GUIDANCE FOR TECHNICAL SPECIFICATION APPLICABILITY TO DEGRADED HVAC EQUIPMENT

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Abstract

Nuclear Power Plant Technical Specifications (TS) are licensing documents that govern the operation of power plants. These documents specify parameters within which the plant must operate to maintain the plant in a safe condition. Listed in the TS are plant equipment and components that must be in operation or be capable of operation for the plant to be considered safe when nuclear fuel is in the reactor. The TS defines durations of time and under what plant conditions equipment can be out of service. When TS equipment is out-of-service, the plant operates under Limiting Conditions for Operation (LCO) and the time frames and conditions specified in the LCOs must be adhered to by the plant to maintain an operating license.

Heating, ventilating, and air-conditioning (HVAC) equipment is governed by the TS. HVAC maintains temperatures within spaces containing TS equipment (either electrical, mechanical or a combination) when needed for the proper functioning of that TS equipment. In this case, the HVAC equipment is considered attendant to the TS equipment being served and, consequently, is governed by the TS.

The problem of applying TS LCOs to attendant HVAC equipment arises whenever the attendant HVAC becomes degraded or out-of-service and the component being served has a short LCO time frame. In many instances, the HVAC is expected to take longer to return to service than the short time frame allows. The LCO requires that the plant be placed in a specified condition such as shutdown or that the attendant HVAC be returned to service within the short time frame. The solution is to determine an appropriate response that will allow the HVAC to be returned to service, as soon as possible, without placing the plant in an unsafe condition.

Each of the following attributes for the attendant HVAC systems should be considered when determining if LCO entries need to be entered for degraded or out-of-service attendant HVAC systems or when providing an appropriate response that does not place the plant under an LCO.

a. Accessibility to the attendant HVAC system for maintenance post accident
b. System redundancy and reliability
c. Temperature profiles
d. Probability of an accident concurrent with a catastrophic failure of equipment
e. Alternate cooling means are available
f. The time of year
g. TS or TRM wording

Guidance for the application of each of the above attributes is provided and examples presented to illustrate how this guidance is to be applied.

Purpose

To provide a methodology for evaluating the applicability of a Limiting Condition for Operation (LCO) defined in plant Technical Specifications (TS) to the "non-TS" heating, ventilating, and air conditioning (HVAC) equipment that support TS equipment. HVAC equipment not specifically designated as TS equipment but needed for the TS equipment to function properly is considered "attendant" equipment to the TS equipment. HVAC equipment that maintains required temperatures in the area of TS equipment (as needed for the TS equipment to function properly) is considered attendant equipment. The scope of this document applies only to HVAC equipment that functions as attendant equipment to TS equipment. HVAC equipment specifically listed in TS and Technical Requirements Manual for the Improved Standard Technical Specifications (TRM), such as air cleanup systems, are not applicable to the scope of this document.

Background

Nuclear Power Plant TSs are licensing documents that govern the operation of nuclear power plants. The TS specify equipment and plant operational parameters within which the plant must operate to ensure safe operation and accident mitigation capabilities. It specifies equipment (components) that must operate under specific plant conditions for the plant to remain within analysis limits and therefore, be considered safe. Additionally, it specifies the maximum duration of

time TS equipment can be degraded or out-of-service before a plant must change its operational mode or initiate shut down. When TS equipment is removed from service, the plant must adhere to all applicable restrictions defined in the TS. When this circumstance occurs, a plant operates under "Limiting Conditions for Operation" (LCO).

Many times systems not specifically listed as TS equipment (i.e., temperature control, pneumatic air, electrical power) are needed to support TS equipment, enabling the TS equipment to fulfill its required function. "Non-TS" equipment needed to support the proper functioning of TS equipment are considered "attendant equipment". As appropriate, the functionality of attendant equipment must be considered under certain LCO conditions.

HVAC equipment maintains temperatures within spaces containing TS equipment (either electrical, mechanical or a combination) as needed for the proper functioning of that equipment. The HVAC equipment is considered attendant to the equipment in the spaces being served due to the temperature requirements that must be met. These temperature requirements must be maintained for normal, transient, and accident conditions. Therefore, HVAC serving TS equipment or components are considered TS attendant equipment and are, consequently, also governed by the TS.

