within the piping section, sealing the pipe. Freeze seal failures can be significant because of the potential for consequential failures such as the loss of decay heat removal or unexpected loss of primary coolant. Verify that freeze seals are being properly monitored and maintained.

- **Submergence of electrical circuits:** In some cases electrical cables that have been submerged in water for an extended period have degraded to the point of failure. Typically, these cables are underground and can only be accessed through inspection manholes. Although it is unlikely that these manholes will be open for inspection, if the opportunity arises, verify that underground cables are maintained in a dry environment. If cables are found submerged, verify that the cables are designed for that environment and that other conditions that could adversely impact the cable, such as corroded cable supports and cable jacket tears, do not exist. (Also see IP 71111.01.)

- **Boric acid corrosion:** Boric acid is used in pressurized water reactors as a reactivity control agent. Its concentration in the reactor coolant is normally less than about 1.0 weight percent. At this concentration, boric acid will not cause significant corrosion even if it comes in direct contact with carbon steel components. In many cases, however, coolant that leaks out of the reactor coolant system loses a substantial volume of its water through evaporation, resulting in the formation of a highly concentrated boric acid solution or boric acid crystal deposits. A concentrated solution of boric acid may be very corrosive, and if not addressed, can have a significant adverse impact on plant components, particularly on carbon steel. The most effective way to prevent boric acid corrosion is to minimize reactor coolant system leakage.

This can be achieved by frequent monitoring of the locations where potential leakage could occur and repairing the leaking components as soon as possible. Verify that there are no boric acid leaks (by looking for boric acid residue) and inform licensee personnel of previously unidentified leaks or if it appears that leaks may not have been fixed.

- **Waterhammer:** Waterhammer is an impulse load created by the sudden stopping and/or starting of a liquid flow which may occur when a valve is opened or closed. The resulting pressure load can have a catastrophic impact on pumps, pressure transducers, turbines, and valves. Waterhammer events typically occur in milliseconds but may last several seconds in large systems. Obvious signs of waterhammer damage include physically distorted piping, supports, and other structural components. Other signs of waterhammer are a "pinging" noise and/or visible piping deflections when the system is in operation. A more subtle sign of waterhammer damage is slightly displaced supports. Look for paint scraping off piping as the support is forced along the piping by the waterhammer. Also look for wall support plates that are separated from the wall by a gap larger than the thickness of an index card. Inform licensee personnel about potential waterhammer damage.

Get out in the field, especially during testing and outages. When you know what normal looks like, abnormal will jump out at you.

- **Heavy loads:** The movement of heavy loads, such as the reactor vessel head or spent fuel storage casks, can have a catastrophic impact if these loads were to fall unexpectedly. Keep informed about schedules of heavy load lifts. Verify to the extent practicable that they are being conducted safely. Verify that a crane flagman is present, if required. Verify that the crane or lifting device is rated above the weight of the load being lifted. Verify the rigging is in good physical condition and has been properly inspected. Look at the general condition of the crane or lifting device. Immediately inform licensee personnel about any cracks indicative of an overloaded condition. Verify that the licensee is following the previously evaluated safe load path. (Also see IP 71111.20 and OpESS FY2007-03.)

- **Temporary radiation shielding:** Lead blankets, sheets, and blocks are sometimes used to shield personnel from radiation sources such as piping systems, components, etc. If licensee staff have attached blankets, sheets, and blocks directly to piping and supports, the weight can stress the components. Temporary shielding should have its own structural support. Temporary shielding should not be supported by the

system components unless analysis has verified that the additional weight is acceptable.

- **Painting:** Painting can have a positive impact on material preservation and overall equipment appearance and can also allow underlying material condition deficiencies to become more readily apparent. However, if not properly done, painting can make equipment inoperable and unavailable. Verify that licensee painting activities have not adversely impacted the painted equipment. Verify that vent holes on pump casings and oil reservoirs have not been painted over, affecting equipment performance. Verify that painting in the vicinity of moving equipment, such as emergency diesel generator fuel racks, does not inadvertently "lock up" the fuel racks, preventing the diesel from attaining rated speed. Another aspect of painting activities to consider is the detrimental impact of paint fumes on the charcoal filters of an emergency filtration system such as the standby gas treatment system in a boiling water reactor. If these systems are in operation during or soon after a painting activity, the charcoal filters may be rendered inoperable in a very short period of time, effectively rendering the entire safety-related system inoperable. Confirm that painting activities are not being conducted in conjunction with emergency filtration system operation (e.g., during surveillance testing).

