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Monticello Nuclear Generating Plant
2807 W County Road 75
Monticello, MN 55362

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Monticello Nuclear Generating Plant
Docket 50-263
Renewed License No: DPR-22

Subject: Correction to Appendix C of the Monticello Individual Plant Examination of External Events

References:
1) Generic Letter 88-20, "Individual Plant Examination for Severe Accident Vulnerabilities – 10CFR 50:54(f)", dated November 23, 1988.
2) NSP Letter to NRC, "Submittal of Monticello Individual Plant Examination of External Events (IPEEE) Report", dated March 1, 1995.
3) NRC Letter to NSP, "Review of Monticello Individual Plant Examination of External Events (IPEEE) Submittal (TAC No. M83644)", dated April 14, 2000.
4) EPRI NP-2005-VI, "Tornado Missile Simulation and Design Methodology", dated August 1981.

NRC Generic Letter 88-20 (Reference 1) required existing plants, pursuant to 10CFR 50.54(f), to perform an Individual Plant Examination for severe accident vulnerabilities and submit the results to the NRC. In response to Reference 1, NSP submitted Appendix C (Reference 2) of the Individual Plant Examination of External Events (IPEEE) addressing internal fires, high winds, floods, and other credible events. The NRC responded (Reference 3) that they had concluded "the aspects of seismic, fires, and high winds, floods, transportation and other external events were adequately addressed."

In Monticello's IPEEE Appendix C, Revision 0, the collective set of credible tornado missile strikes produced a CDF of less than 1E-07. An error was discovered earlier this year which determined that this value was not conservative, and the actual value for CDF is 1.1E-07. This level remains well below the threshold level established in Reference 1 of 1E-6.

The errors in the IPEEE were traced back to translational errors in a document utilized to support calculations for the IPEEE. These errors propagate through the calculation and underestimated the frequency of penetrating type missile strike at MNGP. Specifically, the source of the frequency for missile impact in Tornado Region B for Tornado Intensity F5 was incorrectly copied from Table IV-11 of Reference 4. A value of 1.05 E-05/yr was incorrectly translated as 1.05 E-06/yr in two places. For Tornado Intensity F2, a frequency for missile impact of 1.46 E-04/yr was incorrectly translated as 1.46 E-05/yr in one place. These errors resulted in the original total probability per year for a penetrating type missile of 3.00 E-04. Correcting these errors resulted in a total probability per year for a penetrating type missile of 5.12 E-04 and an updated value for CDF of 1.1E-07.

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The error impacts only Section C.2.2.2 of Appendix C, which covers tornado missiles and high winds. The updated IPEEE Appendix C, Revision 1 is included as Enclosure 1. The conclusions of Appendix C to Monticello's IPEEE remain unchanged.

This issue was documented in Monticello's corrective action program. A search was performed to determine if the paper had been utilized in other license applications. Nothing else has been discovered that references the paper or that would impact either 10 CFR 50.65 (a)(4) assessments or other PRA applications.

Summary of Commitments:

This letter makes no new commitments and no revisions to existing commitments.

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Enclosure

cc: Administrator, Region III, USNRC
Project Manager, Monticello, USNRC
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Monticello
Individual Plant Examination of External Events (IPEEE)

NSPLMI-95001

Appendix C
Revision 1

Other External Events

Revision 1 of Appendix C of the Individual Plant Examination of External Events was issued to address translational errors as documented in the Corrective Action Process under A/R 01240166. The errors originated in a white paper titled "Tornado Generated Missile Philosophy Supporting the MNGP Licensing Basis" (October 1994), which was used to generate the basis calculation (II.SME.95.001) for the Tornado Generated Missile portion of the Appendix to the IPEEE. II.SME.95.001 was revised (Revision 1) to correct the known errors from the white paper, and this appendix is revised to reflect the corrections to that calculation. The conclusion of Appendix C to the IPEEE remains unchanged.

Rev. 1 Prepared by 7-26-10
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Rev. 1 Verified by 7-26-10
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Rev. 1 Approved by 11-16-10
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C.1. SUMMARY

C.1.1 Background

The assessment that is described in this appendix addresses the external events other than seismic and internal fires. These "other" external events include phenomena such as high winds, floods, transportation-related accidents and accidents at nearby facilities that could potentially pose a threat to the Monticello plant. This assessment is performed using the screening approach suggested in Generic Letter 88-20, Supplement 4 [1], and the accompanying guidance for implementation, NUREG-1407 [2].

C.1.2 Plant Familiarization

The Monticello nuclear generating plant is a low power-density BWR-3 with Mark I containment designed by General Electric Company and built by Bechtel Corporation. The reactor core produces 1670 MWt with an electrical output of 545 MWe. The plant is located northwest of Monticello, Minnesota. Construction started on June 19, 1967, and full commercial operation began on June 30, 1971.

Monticello was designed prior to the final issuance of the general design criteria for nuclear power plants (10CFR50, Appendix A) and the 1975 standard review plan (NUREG-75/087) [3]. Instead, the Monticello design followed the proposed Atomic Energy Commission (AEC) general design criteria published in the Federal Register on July 11, 1967 (32FR10213). This review considered the more recent criteria, and any significant differences from the general design criteria and standard review plan are noted when applicable.