The problem of applying TS LCOs to attendant HVAC equipment arises whenever the attendant HVAC renders the TS equipment it supports inoperable due to the HVAC being degraded or out-of-service, and the TS equipment has a short LCO time frame, for example six hours. This typically requires that the plant be placed in a specified condition such as shutdown or the HVAC be returned to service within the LCO time frame. In many cases, the HVAC can be expected to take longer to return to service than the TS LCO timeframe allows. A solution to this problem is to determine an appropriate response, if possible, that will allow the HVAC to be returned to service, as soon as possible, without placing the plant in an unsafe or degraded condition.

Typically HVAC TS LCO problems are encountered in the following situations: 1) Emergency Core Cooling System's (ECCS) pump rooms served by one train of cooling (i.e., cooler) 2) mechanical and electrical equipment spaces served by one train of cooling 3) mechanical and electrical equipment spaces served by two redundant trains of cooling.

The following attributes should be considered when determining if an LCO must be applied to attendant HVAC equipment that has become out-of-service, or if another response can be justified to allow the plant to continue operating without LCO restrictions being applied. Note that a single attribute is generally insufficient to justify continued operation of the TS equipment without entering an LCO. Attributes will vary with the particular situation and must be considered, as applicable, on a case-by-case basis.

Accessibility to the HVAC system for maintenance post-accident: In accordance with design-basis accident criteria, plant safety systems are designed to mitigate accidents, such as a loss of coolant accident, and require no maintenance following an accident to remain operable. This is reflected in design requirements that stipulate equipment must be able to operate for periods from 30 to 100 days following an accident. Consequently, attendant HVAC equipment may be required to also function in a post-accident situation in order to maintain the plant in a safe condition.

An attribute that may be considered in applying LCO restrictions is the accessibility of the HVAC in a post-accident situation that would enable the performance of needed maintenance on the HVAC. Use of this attribute must consider possible radiological exposure to personnel performing the defined scope of repairs in a post-accident situation. An example where this attribute cannot be applied would be in a room containing a space cooler that provides cooling to an emergency core cooling system (ECCS) pump or component. Post-accident, the area around the pump in which the cooler is physically located, would have a high level radiation field preventing personnel from performing maintenance on the attendant cooler. In this case accessibility is prevented and maintenance cannot be justified post-accident.

An example of an area that would be accessible would be a control room chiller located in a habitability space. Post-accident, the chiller would be accessible and radiation levels would not be a concern for needed maintenance activities and some credit for performing the needed maintenance post-accident can be justified. Additionally, the maintenance needed should have a well defined scope and be capable of being performed within a limited duration.

System redundancy and reliability: Systems with redundant components and proven reliability on starts or operation are unlikely to have catastrophic failures concurrent with an accident. Data gathered under implementation of the Nuclear Regulatory Commission's Maintenance Rule will provide a data base for reliability of the various systems and components. Equipment with proven reliability on starts or operation could then be credited with operating reliably and used in an operability argument. An example of this attribute would be in an electrical equipment area served by two trains of HVAC. If one train of HVAC is lost, the issue

of entering an LCO for the affected TS equipment could be required. However, having a redundant train documented to be reliable may be used to justify not entering an LCO while returning the attendant HVAC back to service.

Temperature profiles: Calculations or test data showing the expected transient temperature profiles following a loss of all cooling can be used to determine the acceptable time frames in which maintenance must be performed before temperature limits are reached. Note that many spaces in nuclear power plants are surrounded by huge masses of concrete. This concrete acts as a heat sink and can slow the rate of temperature rise in a space within one hour following a loss of all cooling. An example of this is a general space area normally maintained at 80 °F but during accident conditions temperatures may rise to 104 °F. It may take a significant amount of time, perhaps 20 hours or more, for an area temperature to increase above its accident maximum temperature in this case. This time frame would allow maintenance to be performed to return cooling prior to maximum temperatures being reached. This, of course, takes credit for the area being accessible post-accident.

Probability of an accident concurrent with a catastrophic failure of equipment: (i.e., a failure that renders the equipment completely incapable of performing its function, such as a compressor failure on a chiller). This attribute can be used to justify up to 30 days of LCO time due to the probability that an accident is highly unlikely should one train be out for maintenance. The 30 day time frame is consistent with standard TS time frames for control room chillers. This attribute should be used with a number of other attributes. This could then be used if redundant (opposite train) or alternate means (i.e., temporary cooling) were available. An example of this is an electrical equipment area such as a board room or motor control center that would be accessible post-accident. Temperatures in the area are maintained normally by a non-safety piece of equipment and served post-accident by safety-related equipment. With data showing that the non-safety equipment is reliable, then credit can be taken until the safety grade equipment is returned to service.

