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January 29, 2021

U.S. Nuclear Regulatory Commission
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Subject: Reply to Notice of Violation (EA-20-066)

Reference: Notice of Violation (NRC Inspection Report No. 07201015/2020-201 September 3, 2020 ("IR")), dated December 21, 2020; Division of Fuel Management

Pursuant to 10 CFR 2.201, enclosed is the Reply to a Notice of Violation (EA-20-066) issued to NAC International Inc. on December 21, 2020. We note and appreciate your January 19th e-mail extending the response date to Friday, January 29th.

Should you have any questions regarding this reply, please contact NAC's Director of Licensing, Wren Fowler at 678-328-1236.

Kent S. Cole
President and CEO

Enclosure

Notice of Violation EA-20-066 (excerpted and included for convenience)

Reply to Notice of Violation EA-20-066

cc:

Leira Cuadrado
Chief, Inspection and Oversight Branch
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Office of Nuclear Material Safety and Safeguards

George A. Wilson
Director, Office of Enforcement

ED20210007

ENCLOSURE

NOTICE OF VIOLATION

NAC International
Norcross, Georgia

Docket No. 72-1015
EA-20-066
Enclosure to NRC December 21, 2020 NOV Letter

VIOLATION:

Based on the results of an U.S. Nuclear Regulatory Commission (NRC) inspection conducted at NAC International (hereafter referred to as NAC), on February 24-27, 2020, and subsequent NRC Headquarters in-office review through July 22, 2020, a team of inspectors identified two violations of NRC requirements. In accordance with the NRC Enforcement Policy dated January 15, 2020, the violations are listed below:

Violation 1

10 CFR 72.146(c), "Design control," requires, in part, that a certificate holder shall subject design changes, including field changes, to design control measures commensurate with those applied to the original design.

The MAGNASTOR dry cask storage system FSAR, Revision 7, Section 3.7.3.7, "Concrete Cask Tip-Over," states, in part, that the concrete cask tip-over analyses are performed using LS-DYNA.

The MAGNASTOR dry cask storage system FSAR, Revision 7, Section 3.10.4.4, "Concrete Cask Finite Element Model for Tip-Over Evaluation," states, in part, that the concrete cask, concrete pad, and soil subgrade are constructed of solid brick elements using the LS-DYNA program for cask tip-over evaluation.

Contrary to the above, on December 30, 2016, NAC (Certificate of Compliance No. 1031) implemented a design change for their MAGNASTOR dry cask storage system, Concrete Cask version 5 (CC5) without ensuring that design control measures were commensurate with those applied to Concrete Cask version 1 (CC1) of the design. Specifically, NAC failed to use the computer-based LS-DYNA, as described in the MAGANASTOR FSAR, when performing the design basis tip-over event analysis. NAC determined CC5's resulting deceleration g-loads without inputting angular velocity and mass moment of inertia into LS-DYNA; instead, NAC used a ratioing method to compare the angular velocity of CC5 to the angular velocity of the original design (CC1).

This is a Severity Level IV violation (NRC Enforcement Policy, Section 6.5.d.1).

Violation 2

10 CFR 72.48(c)(2)(viii), “Changes, tests, and experiments,” requires, in part, that a certificate holder shall obtain a CoC amendment pursuant to 10 CFR 72.244, prior to implementing a proposed change that would result in a departure from a method of evaluation described in the FSAR (as updated) used in establishing the design bases or in the safety analyses.

The MAGNASTOR dry cask storage system FSAR, Revision 7, Section 3.7.3.7, “Concrete Cask Tip-Over,” states, in part, that the concrete cask tip-over analyses are performed, in part, using the computer analysis program LS-DYNA.

Contrary to the above, on December 30, 2016, NAC (Certificate of Compliance No. 1031) failed to obtain a CoC amendment from the NRC, pursuant to 10 CFR 72.244, prior to implementing a design change that was a departure from a method of evaluation described in the MAGNASTOR FSAR (as updated). Specifically, for the MAGNASTOR dry cask storage system, Concrete Cask version 5 (CC5), NAC performed a structural evaluation of a design basis tip-over event without using the computer analysis program (LS-DYNA) specified in Section 3.7.3.7 of the FSAR. NAC completed a 10 CFR 72.48 determination, “NAC-16-MAG-018,” dated December 30, 2016, which contained a screening and a 72.48 evaluation that incorrectly concluded the design change did not involve revising or replacing an evaluation methodology described in the FSAR; which resulted in the failure to submit a license amendment request to the NRC in accordance with 72.244.

This is Severity Level III violation (NRC Enforcement Policy, Section 6.1.c.6).

NAC REPLY TO NOTICE OF VIOLATION (EA-20-066)

Summary

NAC does not contest the violations, but we disagree with certain aspects of the bases cited by the NRC for the violations as detailed below. NAC acknowledges the inadequacy of its documentation of the 10 CFR 72.48 ("72.48") screening and the 72.48 evaluation, performed in December 2016, of the modified concrete cask (CC5). However, NAC does not believe that its evaluation involved a departure from a method of evaluation ("MOE") within the meaning of 10 CFR 72.48. Contrary to the NOV, NAC did not substitute a new "ratioing method" or "linear scaling" for its existing licensing basis methodology for the non-mechanistic tip-over event. Instead, based on calculations of key inputs and reasonable engineering judgment, NAC concluded that the existing licensing basis LS-DYNA model and calculations were applicable to the modified (CC5) cask design. In these circumstances, NAC believes a violation related to its 72.48 documentation inadequacy should be classified as Severity Level (SL) IV rather than SL III. This request is additionally supported by the low safety significance to the issue and minor regulatory significance since CC6 was approved by the NRC using the method NAC used for the CC5 72.48, with CC5 meeting all the criteria NRC used in approving CC6 via this method.

NAC believes that the disagreement on certain aspects of the violations may result from reliance on the September 3, 2020 Inspection Report 07201015/2020-201 ("IR") which contained numerous anomalous statements related to the CC5 72.48, so NAC is providing an Appendix A to provide its perspective and clarification for the record. For reference, NAC has attached an Appendix B that succinctly summarizes its CC5 design change, the licensing basis MOE, and NAC's 72.48 evaluation basis related to the non-mechanistic tip-over evaluation.

NAC takes seriously its regulatory compliance obligations and has implemented several corrective and preventative actions that are common to both violations. NAC intends to implement additional actions as NAC more thoroughly understands the basis of the NRC staff's determinations described in the NRC's December 21, 2020 letter ("NOV letter").

Further, NAC urges the NRC to consider the implications this enforcement matter could have for industry implementation of 10 CFR 72.48. Throughout this process, NAC has sought to ensure a clear understanding of the facts and the basis for any violation, so that NAC and the industry can continue to have confidence in the predictability of how the 10 CFR 72.48 rule will be inspected and enforced in the future.

