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November 26, 2012 10 CFR 50.54(f)

U. S. Nuclear Regulatory Commission
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Subject: Duke Energy Carolinas, LLC (Duke Energy)

McGuire Nuclear Station (MNS), Units 1 and 2
Docket Nos. 50-369 and 50-370
Renewed License Nos. NPF-9 and NPF-17

Flooding Walkdown Information Requested by NRC Letter, *Request for Information Pursuant to Title 10 of the Code of Federal Regulations 50.54(f) Regarding Recommendations 2.1, 2.3, and 9.3, of the Near-Term Task Force Review of Insights from the Fukushima Dai-Ichi Accident*; dated March 12, 2012

Reference:

1. NRC Letter, *Request for Information Pursuant to Title 10 of the Code of Federal Regulations 50.54(f) Regarding Recommendations 2.1, 2.3, and 9.3, of the Near-Term Task Force Review of Insights from the Fukushima Dai-Ichi Accident*, dated March 12, 2012

2. NEI 12-07, *Guidelines for Performing Verification Walkdowns of Plant Flood Protection Features*, Revision 0-A, dated May 2012

3. NRC Letter to NEI, *Endorsement of Nuclear Energy Institute (NEI) 12-07, "Guidelines for Performing Verification Walkdowns of Plant Flood Protection Features"*, dated May 31, 2012

On March 12, 2012, the NRC staff issued Reference 1. Enclosure 4 of Reference 1 contained specific Requested Actions, Requested Information, and Required Responses associated with Recommendation 2.3 for Flooding Walkdowns. In accordance with 10 CFR 50.54, "Conditions of licenses," paragraph (f), addressees were requested to confirm within 90 days their intent to use the NRC-endorsed flooding walkdown procedures, and to submit their final response within 180 days of the NRC's endorsement of the walkdown procedure. The 180 day response is to include a list of any areas that are unable to be inspected due to inaccessibility and a schedule for when the walkdown will be completed.

On June 8, 2012, Duke Energy submitted its 90 day response to Enclosure 4 of Reference 1, confirming that the industry guideline, NEI 12-07 (Reference 2), would be used as the basis for the flooding walkdowns at the McGuire Nuclear Station (MNS). NEI 12-07 was endorsed by NRC letter dated May 31, 2012 (Reference 3).

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This submittal comprises the aforementioned 180 day response for MNS. The Enclosure contains the flooding walkdown report addressing the items identified in Appendix D of NEI 12-07. There were no deferred walkdowns.

This letter contains no new regulatory commitments.

This submittal has been reviewed by licensee management, including the technical staff, regulatory staff, and senior management, in accordance with Duke Energy procedures and processes.

Should you have any questions concerning this letter, or require additional information, please contact Michael K. Leisure at (980) 875-5171.

I declare under penalty of perjury that the foregoing is true and correct. Executed on November 26, 2012.

Respectfully submitted,

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Enclosure

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ENCLOSURE

McGuire Nuclear Station Flood Walkdown Report

McGuire Nuclear Station Flood Walkdown Report

Response To 10CFR50.54(f) Letter: "Recommendation 2.3: Flooding"

Executive Summary

This report provides the response of McGuire Nuclear Station to the NRC Letter to Licensees, dated March 12, 2012, "Request for Information Pursuant to Title 10 of the Code of Federal Regulations 50.54(f) Regarding Recommendations 2.1, 2.3, and 9.3 of the Near Term Task Force Review of Insights from the Fukushima Dai-ichi Accident." The flood walkdowns were performed in accordance with the Nuclear Energy Institute flooding walkdown document NEI 12-07, "Guidelines for Performing Verification Walkdowns of Plant Flood Protection Features." This NEI flooding walkdown document provides guidance for assessing external flood protection and mitigation capabilities in accordance with the NRC recommendation in Item 2.3 of SECY 11-0137 and Enclosure 4 of the March 12, 2012 10CFR50.54(f) Letter.

I. Describe the Design Basis Flood Hazard Levels For All Flood-Causing Mechanisms, Including Groundwater Ingress.

This is a description of the design basis criteria used for the design of flooding on the power block area at McGuire Nuclear Station from two sources of natural phenomena. These two sources are: 1) flooding as a result of rising water on the power block and 2) flooding as a result of precipitation on the power block.

<u>Probable Maximum Flood</u>

Flood analyses at McGuire Nuclear Station considered the following postulated events in determining the flood levels for the site:

1. Probable Maximum Flood (PMF) resulting from the probable maximum precipitation in the drainage area.
2. Standard Project Flood (SPF) passing through Lake Norman combined with the seismic failure of one of the upstream dams (due to an Operating Basis Earthquake (OBE). The Standard Project Flood is considered equal to one-half of the Probable Maximum Flood.

All safety related structures at McGuire Nuclear Station are protected from the possible flooding of Lake Norman. These structures and their components are protected from flooding by an earthen dam which extends from the Cowans Ford Dam. The top of the embankment that is adjacent to the spillway at Cowans Ford Dam is located at Elevation 775.0 feet mean sea level (msl). At the plant site, the embankment crest rises to Elevation 780.0 feet msl. With the consideration of these features, the Category I structures and their components are not subject to flooding caused by the most severe assumed flood condition combined with the highest wave effort. [2, 8, 9, 10]

The Probable Maximum Flood (PMF) is determined by calculating the Probable Maximum Precipitation (PMP) over each of the reservoir drainage areas upstream of Lake Norman. Each flood was routed through the Catawba River system to determine the most critical position for producing the maximum reservoir elevation at the McGuire site.