- **Housekeeping:** Housekeeping and overall cleanliness indicates the general attitude of licensee personnel. For example, a licensee organization that demands that the plant be maintained in a good housekeeping condition is also likely to have strong standards regarding other, more significant, aspects of the operation of the facility. Immediately alert licensee personnel about housekeeping issues that could result in a personnel safety hazard (e.g., standing water).

Control Room Observations

Inspectors conducting inspections in the licensee's main control room have an opportunity to observe plant parameters and conditions that, although not necessarily directly related to the primary purpose for their inspection, can provide valuable information concerning licensee performance. In particular, the inspector should look for system components that are in an unexpected configuration or parameters that are at unexpected values based on the operational mode of the plant. Note any adverse plant parameter trends and whether the licensee is aware of the trends. Note whether the plant is in any technical specification (TS) action statement, whether the TS action statements are being met, and whether TS requirements and license conditions are being met. Review visible portions of radiation monitor indications that could provide indication of an apparent uncontrolled release. Review control room logs and equipment out-of-service or clearance logs and verify that these logs appropriately reflect

the plant status observed during the control board walkdown. Ensure that control room operators can explain lit annunciators. Verify that alarms with multiple inputs have a reflash capability to preclude masking a potential degraded condition. Verify that operators implement appropriate compensatory measures for inoperable alarms or alarms without reflash capability.

Pay attention to what is different day to day. Compare unit to unit.

Containment Conditions

Due to the inaccessibility during power operation, the containment provides a wealth of opportunities for inspectors during refueling or maintenance outages when the containment is open for inspection. Inspectors should take full advantage of this opportunity, if time and radiation conditions permit. Inspectors may review the following specific, containment-related items (also see IP 71111.20):

- **Fibrous material:** When the containment is closed after outage activities, verify that plant personnel have removed fibrous material and other materials that could threaten the operability of the containment sump or other mitigating systems.
- **Coatings:** Like fibrous material, containment coatings such as paint can peel or chip and threaten the operability of the containment sump or other mitigating systems. During a containment tour, look for this condition.

Prior to containment closeout, verify that plant personnel have identified and resolved containment coating issues.

- **Other foreign material:** Prior to final containment closeout, verify that plant personnel have removed foreign materials that could migrate to the sump during design basis accident conditions. Such foreign materials include plastic tie-wraps, duct tape, rope, flashlights, paper, loose insulation, loose insulation covering, plastic sheeting, and tools.

> ***Nothing substitutes for being there. You have to climb, look at things, and get dirty.***

- **Containment air lock closure capability:** Most plants are required to be able to expeditiously isolate containment under certain conditions during outage activities. If this capability is required, verify that the plant maintains capability through the use of quick disconnect hoses through containment air locks.

- **Sump screens:** One of the most vulnerable passive systems in the containment is the containment sump. Sump screens are required to prevent material of a certain size from entering the sump area. This is most commonly accomplished through the use of a screen material around the sump. Routinely confirm that the sump screen has no obvious defects and is intact with no gaps. Verify that

no bypass paths around the sump screen exist that could allow debris larger than the sump screen mesh size to enter the sump. Also look for oil in containment sumps. This may be indicative of oil leakage problems with equipment requiring lubricants for operation.

- **Structures near the containment wall:** At some facilities, structures such as floor grating and scaffolding are required to be maintained greater than some minimal distance from the containment wall to ensure that the integrity of the containment is maintained during a design basis or seismic event. Question the presence of permanent structures in close proximity to the containment wall.

External Event Related Issues

- **Flooding:** Flooding due to external and internal causes is a significant contributor to risk at some facilities. Flooding has the potential to render multiple trains of equipment and support equipment inoperable, resulting in a significant increase in plant risk. Flooding can also prevent or limit operator mitigation and recovery actions.