ORGANIZATION OF THIS RESPONSE

The NOV letter, pursuant to 10 CFR 2.201, indicated that our response "should include for each violation: (1) the reason for the violation, or, if contested, the basis for disputing the violation or severity level; (2) the corrective steps that have been taken and the results achieved; (3) the corrective steps that will be taken to avoid further violations; (4) your plan and schedule for completing short and long term corrective actions and (5) the date when full compliance will be achieved". Given that substantially the same facts are common to both violations, and that the corrective actions are likewise common, NAC has organized its response to enhance efficiency and clarity as follows:

1. VIOLATION 1 REASON FOR THE VIOLATION

2. VIOLATION 2 REASON FOR THE VIOLATION AND BASIS FOR DISPUTING THE SEVERITY LEVEL

3. CORRECTIVE STEPS THAT HAVE BEEN TAKEN AND THE RESULTS ACHIEVED
4. CORRECTIVE STEPS THAT ARE ONGOING OR WILL BE TAKEN TO AVOID FURTHER VIOLATIONS
5. PLAN AND SCHEDULE FOR COMPLETING SHORT AND LONG TERM CORRECTIVE ACTIONS
6. DATE WHEN FULL COMPLIANCE WILL BE ACHIEVED

1. VIOLATION 1 REASON FOR THE VIOLATION:

NAC does not contest Violation 1 but offers the following clarifications to make sure the record and basis for any cited violation is accurate and clear. The reason for the violation was inadequate documentation of use of design controls related to the NAC 72.48 evaluation.

NAC followed its NRC-approved QA Program and associated Quality Procedures in executing the design change for CC5. In this regard, Section 3.2.3, Conclusions, of the IR (p. 11) reinforced the adequacy of NAC's design controls:

> *"The team determined that administrative controls and procedures were adequately established to control NAC storage cask system and component design consistent with the requirements of the QAM and 10 CFR 72.146, Design control. Engineering design control program procedures and processes were clearly defined and contained adequate controls for design input, analysis, and design verification. Design verification methods (design review, alternate calculations, qualification testing) were described in procedure QP 3-4, Design Verification, with clear instructions for verifying final design adequacy."*

NAC staff executed the design change utilizing a Design Change Request, which resulted in the screening and evaluation of the change via 72.48. Since the generic FSAR pad and soil remained unchanged and the new CC5 cask and the licensing basis CC1 cask are similar in design, materials, and construction, NAC determined that the previous results of the licensing basis LS-DYNA model for CC1 were applicable to CC5 after performing calculations confirming that the angular velocities were essentially the same. NAC used the licensing basis design control measures in the FSAR. Specifically, NAC used the conservation of energy portion of the 3-part licensing basis methods of evaluation (as described further below) in the FSAR to validate the applicability of the licensing basis LS-DYNA model and results. This is validation used the relative difference in angular velocity (a key derived input) between cask design CC5 and CC1. Because the relative difference in angular velocity was less than 1%, NAC concluded that the licensing basis LS-DYNA (and ANSYS) model and calculation results were applicable to CC5

To support NAC's 72.48, NAC performed a calculation (Revision 4 of Calculation 71160-2014-Appendix H) where the FSAR conservation of energy equation portion of the MOE was used to quantify and confirm that the relative impact velocity of CC5 to CC1 was conservative or essentially the same as the licensing basis value. Because the related licensing basis *design controls were unchanged* (same basic design, materials, construction of the concrete cask impacting the same licensing basis pad), the confirmation of similar impact angular velocities was appropriate for determining if the existing LS-DYNA evaluation was representative of CC5.

NAC does not agree with the statement from the NOV letter that "NAC determined CC5's resulting deceleration g-loads without inputting angular velocity and mass moment of inertia into LS-DYNA; instead, NAC used a ratioing method to compare the angular velocity of CC5 to the angular velocity

of the original design (CC1)." The statement is technically inaccurate in that NAC did not determine g-loads, except to conclude that the existing LS-DYNA evaluation for CC1 was applicable to CC5.

Whether the similarity was presented as a ratio or a percentage variance is immaterial. NAC did not use an alternate method to LS-DYNA but concluded that the existing LS-DYNA evaluation was applicable to CC5 and did not deviate from the design controls in the FSAR.

NAC still acknowledges (as we did at the PEC) that there is an opportunity to strengthen our documentation of 72.48 evaluations related to cask design. We recognize that we did not fully document that our CC5 design change was subjected to design control measures commensurate with those applied to the original design when using the conservation of energy equations to determine the relative velocity between CC5 and CC1.

2. VIOLATION 2 REASON FOR THE VIOLATION AND BASIS FOR DISPUTING THE SEVERITY LEVEL:

NAC does not contest Violation 2 but respectfully disagrees with aspects of the NRC's analysis of Violation 2 as well as the characterization of the violation as Severity Level III. Contrary to the premises of Violation 2, NAC did not change the method of evaluation described in the FSAR by substituting linear scaling or a ratioing method for angular velocity comparisons for the licensing basis LS-DYNA impact calculations. Thus, NAC does not believe its 72.48 evaluation involved a "departure from a method of evaluation" within the meaning of the regulation. This is because it did not involve changing a method described in the FSAR to another method for the intended application that required prior NRC approval. What NAC did is rely on the existing LS-DYNA model and calculation results as applicable versus substituting an alternate linear scaling methodology in lieu of LS-DYNA. NAC acknowledges, however, that the documentation of our 72.48 evaluation was not adequate to demonstrate compliance with the requirements. NAC's broad corrective actions are designed to address this deficiency and prevent recurrence.

NAC's MOE for Cask Tip-Over Event

NAC's approach was to quantify that the impact angular velocity (a critical input to LS-DYNA) would not change. NAC used the conservation of energy part of the three-step MOE to determine that the downstream LS-DYNA and ANSYS evaluations remained representative. NAC's method of evaluation for tip-over consists of three steps as follows:

1. Using conservation of energy to determine the angular velocity prior to impact of the cask on the ISFSI pad based on its maximum potential energy.
2. Using LS-DYNA to determine the deceleration g-loads the cask experiences resulting from impact with the ISFSI pad.
3. Calculating the structural stress levels in the canister and basket with ANSYS using bounding impact accelerations.

Note that LS-DYNA is not used to calculate the maximum potential energy or resulting angular velocity prior to impact – i.e., the cask geometry and angular velocity are inputs to LS-DYNA developed from conservation of energy equations.

NAC's Approach for Tip-Over Evaluation for CC5

Contrary to the NOV letter, NAC did not replace LS-DYNA by "changing from a method described in the FSAR to another method" – in other words, NAC's 72.48 evaluation of CC5 does not involve wholesale substitution of another method or method(s) for LS-DYNA as a portion of the licensing basis MOE. Based on calculations of key inputs and reasonable engineering judgement, NAC determined that the CC5 design was essentially the same as the CC1 design and that the licensing basis for CC1 in all critical characteristics was applicable to CC5 and that no further evaluation for CC5 using LS-DYNA or ANSYS was needed. NAC's rationale was that it became clear and obvious that a cask design with essentially the same height, same materials and construction that impacted the same ISFSI concrete foundation with approximately the same impact angular velocity is going to produce essentially the same results as the licensing basis.

