RAIO-0917-56030

September 18, 2017

Docket No. 52-048

U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
One White Flint North
11555 Rockville Pike
Rockville, MD 20852-2738

SUBJECT: NuScale Power, LLC Response to NRC Request for Additional Information No. 100 (eRAI No. 8906) on the NuScale Design Certification Application

REFERENCE: U.S. Nuclear Regulatory Commission, "Request for Additional Information No. 100 (eRAI No. 8906)," dated July 21, 2017

The purpose of this letter is to provide the NuScale Power, LLC (NuScale) response to the referenced NRC Request for Additional Information (RAI).

The Enclosure to this letter contains NuScale's response to the following RAI Questions from NRC eRAI No. 8906:

- 10.04.01-1
- 10.04.01-2
- 10.04.01-3
- 10.04.01-4
- 10.04.01-5

This letter and the enclosed response make no new regulatory commitments and no revisions to any existing regulatory commitments.

If you have any questions on this response, please contact Darrell Gardner at 980-349-4829 or at dgardner@nuscalepower.com.

Sincerely,

Zackary W. Rad
Director, Regulatory Affairs
NuScale Power, LLC

Distribution: Gregory Cranston, NRC, OWFN-8G9A
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Enclosure 1: NuScale Response to NRC Request for Additional Information eRAI No. 8906

Enclosure 1:

NuScale Response to NRC Request for Additional Information eRAI No. 8906

NuScale Power, LLC
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Response to Request for Additional Information
Docket No. 52-048

eRAI No.: 8906
Date of RAI Issue: 07/21/2017

NRC Question No.: 10.04.01-1

10 CFR 52.47(c)(2) requires that a standard design certification of “a nuclear power reactor design that … uses simplified, inherent, passive, or other innovative means to accomplish its safety functions must provide an essentially complete nuclear power reactor design except for site-specific elements such as the service water intake structure and the ultimate heat sink, and must meet the requirements of 10 CFR 50.43(e).”

GDC 60 requires, in part, a power unit design to “include means to control suitably the release of radioactive materials in gaseous and liquid effluents … produced during normal reactor operation, including anticipated operating occurrences.” As stipulated in SRP Section 10.4.1, Section II, “Acceptance Criteria”, Item 1, the design of the main condenser (MC) is acceptable if the integrated design of the system meets the requirements of GDC 60 as related to failures in the design of the system which do not result in excessive releases of radioactivity to the environment.

FSAR Tier 2, Section 10.4.1.3 states that the condenser air removal system (CARS), as described in FSAR Tier 2, Section 10.4.2, monitors the removed gases [from the main condenser] for radioactivity and can be isolated. FSAR Tier 2, Section 10.4.2.3 states that if the effluent discharge from the main condenser becomes contaminated, there is provision to detect and isolate the non-condensable gases and vapor mixture discharged flow from the CARS and manually route it to balance of plant drainage system.

As written, the staff understands that only the CARS portion is isolated but not the steam source into the main condenser (MC). Therefore, the staff is unable to determine how the main condenser meets GDC 60 to isolate its steam source upon radiation detected in the main condenser (via the CARS system).

The applicant is requested to provide additional information on the provisions to isolate the MC steam source upon radiation detection in the MC (via the CARS) or provide justification as to why the MC does not need to meet GDC 60. The applicant is also requested to include a description of any valves, automatic or manual operation, and any support system needed. The FSAR is to be modified accordingly.

NuScale Response:

Section 11.5.2.2.8 provides a description of the process radiation monitors for the Main Steam System (MSS). Section 11.5.2.1.2 provides a description of the process radiation monitors for the Condenser Air Removal System (CARS). Each of these sections states in part that the alarm setpoints, control room monitoring capability, and operator response in accordance with site procedures ensures compliance with GDC 60.

The condenser air removal system (CARS) controls the release of radioactive materials to the environment, consistent with GDC 60, by isolating flow from the CARS. There are no specific regulatory requirements in GDC 60 to isolate the steam source to the main condenser upon radiation detected in the main condenser. Isolation of the discharge flow from the CARS terminates any external releases via this pathway.

The design of these systems, control room monitoring capability, and operator response in accordance with site procedures ensures that failures in the design of the systems do not result in excessive releases of radioactivity to the environment.