Assess the material condition of passive flood protection systems and features during routine plant entries. Look at the following features:

- sealing of equipment below the floodline, such as electrical conduits
- holes or unsealed penetrations in floors and walls between flood areas

- physical condition of flooding barriers, such as expansion joints for piping that penetrates safety-related equipment room ceilings and walls
- adequacy of watertight doors between flood areas, including door seals
- operable sump pumps, level alarms, and control circuits
- unsealed concrete floor cracks

Note whether plant personnel have removed flood barriers around a room for maintenance activities and what, if any, compensatory measures personnel have established.

When screening corrective action reports, keep a list of items to follow up on during subsequent plant tours.

- **Cold weather:** Icing and freezing from extreme cold weather conditions is a common-cause failure mechanism that can quickly affect a variety of systems, unless mitigating actions are promptly taken. Extreme cold weather conditions can affect intake structures, process lines, emergency diesel generator oil and grease viscosities, essential chillers, electrical systems, and heating, ventilation, and air conditioning systems. Lack of proper design, incomplete review of operating experience, and insufficient attention to cold weather preparations are responsible for many events that occur. Be aware of the potential for

equipment problems during cold weather conditions and inspect systems potentially affected during cold weather conditions to ensure that these systems remain operable. Review the licensee's methods for verifying proper operation of heat trace freeze protection circuits. Verify that the licensee monitors wet pipe sprinkler systems and standpipes if susceptible to freezing. During periods of cold weather, check the condition of insulation for exposed instrument sensing lines for equipment such as the secondary PORVs. Relatively small gaps in the insulation can cause the line to the controller to freeze and result in intermittent lifting or failure of the valve.

- **High winds:** High winds can present a hazard to the plant if the licensee does not properly control equipment in proximity to the switchyard. Verify that all loose metal objects (e.g., sheet metal or other metallic material that could present a shorting hazard to breakers, transformers, and other electrical equipment) are properly controlled in the event of a tornado or other high wind conditions.

Fire Protection

Fire can be a significant contributor to reactor plant risk. The fire protection program extends the concept of defense-in-depth to fire protection. Fire protection includes preventing fires from starting; rapidly detecting, controlling, and extinguishing those fires that do occur; and providing protection for structures, systems, and components (SSCs) important to safety so that

a fire that is not promptly extinguished by fire suppression activities will not prevent the safe shutdown of the reactor.

Assess the material condition of active and passive fire protection systems and features, their operational lineup, and operational effectiveness during routine plant entries. Verify the following items during these entries:

- **Control of transient combustibles and ignition sources:** Observe if transient combustible materials are in the area. If you observe transient combustibles, verify that they are controlled in accordance with licensee administrative procedures. The licensee should store transient combustibles (e.g., aerosols or combustible/flammable liquids) in approved containers and in such quantities as defined by procedure.

You must remain aware of operating experience (OpE). Frequently review value added findings. Communicate your questions and issues.

- **Control of hotwork:** Observe if plant personnel are performing any welding, grinding, brazing, or flame cutting. Verify that for all hotwork, a dedicated fire watch with a dedicated fire extinguisher is available to extinguish a fire, in accordance with licensee procedures. In general, this dedicated fire watch should not be engaged in any other activities and should remain posted for at least 30 minutes after personnel has completed hotwork.

- **Fire suppression systems:** Verify by visual observation that sprinkler heads are not obstructed by overhead equipment, that water supply valves are open, and that the fire water supply and pumping capability is available. Where a jockey pump maintains the fire protection water supply pressure, note if system maintains steady pressure or if the jockey pumps are cycle excessively. Observe any material condition issues that may affect performance of the system, such as mechanical damage, painted sprinkler heads, or corrosion. For gaseous suppression systems such as halon or carbon dioxide, verify that plant equipment does not block nozzles and impede gas dispersal. For gaseous systems, compare bottles to verify that the vent piping off the bottles is piped correctly. Verify that the suppression agent charge pressure is within the normal operating band and that supply valves are open as required. Observe any material condition that may affect the performance of the system, such as mechanical damage, corrosion, damage to doors or dampers, open penetrations (open floor drains may preclude proper gaseous concentration following actuation), or nozzles blocked by plant equipment. In rooms protected by total flooding gaseous suppression agents such as CO_2 or halon-1301, be especially sure that egress door latches fully engage. These rooms will pressurize upon system discharge; if door latches fail and allow the door to open, the room will not maintain design concentrations.