NRC Regulations and Guidance

NRC regulations in 10 CFR 72.48 allow a cask designer (certificate holder) to make changes to the licensing basis design of a cask without prior NRC approval, provided certain conditions are met. Pursuant to 10 CFR 72.48(c)(2)(viii), a certificate holder must obtain a CoC amendment for a proposed change that would "Result in a departure from a method of evaluation described in the FSAR (as updated) used in establishing the design bases or in the safety analyses." A "*departure*" from a MOE described in the FSAR (as updated) used in establishing the design bases or in the safety analyses is defined in 10 CFR 72.48(a)(2) as follows:

> "(i) Changing any of the elements [of] the method described in the FSAR (as updated) unless the results of the analysis are conservative or essentially the same; or
>
> (ii) Changing from a method described in the FSAR to another method unless that method has been approved by NRC for the intended application."

NRC guidance on implementing 10 CFR 72.48 is contained in the most recently published (September 22, 2020) version of Regulatory Guide 3.72, Rev. 1, *Guidance for Implementation of 10 CFR 72.48,"Changes, Tests, And Experiments*." Page 3 of Regulatory Guide 3.72, Rev. 1 states that:

> *"The statement of considerations (SOC) for the final rule states that a departure from an MOE as described in the FSAR (as updated) used in establishing the design bases or in the safety analyses means (1) changing any of the elements of the method described in the FSAR (as updated) unless the results of the analysis are conservative or essentially the same or (2) changing from a method described in the FSAR to another method unless that method has been approved by the NRC for the intended application."*

As noted in Regulatory Guide 3.72, Rev.1, the Commission explained what would constitute a "departure from a method of evaluation" in the Statement of Considerations for the 1999 final rule amending 10 CFR 50.59 and 72.48 ("1999 SOC") and allowed flexibility particularly by limiting "the need for review to those changes to methods that could impact upon the acceptability of performance were the results to be at the limiting values." Specifically, the 1999 SOC stated as follows:[3]

> *"For the purposes of this rule, a departure from a method of evaluation described in the FSAR (as updated) used in establishing the design bases or in the safety analyses means (1) changing any of the elements of the method described in the FSAR (as updated) unless the results of the analysis are conservative or essentially the same;*

[3] 64 Fed. Reg. 53582, 53598 (October 4, 1999).

> *or (2) changing from a method described in the FSAR to another method unless that method has been approved by NRC for the intended application. Results from a changed method are conservative relative to results from the previous method, if closer to the limits or values that must be satisfied to meet the design bases.*
>
> *Results are ''essentially the same'' if they are within the margin of error needed for the type of analysis being performed, even if tending in the nonconservative direction. Results are essentially the same if the variation in results because of the change to the method is explainable as routine analysis sensitivities, and the differences in the results are not a factor in determining whether any limits or criteria are satisfied. The determination can be made through benchmarking (new vs. old method) or may be apparent from the nature of the changes between the methods. When benchmarking a method to determine how it compares to the previous one, the analyses that are done must be for the same set of plant conditions, otherwise, the results may not be comparable. Approval for intended application includes assuring that the approved method was approved for the type of analysis being conducted, generically approved for the type of facility using it, and that all terms and conditions for use of the method are satisfied.*
>
> *The rule words were chosen to allow licensees only a small degree of flexibility in methods where the results are tending in the non-conservative direction, without burdening either the licensee or the NRC with the need to review very small changes that are not important with respect to the demonstrations of performance that the analyses are providing.* ***The intent is to limit the need for review to those changes to methods that could impact upon the acceptability of performance were the results to be at the limiting values.*** *(Emphasis supplied by NAC)."*

NAC's 72.48 Evaluation was Consistent with the MOE but Documentation was Lacking

Here, NAC does not believe it changed any of the elements of the MOE described in the FSAR within the meaning of 72.48(a)(2). Instead, NAC determined through its 72.48 evaluation that the licensing basis LS-DYNA model for CC1 was applicable to CC5 given the similarity in angular velocities, and cask design, materials, and construction. NAC calculated the relative angular velocities using the standard conservation of energy equation. With respect to NAC's use of a hand calculation for calculating the mass moments of inertia for CC5 and CC1, NAC believes this would fall within the "unless" exception set forth 72.48(a)(2)(ii) because that method was previously accepted by NRC for the intended application. The NAC-MPC (72-1025 - FSAR Section 11.2.12.2.1) and NAC-UMS (72-1015 – FSAR Section 11.2.12.3.1) systems are licensed by the NRC this way.

It is NAC's position that the complete reperformance of the licensing basis analysis does not need to occur in every instance of a 72.48 design change. NAC's determination that CC5 is essentially the same cask as CC1, and that no further LS-DYNA or ANSYS calculation were required is reasonable and consistent with precedent. The NRC has frequently accepted bounding or representative evaluations as part of a licensing basis or has approved license or CoC amendments that do not exercise the full extent of MOE analysis models for all evaluations in the licensing basis. A position that found that not performing all the licensing basis analyses to support a 72.48 evaluation would appear to be a new regulatory position that would significantly limit the use of the 72.48 process as it is described in the regulations.

NAC's calculation of the mass moment of inertia ("MMOI") also did not reflect a departure from the MOE. NAC calculated the MMOI in calculation 71160-2014 Appendix H for the CC5 and CC1 using hand calculations to calculate CC5's angular velocity ratio using the conservation of energy equation from the FSAR. NAC performed hand calculations for the MMOI because the intent of relative angular

velocity equation was to determine if the existing licensing basis LS-DYNA model and calculations were representative of CC5 or if a new LS-DYNA cask model and calculations were required to be performed. However, this did not constitute a “departure” because this method had been previously approved by the NRC for the intended application in connection with the NAC-MPC and NAC-UMS systems as noted above.

Please note that, with respect to the calculation of mass moment of inertia, the FSAR states in section 3.10.4.4 that the LS-DYNA is used to “automatically calculate” the MMOI of the concrete cask about the pivot point, and there is no other MAGNASTOR FSAR reference to a method of calculating MMOI. MMOI is a physical attribute of an object that can be calculated accurately by many well-established methods, including classical hand calculations. Almost every computer software that utilizes solid modelling or finite element modelling of an object (like a cask) will compute an MMOI as part of a derived input to subsequent model simulations, just as LS-DYNA does for MMOI as a derived input to LS-DYNA impact calculation. NAC’s deficiency in preparing and documenting its 72.48 evaluation was failing to recognize that the FSAR pointed only to LS-DYNA as a method for calculating the MMOI. Since the MMOI is a fundamental characteristic of an object and can be calculated accurately by many well-established methods, including classical hand calculations, NAC’s engineers assumed these classical methods of calculating MMOI could be used to determine the relative difference of the angular velocity at impact.