C.1.3 Overall Methodology

The NRC's Generic Letter 88-20, Supplement 4, and the accompanying guidance for documentation, NUREG-1407, include a recommended screening approach that can be used to evaluate the impact of high winds, external floods, and transportation and nearby facility accidents. Figure C.1 is a flow chart of this recommended screening approach. The steps shown in this figure represent a series of analyses in increasing level of detail, effort, and resolution. This approach was followed for the Monticello evaluation of other external events.

After identifying the external events that should be considered for Monticello, the 1975 Standard Review Plan, NUREG-75/087, was reviewed to determine if its criteria are satisfied at Monticello. Because Monticello received its operating license prior to 1975, it was necessary to review Monticello's Updated Safety Analysis Report (USAR) [4] and subsequent analyses to make this assessment. If the standard review plan (SRP) requirements are satisfied and a confirmatory walkdown does not identify unique vulnerabilities not included in the original design bases for the external event under evaluation, it is judged by the NRC in Generic Letter 88-20, Supplement 4, that the contribution from that hazard to the core damage frequency is less than 10^{-6} per year, and that hazard can be screened from further consideration.

If the SRP is not satisfied, additional analyses may be necessary, up to and including the development of probabilistic risk assessment models to evaluate the specific concerns. These steps are described in more detail in section C.2.

C.1.4 Summary of Major Findings

Based upon the evaluations presented in section C.2, there is no "other" external event (fire and seismic are examined in separate appendices) that is a safety concern to the Monticello plant. No vulnerabilities were identified, and the screening criteria contained in NUREG-1407 and Generic Letter 88-20, Supplement 4, are satisfied for all events. Because no vulnerabilities were found in this assessment, no changes to plant hardware or procedures are recommended.

Simple walkdowns were performed to confirm the results of the evaluations. The observations from those walkdowns were reviewed and factored into the appropriate portions of the evaluation, prompting further analysis in some cases. Ultimately, the walkdowns confirmed the conclusions discussed in the next section and identified no additional unique vulnerabilities.

Most of the external events considered could be readily screened from further consideration because they either do not apply to the Monticello site (e.g., volcanos, avalanches, landslides) or have limited impact based on the history of the site (e.g., lightning). The remaining events — high winds, external flooding, and hazards due to local transportation and nearby facilities — were evaluated in greater detail. High winds were dismissed as a potential threat due to the design of the plant, using ASCE Paper No. 3269 [5] as a basis, which is recognized by the SRP as sufficient. The threat posed by tornado winds is well below the 10^{-6} per year screening criteria because of the low likelihood of winds exceeding the levels of concern in the Monticello area, and because of the plant's ability to withstand tornado-induced differential pressures and tornado missiles.

Flooding is adequately addressed through the existing Monticello flood protection plan, which includes procedures detailing specific actions to be taken in the event of the rare occurrence of flooding conditions that can affect the site. The adequacy of the plant's design with respect to the probable maximum precipitation was established using a conservative and detailed analysis that showed that roof drainage is sufficient to prevent the accumulation of rain water above critical levels.

Transportation accidents do not pose a serious threat to the safety of the plant staff or structures. The assessment considered aircraft accidents and determined that the site is safely removed from federal airways, holding patterns, and approach patterns; is remotely located from any military installation and not exposed to military-related training flights; and is well below the screening criteria in terms of the potential threat posed by small aircraft traffic in the vicinity of the site. Even though Monticello is located on the bank of the Mississippi River, there is no credible threat to the plant from transportation accidents on the river because of the minimal traffic that occurs this close to the river's headwaters; the river is too shallow to allow much more than pleasure craft activity. The explosive hazard presented by volatile materials carried in pipelines, railroad cars, or trucks, or from sources located on site, is bounded by the overpressure design of the plant's critical structures. The threat from an explosion due to volatile materials or processes at neighboring industrial or military facilities is inconsequential, since the threat posed by industrial facilities is bounded by pipelines, rail and truck traffic which are nearer to the site, and there is no military installation in the vicinity of the plant.

The last external event to be considered in the assessment was hazardous material spills from sources on site, from facilities near the site, or from transportation means (highway or rail) adjacent to the site. A recent toxic chemical study performed by Northern States Power establishes that there is no significant risk to the plant staff as a result of the potential sources of toxic chemical releases. This toxic chemical study concluded that the control room operators are sufficiently protected from incapacitation without toxic chemical detection equipment; this provided the basis for requesting and receiving an amendment to the Monticello technical specifications to delete the operability requirements for the installed chlorine detectors.