- **Manual fire fighting equipment:** Verify that the access to portable fire extinguishers is not obstructed by plant equipment or work activities. Verify that the pressure gauge reads in the acceptable range, that nozzles are clear and unobstructed, and that charge test records indicate that testing has been accomplished within the required periodicity. Verify that fire extinguishers are in good material condition . Verify that fire extinguishers are not corroded by feeling all surfaces, including the underside, for evidence of rust.

Verify that fire brigade equipment is properly stored and maintained and that personal protective equipment is in good condition and free of rips or tears. Equipment such as flashlights, radios, self-contained breathing apparatus (SCBA), etc. should be maintained in sufficient quantities and stored in accessible locations for fire emergencies.

- **Fire hose stations and standpipes:** Verify that the general condition of fire hose stations is satisfactory:

  — fire hose is in satisfactory material condition

  — fire hose nozzle is not mechanically damaged and is correct for the application

  — valve handwheels are in place

  — fire hose reel is correctly mounted to the fire hose standpipe, has free movement and is not otherwise obstructed by plant equipment

— a spanner wrench is in close proximity to the fire hose station to aid in the operation of the isolation valves and

— the seal to prevent the reel from unwinding, if required, is properly wired in place when not in use.

- **Fire doors:** Observe the material condition of the fire doors. Verify that fire doors are not propped open or prevented from closing fully (such as with temporary electric cords running through a door opening) without the required impairment permits. Verify that the door latching hardware functions properly. Verify that the doors are properly closed when not in use. Caution: fire door impairment (and periodic fire watch compensatory measures) may not be sufficient for a multipurpose door (fire/high energy line break (HELB)/flood protection watertight).

- **Electrical raceway fire barrier devices:** Observe the material condition of electrical raceway fire barriers such as cable tray fire wraps. Verify that no cracks, gouges, holes, rips, or gaps exist that could compromise the ability of the material to function properly.

Focus on changes, decisions, and adjustments made in-process or with short lead times.

- **Ventilation system fire dampers:** Observe the material condition of fire dampers and verify that fusible links are in place and appear to be in good physical condition.

- **Fire proofing:** Observe the material condition of fire-proofing materials and verify that the material is installed with all areas uniformly covered with no bare areas.

- **Fire barrier and fire area/room/zone electrical penetration seals:** Observe accessible electrical and piping penetrations and verify that seals are properly installed and in good condition. Verify that core bores (holes) drilled through concrete for the passage of electrical cables between fire zones are properly sealed with fire retarding material.

- **Roll-up fire doors:** Verify that no objects or debris are in the path that would prevent the door from closing freely when needed (actuated).

- **Emergency lighting:** Verify that emergency lighting unit batteries are being properly maintained by observing the unit's lamp or meter charge rate indication and specific gravity indication. An emergency lighting unit that is continuously on fast charge is a potential indication of a failed battery. Look for other potential problems such as dirty emergency lighting lamps that decrease the output of the emergency lights, lights that are improperly aimed, and loose lamp pivot connections that result in incorrectly aimed lights.

- **Smoke detectors:** Verify that smoke detectors are installed near the ceiling and that if beam pockets are larger than 2.5 meters (8 feet) on center, a separate smoke detector is installed in each beam pocket.

- **Electrical separation criteria:** Verify that temporary electrical cables or extension cords are not draped over or tie-wrapped to safety-related conduits or near safety-related cable trays.
- **Epoxy coatings:** If not properly procured and applied, epoxy floor coatings can, under certain circumstances, represent a significant and unanticipated fire load. Verify that these coatings do not exceed more than about 1/8-inch in thickness and bring any discrepancies to the attention of licensee personnel.
- **Space heaters:** Space heaters are commonly used during the winter. Verify that licensees have considered the following items before placing space heaters in service: (1) fire hazards or combustibles near the space heater; (2) damage to or effect on the operability of equipment; and (3) the effect of accelerated aging on the environmental qualification of electrical equipment.

When emergent issues arise, walk down the issue in the field if possible. Follow up periodically until the issue is resolved to ensure conditions do not degrade further.