FSAR Section 10.4.1.3 has been revised to include this detail.

Impact on DCA:

FSAR Section 10.4.1.3 has been revised as described in the response above and as shown in the markup provided in this response.

RAI 10.04.01-1

General Design Criterion 5 was considered in the design of the MC. The components in the MC are not shared among NPMs; therefore, the MC does not significantly impair the ability of other NPMs to perform their safety functions. Redundant radiation monitors are located on each of the two steam lines upstream of the secondary main steam isolation valves as described in Section 11.5.2.2.8. If a high radiation condition is detected on the main steam line radiation monitors (see Table 10.3-2 and Table 10.3-4), an alarm in the main control room will cue the operators to take actions to mitigate the event per applicable operating procedures. The Condenser Air Removal System also includes a monitor on the gaseous effluent discharge line as described in Section 11.5.2.1.2 which actuates an alarm in the main control room when the high and high high set points are reached. (see Table 12.3-33). Operator action will include monitoring steam generator information to determine if a steam generator tube leak or break has occurred. Actions may include shutting down the reactor module and isolating the main steam line for a leaking steam generator.

General Design Criterion 60 was considered in the design of the MC. The MC design satisfies GDC 60 with regard to control of radioactive material releases to the environment. The MC is anticipated to contain negligible quantities of radioactive contaminants during power operation and during shutdown. To control the releases of radioactive contaminants, the air and non-condensable gases in the condenser are removed by the condenser air removal system. There is no buildup of non-condensable gases in the MC during normal operations because the liquid ring vacuum pump operates continuously during operation of the MC. The CARS has process radiation monitors on the gaseous effluent lines that discharge to atmosphere capable of detecting radioactivity in the gaseous effluent. Primary-to-secondary leakage contamination and the radiological monitoring instrumentation are addressed in Section 11.5. Leakage from the hotwell is collected and retained by a leakage detection system.

RAI 10.04.01-2

Leakage from the condenser hotwell will flow into the Balance of Plant Drain (BPD) system via the turbine building floor drains as described in Section 9.3.3 and as shown on Figure 9.3.3-2. The BPD drain tanks, located adjacent to each turbine building are equipped with radiation monitors to determine if contamination is present as described in Section 9.3.3.2.1. A high-level detection shuts down the sump pumps and alarms in the main control room. Operations will then investigate and can reroute the discharge to the liquid radwaste system if the contamination is too high for offsite discharge. Once the source of contamination is determined and corrected, the BPD sump discharge will be returned to the normal offsite discharge alignment.

RAI 10.04.01-2, RAI 10.04.01-1

Collection of condensate from a condenser hotwell leak is performed by the BPD system as described in Section 10.4.1.2.2, and is not connected to the Condensate and Feedwater system. However, frequent operation of the makeup water valves between the condensate storage tank and the hotwell, a monitored parameter, will provide indirect indication of a leak.

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NRC Question No.: 10.04.01-2

GDC 60 requires, in part, a power unit design to "include means to control suitably the release of radioactive materials in gaseous and liquid effluents … produced during normal reactor operation, including anticipated operating occurrences." As stipulated in SRP Section 10.4.1, Section II, "Acceptance Criteria", Item 1, the design of the main condenser (MC) is acceptable if the integrated design of the system meets the requirements of GDC 60 as related to failures in the design of the system which do not result in excessive releases of radioactivity to the environment.

FSAR Tier 2, Section 10.4.1.3 states that leakage from the hotwell is collected and retained by a leakage detection system. However, the staff is unable to determine how the leakage will be collected and controlled.

The applicant is requested to provide additional information on how the MC design and provisions would address GDC 60 or provide justification as to why the MC does not need to meet GDC 60. The applicant is also requested to include a description of the process of draining the hotwell and the ability to maintain control of the drained, potentially radioactive liquid. The FSAR is to be modified accordingly.