A search for historically great storms that occurred near the Catawba River basin was made to derive a hypothetical flood that would be the most severe, reasonably possible flood to occur at the McGuire site. The greatest storm over the Catawba River basin area is recorded for the period July 13-17, 1916. To arrive at the Probable Maximum Precipitation (PMP) over the Catawba River basin, the July 13-17, 1916 storm was selected based upon meteorological and physiographic considerations as a guide to the determination of time and area rainfall distribution pattern. The following adjustments were made to this storm to increase its magnitude and intensity to such values which are considered to be equal to the Probable Maximum Precipitation over the Catawba River basin:

1. Rainfall depth-duration values were distributed in accordance with that of the 1916 storm. The adjusted July 1916 storm most closely approximates the theoretical Probable Maximum Precipitation depth-area-duration values for the Lake Norman drainage area.
2. The storm position was transposed over a limited distance within the Catawba River basin to produce a maximum concentration of precipitation over a selected area.
3. Precipitation amounts were increased 40 percent.

Several trial positions of the storm center were made to determine the most critical position for producing the maximum flood. To determine the probable maximum flood flow, a series of computer simulations were performed using different storm center positioning and different upstream dam failure sequences. The storm center was positioned over each of the reservoir drainage areas in turn and then routed through the Catawba River system. In addition, the direction of the storm travel was assumed in both the upstream and downstream directions for comparison of the maximum runoff. Eleven storm simulations were investigated for this analysis. These storms were numbered 9 through 14, 14A, and 15 through 18. [3, 9, 11]

Each of the reservoir drainage areas was divided into sub-areas or tributary divisions. There were a total of twenty-two tributary divisions. Each sub-area varied in size dependent upon the number of larger tributary streams flowing into each reservoir. Unit hydrographs of these areas were developed for synthesis in flood routing. Probable Maximum Precipitation was applied to the unit hydrographs with considerations for precipitation losses. A value of 0.5 inches was deducted for an initial loss, and a rate of 0.10 inches per hour was applied for infiltration losses.

Water levels in the power block area are predicted by routing the Probable Maximum Flood (PMF) through the Catawba River system. This analysis results in the hydrographs and reservoir elevation at Lake Norman. The Probable Maximum Flood is routed through the system assuming that the discharges from generation of power continue unless reservoir levels overtop bulkheads and embankments. These bulkheads and embankments are used to protect the hydroelectric powerhouses. Once the bulkheads have been overtopped, discharge through the powerhouse is stopped for the remainder of the storm period. The McGuire site was analyzed for hourly incremental amounts of rainfall excess for a 54 hour duration period to determine the

Probable Maximum Precipitation. As a result of this analysis, the Storm No. 13 produced the maximum reservoir elevation at the Cowans Ford reservoir. [3, 9, 11]

For Storm No. 13, the routing of the Probable Maximum Flood (PMF) through the Catawba River system resulted in a maximum Elevation of 767.9 feet msl at Lake Norman (Cowans Ford). This results in a freeboard of 2.1 feet to the top of the bulkhead of the Intake Structure (El. 770.0 feet) and a freeboard of 7.1 feet to the top of the protective embankment at Elevation 775.0 and a freeboard of 12.1 feet to the top of the protective embankment at Elevation 780.0. [3, 9, 11]

The total wave height on the embankment at Cowans Ford is 6.0 feet. This wave height plus the Probable Maximum Flood elevation of 767.9 feet msl yields an overall elevation of 773.9 feet msl. This results in a freeboard of 6.1 feet to the top of the protective embankment (at Elevation 780.0) upstream of the McGuire site.

In addition to this analysis for wave height and runup, an alternative procedure for determining wave heights, runup, and the associated static and dynamic forces was performed. With this alternative, wave effects were analyzed for a sustained overland wind speed of 40 miles per hour (mph) acting simultaneously with the Probable Maximum Flood (PMF) elevation at 767.9 feet msl for Lake Norman. [3, 9, 11]

The Cowans Ford Dam and the Intake Structure are both subject to the same wind waves. Although neither of these structures is safety-related and their failure would not endanger the plant, they were analyzed to determine their ability to withstand the design wave forces. The design waves for Lake Norman are generated by a 40 mph sustained overland wind over the entire length of the effective fetch. The maximum fetch for Lake Norman is 5.30 miles, and the effective fetch is 2.04 miles. The results of this analysis confirmed that both Cowans Ford Dam and the Intake Structure would be safe from any damaging effects due to wave forces. [3]

The effects of the seismic failure of upstream dams coincident with the Standard Project Flood (SPF) have also been evaluated. All of the five dams upstream of the McGuire site are part earth embankment and part concrete gravity type structures. The effects of seismic failure of each individual dam, coincident with the Standard Project Flood (SPF) (which is assumed to be one-half of the Probable Maximum Flood (PMF)), were analyzed. Of all of the various potential dam failures that were analyzed, the failure of the upstream Bridgewater Dam produced the highest water elevation at the McGuire site. The highest water elevation due to this dam failure is El. 762.6 feet msl, and the highest water elevation due to this dam failure with the addition of waves is El. 767.71 feet msl. [4, 9, 12]

The Probable Maximum Hurricane (PMH), as defined in the National Oceanic and Atmospheric Administration Report HUR7-97, is used to determine the probable maximum meteorological winds at the McGuire site. [5, 9, 13] The hurricane track that is considered possible to occur is chosen based on criteria to maximize the surge and wave effects at the McGuire site. The critical path for the Probable Maximum Hurricane assumes a pattern similar to the path of the July 1916 storm. With the hurricane originating in the lower latitudes, the storm center moves shoreward in a northwesterly direction, crossing the coast of Myrtle Beach, South Carolina; after turning westward, the storm center passes through the heart of the McGuire site.