Security Issues

Inspectors have numerous opportunities to observe security personnel and licensee security measures during inspections and should take advantage of these opportunities to assess the security program. Most inspectors are not security experts, but with common sense and alertness an inspector can assess the effectiveness of a licensee's security organization. During daily in-processing prior to entering the plant protected area, look at security personnel operating equipment such as explosive detectors and metal detectors, and observe their response to alarms and other unusual situations. Observe security force personnel in the field and verify that they are performing their duties in a professional manner.

> ***Note:*** ***Under no circumstance should an inspector "test" the effectiveness of a licensee's security staff, such as by intentionally causing the actuation of a security alarm.***

Occupational Safety

Two memoranda of understanding (MOUs) dated October 21, 1988, and July 26, 1996, between the NRC and the Occupational Safety and Health Administration (OSHA) provide for inspector involvement, during inspections of operating reactors, in the identification and disposition of safety concerns. Notify licensee management and, as appropriate, the NRC regional office OSHA liaison officer of nonradiological hazards personally observed or reported by licensee employees.

The following specific areas should be routinely observed during an inspection of in-plant activities:

- **Personal protective equipment:** Verify personnel are wearing all required personal protective equipment (PPE) such as hearing protection, eye protection, and head protection. Additional protection may be required based on local conditions, such as "double hearing protection" in designated areas (i.e., in the emergency diesel generator room during emergency diesel generator testing); the use of a lanyard with a "break-away" feature for the display of identification badges and dosimetry; tucking in of neckties and any other loose clothing in the vicinity of rotating equipment; and footwear that is in good condition and protects against injury due to falling objects.

- **Fall-related injuries:** Safety reports indicate that the most frequently treated injuries at nuclear plants are those resulting from falls and tripping. Verify that permanent ladders firmly attached to anchor points are sturdy and do not wobble. Verify that licensee personnel using moveable ladders do so in a safe manner. A ladder tender helps avoid a fall. No one should ever stand on the top step of a ladder. Injuries can occur when personnel attempt to carry items when climbing up or down a ladder. Be aware of this when walking to/from an activity and ensure that no one is carrying more than what is safe. Verify that workers use safety harnesses, when required, to prevent a fall.

- **Electrical shock:** Electrical shock most commonly occurs from working on open wires while components are energized and from the use of unsafe extension cords and temporary service leads. Verify that this work is done in a safe manner using appropriate equipment.
- **Heat stress awareness:** Some areas of nuclear power plants may have high heat and humidity levels due to operating equipment, steam lines, and limited ventilation. Verify that licensee personnel have taken adequate precautions to protect workers from heat-related stress.
- **Containment entry:** When entering the containment under adverse environmental conditions, make sure you understand the licensee's containment entry program and its provisions for ensuring the safety of personnel. These may include prejob briefings, access and egress controls, stay-time monitoring, contingency planning, personnel accountability, in-containment telecommunications features, and operation and controls for the containment airlocks (normal and emergency).
- **Confined space entry:** Confined space accidents have resulted in fatalities at nuclear plants. Environments in which the oxygen levels are limited or unknown are considered to be confined space areas and entry into these areas is required to be strictly controlled. Verify that personnel accessing these areas are qualified, that the licensee has obtained and posted a confined space entry permit, and that the plant is meeting other confined space entry requirements.

- **Diving activities:** Diving accidents have resulted in fatalities at nuclear plants. Ensure these activities are being accomplished safely. Verify that control room personnel are aware that diving activities are occurring and that controls are in place to prevent energizing rotating equipment in the vicinity of the divers. Each diver should have a diving tender who can quickly respond to an unexpected situation.
- **Smoking area locations:** Verify that designated smoking areas are not near explosive tanks or other combustibles, such as hydrogen tanks.
- **Equipment issues:** Verify that personnel safety devices installed in the plant are in good material condition and that workers are not engaging in unsafe work practices that otherwise could be made safer with the installation of safety devices.
- **Lighting:** Verify that areas routinely entered by plant personnel are sufficiently illuminated to avoid a fall or other injury. For areas that are not routinely accessed, verify that personnel are using flashlights or other temporary lighting.
- **Scaffolding:** Temporary scaffolding can present a number of personnel safety issues if not erected properly. Verify that the scaffolding has toe-boards to prevent tools and other heavy objects from accidently being kicked off the scaffolding onto someone below. Verify that the general condition of the scaffolding is good. Always verify that a scaffold tag is in place indicating that the scaffolding has been reviewed and approved.