NuScale Response:

Leakage from the condenser hotwell will flow into the Balance of Plant Drain (BPD) system via the turbine building floor drains as described in Section 9.3.3 and as shown on Figure 9.3.3-2. The BPD drain tanks, located adjacent to each turbine building are equipped with radiation monitors to determine if contamination is present as described in Section 9.3.3.2.1. A high-level detection shuts down the sump pumps and alarms in the main control room. Operations will then investigate and can reroute the discharge to the liquid radwaste system if the contamination is too high for offsite discharge. Once the source of contamination is determined and corrected, the BPD sump discharge will be returned to the normal offsite discharge alignment.

Collection of condensate from a condenser hotwell leak is performed by the BPD system as described in Section 10.4.1.2.2, and is not connected to the Condensate and Feedwater system.

FSAR Section 10.4.1.3 has been revised to include additional detail consistent with this response.

Impact on DCA:

FSAR Section 10.4.1.3 has been revised as described in the response above and as shown in the markup provided in this response.

RAI 10.04.01-1

General Design Criterion 5 was considered in the design of the MC. The components in the MC are not shared among NPMs; therefore, the MC does not significantly impair the ability of other NPMs to perform their safety functions. Redundant radiation monitors are located on each of the two steam lines upstream of the secondary main steam isolation valves as described in Section 11.5.2.2.8. If a high radiation condition is detected on the main steam line radiation monitors (see Table 10.3-2 and Table 10.3-4), an alarm in the main control room will cue the operators to take actions to mitigate the event per applicable operating procedures. The Condenser Air Removal System also includes a monitor on the gaseous effluent discharge line as described in Section 11.5.2.1.2 which actuates an alarm in the main control room when the high and high high set points are reached. (see Table 12.3-33). Operator action will include monitoring steam generator information to determine if a steam generator tube leak or break has occurred. Actions may include shutting down the reactor module and isolating the main steam line for a leaking steam generator.

General Design Criterion 60 was considered in the design of the MC. The MC design satisfies GDC 60 with regard to control of radioactive material releases to the environment. The MC is anticipated to contain negligible quantities of radioactive contaminants during power operation and during shutdown. To control the releases of radioactive contaminants, the air and non-condensable gases in the condenser are removed by the condenser air removal system. There is no buildup of non-condensable gases in the MC during normal operations because the liquid ring vacuum pump operates continuously during operation of the MC. The CARS has process radiation monitors on the gaseous effluent lines that discharge to atmosphere capable of detecting radioactivity in the gaseous effluent. Primary-to-secondary leakage contamination and the radiological monitoring instrumentation are addressed in Section 11.5. Leakage from the hotwell is collected and retained by a leakage detection system.

RAI 10.04.01-2

Leakage from the condenser hotwell will flow into the Balance of Plant Drain (BPD) system via the turbine building floor drains as described in Section 9.3.3 and as shown on Figure 9.3.3-2. The BPD drain tanks, located adjacent to each turbine building are equipped with radiation monitors to determine if contamination is present as described in Section 9.3.3.2.1. A high-level detection shuts down the sump pumps and alarms in the main control room. Operations will then investigate and can reroute the discharge to the liquid radwaste system if the contamination is too high for offsite discharge. Once the source of contamination is determined and corrected, the BPD sump discharge will be returned to the normal offsite discharge alignment.

RAI 10.04.01-2, RAI 10.04.01-1

Collection of condensate from a condenser hotwell leak is performed by the BPD system as described in Section 10.4.1.2.2, and is not connected to the Condensate and Feedwater system. However, frequent operation of the makeup water valves between the condensate storage tank and the hotwell, a monitored parameter, will provide indirect indication of a leak.

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NRC Question No.: 10.04.01-3

GDC 4 requires, in part, that SSCs important to safety be “appropriately protected against dynamic effects, including…the effects of discharging fluids …”

FSAR Tier 2 Section 10.4.1.3 states that the resulting flood from a failure of the MC hotwell does not prevent operation of a safety-related system because there are no such systems located in the TGB. The staff is concerned about flood waters exiting the TGB and potentially impacting SR SSCs elsewhere on the site. FSAR Tier 2, Section 10.4.5.3 states that the grade slope outside the TGB and cooling towers is such that is directs water away TGB and Cooling Tower. FSAR Tier 2, Section 3.4.2.1 states that the grade slope will be 1.5%. It is not clear to the staff, how the design, as currently stated in the FSAR, ensures the grade slope sufficiently funnels discharged water away from all structures/buildings containing safety-related SSCs. In addition, there are several buildings and structures on the site that are outside the scope of the design certification and thus their location and design could impede the ability to ensure flood waters are channeled away from SSCs important to safety.