Considering that Lake Norman is an inland lake, there is no history of surge or seiche flooding available. Therefore, the surge and seiche values are determined based upon theoretical methods. With an adjusted maximum wind velocity of 96 mph blowing in the direction of the effective fetch to the earthen dike, the surge is computed to be 0.90 feet. With the maximum pressure gradient during a Probable Maximum Hurricane, the seiche is estimated to be 1.93 feet. The seiche is calculated with the following assumptions:

1. The eye of the hurricane is centered over the McGuire site.
2. The effective seiche distance is nine miles.
3. The atmosphere pressure varies according to Formula 1 of the National Oceanic and Atmospheric Administration Report HUR 7-97[19]

Also, the water surface elevation of Lake Norman is assumed to be 760.0 feet msl for surge and seiche analyses.

The effects of wave action and resonance of the water waves due to the Probable Maximum Hurricane were considered to not be critical factors in flooding at the McGuire site. Deep water waves generated by the Probable Maximum Hurricane winds were analyzed to determine any effects on the Cowans Ford Dam and the McGuire Intake Structure. This analysis determined the wind effects of the 96 mph winds of the PMH acting with the full pond water level for Lake Norman (El. 760.0 feet msl). This analysis concluded that this scenario was an extremely unlikely occurrence since the maximum recorded wind speed for the area was 57 mph. The resonance of the water waves was also deemed to not be a factor in flooding at the McGuire site because of the natural irregularity of Lake Norman's shoreline. [5, 9, 13]

The effects of wave runup caused by the Probable Maximum Hurricane (PMH) are considered in the flood analysis. The runup associated with the breaking of significant waves and maximum waves is 9.41 feet and 11.92 feet, respectively. The most severe combination of surge, seiche, and wave runup with Lake Norman at full pond (El. 760.0 feet) results in a maximum elevation of 774.75 feet for maximum waves and 772.24 feet for significant waves. Considering that the Cowans Ford Dam embankment is at El. 775.0 feet and the protective dike upstream of the plant yard is at El. 780.0 feet, there would be no overtopping caused by the Probable Maximum Hurricane (PMH). [5, 9, 13]

Considering the various design basis flood hazard levels at the plant site, compiled below is a summary of the flood events as well as the elevation results of the flood analyses.

1. Considered for all of the flood events, the earthen dike protects the plant site with a top elevation at El. 780.0 feet, and Lake Norman is regarded at a full pond elevation of El. 760.0 feet. [1, 2, 5, 6, 8]
2. The flood level for a Probable Maximum Flood (PMF) at Lake Norman is at El. 767.9 feet. [3]

3. The flood level for a Probable Maximum Flood (PMF) at Lake Norman with waves is at El. 773.9 feet. (3)
4. The flood level for an upstream dam failure is at El. 762.6 feet. (4)
5. The flood level for an upstream dam failure with waves is at El. 767.71 feet. (4)
6. The flood level for a Probable Maximum Hurricane (PMH) with a wind of 96 mph and with Lake Norman at full pond is at El. 774.75 feet for maximum waves and at El. 772.24 feet for significant waves. (5)

Groundwater

The groundwater levels around the safety related buildings are controlled by a permanent Category I underdrain groundwater system located under the Auxiliary Building and the Reactor Building. The underdrain system consists of a grid of interconnected flow channels at the top of rock or at the top of fill concrete and below the foundation slabs. This grid of flow channels drains the entire general foundation of the Reactor Building and Auxiliary Building. Also, an exterior wall drain system composed of two separate flow pathways extends around the foundation perimeter. In addition, the concrete walls have waterstops located at construction joints to prevent groundwater from entering the buildings. Both the exterior wall drain system and the underdrain groundwater system transport the groundwater to the three sumps in the Auxiliary Building. In each sump, there are two 250 gallons per minute Category I pumps, and each pump is capable of handling the total flow into the sumps and capable of maintaining the water level automatically in each sump. Since the three sumps are interconnected by the grid drain channels, all six pumps are available to discharge groundwater. Eleven permanent groundwater monitors are installed around the perimeter of the Auxiliary Building and the Reactor Building exterior walls in order to monitor the groundwater levels in the zoned wall filter drain system. The exterior zoned wall filter drain system will not be flooded by surface flood water since the top of the zoned wall filter is located 5 feet below the plant yard and the zoned wall filter has a cover of earthen backfill 5 feet thick. Thus, the exterior wall drain system and the underdrain groundwater system will prevent a rise in the groundwater around the exterior building walls. (7, 15, 17)

Probable Maximum Precipitation

The runoff of excess water due to the Probable Maximum Precipitation (PMP) was determined using rainfall intensities and critically arranged time increments over a six hour period. This resulted in a runoff maximum rainfall intensity of 14.7 inches per hour. (6, 17)

Two methods were used to analyze the effects of excess water backup on the structures. The first method of analysis assumed that there was perimeter runoff and that the storm drainage system was operating at 1/2 of its total capacity. This accounted for any debris or obstacles partially blocking the drain system. Using this method of analysis, the water ponds to an elevation of 760.28 feet msl. This elevation is below the exterior doorway curbs of the safety-related structures. All exterior doorways are provided with curbs (or thresholds) at Elevation 760.5 feet msl. (6, 15, 17, 20)

The second method of analysis assumed that the storm drainage system is completely inoperative or totally blocked and that the entire Probable Maximum Precipitation runoff is discharged by sheet flow at the perimeter of the yard. The assumption was also made that the perimeter of the protected area would act as a weir for runoff to overflow the perimeter. Thus, when the quantity of flow from the PMP equaled the quantity of flow crossing the weir in a given period of time, equilibrium would be reached and the depth of ponding could be determined. With this method of analysis, some of the plant structures would act as obstructions to water flowing over the entire weir; therefore, the length of the weir was not assumed to be the entire distance around the plant but was divided into segments. These segments were determined by how the runoff would actually flow through the plant yard. Using this method, the water ponds to an elevation of 760.375 feet msl. This elevation is also below the elevation of all the exterior doorway curbs (or thresholds) of the safety-related structures. This analysis shows that the subsurface component of the storm drainage system is not required to be functional to protect the safety-related structures at the McGuire site. [6, 15, 17, 20]

Therefore, based upon the conclusion of these two analyses, all of the safety-related structures are safe from being flooded by the runoff from the Probable Maximum Precipitation (PMP). The maximum water depth adjacent to the plant is El. 760.375 feet. [6, 15, 17, 20]

II. Describe protection and mitigation features that are considered in the licensing basis evaluation to protect against external ingress of water into SSCs important to safety.