- **Compressed gas cylinder storage:** Due to their relatively high center of gravity when in the upright position, compressed gas cylinders can cause a worker injury if not properly stored. Verify that these cylinders are capped and controlled to prevent them from falling over. A punctured cylinder or broken valve can become a missile hazard when the compressed gas discharges.

- **Total flooding gaseous suppression areas:** In rooms protected with total flooding gaseous fire suppression systems, verify that all egress doors are properly labeled to warn occupants of a possible system discharge.

Access Controls to High Radiation Areas, Locked High Radiation Areas, and Very High Radiation Areas

- In general, areas with radiation levels of greater than 1 rem/hr must be controlled by a locked door; areas greater than 100 mrem/hr and less than 1 rem/hr must be controlled through some type of barricading device, such as a door or swing gate. Verify doors or other barriers to these areas are properly controlled. Verify that walls or other barriers, such as fences, do not have openings and are of sufficient height so that an individual cannot easily enter the area.

- Verify that an unauthorized individual cannot gain access to a very high radiation area.

Emergency Preparedness

Most inspectors are not expected to be emergency preparedness experts but common sense and awareness of basic emergency preparedness concepts, emergency response facilities and equipment, and licensee organizational structures can enable an inspector to make a basic assessment of the effectiveness of the licensee's emergency response organization.

The inspector can observe the following:

- in-plant emergency response facilities (ERF) are maintained ready
- plant announcements can be heard, especially in workshops or warehouse areas
- response team musters are well attended by the duty team
- key individuals carry devices such as pagers or phones for event response
- key management duty team decisionmakers attend team meetings and training
- operating events and experience are discussed during licensee training sessions

Inspectors should be familiar with the licensee's emergency plan (E-Plan), event classification scheme, and the general event categories (e.g., abnormal radiation levels, hazards, and fission barrier tables) so that if an event is declared, the inspector can understand its significance.

USEFUL INSPECTION TIPS

Knowledge Is Power

- Know which ventilation systems are critical support equipment (such as those for emergency diesel generators). And know the conditions for which they are required to be operable. For example, the number of ventilation fans required to be functioning may change based on outside temperatures.
- Know the basic values of key design information for the site. Know the site flooding elevation, electrical separation criteria between trains, where design ventilation boundaries are assumed, etc. Being familiar with these types of design information will enable you to identify problems, even if you do not understand the work in progress. Summary sheets for this type of information could be made up for your site, sort of a short focus briefing for each visiting inspector.
- Be familiar with the site's color coding for safety-train and instrumentation channel conduit and cabling.
- Residents should understand a licensee's security defensive strategy so when touring the plant you can observe whether you think there are any vulnerabilities. Residents who have a high level of integrated plant knowledge should work with security inspectors to identify potential vulnerabilities.
- Remain generally knowledgeable of the medical restrictions placed on operator licenses.

- A measure of a licensee's commitment to quality and safety can be determined by analyzing the effectiveness and support of the licensee's quality assurance (QA) program. Good licensees have aggressive QA programs and management that fully supports their proper implementation. It is very important to understand QA concepts and how QA systems work.

Learn To Listen, Listen To Learn

- Learn to listen. Every person you meet in the field knows something about the plant that you don't; find out what that is.
- When gathering information by talking with plant personnel, remember the saying "trust but verify." Remember that different does not necessarily mean wrong, so don't use another plant as the regulatory standard.
- Never underestimate the potential for miscommunication. Try to corroborate interviews.
- Be tactful. You want people to talk to you. Listen to what people say, regardless of their position. Janitors, craftsmen, technicians, and secretaries can all provide useful information.
- Be approachable. If people feel intimidated by you, they are far less likely to talk to you.
- Be professional. Build trust with the licensee. Trust but verify!
- Listen, Listen, Listen. Workers will tell you where to look in general conversation without making an allegation, just listen.