The applicant is requested to provide additional design information, including any supporting figures, drawings, and analyses, regarding the acceptability of the 1.5% grade slope to perform its duty and protect SSCs from flood water. The applicant is also requested to add a COL item to ensure the COL applicant takes into account all final structures/buildings and site-specific grade characteristics to maintain the ability to channel flood waters away from important to safety SSCS. The FSAR is to be modified accordingly.

NuScale Response:

FSAR Section 3.8.4.1, "Description of Structures," states site grade is approximately 6” below plant grade (which is 100’ El), and that the slope is away from structures. Although there are several buildings and structures on the site that are outside the scope of the design certification, the requirements of FSAR Section 3.8.4.1 applies to all structures on the site, so these buildings and structures are included. Since the slope is away from all structures, flood waters will channel away from all structures. Additionally, the COL applicant is required to demonstrate the site is properly graded to prevent localized flooding as discussed in FSAR Table 2.0-1, under the Hydrologic Engineering subsection.

Although not written specific to the main condenser (MC) hotwell, SRP 10.4.5, Section II.1 indicates that the requirements of GDC 4 are met when flooding of safety-related areas that result from a malfunction or a failure of a component or piping of the CWS does not have unacceptable adverse effects on the functional performance capabilities of safety-related systems or components. Flood waters exiting the turbine building (TB) as a result of a failure of the MC hotwell would be bounded by the effect of flood waters exiting the TB resulting from a failure of a CWS component or piping.

SRP 10.4.1, Section III.3.A, indicates that the review criteria for a failure of a MC and the resulting flooding are met when the operation of any essential systems are not precluded. FSAR Section 3.6 describes essential systems as those required to shut down the reactor and mitigate the consequences.

The reactor building (RXB) and control building (CRB) are the only safety-related buildings on a NuScale site. The RXB contains structures, systems and components (SSCs) important to safety and the CRB supports the module protection system by housing and providing structural support. FSAR Section 3.4.1.4 addresses flooding outside the RXB and CRB and concludes by stating that the failure of equipment outside the CRB and RXB cannot cause internal flooding. Flooding exterior to the RXB and CRB would not impact the ability of the plant to safely shutdown as these structures are sealed, penetrations below grade are minimized as described in FSAR Section 3.4.2.1, and the passive safety system design of the reactor module does not require any water systems outside of the ultimate heat sink pool to provide shutdown cooling.

NuScale believes the FSAR content described above addresses the concern about flood waters exiting the TB and potentially impacting safety-related SSCs elsewhere on the site.

Impact on DCA:
There are no impacts to the DCA as a result of this response.

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NRC Question No.: 10.04.01-4

10 CFR 52.47(c)(2) requires that a standard design certification of “a nuclear power reactor design that … uses simplified, inherent, passive, or other innovative means to accomplish its safety functions must provide an essentially complete nuclear power reactor design except for site-specific elements such as the service water intake structure and the ultimate heat sink, and must meet the requirements of 10 CFR 50.43(e).”

SRP 10.4.1, Section III.3.D states that design provisions have been incorporated into the MC that will preclude component or tube failures due to steam blowdown from the turbine bypass system.

In the review of FSAR Tier 2, Section 10.4.1, the staff was unable to find information addressing the MC design provisions to preclude component and tube failures due to steam blowdown.

The applicant is requested to provide the additional MC provision information, including any supporting figures and drawings, or provide justification as to why the MC does not need to meet the SRP and 10 CFR 52.47. The FSAR is to be modified accordingly.

NuScale Response:

The main condenser is designed to accept 100% bypass steam flow using a bypass steam distribution header that guides the bypass steam away from the tubes and baffle plates that shield the condenser tubes from ricochet steam impingement. The combination of these features allows the condenser to receive bypass steam indefinitely without damage to the condenser tubes or internal components.

FSAR Section 10.4.1.2.2 has been revised as described in the response above and as shown in the markup provided in this response.

Impact on DCA:

FSAR Section 10.4.1.2.2 has been revised as described in the response above and as shown in the markup provided in this response.