This is a description of the protection features that are credited in the licensing basis to protect safety-related systems, structures, and components against external sources of flooding and against external ingress of water.

Earthen Dike

All safety-related structures at the McGuire site are protected from the possible flooding of Lake Norman. These structures are protected from flooding by an earthen dam and the dike extension of Cowans Ford Dam. The top of the embankment that is adjacent to the spillway at Cowans Ford Dam is located at El. 775.0 feet msl. At the plant site, the embankment crest rises to El. 780.0 feet msl. [1, 2, 5, 6, 8]

Below Grade Pipes and Penetrations

Also, to help prevent flooding of these safety-related structures, other design features are implemented at the McGuire site. One of these design features is that the below grade piping entering the Auxiliary Building is encased in the structural foundation slabs or structural walls. These low level pipes do not require penetration seals.

Piping for the fire protection system is the only piping that penetrates the exterior wall of the Auxiliary Building and is not encased in the structural concrete wall. However, the fire protection system piping is encased in concrete that was poured against the outside face of the exterior wall of the Auxiliary Building. The lowest elevation that this piping penetrates the building is at El. 755.33 feet. To prevent an inflow of water into the building, a flexible water seal is provided on the inside of the Auxiliary Building in the penetration. This seal is placed between the penetration sleeve and the fire protection system piping. [6, 14]

Another design feature to help prevent the flooding of safety-related structures is that the electrical penetrations and trenches are sealed to prevent the inflow of water into the buildings. This design feature is applicable for the Refueling Water Storage Tank (FWST) Trench penetrations, Diesel Generator Room penetrations, Security Trench penetrations, and the Low Level Intake and Intake Structure Trench. The elevation of these penetrations and trenches are located below the maximum water elevation due to the Probable Maximum Precipitation (PMP). The maximum water level in the plant yard due to the Probable Maximum Precipitation (PMP) is El. 760.375 feet. [6, 8, 17]

Exterior Doorways

Another one of the design features is that all of the exterior doorways are equipped with 6" high curbs or thresholds (El. 760.5 feet). These 6" high door thresholds are used to prevent the inflow of water into the buildings. The maximum water level in the plant yard due to a Probable Maximum Precipitation (PMP) is El. 760.375 feet. [6, 15, 17, 20]

Roof Drains and Storm Drainage System

Another source of flooding is from the Probable Maximum Precipitation (PMP) at the McGuire site. The safety-related structures are protected against flooding from the Probable Maximum Precipitation (PMP) with a system of roof drains, a surface collection system, and ditches. These are arranged around the plant site in such a way to direct runoff away from the site to natural drainage channels. [6, 15]

Roof drains are provided on all safety-related structures. Roof drains are designed to discharge at a rate of 5 inches of water per hour. During the Probable Maximum Precipitation (PMP), any runoff on the building roofs that is not discharged by the roof drains to the storm drainage system will flow off the roofs and onto the plant yard. Parapets are provided on the roofs of the Reactor Building and the Fuel Handling Building. On the Auxiliary Building, parapets are provided on just three sides of the roof.

Scuppers are provided in the parapets on the Fuel Handling Building. These scuppers are about 6 inches high and 9 inches wide are located about 3.5 inches above the finished roof surface. In the event of ponding water on the roof, the scuppers allow water to flow through the parapets and onto the plant yard. If all of the roof drains become clogged during a Probable Maximum Precipitation (PMP), the maximum depth of water that would accumulate on the Fuel Handling Building would be approximately 11.5 inches. The Fuel Handling Building roof has been designed for this additional loading.

Scuppers are not provided in the parapets for the Reactor Building. If all of the roof drains on the Reactor Building become clogged, water will pond to the top of the parapets and then began to spill over the side. The roof of the Reactor Building is designed to withstand this hydrostatic loading due to the accumulation of water behind the parapet during the Probable Maximum Precipitation (PMP).

On the Auxiliary Building, parapets are provided on no more than three sides of the roof levels. At the south end of the main level of the Auxiliary Building (El. 784.0 feet), no parapet was built. But, the Turbine Building is located at this end. The southeast and southwest sides of the main level of the Auxiliary Building are open and have no parapets. These open sides provide a pathway to discharge any ponding water. Therefore, during a Probable Maximum Precipitation (PMP), any water that could possibly pond on the Auxiliary Building roof would be discharged through these open sides of the roof. The roof of the Auxiliary Building is designed to withstand the loading due to the maximum accumulation of water on the roof.

All of the pipe sleeves, ventilators, and curbs that penetrate the roofs of these safety-related structures have been extended up above the level of excess ponding caused by the Probable Maximum Precipitation (PMP). By raising the height of these items, potential pathways of floodwaters into the building through the roof are eliminated. All safety-related penetrations and hatches on the roof are waterproofed sufficiently to ensure that their integrity is maintained during the Probable Maximum Precipitation (PMP). [6, 15, 16]

The storm drainage system is used to drain precipitation away from the plant structures and plant yard. The storm drainage system is a Category III system and is not safety-related. The system consists of a network of surface and subsurface flow channels which direct flow away from the plant and towards the Catawba River downstream of the Cowans Ford Dam. The storm drainage system prevents excessive flow to the underdrain groundwater system, which is used to control the groundwater levels beneath the Reactor Building and the Auxiliary Building. The storm drainage system also accepts and drains the effluent from the roof drains of the structures at McGuire Nuclear Station.