Alternate cooling means are available: Other cooling systems are available for cooling the space to maintain acceptable temperatures even though they may be non-safety related, opposite train, or temporary. An example of this is a space that is normally cooled by a chiller. The chiller is down to fix refrigerant leaks. Ventilation air is shown to be capable of maintaining space temperatures. An operability argument can then be made that ventilation air will maintain temperatures until the chiller is returned to service.

The time of year: NRC Generic Letter (GL) 91-18 provides guidance on this. The letter recognizes that seasonal changes make the need for HVAC unnecessary at certain times of the year. For example, heaters to maintain freeze protection would not be needed in the summer time. Another example is a chiller required for summertime operation. During cold temperatures experienced in winter, the chiller is not needed and may be taken out of service without entering an LCO.

TS wording and Technical Requirements Manual for the Improved Standard Technical Specifications (TRM) wording: The wording, as it applies to the attendant HVAC, would determine if and when the LCO would be entered. An example scenario would be an electrical equipment space air conditioning system that stops cooling. The LCO for the electrical equipment need not be entered if the HVAC serving the area has a separate LCO or TRM requirement and the LCO specifically applies to the electrical equipment and not to the HVAC.

Time frames varying from several hours to 30 days can be applied based upon a combination of the above attributes. Note that as long as the requirements for the TSs are being met, LCOs do not have to be entered. This does not relieve the plant from performing maintenance to return HVAC to an operable status.

Example Scenarios

Following are example scenarios demonstrating when an LCO entry would or would not be entered whenever attendant HVAC equipment becomes degraded or out-of-service. Out of service implies that the equipment is inoperable. These examples are not all inclusive and different attributes can be applied for a particular condition that arises:

Example of when an LCO entry would be required:

ECCS pump rooms served by one train of cooling. Pump rooms are typically served by only one train of cooling. Pump room coolers, also called air handling units, do not have their own TS but would fall under the TS requirements for the pump itself. The typical LCO time frame for non-redundant HVAC systems is seven days; however shorter time frames are used for more critical systems. Entry into an LCO for the pump is required whenever a room cooler is out of service, for example, to fix a coil leak.

This conclusion is based on the following:

- The cooler is considered attendant equipment because the pump room equipment is qualified to operate within a certain range of environmental parameters. The loss of the cooler also results in the loss of assurance that temperatures can be maintained. With the loss of the cooler, required temperatures cannot be assured and the LCO is entered.
- The system is inaccessible post-accident for maintenance. Following an accident, the pump subjects the room to radiation shine from the pump and possible airborne radiation from any seal leakage. Because the cooler is located in the in the same room as the pump, the radiation doses in these areas typically prevent personnel from entering post accident.
- The system is not redundant. Here there would need to be two coolers within the room to keep from entering the LCO.
- Temperature transients within the room may exceed the allowable maximums in a very short period of time if cooling is unavailable. Typically small spaces with high heat loads will heat up rapidly. This short time frame (usually 30 minutes or less) would prevent plant Operations personnel from taking any remedial action and therefore, results in entering an LCO.
- An alternate means of cooling is not available.

Note that an LCO would not be required to be entered if an alternate means of cooling was available. An example of an alternate means of cooling would be supplying temporary cooling to the pump room from another safety-related cooler. This safety-related cooler could be able to handle the additional load during cold outdoor temperatures experienced in the wintertime due to the low river water temperature. This is due to the fact that ECCS pump room and area coolers typically use river water as a cooling medium. The coolers are sized to remove heat based on maximum high river temperatures. With lower river temperatures, the coolers can remove more heat and, thus, are able to handle greater heat loads.

Examples of when an LCO need not be entered:

Electrical equipment areas served by one train of cooling. This differs from the above pump room example as electrical heat loads do not change dramatically from non-accident to accident conditions. LCO entries for electrical equipment, such as switchgear and motor control centers, would not be necessary provided temperatures remain below the abnormal limits for the equipment. This is based on having all of the following attributes:

- The HVAC equipment is accessible post-accident for maintenance. That is, the electrical equipment areas and their associated cooling systems can be accessed to perform needed maintenance activities following an accident.
- Temperature profiles in the space indicate that abnormal temperatures will not be reached for several hours, say 20 hours or longer, which could allow sufficient time to identify the condition and take corrective action.
- Probability of an accident is remote concurrent with the time frame the equipment is inoperable. If the probability of an accident is small during the time frame the equipment is to be out of service, then this can help support the operability call that an LCO need not be entered.
- Wording in the TS or TRM indicates that LCOs need not be entered provided temperatures remain below abnormal limits. Specific wording addressing this needs to be in the TS or TRM.