- Always check when engineering says that operations verifies something.
- Get to know the operators and maintenance technicians so they are comfortable in your presence. They will give you a lot of food for thought.
- Ask the same questions of several different people or several different levels of the licensee organization involved in the same issue. Afterwards, compare answers.
- Engineers, planners, and mechanics do not always have the same understanding of "skill of the craft." For example, engineers and planners sometimes expect the mechanic to go to the technical manual to determine if bolts need torquing, and if so to what tightness. The mechanics may follow training which states that if the work package doesn't call for torquing, it only gets wrench tightened. The same problem occurs with thread locking compounds.

Wear Out, Don't Rust Out

- During operation/surveillance testing of EDGs during hot summer ambient conditions, check the operational limits for the scavenging/intake air against the vendor thresholds for derating the EDG. This is particularly important if there is minimal margin between the EDG output and the required emergency loads.
- Nonroutine tasks and restoration from modifications or maintenance are always good inspection opportunities.

- Review the control room narrative log and follow up with field verification.
- Stay current on operating experience, operability determinations, risk-informed operator actions, safety evaluation reports and licensee commitments that can be verified in the field.
- You can get a lot of good leads from attending the daily reactor operators brief in the control room.
- Tour remote locations.
- Spend time with other inspectors in the plant. Two sets of eyes and two questioning minds are better than one. Make it a habit to occasionally tour the plant with other inspectors (other residents or visiting inspectors). It's a win-win situation as almost everyone can learn something.

Be Insatiably Curious

- Ask "why" a lot. Use a questioning attitude.
- Pick an item of which you are not sure of its function and take a few minutes to familiarize yourself with it. Then ask yourself whether what appears to be its function matches with your training or understanding of the plant. If not, or you are unsure, make a note to look at the final safety analysis report (FSAR) when you return to the office.
- Question the adequacy of software which performs safety functions.
- When reviewing engineering and technical work, question anything that does not comport with your BWR/PWR training.

- Maintain a questioning attitude about licensee equipment and actions that could impact the ability of safety-related equipment to fulfill its design basis functions. For example, ask the licensee is if he has performed periodic calibration or preventive maintenance. Were the actions timely and appropriate?

- Make sure that your field observations align with the design basis and good engineering judgment.

Don't Major in Minor Things

- Note whether an area has more than one train of safety-related equipment. Areas that have more than one train are prime candidates for a fire protection inspection. If the area has more than one train, check the individual plant examination (IPE) for the risk importance of the area when you get back to the office.

- Review pending licensing actions that may impact the current design basis of the plant.

- For visiting regional specialists, going over the inspection procedure with the licensee well ahead of the inspection allows the licensee to prepare a package and helps to knock off the relatively basic issues early in the inspection. This allows the inspector to effectively use his or her time to look at the more risk significant issues.

- Go back to the basis documents. What was this thing designed to do? What will it do?

The Devil Is in the Details

- Closely review licensee contingency plans for risk mitigation. Don't just look at the plan. Pick several actions. Will the components be accessible? Are special tools necessary? Are the tools prestaged? Are the personnel trained to perform the task?
- Question licensee investigations of identified problems. Resolution of one issue may leave closely related issues overlooked.
- Verify that vendor information is being properly considered in technical issues and maintenance activities. Occasionally things are not maintained or implemented as designed.
- Use your knowledge of the expected plant response and the plant design to question discrepancies overlooked by licensee personnel. This also applies in the simulator and for procedure deficiencies.
- Use the NRR Dynamic Web Site (http://nrr10.nrc.gov/nrr-office/rps/dyn/index.cfm) to do key word searches for an area you are inspecting. Put in dates for the beginning of the Reactor Oversight Program (ROP) (4/1/98) to the current date and find all non-cited violations (NCVs) for a particular subject. It can be used by new inspectors to key into problems that have occurred in the past. You can also sort by inspection procedure.
- Always bring the basics with you when you go out into the plant: a flashlight, a notebook, and a pen.