Thus, as we recognize, NAC’s 72.48 evaluation should have more clearly documented a change in the calculation methodology of the MMOI input of the conservation of energy portion of the MOE for tip-over (i.e., where potential energy during the tip-over calculation is equated to kinetic energy). NAC acknowledges that its use of a hand calculation for comparing the relative MMOIs of CC5 and CC1, while technically adequate and not a departure from an MOE, should have been more adequately documented since we determined that a new CC5 specific LS-DYNA analysis was not needed. The key point we want to emphasize is that this alternate method of calculating an MMOI, is not an alternate method of performing an LS-DYNA impact calculation. Although it was performed after NAC’s 2016 72.48 evaluation, NAC notes that its November 2, 2020 submittal evaluated the MMOI calculated by LS-DYNA, the hand calculation used in the 72.48, and from a detailed solid model of the cask (the most physically detailed and accurate representation of the cask). The results showed that the ratio of MMOI for CC5 to CC1 was within 1% using all the MMOI sources, which (although after the fact) shows that the MMOI aspect of the method that NAC used in its 72.48 was also “essentially the same” pursuant to 10 CFR 72.48(a)(2)(i) as the licensing basis.

NAC applied engineering judgment in its 72.48 evaluation for CC5, supported by calculations using key derived inputs. This allowed NAC to conclude that the casks (CC5 compared with CC1) were essentially the same and thus a reasonable basis existed that execution of the full LS-DYNA model unique to CC5 was not needed. It is clearly more than just an angular velocity comparison, and involves confirming similarity in pads, cask geometry, cask materials, and cask construction. This culminates in a conclusion that it is unnecessary to perform LS-DYNA analysis on CC5.

The NRC's NOV letter explains the NRC's basis for Violation 2 as follows (pages 2-3; emphasis supplied by NAC):

> *"The **use of an angular velocity ratioing method** produced inconsistent, and sometimes nonconservative results, when compared to its corresponding LS-DYNA results."*

NAC does not agree that it relied on a ratioing method to calculate accelerations in lieu of LS-DYNA. As noted, NAC used the licensing basis method of evaluation (conservation of energy equation) to determine the angular velocity for CC5 compared with that for CC1 to determine the relative difference in angular velocity between CC5 and CC1. NAC's evaluation found that the difference was *less than 1%*. NAC therefore concluded that the licensing basis LS-DYNA model and results were applicable to CC5, without the need to design and run a new LS-DYNA model. NAC considers that this approach did not represent a "departure" from the MOE within the meaning of the regulation and the Commission's explanation of the term in the 1999 SOC.

NAC respectfully disagrees that its 72.48 evaluation for CC5 reached a conclusion that "produced inconsistent and sometimes non-conservative results when compared to LS-DYNA." While NAC did not perform an LS-DYNA model for CC5 as part of its 72.48, a subsequent supplemental LS-DYNA calculation was performed as documented in our November 2, 2020 letter, which confirms our 72.48 conclusion. The LS-DYNA Basket peak acceleration was 25.8g (CC5) versus 26.6g (Licensing Basis CC1), and LS-DYNA TSC (transportable storage canister) peak acceleration was 28.9g (CC5) versus 29.6g (Licensing Basis CC1). The results show that if NAC had executed LS-DYNA calculations to support its 72.48 evaluation the results would have been bounded by the licensing basis CC1 results. **The results also show that CC5 LS-DYNA results are essentially the same as CC1 (within 3%), consistent with NAC's conclusion from its 72.48.** It is noteworthy that there are no regulatory limits for acceleration loads, and that NAC used bounding values of 35g (basket) and 40g (canister) as inputs in its ANSYS structural evaluation for the tip-over event.

Severity Level of Violation 2

NAC believes that Violation 2 should not be categorized as SL III but at a lower severity level such as but not more severe than SL IV, given that the 72.48 evaluation concluded that CC5 and the original design (CC1) were essentially similar, and the CC1 licensing basis LS-DYNA and ANSYS calculations were applicable to CC5. Thus, because the results supported a conclusion that a CoC amendment was not required, a corollary result is no substantial safety significance or regulatory significance should be associated with this violation. As noted, NAC acknowledges that our documentation of the 72.48 evaluation was not adequate to demonstrate conformance with the applicable regulatory requirements, but such a documentation deficiency should not be considered to have safety or regulatory significance for enforcement purposes.

As the basis for the SL III classification, the NOV letter states, without providing a technical basis or other rationale, that "staff determined it would not have approved the MOE used by NAC (angular velocity ratioing method) to analyze the CC5 for a cask tip-over event and that prior Commission review and approval was necessary to depart from the MOE described in the FSAR (as updated). As such, staff determined this violation impacted the NRC's ability to perform its regulatory function. Therefore, Violation 2 has been characterized in accordance with the Enforcement Policy at Severity Level III." (Emphasis supplied by NAC.)

In addition to the comparable analysis results for CC5 and the licensing basis CC1, NAC believes that NRC's recent approval of our CC6 evaluation (MAGNASTOR CoC Amendment 9) is relevant to a discussion of the severity level of Violation 2. NAC understands the NRC's concern related to the intricacies of complex impact problems involved in evaluating the non-mechanistic tip-over. NAC has agreed that the use of a simplified linear scaling methodology in lieu of LS-DYNA to calculate g-loads

as used for the APS site-specific tip-over evaluation where soil and pad conditions changed was inappropriate. However, with respect to CC5 incorporation into the FSAR, there were no soil or pad changes relative to CC1, and the CC5 cask geometry, materials, and construction characteristics were quite similar to CC1.

NAC recognizes the NRC considers that Amendment 9 was directed to CC6 and was not meant to broadly endorse the angular velocity comparison method used in Amendment 9 for all cask design changes and/or with differing soil and pad characteristics. Nevertheless, for purposes of this response to the NOV letter it is relevant that the NRC's review of Amendment 9 found that the difference in angular velocity for CC6 relative to CC1 of less than 2% *was acceptable* when certain other criteria or design controls for similarity to licensing basis analyses were met. See p. 8 discussion in the Safety Evaluation Report for MAGNASTOR Amendment No. 9 (CC6) (ML20307A119), as follows:

> *"The staff reviewed the applicant's approach and statement and although the staff finds that use of angular velocity alone is a simplistic approach that does not consider the intricacies of complex impact problems involved in evaluating the non-mechanistic tip-over. A more comprehensive evaluation that can evaluate the non-linearity in the analysis (e.g., an analytical evaluation with a LS-DYNA model) should be used for analyses involving more significant changes in angular velocity than that used for CC6 when compared to the tip-over analysis for CC1. Specifically, a comprehensive tip-over analysis should also consider variations in: (i) material properties (soils underneath the independent spent fuel storage facility (ISFSI) pad and the concrete pad [if different from the pad/soil used for CC1]; concrete cask; steel liner; basket; and fuel), (ii) geometric and material non-linear behavior during time-dependent dynamic impact loading, and (iii) interactions between soil-pad, pad-cask, and cask-internals (liner, basket and fuels), in addition to an angular velocity. This is the approach used for the analysis of tip-over for the CC1. Angular velocity is only one parameter among many modeling parameters that should be considered in the analyses of a tip-over event. However, despite having not performed a more in-depth tip-over analysis, the staff has concluded that no additional non-mechanistic tip-over analysis of the CC6 is needed, in this instance, because there is reasonable assurance that the CC6 will perform its intended safety functions under a non-mechanistic tip-over event. This is due to conservatism and similarity of the CC6 to other applicant's concrete casks as shown in Table 3.3 of this SER below. Specifically: (i) CC1 was designed with an additional 50% margin with the g-loads calculated by LS-DYNA tip-over analysis (i.e., design-basis of 35.0g and 40.0g at the top of the fuel basket and cask, respectively, compared to calculated g-loads); (ii) both the CC1 and CC6 are evaluated on the same pad; (iii) the CC1 and CC6 are of similar construction; (iv) the CC6 is shorter and has a slightly shorter center of gravity as compared to the CC1, therefore it is more stable; and (v) the initial angular velocity of CC6 is within 2% of the CC1."*