The MC components include:

- condenser
- deaerator
- instrumentation
- hotwell
- inlet and outlet connections

The MC is designed to deaerate the condensate. The condenser air removal system (CARS) removes the dissolved oxygen as well as other non-condensable gases as described in Section 10.4.2.

10.4.1.2.2 System Operation

For system startup, the CARS is used to establish vacuum in the condenser. Steam from the auxiliary steam header is used to deaerate the condensate water. The auxiliary steam header is supplied steam from either the auxiliary boiler system (ABS) or from the main steam system (MSS). The deaerated condensate is routed through the condensate polishers to adjust CFWS water chemistry within limits, then to a spray line in the condenser to facilitate cleaning of the condenser hotwell.

During normal power operation, exhaust steam from the turbine is directed into the MC where the steam is expanded, condensed, and collected in the MC hotwell. The MC also receives auxiliary system flows, such as turbine bypass, feedwater heater vents and drains, and gland sealing steam spillover and drains. The condenser hotwell receives primary makeup from the condensate storage tank (CST). The condensate pumps transfer the condensate from the hotwell to the condensate polishing system.

The MC operates under a vacuum that is maintained by the CARS. Non-condensable gases and air inleakage are collected in the MC and removed by the CARS to control contaminants and maintain the secondary water chemistry within an acceptable range as described in Section 10.3.5. The system has sampling lines provided to monitor for radioactivity and water chemistry as described in Section 9.3.2.

For off-normal operations, the condenser hotwell provides excess capacity. The MC hotwell is designed to store extra full-load condensate system operating flow during normal operation. In addition, the hotwell has a standby surge storage capacity. See additional information in Table 10.4-1.

RAI 10.04.01-4

During anticipated operational occurrences (AOOs), the MC is capable of accepting full-load steam flow from the TBS in conjunction with residual turbine exhaust while maintaining a vacuum. Operation of the TBS is discussed in Section 10.4.4. To protect the MC from superheated steam from the turbine bypass, a desuperheater is installed that is capable of cooling the 100 percent turbine bypass flow of superheated steam to saturated conditions. Additionally, the main condenser contains a bypass steam distribution header that guides the bypass steam away from the tubes and a baffle plate that shields the condenser tubes from high-pressure steam impingement coming from the bypass distribution header. The combination of these features allows the condenser to receive bypass steam indefinitely without damage to the condenser tubes or internal components.

Air leakage is monitored and minimized to maintain acceptable water chemistry. Continuous deaeration is performed. The CARS discharge is also monitored to detect radiation in the system. In the unlikely event of a primary-to-secondary side leak due to a steam generator tube failure (SGTF), it is possible for the steam and the resulting condensate to become contaminated. In the event of an SGTF, the MSS and CFWS provide secondary isolation capabilities to minimize contamination.

Several methods are used to detect, control, and facilitate correction of leakage of cooling water into the condensate. The condenser is constructed of materials expected to prevent inleakage, and the module control system (MCS) is used to monitor the CFWS for inleakage. The permitted inleakage rate based on the capacity of the CPS is specified in Table 10.4-13.

To monitor for circulating water ingress, cation conductivity is measured in a number of locations in the hotwell and in the condensate lines with in-line samples.

Condensate water egress to the environment is monitored by radiation monitors on the balance-of-plant drain system (BPDS), providing a positive means of ensuring that inadvertent radioactive discharges to the environment do not occur.

The MC hotwell has water level control that provides automatic makeup or rejection of condensate water to maintain water levels within the normal operating ranges. On low water level, the makeup control valves automatically open and condensate water is gravity fed to the hotwell from the CST. On high water level the condensate reject control valves automatically open to divert water from the condensate pump discharge to the CST. Makeup and overflow needs are provided on a normal basis, with redundant emergency makeup and overflow provisions for rapid condensate level requirements during abnormal situations. The condensate storage tank is further discussed in Section 10.4.7.