Additionally, LCOs need not be entered if data and/or analysis indicate that with cold temperatures in winter, outside air for ventilation provides adequate cooling to maintain area temperatures acceptable and below the normal maximum. An example application of this guidance is as follows:

Mechanical and electrical equipment spaces containing multiple systems and components and served by two 100 percent redundant trains of cooling. An example of this would be electrical power boards or the control room. This operability evaluation would be made if one of the two trains of equipment was out-of-service for maintenance or if there was an unanticipated failure. LCOs for the affected equipment need not be entered provided that:

- Temperature is being maintained below the abnormal maximum. The redundant train of cooling is maintaining the space temperature within the required range.
- The redundant train of equipment is operable. It is maintaining temperatures as discussed above.
- Probability of an accident is remote concurrent with the time frame the affected HVAC equipment is inoperable. If the probability of an accident is small during the time frame of the equipment being inoperable, then this can help support the operability call that an LCO need not be entered.
- Alternate cooling means are available. Additional equipment is available for cooling such as portable equipment staged to provide cooling or permanently installed ventilation equipment that can be used to provide additional cooling.

In this example, other items that may be considered are accessibility for maintenance, temperature transients in the affected areas, and time of year. Note that as this is considered a degraded condition, the HVAC still needs maintenance performed to return the equipment to service. Typically the LCO timeframe for redundant TS HVAC equipment is 30 days, and that the affected equipment should not be out of service for longer than 30 days. Typical HVAC systems that this guidance applies to are equipment needed to mitigate a Chapter 15 accident as defined in the plant's Final Safety Analysis Report, and are not already specifically covered by a TRM or TS:

ECCS pump room coolers (i.e. Residual Heat Removal (RHR), Safety Injection (SI), Reciprocal and Centrifugal Charging, Containment Spray)
Gas treatment systems room coolers
Safety-related transformer room ventilation
Vital battery room ventilation
Safety-related space room coolers
Diesel building ventilation systems
Safety-related electrical board room A/C

Note that the guidelines presented can be used to evaluate other HVAC equipment, especially equipment needed to mitigate a 10 CFR 50, Appendix R event.

Excluding Tennessee Valley Authority plants, 15 plants representing 24 units were surveyed in 1996 to obtain information on how other plants made their operability determinations when attendant HVAC equipment was out-of-service. Results of the survey indicated greater than 80 percent of the plants consider TS equipment inoperable if the attendant HVAC equipment is inoperable and they enter the applicable LCOs for the affected equipment. Six of the surveyed plants indicated they would not enter an LCO if the space temperature is below the maximum allowable design limit or an analysis exists supporting continued operation. This survey is not all inclusive and only indicates that this guidance is consistent within the industry. Respondents to the survey also indicated that TS wording is a critical item in determining operability.

Conclusion

Several attributes of attendant HVAC systems can be considered and evaluated to determine if LCO entries need to be entered for out-of-service attendant HVAC systems. Any or all of these attributes may be used to determine LCO applicability:

- Accessibility to the HVAC system for maintenance post-accident
- System redundancy and reliability
- Temperature profiles
- Probability of an accident concurrent with a catastrophic failure of redundant HVAC equipment
- Alternate cooling means are available
- The time of year
- TS wording or TRM wording

Note that degraded or out-of-service HVAC still requires that maintenance be performed. In general, the LCO time frame for redundant TS HVAC equipment is typically 30 days and attendant HVAC equipment should not be out of service for longer than 30 days. The typical LCO time frame for non-redundant HVAC systems is 7 days; however, shorter time frames are used for more critical systems.

References

1. Nuclear HVAC Utilities Group (NHUG) White Paper, "30 Day LCO Feasibility MCR Air Conditioning", Draft 1, Summer 1995.
2. Generic Letter (GL) 91-18. This has been incorporated into the NRC Inspection Manual, Part 9900.
3. LIS Survey #96075, "LIS Survey Regarding Operability Determinations When Supporting Equipment is Out of Service".
4. NUREG 1431, Westinghouse Standard Technical Specifications, Section 3.7.11, "Control Room Emergency Temperature Control System".
5. TVA Engineering Bulletin (RIMS B45 960703 001), "Guidance for Technical Specification Applicability to Attendant HVAC Equipment".