NRC documented in its SER for MAGNASTOR CoC Amendment 9 its explicit criteria and basis for accepting CC6 based on the relative velocity comparison. NAC's PEC presentation used these criteria in its evaluation of CC5 and showed compliance to the Amendment 9 criteria for use of the relative angular velocity comparison. The language in the SER for Amendment 9 does not *expressly preclude application of the criteria* to show, even if in hindsight and even for purposes of assessing the severity level of the violation here, the acceptability of NAC's CC5 evaluation from a technical standpoint. Since CC5 was *less than 1% different from CC1* on the key factor of angular velocity and CC5 met the other criteria specified by NRC, then logically CC5 would have similarly been found technically acceptable and would have likewise been approved by the NRC.

NAC's 72.48 evaluation did not rely on a linear scaling or ratioing method or otherwise depart from the licensing basis MOE. Considering the direct analog to the approval of CC6 and NAC's supplemental LS-DYNA calculation confirming the adequacy of the CC5 design, NAC respectfully requests that the NRC reconsider the Severity Level in light of the clarifications in this response.

NRC Precedent

NRC precedent indicates that violations of 10 CFR 72.48 related to a departure from a method of evaluation are generally assessed as SL IV. In most cases, the NRC has found that such violations had minor significance and were classified as SL IV violations or non-cited violations. Examples include North Anna Power Station, Notice of Violation dated July 24, 2019 (Accession No. ML19197A030)(licensee implemented a change to the North Anna ISFSI's SAR that resulted in a change to a method of evaluation – i.e. removed "the [ASME] Boiler and Pressure Vessel Code requirement to meet minimum impact toughness criteria for the lid closure bolts of the TN-32 HBU Dry Storage Cask" without seeking an amendment); TN Americas LLC, Notice of Violation dated February 13, 2017 (Accession No. ML15294A455)(a change by TN Americas to a method of evaluation in the Standard NUHOMS System FSAR for CoC 1004 was considered Severity Level IV violation of 10 CFR 72.48, later made a non-cited violation); and Holtec International, Notice of Violation dated February 24, 2011 (Accession No. ML110450157) (Severity Level IV violation of 10 CFR 72.48(c)(2)(viii), as Holtec failed to obtain a CoC amendment for a change to its FSAR that "is a departure from the method of evaluation originally used to establish the safety analysis for cladding integrity during a drop accident event").2

Potential Policy Implications

From a policy perspective, NAC notes that taking escalated enforcement (a SL III violation) for a disagreement with a CoC holder's 72.48 evaluation will create serious risk and uncertainty for the spent fuel storage cask industry. CoC holders will be uncertain as to when cask changes implemented in accordance with the 72.48 process will be challenged later by NRC staff, with the potential for escalated enforcement action for failure to request a CoC amendment even where the CoC holder's evaluation found that the criteria of 72.48 were not triggered. There are two potential reactions for licensees: 1) never change the MOE and always apply and reperform the entire licensing basis modeling and analysis for all 72.48 evaluations, or 2) submit an MOE, element of an MOE or input change to the NRC for prior approval via a license amendment request. Clearly, these responses would be at odds with the intent of the 72.48 process. In the 1999 SOC, the Commission indicated that the revisions to Sections 72.48 and 50.59 at the time were intended not to "burden" licensees or the NRC with the need to review minor changes that were not important for the demonstration of performance. 64 Fed. Reg. 53582, 53598

2/ See also, Holtec International, Notice of Violation dated April 24, 2019 (Accession No. ML19072A128) (Severity Level IV violation pursuant to the NRC Enforcement Policy, Section 6.1.d.2; three examples of failing to adequately perform a 10 CFR 72.48 evaluation prior to implementing proposed changes and failing to obtain CoC amendments pursuant to 10 CFR 72.244).

Conclusion – Violation 2:

NAC's 72.48 evaluation performed for the CC5 non-mechanistic tip-over did not result in a "departure" from the existing MOE in the licensing basis, although we acknowledge that the documentation was inadequate to demonstrate conformance with the requirements. The CC1 FSAR LS-DYNA licensing basis was reasonably determined to be applicable to CC5 based on the similar angular velocity, cask geometry, materials, and construction with the same licensing basis ISFSI pad and soil characteristics. NAC's supplemental LS-DYNA calculation confirmed the similarity in results and the adequacy of the design. Accordingly, there is low safety and regulatory significance associated with the violation.

Based upon the 1999 SOC and the regulations and including – if even in hindsight - Amendment 9 regarding CC6, NAC assumes that it is possible to comply with 72.48 in evaluations we perform of design changes for future CC"X" designs on a case-by-case basis without performing *in every instance* an analytical evaluation with a LS-DYNA model. For NAC to be expected to do so, which appears to be the premise of Violation 2, would be contrary to the SER approval of Amendment 9 with respect to CC6 as noted above.

Regarding NAC's position on Violation 2, we are hopeful that the NRC will consider NAC's thorough explanation in assessing how to characterize the violation and severity level. NAC in good faith desires closure based upon the corrective steps taken and results achieved, as described below.

3. <u>CORRECTIVE STEPS THAT HAVE BEEN TAKEN AND THE RESULTS ACHIEVED:</u>

NAC has taken several corrective steps to address the inadequate 72.48 related documentation as noted above and to prevent recurrence. The corrective steps taken by NAC were described in the presentation for the PEC (at slide 35 and 36) and included re-analysis of cask design changes and inspection of NAC 72.48 activities with respect to linear scaling and ratioing dispositions. NAC appreciates the recognition by NRC for NAC's performing re-analysis and the other corrective actions. The following is a summary of actions that have been taken, which were discussed during the PEC:

- NAC issued a self-identification report for potential escalation within NAC's Corrective Action Program ("CAP") pending the outcome of this enforcement action.

- NAC prepared an LS-DYNA model to explicitly evaluate the CC5 cask for the non-mechanistic tip-over impact onto the FSAR pad and soil. The CC5 cask was modeled in LS-DYNA using an approach consistent with the licensing basis analysis of CC1/CC2 (FSAR Sections 3.7.3.7 and 3.10.4.4). The results (NAC Calculation No. 71160-2034, Revision 0) confirmed that the LS-DYNA run produced peak accelerations for CC5 that were essentially the same as the licensing basis analysis.