The surface flow of the storm drainage system consist of graded plant yards directing flow to catch basins, drainage ditches (adjacent to the plant yard railroad tracks) directing flow away from the plant, paved spillway ditches connecting the Standby Nuclear Service Water (SNSW) Pond with the Wastewater Collection Basin, and paved spillway ditches connecting the Wastewater Collection Basin with the Catawba River.

The subsurface channels of the storm drainage system consist of a network of interconnected buried flow channels that are constructed of corrugated metal pipe and PVC pipe. These channels are located directly beneath the catch basins which are distributed throughout the plant yard to drain the precipitation. These channels accept the discharge from the roof drains and the discharge from the groundwater Sump 'C'. The groundwater that is collected in Sump 'C' (one of three sumps located in the Auxiliary Building used to collect groundwater from the permanent underdrain system) is pumped to a free outfall at the storm drainage system. The invert of a free outfall is located two feet above the plant yard grade to prevent flooding of the groundwater drainage system by local runoff. In the event the storm drain system becomes blocked, the sump discharge would flow to adjacent catch basins or would discharge off the yard by sheet flow.

The storm drainage system discharges to the Standby Nuclear Service Water Pond (SNSW Pond), the Wastewater Collection Basin, and the Catawba River. In the event the SNSW Pond exceeds its capacity, the water would drain through an overflow spillway into a paved spillway ditch. This ditch directs the effluent to the Wastewater Collection Basin. In the event the Wastewater Collection Basin exceeds its capacity, the water would drain through an overflow spillway into another paved spillway ditch that would discharge the water into the Catawba River at a location downstream of Cowans Ford Dam.

The storm drainage system is designed for 4 inches per hour precipitation. Any additional precipitation remaining would collect on the plant yard, or it would overflow the plant yard by sheet flow. Large amounts of collected precipitation on the plant yard is due to the 1 foot differential between the high points of the plant yard at Elevation 760.0 feet and the top of the catch basins at Elevation 759.0 feet. This 1 foot differential creates "pockets" or "pyramids" of storage of water around the McGuire site. The volume capacity of these "pyramids" is approximately 155,000 cubic feet. The runoff of excess water is directed away from the plant structures and towards the catch basins using a minimum ground slope of 1.4%. Although the storm drainage system was not designed to discharge the Probable Maximum Precipitation (PMP), the drainage system was analyzed to ensure that the buildup of water from a Probable Maximum Precipitation will not endanger any safety-related structures. The runoff of excess water due to the Probable Maximum Precipitation (PMP) was determined using rainfall intensities and critically arranged time increments over a six hour period. This resulted in a runoff maximum rainfall intensity of 14.7 inches per hour. (6, 7, 15, 17)

Two methods were used to analyze the effects of excess water backup on the structures. The first method of analysis assumed that there was perimeter runoff and that the storm drainage system was operating at 1/2 of its total capacity. This accounted for any debris or obstacles partially blocking the drain system. Using this method of analysis, the water ponds to an elevation of 760.28 feet msl. This elevation is below the exterior doorway curbs of the safety-related structures. All exterior doorways are provided with curbs (or thresholds) at Elevation 760.5 feet msl. (6, 15, 17, 20)

The second method of analysis assumed that the storm drainage system is completely inoperative or totally blocked and that the entire Probable Maximum Precipitation runoff is discharged by sheet flow at the perimeter of the yard. The assumption was also made that the perimeter of the protected area would act as a weir for runoff to overflow the perimeter. Thus, when the quantity of flow from the PMP equaled the quantity of flow crossing the weir in a given period of time, equilibrium would be reached and the depth of ponding could be determined. With this method of analysis, some of the plant structures would act as obstructions to water flowing over the entire weir; therefore, the length of the weir was not assumed to be the entire distance around the plant but was divided into segments. These segments were determined by how the runoff would actually flow through the plant yard. Using this method, the water ponds to an elevation of 760.375 feet msl. This elevation is also below the elevation of all the exterior doorway curbs (or thresholds) of the safety-related structures. This analysis shows that the subsurface component of the storm drainage system is not required to be functional to protect the safety-related structures at the McGuire site. (6, 15, 17, 20)

Therefore, based upon the conclusion of these two analyses, all of the safety-related structures are safe from being flooded by the runoff from the Probable Maximum Precipitation (PMP). The maximum water depth adjacent to the plant is El. 760.375 feet. (6, 15, 17, 20)

III. Describe any warning systems to detect the presence of water in rooms important to safety.

There are no credited flood protection warning systems to detect the presence of water in the rooms that are important to safety for an external flood source.

IV. Discuss the effectiveness of flood protection systems and exterior, incorporated, and temporary flood barriers. Discuss how these systems and barriers are evaluated using the acceptance criteria developed as part of Requested Information Item 1.h.

The flood protection features are considered acceptable if no conditions adverse to quality were identified during walkdowns and verification activities as determined by the corrective action program. Conditions adverse to quality are those conditions that prevent the flood protection feature from performing its credited function during a design basis external flooding event. These adverse conditions are deemed as deficiencies. This is a review of the effectiveness of the flood protection features and how they were assessed to meet this acceptance criterion.