The MC tubes and tubesheet overlay are constructed of materials to help prevent corrosion and erosion, compatible with the chemistry requirements for the feedwater treatment system (FWTS) and condensate polishing system (CPS). Other methods used to reduce the corrosion and erosion of MC tubes and components include:

- chemical treatment of the circulating water system as addressed in Section 10.4.5
- use of main condenser tube cleaning as described below
- control of secondary side water chemistry as described in Section 10.3.5

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NRC Question No.: 10.04.01-5

GDC 4 requires, in part, that SSCs important to safety be “appropriately protected against dynamic effects, including…the effects of discharging fluids …” Item III.2.A of SRP Section 10.4.1, “Main Condensers,” states that the requirements of GDC 4 are met by providing a means for controlling and correcting cooling water leakage into the condensate.

FSAR Tier 2, Section 10.4.1.2.2 states that [circulating water system (CWS)] cooling water ingress [into the main condenser] is monitored using cation conductivity measured at numerous locations. The module control system (MCS) is used to monitor the condensate and feedwater system (CFWS) for inleakage. The CFWS, to which the MC is connected to, is used to monitor inleakage from the CWS into the MC since the MC is part of the CFWS. This monitoring is acceptable because the CWS is pressurized while the MC runs at a vacuum, thus the direction of leakage would be from the CWS into the MC which in turn is connected to the CFWS.

The staff’s review of FSAR Tier 2, Sections 10.4.1 and 10.4.5, was unable to find information related to the control and correction of any ingress of water from the CWS once detected.

The applicant is requested to provide additional design information including any supporting figures and drawings, to demonstrate, upon detection, the ability to control and correct inleakage or provide justification as to why the MC does not need to meet GDC 4. The FSAR is to be modified accordingly.

NuScale Response:

With respect to GDC 4:

The requirements of General Design Criteria (GDC) 4, as stated in 10 CFR 50, Appendix A, applies to "structures, systems, and components (SSC) important to safety." As stated in FSAR Section 10.4.1.3, the main condenser (MC) serves no safety-related functions, is not credited for mitigation of a design basis accident (DBA), and has no safe shutdown functions. GDC 4 was considered in the design of the MC. The design of the MC provides protection of safety-related SSCs from the environmental conditions associated with normal operation, maintenance, testing, and postulated accidents. A failure of the MC hotwell that releases the water inventory and the resulting flooding does not prevent the operation of a safety-related system because no such systems are located in the Turbine Generator Buildings (TGBs). A requirement to "control and correct" any ingress of water from the cooling water system (CWS) has no applicability with respect to GDC 4.

NuScale believes that it is not necessary to provide a means for controlling and correcting cooling water leakage into the condensate in order to meet the requirements of GDC 4.

With respect to GDC 60:

FSAR Sections 11.5.2.1.6 and 11.5.2.1.7, state that the CWS is not expected to contain radioactive materials, and is not expected to become contaminated. Contamination of the main condenser could occur as a result of steam generator tube leakage. The CWS is at a higher pressure than the main condenser, thereby preventing the release of radioactive materials into the CWS. To ensure the CWS effluent is continuously monitored, the cooling tower blowdown line, cooling tower overflow line, and storm drains adjacent to the cooling towers are routed to the utility water system (UWS) where the liquid effluent is continuously monitored for radioactive materials at the point of release. System monitoring and operator response in accordance with site procedures ensures compliance with GDC 60.

FSAR Section 10.4.1.2.2 states that "several methods are used to detect, control and facilitate correction of leakage of cooling water into the condensate." Monitoring for conductivity is one of those methods which also includes a signal to the module control system (MCS). As described in FSAR Section 7.0, the MCS is one of the instrumentation and control (I&C) systems that provide the capability to control plant systems manually and automatically during normal, steady state, and transient power operation.

Small amounts of CWS inleakage to the condensate are controlled by the condensate polishers. If the leakage gets too large, as determined by the required frequency of polisher resin regenerations, operators would be expected to respond. One possible path operators could take to correct leakage, facilitated by NuScale's design, would be to take one half of the condenser out of service at a time so that any leaking tubes could be plugged while the other half remains online.

NuScale believes that the FSAR, as currently written, meets GDC 60. NuScale does not consider that GDC 4 is applicable to the design. NuScale notes that requirements for controlling and correcting CWS water leakage into the condensate are for secondary side chemistry considerations.

Impact on DCA:
There are no impacts to the DCA as a result of this response.