- NAC performed LS-DYNA analyses for all MAGNASTOR relevant cask designs, CC3, 4, 5 and 6. These analyses found consistency with the FSAR CC1/CC2 licensing basis results and found that they remain bounded by the licensing design basis accelerations used in the FSAR ANSYS calculations.

- NAC verified that LS-DYNA was used for all subcontracted site-specific implementations of CC3, CC4, CC5 and CC6.

- NAC reviewed our earlier cask designs, the MPC and UMS systems, and found the tip-over analyses to be consistent with the current NAC MAGNASTOR licensing basis.

4. CORRECTIVE STEPS THAT ARE ONGOING OR WILL BE TAKEN TO AVOID FURTHER VIOLATIONS:

The following actions and process improvements are ongoing to enhance performance related to design control and prevent recurrence of the inadequate documentation:

- NAC has elevated the self-identification report noted above to Corrective Action Report (CAR) No. 21-01 to further improve our design control procedures associated with the 72.48 process.

- As part of the CAR No. 21-01 as noted above, NAC will do the following:

  - Perform an Extent of Condition Review.
  - Perform Root Cause Analysis with identified corrective actions to prevent recurrence.
  - Evaluate and revise NAC's design control procedures for weakness related to 10 CFR 72.146(c).
  - Evaluate and revise NAC's design control procedures for weakness related to 10 CFR 72.48(c)(2)(viii).
  - Evaluate and revise NAC's design control procedures for weakness related to Regulatory Guide 3.72, Rev. 1, NEI 12-04, Rev. 2, and NEI 96-07, Appendix B.
  - Update NAC's training program based on the above and conduct remedial training of appropriate personnel.

- NAC will add CC3 and CC4 to the calculation (NAC Calculation No. 71160-2034) for the CC5 design change. This action will support an update of the FSAR.

5. PLAN AND SCHEDULE FOR COMPLETING SHORT AND LONG TERM CORRECTIVE ACTIONS:

Actions to address the inadequate documentation are complete. Longer term actions under the CAR are tracked in our CAP as appropriate. For the additional actions listed above, the plan and schedule are below:

- The actions under the CAR are intended to be completed by second quarter of 2021.

6. DATE WHEN FULL COMPLIANCE WILL BE ACHIEVED:

NAC considers it is currently in full compliance because use of CC5 is limited to one site (APS Palo Verde) and a site-specific Tip-Over Analysis using LS-DYNA was performed (NAC Calculation No. 30032-2010) prior to the first cask loading. Likewise, for site-specific Tip-Over Analysis, NAC has performed LS-DYNA for CC3 and CC4 to determine impact accelerations.

Enclosure to ED20210007
APPENDIX A

NRC Inspection Report 072001015/2020-201 ("IR")
(Enclosure to NRC Letter September 3, 2020 (EA-20-066)

Summary of NAC Positions on Key Disagreements with NRC IR Statements

1. IR - General Comment In many locations in the IR, LS-DYNA is simply referred to as "the" method of evaluation ("MOE") for tip-over evaluations without providing an accurate description of the licensing basis MOE for tip-over evaluations presented in the NRC FSAR for MAGNASTOR.	**NAC Position** Please note that the licensing basis MOE for tip-over evaluations presented in the NAC FSAR for MAGNASTOR includes: • Application of conservation of energy to calculate impact angular velocity from the maximum potential energy position of the cask [FSAR Section 3.10.4.4] • Application of LS-DYNA to calculate g-loads (deceleration) resulting from the cask impact on the pad using impact angular velocity as an input [FSAR Section 3.7.3.7] • Application of ANSYS to calculate the maximum stress in the canister and basket resulting from the peak deceleration g-loads from LS-DYNA [FSAR Section 3 and 12]" o TSC analysis for tip-over in §3.7.1.3 o PWR Basket analysis for tip-over in §3.7.2.1.3 & §3.10.1.3.3 o BWR Basket analysis for tip-over in §3.7.2.2.2 & §3.10.2.3.3 o Summarized in Section 12.2.12.4: "The detailed structural evaluations for the TSC and basket are provided in Section 3.7.1 and Section 3.7.2, respectively. ANSYS finite element models are used to evaluate the side impact loading condition. A 40g inertial load for the canister and 35g for the baskets is conservatively considered." Thus, the representation in the IR that LS-DYNA is the only MOE for tip-over is inaccurate, which appears to have led to the misunderstanding that LS-DYNA is used to calculate angular impact velocities. Specifically, LS-DYNA uses – as an input parameter - angular impact velocity determined by the conservation of energy from the maximum potential energy. NAC did not replace LS-DYNA as part of the MOE with linear scaling or any other method to calculate g-loads. NAC evaluated and concluded that the existing licensing basis LS-DYNA calculations for CC1/2 were representative of and applicable to CC5, without reproducing LS-DYNA calculations or using a departure from the MOE. NAC quantified that the key input (angular impact velocity) for CC5 was so similar to CC1/2 (<1% difference) that no further LS-DYNA or ANSYS evaluations of CC5 tip-over would be meaningful or required. NAC also considered that, with respect to CC5 incorporation into the FSAR, there were no soil or pad changes relative to CC1, and the CC5 cask geometry, materials, and construction characteristics were quite similar to CC1. **See** NAC Predecisional Enforcement Conference Presentation ("**PEC**") **Slides 9-11, 28;** NRC PEC Transcript (ML20330A238; ADAMS Posted 12/16/2020) ("**Transcript**") **Pages 25-28, 33 and 38-39.**