Earthen Dike

The earthen dike is a feature that is to protect the safety-related structures from the possible flooding of Lake Norman. During the inspections, the elevation of the earthen dike along the northern perimeter of the plant was to be verified and compared to the worst-case external flooding event elevation. The maximum elevation due to a Probable Maximum Flood (PMF) is 767.9 feet. The maximum elevation due to a Probable Maximum Flood (PMF) with wave action is 773.9 feet. The maximum elevation due to a Probable Maximum Hurricane (PMH) with winds of 96 mph and at full pond (El. 760 feet) is 774.75 feet for maximum waves and 772.24 feet for significant waves. [1, 2, 3, 4, 5, 6, 8]

Surveys of the earthen dike were taken along the northern perimeter of the McGuire site. The lowest elevation along the impacted perimeter was found to be El. 780.42 feet. The highest elevation along the impacted perimeter was found to be El. 781.27 feet. The earthen dike was also visually inspected for physical impairments. There were no deficiencies identified during inspections. Because the elevation of the earthen dike is greater than the worst-case external flooding event elevation and because there were no deficiencies found, the earthen dike was deemed acceptable. [21]

FWST Trench Penetrations

A protection feature that is used to prevent the flooding of the safety-related structures due to maximum water elevation at the site is the Refueling Water Storage Tank (FWST) Trench penetrations. The maximum water elevation due to the Probable Maximum Precipitation (PMP) is El. 760.375 feet. With the penetrations below the maximum water elevation, the trench could potentially become flooded. These penetrations are located inside the FWST Trench, and the piping penetrates the exterior wall of the Auxiliary Building. The elevation of these penetrations is below the maximum water level, and the lowest penetration is located at approximately El. 756'-7". All of these penetrations with the exception of two electrical penetrations consist of piping encased in concrete poured against the outside surface of the exterior wall of the Auxiliary Building. This prevents excessive inflow due to the maximum water elevation at the structure. The two penetrations that are exceptions are electrical penetrations which do not use embedded pipe in the concrete. These two penetrations are sealed to prevent the inflow of water. All of the FWST Trench penetrations were visually inspected for degradation. There were no deficiencies identified during the inspections. It was also determined that the penetrations were sealed properly, and the pipes were embedded in concrete. Based on these criteria, these below grade FWST Trench penetrations were deemed acceptable. (6, 8, 17, 21)

Diesel Generator Room Penetrations

Another protection feature that is used to prevent the flooding of the safety-related structures due to maximum water elevation at the site is the Diesel Generator Room penetrations. These penetrations are electrical conduit pipes that are routed from an exterior manhole. The maximum water elevation due to the Probable Maximum Precipitation (PMP) is El. 760.375 feet. These penetrations are located inside each of the Diesel Generator Rooms. The elevation of these penetrations is below the maximum water level, and the lowest penetration is located at approximately El. 758'-6". These penetrations are sealed to prevent excessive inflow due to the maximum water elevation at the structure. The Diesel Generator Room penetrations were visually inspected for degradation. There were no deficiencies identified during the inspections. It was also determined that the penetrations were sealed properly. Based on these criteria, these below grade Diesel Generator Room penetrations were deemed acceptable. (6, 8, 17, 21)

Security Trench Penetrations

The Security Trench penetrations to the Unit 2 Turbine Building are another protection feature that is used to prevent the flooding of the safety-related structures due to maximum water elevation. These penetrations in the trench are located on the exterior wall of the Unit 2 Turbine Building. The elevation of these penetrations is below the maximum water level of El. 760.375 feet due to the Probable Maximum Precipitation (PMP), and these penetrations are located at El. 758'-0" and El. 758'-8". These penetrations are sealed to prevent excessive inflow due to the maximum water elevation at the structure. The Security Trench penetrations were visually inspected for degradation. There were no deficiencies identified during the inspections. It was also determined that the penetrations were sealed adequately. Based on these criteria, these below grade Security Trench penetrations were deemed acceptable. (6, 8, 17, 21)

Low Level Intake and Intake Structure Trench

Another protection feature that is used to prevent the flooding of the safety-related structures due to maximum water elevation at the site is the trench from the Low Level Intake Structure and the Intake Structure to the Unit 1 Turbine Building. The trench enters the Unit 1 Turbine Building near the northwest corner of the building. The top elevation of this concrete trench is at El. 760'-6" except at the roadway area. At the roadway, the top elevation of the trench drops down to El. 760'-0". Considering that the top of the trench at the roadway is below the maximum water level of El. 760.375 feet due to the Probable Maximum Precipitation (PMP), the trench is sealed to limit the water intrusion. This trench was visually inspected for degradation. There were no deficiencies identified during the inspections. It was also determined that the trench was adequately sealed. Based on these criteria, this trench from the Low Level Intake Structure and the Intake Structure to the Unit 1 Turbine Building was considered acceptable. (6, 8, 17, 21)

Fuel Building Parapet Wall Scuppers and Drains

Parapet wall scuppers and drains on the roofs are protection features that are used to protect the safety-related Fuel Building from flooding due to the Probable Maximum Precipitation (PMP). The parapet walls and drains are located on the roofs of the Fuel Building at El. 804'-6" and El. 825'0". The parapets are provided with scuppers in order to allow any ponding water on the roof to be discharged onto the plant yard. The Fuel Building roofs were visually inspected for deficiencies with the parapets and drains. There were no deficiencies identified during the inspections. It was determined that the roof parapet walls, drains, and scuppers were clear and functional. Based on these criteria, the parapet walls and drains found on the Fuel Building roofs were considered acceptable. (6, 15, 16, 21)

Auxiliary Building Drains and Discharge Pathways

Drains and discharge pathways on the roofs are protection features that are used to protect the safety-related Auxiliary Building from flooding due to the Probable Maximum Precipitation (PMP). The parapet walls and drains are located on the roofs of the Auxiliary Building at El. 784'-0". The parapets are provided on not more than three sides on all roof levels of the Auxiliary Building. There is no parapet on the south end of the main level of the Auxiliary Building. This provides a pathway to discharge any water that may pond on the roof during the Probable Maximum Precipitation (PMP). The Auxiliary Building roofs were visually inspected for deficiencies with the parapets and drains. There were no deficiencies identified during the inspections. It was determined that the water discharge pathways and drains were clear and functional. Based on these criteria, the parapet walls and drains found on the Auxiliary Building roofs were considered acceptable. (6, 15, 16, 21)