- Remember, OSHA regulations apply to you too! Wear your eye, ear, and feet protection.
- Keep a low threshold, and do not easily let the licensee "explain it away." If it does not seem right, it probably isn't.
- Gather plant status information from a variety of sources. Things should fit together. Explore disconnects.
- Accompany the system engineer on a system walkdown. You get a feel for how often he/she actually looks at the system and whether he/she has surfaced all the real issues. Written notes from past walkdowns can be very enlightening.
- Several plants, in the interest of the As-Low-As-Reasonably-Achievable initiative (ALARA), have been using video surveillance systems in lieu of more extensive operator rounds. It is useful to request entry into those areas, and you will generally find that you cannot see everything (and every area) from the camera.
- When issues surface during surveillance testing or are self-revealing in nature, ask yourself if there was some precursor or sign that could have allowed you to identify the issue sooner.
- Engage control room personnel by discussing observations.

No Time to Lose

- You don't have time to learn all of the industry's lessons through your own experiences. You must remain aware of operating experience (OE). Frequently review the value added findings on the Division of Reactor Projects (DRP) Web pages. Discuss your questions and issues with other inspectors (at other sites and within the Division of Reactor Safety (DRS)). Use the value added findings list to see what techniques have worked for others.

- Take notes. Include the FSAR and NRC SERs in your verification sources. If you can't find a requirement for something you think may be a problem, consult NUREG-0800, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants," also known as the SRP. The SRP will indicate what codes, standards, *Code of Federal Regulations* sections, regulatory guides, etc. that the staff uses to evaluate the licensee's design and operating principles. The licensee's NRC-approved QA plan, the fire protection QA plan, and other QA requirements and lists are also sources of applicable standards and regulatory guides. Do not be embarrassed to ask more experienced inspectors for opinions on your observations (however, you may want to look at the FSAR first).

- Make use of NRC operating experience. Consider creating a notebook that includes

inspection procedure (e.g., 71111.04, "Equipment Alignment"), the NRC findings, and NCVs issued in the last 2 years. This notebook will help maintain consistency and also provide information on the type of findings that other inspectors are identifying. Consider developing a tool box for every inspection procedure with a listing of applicable information such as technical specifications, FSAR, applicable licensee procedures, etc.

- Review the inspection history for your facility. (Sometimes issues have a way of recurring.)
- Pay attention to problems at other plants. Look for similarities.
- Discuss technical issues with regional specialists.
- Talk with the other resident every day about what you saw and heard.

There Are No Challenges, Only Opportunities

- Do not just focus on the root cause of an event. Think of the event in an integrated fashion—did everything function as planned and following design?
- Always maintain a questioning attitude. No matter how obvious the problem, never assume that it has already been identified and addressed. Ask open-ended questions (e.g., what can you tell me about this).

- Tour the plant slowly and look for unusual plant conditions. If you are new to a facility, it is not always easy to know what constitutes a normal situation or configuration. One method to determine whether a piece of equipment is in a normal configuration or whether a situation is acceptable is to compare the identified configuration or condition to a redundant piece of equipment or area.
- While conducting a routine inspection, use the opportunity to inspect other aspects of the licensee's facility.
- Be aware of the effect of plant problems on plant safety.

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NRC acknowledges the efforts of the Inspector Field Observation Best Practices Team for sharing their experience and knowledge with all inspectors.

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INSPECTION TIPS

- Stop–Look–Listen–Learn. Stop and stand in an area for 5 to 15 minutes. It is amazing what will stand out, or who will walk by with an interesting story.
- Get out in the field, especially during testing and outages. When you know what normal looks like, abnormal will jump out at you.
- Keep a list of follow up items when screening corrective action reports. Use this list during subsequent plant visits.
- When emergent issues arise, walk down the issue in the field, if possible. Follow up periodically until the issue is resolved to ensure conditions do not degrade further.
- Watch for and take advantage of opportunities to tour normally inaccessible areas. Nothing substitutes for "being there." You have to climb, look at things, and get dirty.
- Follow the string, extension cord, temporary label, or anything out of the ordinary. There's usually a story.
- You must remain aware of operating experience (OE). Frequently review value added findings. Communicate your questions and issues.
- Pay attention to what's different day to day. Compare unit to unit.
- Focus on changes, decisions, and adjustments made in-process or with short lead times.

Suggestions for Improvements

Please submit comments and suggestions for improvement per the requirements of Inspection Manual Chapter 0801, "Reactor Oversight Process Feedback Program."

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