2. IR p. 12, para. 2 "Instead of using LS-DYNA, NAC used linear scaling (ratios) to account for changes in the design."	**NAC Position** LS-DYNA is one element of the MOE for cask tip-over. NAC did not substitute any MOE for LS-DYNA. NAC concluded that the existing licensing basis LS-DYNA evaluation was applicable to CC5 because of similarity in design to CC1/2 (the licensing basis design). The IR refers to "linear scaling (ratios)", "linear scaling method" or "scaling method" frequently but does not state what the linear scaling method is, how it supposedly was applied, or what outputs it has produced, except in one instance (p. 13) where the IR erroneously described linear scaling as "to compare hand calculated acceleration results to the previous non-linear LS-DYNA acceleration results." **See PEC Slides 23, 32; Transcript Pages 38-40.**
3. IR p. 13, para. 1 **"**The team consulted the NRC Materials and Structural Branch in the Division of Fuel Management of the Office of Nuclear Material Safety and Safeguards and independently assessed the two cask designs and determined that the angular momentums were not the same due to the differences in the casks' masses. The inspectors determined that NAC's usage of a scaling method resulted in the errant determination that each cask had a uniform density cylinder."	**NAC Position** NAC never asserted that the casks' mass, moment of inertia or angular momentum were the same. NAC used the cask geometry, including mass and moment of inertia to determine the maximum potential energy and corresponding angular velocity immediately prior to impact. Since the generic FSAR pad and soil remained unchanged and the new CC5 cask and the licensing basis CC1 cask are similar in design, materials, and construction, NAC determined that the previous results of the licensing basis LS-DYNA model for CC1 were applicable to CC5 after performing calculations confirming that the angular velocities were essentially the same. An approximate 5-6% increase in both the cask mass and moment of inertia was accounted for in determining the CC5 angular velocity. From a technical perspective, given the same ISFSI pad and all of the similarities between the two cask designs, the critical design control parameter was confirmation of conservative or essentially the same angular velocity. With all other conditions the same or similar, a slightly heavier cask would decelerate slightly slower than a lighter one. Thus, the CC5 change while being essentially the same, would be expected to have acceleration g-loads slightly lower than CC1, as was confirmed by supplementary LS-DYNA calculations for CC5. NAC did not make any determinations nor state that each cask had a uniform density cylinder. NAC determined that, for comparison of angular velocity between the two similar cask designs, a classical representation of the moment of inertia for a uniform density cylinder could be used with limited inputs (i.e., a uniform distributed cylinder but having the correct center of gravity (CG) for the distributed system). NAC also provided supplementary information in its November 2nd submittal that demonstrated that its assessment of the relative angular velocity between CC5 and CC1/2 were very similar between its 72.48 evaluation method which used a uniform cylinder moment of inertia and the LS-DYNA moment of inertia. **See PEC Slides 19, 29, and 31; Transcript Pages 40-41, 38, 42-47 and 55.**

4. IR p. 13, para. 1 "Despite the CC1 and CC5 casks having differences (e.g., cask height, cask center of gravity, cask steel liner thickness, cask lid thickness, the addition of 3-inch steel bars in ventilation inlets to CC5, and rebar spacing) NAC failed to analyze the CC5 cask with LS-DYNA as applied to the original design."	**NAC Position** NAC showed in the PEC that the licensing basis LS-DYNA model was a simplified representation that did not explicitly model many of the listed features like cask steel liner thickness, shield bars in the vents, rebar spacing. The addition of these relatively small masses in a relatively uniform manner would not significantly alter the relative moment of inertia when comparing the two except proportionally to the mass and height/CG differences, which are accounted for in the equations NAC utilized to estimate relative angular velocities. NAC determined that all of these design changes had an approximate 5-6% increase in both the cask mass and moment of inertia. NAC properly determined that these changes in CC5 resulted in insignificant changes in the angular velocity (<1%) and CC5 was thus adequately within the margins established in the FSAR. Since all the other cask design, materials, and construction were similar, NAC determined that the existing LS-DYNA calculation was applicable to CC5. NAC believes a licensee is permitted under 72.48 the latitude to determine than a licensing basis analysis is bounding or representative without the need to re-perform the full licensing basis calculations. **See PEC Slide 30; Transcript Pages 42-44**
5. IR p. 13, para. 3 "Instead, NAC implemented a design change to particular MAGNASTOR CC designs using a linear scaling method to compare hand calculated acceleration results to the previous non-linear LS-DYNA acceleration results.	**NAC Position** NAC respectfully disagrees. This statement is incorrect. NAC did not compare hand calculated accelerations as there are no "hand calculated acceleration results" within any of NAC's CC5 72.48 evaluations. NAC determined that the angular velocity inputs to LS-DYNA did not change significantly. NAC did not determine g-loads, except to conclude that the existing LS-DYNA evaluation for CC1 was applicable to CC5. **See PEC Slides 28, 32; Transcript Pages 38-40, 47-50.**

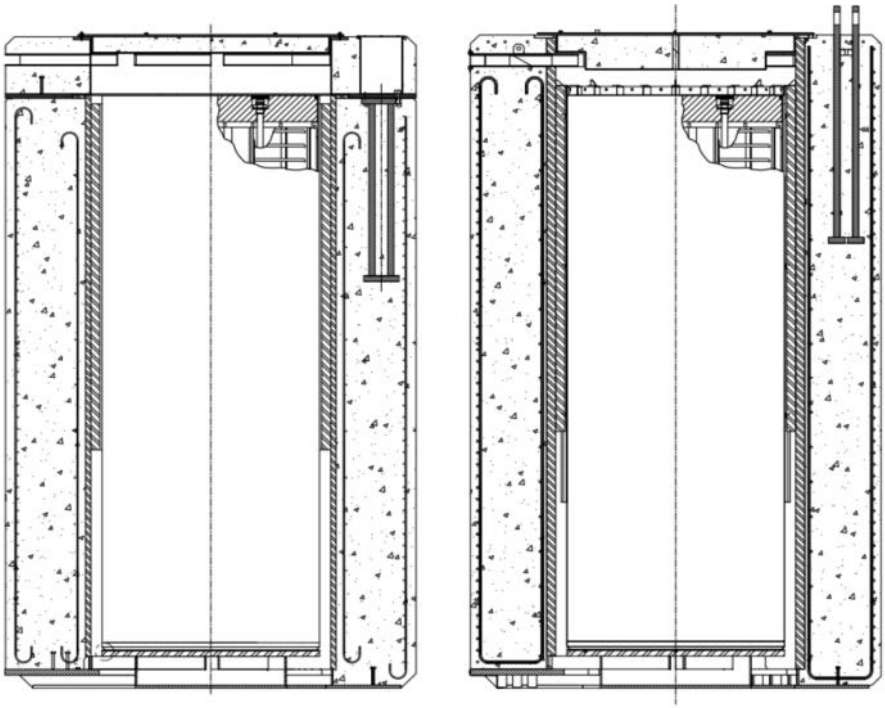
6. IR p. 15, para. 3 "Further, the staff assessed that this new or different method of linear scaling or ratioing would likely not be approved by the technical staff because so many variables such as the concrete and soil material properties, pad and soil configurations (e.g., compressive strength) can change simultaneously and there is an inter-dependence between those input parameters."	**NAC Position** NAC respectfully disagrees. NAC has noted that for the incorporation of CC5, soil and pad properties were not variables in the determination, and neither were other key attributes (design, material, and construction). These conditions and variables that the staff states are the basis for not likely approving the "method" are not operative relative to the CC5 design change and its 72.48. Further, NAC has received approval by the NRC for the addition of CC6, submitted in Amendment 9 to NAC's MAGNASTOR FSAR, on the same basis used for the determination for CC5 that was added by 72.48. The following statement is made in the CC6 NRC SER: "…despite having not performed a more in-depth tip-over analysis, the staff has concluded that no additional non-mechanistic tip-over analysis of the CC6 is required because there is reasonable assurance that the CC6 will perform its intended safety functions under a non-mechanistic tip-over event. This is due to conservatism and similarity of the CC6 to other applicant's concrete casks as shown in Table 3.3 of this SER below. Specifically: (i) CC1 was designed with an additional 50% margin with the g-loads calculated by LS-DYNA tip-over analysis (i.e., design-basis of 35.0g and 40.0g at the top of the fuel basket and cask, respectively, compared to calculated g-loads); (ii) both the CC1 and CC6 are evaluated on the same pad; (iii) the CC1 and CC6 are of similar construction; (iv) the CC6 is shorter and has a slightly shorter center of gravity as compared to the CC1, therefore it is more stable; and (v) the initial angular velocity of CC6 is within 2% of the CC1." NRC documented in its SER for MAGNASTOR CoC Amendment 9 its explicit criteria and basis for accepting CC6 based on the relative velocity comparison. NAC's PEC presentation used these criteria in its evaluation of CC5 and showed compliance to the Amendment 9 criteria for use of the relative angular velocity comparison. Since CC5 was *less than 1% different from CC1* on the key factor of angular velocity and CC5 met the other criteria specified by NRC, then logically CC5 should similarly be technically acceptable. **See PEC Slides 25, 29, 32; Transcript Pages 25-36, 40-41, 47-50.**