Reactor Building Drains

Drains on the roofs are protection features that are used to protect the safety-related Reactor Building from flooding due to the Probable Maximum Precipitation (PMP). The top of the parapet walls are located on the roofs of the Reactor Building at El. 885'-4½". The drains are located on the roofs of the Reactor Building at El. 876'-0½". The parapets on the Reactor Building roofs are not provided with scuppers, and the drains are not required to be functional. If the drains become clogged, the water would pond to the top of the parapet walls and then spill over the side. This provides a pathway to discharge any water that may pond on the roof during the Probable Maximum Precipitation (PMP). The Reactor Building roofs were visually inspected for deficiencies with the parapets and drains. There were no deficiencies identified during the inspections. It was determined that the roof parapet walls and drains were clear and functional. Based on these criteria, the parapet walls and drains found on the Reactor Building roofs were considered acceptable. (6, 15, 16, 21)

Plant Yard Drainage

Another protection feature that is used to prevent the flooding of the safety-related structures due to maximum water elevation at the site is the plant yard drainage. The flooding due to the Probable Maximum Precipitation (PMP) would either collect on the plant yard or it would overflow the plant yard by sheet flow (also referred to as perimeter runoff). The plant yard must drain the water away from the power block area in order to maintain the maximum water level in the yard below the Probable Maximum Precipitation (PMP) flood level. The maximum water elevation due to the Probable Maximum Precipitation (PMP) is El. 760.375 feet. In order to confirm the flooding analysis results for the present physical conditions at the plant site, Engineering developed an updated topographic survey of the plant yard and performed flooding analyses for a Probable Maximum Precipitation event at the site based upon the current UFSAR methodology. Based upon the Probable Maximum Precipitation re-analysis, the maximum flood elevation will not increase from the existing El. 760.375 feet. The plant yard was also inspected, and it was determined that the plant yard is free and clear of any major obstructions that would prevent the yard from draining water (due to a Probable Maximum Precipitation event) away from the power block area. There were no deficiencies identified with the yard drainage. Based on these criteria, the plant yard drainage was considered acceptable.

Also, based upon the topographic surveys conducted by Engineering, it was determined that the maximum height of the crown of the pavement around the plant yard had remained essentially unchanged. The crown of the surrounding pavement serves as the high point in the yard. The precipitation flows from the high point to the yard drainage, and the precipitation falling outside of the crown of the surrounding road would flow downhill and away from the plant. The survey concluded that the high point of the road remained at El. 760'-0" and that there have been no changes that would drive more water toward the buildings. [6, 8, 15, 17, 20, 21]

Exterior Doorway Thresholds

Another protection feature that is used to prevent the flooding of the safety-related structures due to maximum water elevation at the site is that all of the exterior perimeter doorways are equipped with thresholds located 6" from the grade level at El. 760.0 feet or they are provided with curbs located 6" from the grade level at El. 760.0 feet. The thresholds and curbs at the exterior perimeter doorways are to be located at El. 760.5 feet. The maximum water elevation due to the Probable Maximum Precipitation (PMP) is El. 760.375 feet. To verify that the elevations of the exterior perimeter doorway thresholds and curbs have a minimum of El. 760.5 feet or that they are equipped to prevent the inflow of water into the buildings, surveys and inspections were performed at the exterior perimeter doorway thresholds. All of the exterior perimeter doorway thresholds or curbs were determined to be at El. 760.5 feet or greater.

As a result of the surveys and inspections of the exterior perimeter doorways, it was determined that the doorway thresholds and curbs meet the minimum elevation requirements, and there are no deficiencies with the exterior perimeter doorways. Based on these criteria, the exterior perimeter doorways were considered acceptable. (6, 8, 15, 17, 20, 21)

Fire Protection Piping Penetrations

The Fire Protection Piping penetrations to the Auxiliary Building are another protection feature that is used to prevent the flooding of the safety-related structures due to maximum water elevation. These penetrations at the Column Q-Q wall are located on the exterior wall of the Auxiliary Building. The elevation of these penetrations is below the maximum water level of El 760.375 feet due to the Probable Maximum Precipitation (PMP), and these penetrations are located at El. 755'-4". These piping penetrations are encased in concrete that was poured against the outside face of the exterior wall of the Auxiliary Building to prevent excessive inflow due to the maximum water elevation at the structure. The Fire Protection Piping penetrations were visually inspected for degradation. There were no deficiencies identified during the inspections. It was also determined that the penetrations were sealed adequately. Based on these criteria, these below grade Fire Protection Piping penetrations were deemed acceptable. (6, 8, 14, 17, 21)

V. Present information related to the implementation for the walkdown process (e.g., details of selection of the walkdown team and procedures) using the documentation template discussed in Requested Information Item 1.j, including actions taken in response to the peer review.

Development of the walkdown scope was in accordance with NEI 12-07, Guidelines for Performing Verification Walkdowns of Plant Flood Protection Features. A list of flood protection features that are credited in the current licensing basis criteria for protection against flooding events was identified and developed. Walkdown packages were prepared for all flood protection features that fall within the scope of this walkdown guidance.

The personnel who were selected for the walkdown team to perform walkdown inspection activities were chosen based upon experience and knowledge. There were three engineers selected to serve on the walkdown inspection team. All three engineers are knowledgeable of the site current licensing basis. All three engineers are also licensed Professional Engineers and are registered in North Carolina. Each have a minimum of 25 years of structural engineering experience and are trained to perform visual inspections of plant structures, systems, and components. Also, all three personnel completed and successfully passed the following INPO NANTeL training: 1) Generic Flood Protection Walkdown Awareness Certification and 2) Generic Verification Walkdowns of Plant Flood Protection Features Certification.