Enclosure to ED20210007
APPENDIX B
Summary of CC5 design change, licensing basis tip-over methodology, and 72.48

What is the Design Change?

The CC5 liner is based on a 3-inch liner thickness design. It provides enhanced shielding relative to CC1. Materials of cask construction are the same between CC5 and CC1, and weights and dimensions are similar: (PEC Slide 30)

- Concrete Cask outside and inside diameter are the same.
- Cask height is essentially the same – 0.6" - 0.3%.
- Cask center of gravity is essentially the same – 2.1" - <2%.
- Shielding enhancements - Loaded cask weight increased by ~17,500 lbs., this is less than 6% and is largely comprised of distributed masses with little impact on the CG of the system including:
- Rebar spacing of the outer cage is slightly denser but distributed (~900 lbs. – 0.3%).
- Cask liner is 1.25" thicker and, although a more significant contributor to the system weight increase (14,900lbs - ~4%), is distributed.
- Cask lid thickness (1,630lbs) and inlet vent steel bars (580 lbs.), are more local masses but contribute a very small percentage (0.7%) to the system weight.



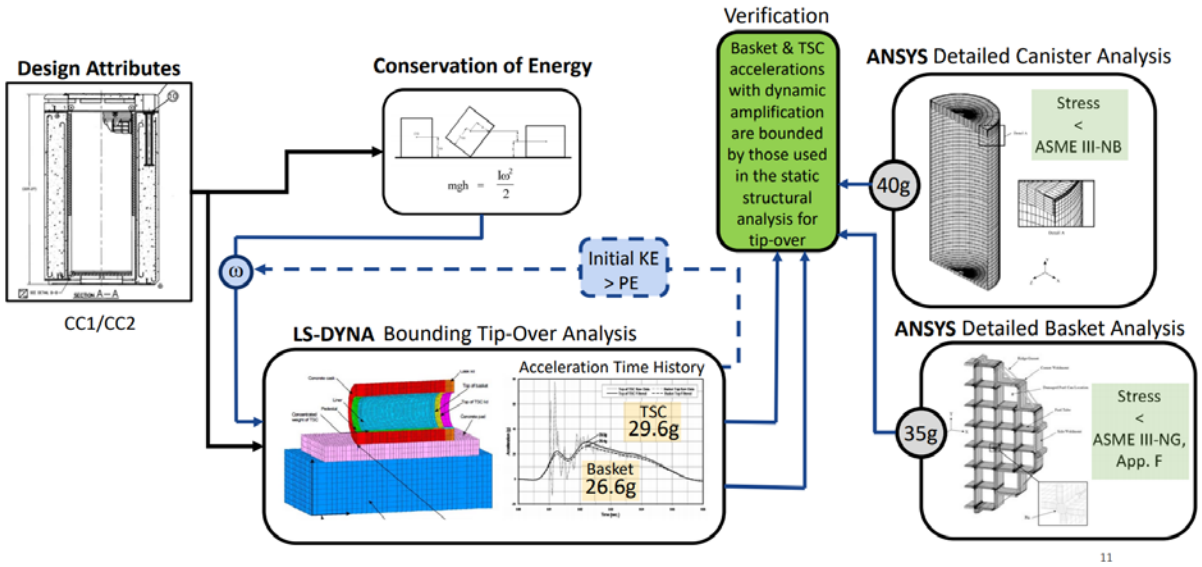
CC1/CC2 CC5

CC1/CC2	CC5	Characteristic
225.27	225.90	Concrete Cask Height H (in)
1.75	3.00	Concrete Cask Liner Thickness (in)
26.50	25.25	Concrete Thickness (in)
136.00	136.00	Concrete Cask Outside Diameter (in)
130.079	132.14	Concrete Cask CG to Rotation Point d_{cg}

What is the Licensing Basis Method of Evaluation for Tip-over?

The MOE for tip-over is a 3-step process: (PEC Slide 11)

- Using conservation of energy to determine the angular velocity prior to impact of the cask on the ISFSI pad based on its maximum potential energy.
- Using LS-DYNA to determine the deceleration g-loads the cask experiences resulting from impact with the ISFSI pad defined in the FSAR.
- Calculating the structural stress levels in the canister and basket with ANSYS using impact accelerations which bound the LS-DYNA results



What is the Design Control Process?

NAC issued CC5 engineering drawings (via Design Control Request ("DCR") 30032 Rev. A), which provided the design basis for CC5 to implement the required cask design changes to address APS site specific design requirements.

DCR(L) 71160-561-8B was written upon issuance of Rev. 0 of CC5 engineering drawing 30032-061 for development of license drawing.

DCR(L) 71160-561-8B also indicated the need for 72.48 (checkbox) performance, and initiated reservation of FSAR DCR(L) 71160-FSAR-7Q (QP driven to ensure alternate design gets into FSAR)

Affected License Drawings identified:
71160-562 change by DCR(L)71160-562-8B
71160-590 change by DCR(L)71160-590-7A.

What steps did NAC follow in its 72.48 Process?

The changes of the DCR(L) are dispositioned via 72.48 Determination No. NAC-16-MAG-018.

- Change determined to be subject to “Screening”
- Screening Question (1) checked Yes – “Evaluation is Required”
- Evaluation Questions all checked No – “Prior NRC approval is not required”.

Document Control Actions – Update License drawings and FSAR via 71160-FSAR-7Q.

What Analyses were performed to validate CC5 to support 72.48 evaluation?

Calculation 71160-2014, Appendix H. Revision 4 – Structural and thermal performance

- Using conservation of energy, determine the potential energy and impact angular velocity for CC5 as compared to CC1/CC2 (Same approach used on CC3 and CC4). (PEC Slide 18)
    - If angular accelerations are less than or essentially the same, CC5 can be considered essentially the same and CC1/CC2 accelerations are representative of CC5. (PEC Slide 20)
    - If angular velocity of CC5 is greater than CC1/CC2, LS-DYNA should be run to determine impact accelerations.
        - LS-DYNA results will be validated against the ANSYS accelerations used in the licensing basis for MAGNASTOR.