For each item on the walkdown list, the walkdown team performed a visual inspection to assess the capability of the item to perform its required function. A visual comparison of the physical condition of the structure, system, or component was compared to the acceptance criteria. The walkdown inspection results were evaluated by station engineering staff and engineering supervision; these walkdown inspection results are documented in Calculation MCC-1612.00-00-0002. [21]

In summary, all of the flood protection features that are credited in the current licensing basis were inspected, and all were evaluated to be acceptable. There were no flooding walkdown observations that were identified as deficiencies as determined by the corrective action program.

VI. Results of the walkdown including key findings and identified degraded, non-conforming, or unanalyzed conditions. Include a detailed description of the actions taken or planned to address these conditions using the guidance in Regulatory Issues Summary 2005-20, Rev. 1, Revision to NRC Inspection Manual Part 9900 Technical Guidance, "Operability Conditions Adverse to Quality or Safety," including entering the condition in the corrective action program.

The results of the walkdowns performed for the flood protection features that are credited in the current licensing basis did not identify any degraded, non-conforming, or unanalyzed conditions. There were no deficiencies determined by the corrective action program, and there were no observations that were dispositioned as deficiencies. [21]

VII. Document any cliff-edge effects identified and the associated basis. Indicate those that were entered into the corrective action program. Also include a detailed description of the actions taken or planned to address these effects.

As a result of the walkdown process, all of the flood protection features that are credited in the current licensing basis were inspected, and all were evaluated to be acceptable. The available physical margins for all of the flood protective features have been collected and documented on the Walkdown Record Forms. [21]

Flood protection features with cliff-edge effects denote that the safety consequences of a flooding event may increase sharply with a small increase in the flooding level. As a result of the walkdown process, none of the flood protection features were identified as having cliff-edge effects. Below is a review of the flood barriers which could have potential cliff-edge effects:

1. Flood water from a Probable Maximum Precipitation (PMP) event (El. 760.375 feet) could begin to enter the Auxiliary Building at El. 760.5 feet if the flood water exceeded the existing 1½" margin. This was not considered a cliff-edge effect due to the following:
   - The critical Probable Maximum Precipitation event is 6 hours which limits the available volume of flood water. [6]
   - In order to enter the safety-related portion of the Auxiliary Building, the flood water would have a torturous path of doors which would limit the flow rate.
   - If the flood water entered the non-safety-related Turbine Building, the flood water in the building would not affect the safety-related Auxiliary Building due to the flood wall between the Auxiliary Building and the Turbine Building.
   - If the flood water made it into the Auxiliary Building, existing sumps would aid with the water removal.

2. Flood water from the Probable Maximum Flood (PMF) was not considered a cliff-edge effect due to the margin between the protective earthen dike (with a top elevation of 780.0 feet) and the maximum flood water elevations (El. 767.9 feet for maximum flood water elevation (PMF) and El. 774.75 feet for maximum hurricane waves (PMH)). [1, 2, 3, 5, 8, 9, 10, 11, 13]

VIII. Describe any other planned or newly installed flood protection systems or flood mitigation measures including flood barriers that further enhance the flood protection. Identify results and any subsequent actions taken in response to the peer review.

There are no planned or newly installed flood protection systems or flood mitigation measures identified as a result of the flood walkdown process. No additional changes were determined to be required to further enhance the flood protection at the plant site.

IX. References:

A. Updated Final Safety Analysis Report (UFSAR)

1. **UFSAR Section 2.4** **Hydrology**
2. **UFSAR Section 2.4.2** **Floods**
3. **UFSAR Section 2.4.3** **Probable Maximum Flood (PMF) On Streams and Rivers**
4. **UFSAR Section 2.4.4** **Potential Dam Failures (Seismically Induced)**
5. **UFSAR Section 2.4.5** **Probable Maximum Surge and Seiche Flooding**
6. **UFSAR Section 2.4.10** **Flood Protection Requirements**
7. **UFSAR Section 2.4.13** **Groundwater**
8. **UFSAR Section 3.4** **Water Level (Flood) Design**

B. MCS-1465.00-00-0012 **Design Basis Specification For Flooding From External Sources**

9. **MCS-1465.00-00-0012 Section 3.2** **Flood Design**
10. **MCS-1465.00-00-0012 Section 3.2.1** **Design Considerations**
11. **MCS-1465.00-00-0012 Section 3.2.2** **Probable Maximum Flood (PMF)**
12. **MCS-1465.00-00-0012 Section 3.2.3** **Potential Dam Failure**
13. **MCS-1465.00-00-0012 Section 3.2.4** **Probable Maximum Surge and Seiche Flooding**
14. **MCS-1465.00-00-0012 Section 3.3** **Flooding Protection**
15. **MCS-1465.00-00-0012 Section 3.4** **Probable Maximum Precipitation (PMP) Protection**
16. **MCS-1465.00-00-0012 Section 3.4.1** **Roof Drains and Parapets**
17. **MCS-1465.00-00-0012 Section 3.4.2** **Storm Drainage System**
18. **MCS-1465.00-00-0012 Section 3.5** **Combination of Flood Event With Seismic Event**

C. General References

19. **HUR 7-97 Interview Report - Meteorological Characteristics of the Probable Maximum Hurricane, Atlantic and Gulf Coasts of the U.S., Office of Hydrology, Corps of Engineers, 1968**
20. **PIP G-11-01700 and EC108849 - Update MNS Topography Map and PMP Flood Analysis**
21. **Calculation MCC-1612.00-00-0002 – 10CFR50.54 Recommendation 2.3 Fukushima Near-Term Task Force (NTTF) Flood Walkdown Inspections**