C.2. ASSESSMENT OF OTHER EXTERNAL EVENTS FOR MONTICELLO

C.2.1 External Events Considered for Monticello

NUREG/CR-5042, "Evaluation of External Hazards to Nuclear Power Plants in the United States," December 1987 [6], contains a list of other external events which may need to be considered by nuclear power plants. The NRC staff, in their review of this and similar lists, concluded that many of the events can be discarded from consideration due to the low frequency of occurrence and the subsequently low conditional probability of core damage. Other events may be removed because they or their effects are considered within the internal events IPE. However, each plant is to review this list and ensure that there is no unique plant-specific design or operating characteristic which may require that the events be evaluated. A review of the list of events as they apply to Monticello confirms that the following events can be removed from further consideration:

Severe temperature transients (extreme heat, extreme cold): The effects of these events are usually limited to the ultimate heat sink and the loss of offsite power because of the slow-acting plant responses and the time available to initiate shutdown and mitigative actions. The Monticello plant is in a region which tends to be affected more by extreme cold than by extreme heat. Important piping systems and liquid storage tanks at Monticello are either inside heated buildings or are protected from the cold by heat tracing or insulation. The effect on the heat sink would evolve very slowly, allowing sufficient time for the operators to take action to ensure that the decay heat removal function was maintained. The situation could be dealt with in a straight-forward manner given the operating procedures and the number of systems in place at Monticello to provide decay heat removal — see the discussion of decay heat removal in the Monticello IPE [7]. Monticello's Operations Manual [8], section A.6, "Acts of Nature," includes instructions for dealing with high river water temperature. The initiating event frequency for loss of offsite power events includes those due to severe temperature extremes, and the impact of loss of heating, ventilating and air conditioning had limited impact on the results of the IPE. Therefore, no further analysis of these events is necessary.

Severe storms, including ice, hail, snow, dust, and sand storms: The major impact of these storms is upon offsite power availability. Windstorms may also affect the plant ventilation system or the ultimate heat sink. The Monticello IPE considers the impact of severe storms within the loss of offsite power frequency. As discussed below for external fires, the ability to maintain control room habitability is ensured by the design of the control room ventilation and filtration system. Any impact on the ultimate heat sink would be slow-acting and could be countered with a number of the systems available at Monticello to provide decay heat removal (see above). Since other possible impacts such as external flooding are considered separately, no further analysis of these events is necessary.

Lightning: As stated in NUREG-1407, section 5.1, lightning primarily affects the loss of offsite power frequency, which is evaluated in the Monticello IPE analysis. A review of plant-specific data compiled for Monticello identifies that there have been twelve known lightning strikes at the site, but none has damaged any equipment important to safety. The impacts of severe weather are also incorporated into the IPE's initiating event frequency for loss of offsite power by using generic approaches and data applicable to the site location, as described in NUREG-1302, "Evaluation of Station Blackout Accidents at Nuclear Power Plants" [9], and NUMARC 87-00, "Guidelines and Technical Bases for NUMARC Initiatives Addressing Station Blackout at Light Water Reactors" [10]. Therefore, no further review of this event is required.

External fires: These are fires which occur outside the plant site boundary, such as forest fires and grass fires. Potential impacts include loss of offsite power, forced isolation of the plant's ventilation system, and possible control room evacuation due to smoke. Because the plant's protected area is cleared of forest and brush, it is extremely unlikely that a fire would spread to the site. Therefore, the potential effects of external fires can be limited to loss of offsite power and isolation of the ventilation system.

The loss of offsite power frequency for Monticello includes data on events from all causes. No external fire has caused a loss of offsite power event at Monticello. If such an event had occurred, its impact on plant response would have been incorporated in the Monticello IPE. No additional analysis of the impact of external fires on loss of offsite power response is required.

Were it necessary, the isolation features of the ventilation system would be used to maintain an acceptable environment in the control room. The system is designed to protect the control room environment from a variety of hazards, including radiological releases, toxic chemical releases, and fires starting within the plant boundary. The hardware features which protect the operators in these events also would protect the operators in the event of smoke from offsite fires. Although manual isolation of ducting and initiation of fans, etc., may be necessary in the event of smoke, there is high confidence that the operators will detect the smoke and take appropriate action. There is sufficient time for the operators to initiate the emergency filtration train (EFT), if necessary. The EFT system receives power from essential sources, including emergency diesel generators in case of a loss of offsite power. There is also sufficient battery back-up power to operate DC-powered equipment reliably in the event of loss of AC power to the battery chargers. Therefore it is concluded that the effects of external fires upon the plant are negligible, and no further analysis is required.

Extraterrestrial activity: This includes objects such as meteors or artificial satellites which could enter the earth's atmosphere from space. Because of the speed at which these objects may strike the earth (estimated to be at least 37,000 feet per sec — see NUREG/CR-5042), the damage to structures or components struck, or even just missed, by these objects is significant. However, NUREG/CR-5042 indicates that the probability of a meteorite strike ranges between 6E-8 and 7E-10 per reactor year. Therefore, on the basis of their low probability, these events can be screened from further consideration.

Volcanic activity: These events do not apply to the Monticello site.

Earth movement (avalanche, landslide): Avalanches do not apply to any plant in the United States. Landslides and other large earth movements other than earthquakes are also discounted at Monticello because the site is on relatively level terrain. Reviews by the NRC staff also conclude that these issues are insignificant for all nuclear plant sites [NUREG-5042].

After the elimination of the preceding events, the events which must be considered further for Monticello are limited to the following:

- High winds and tornados
- External flooding
- Transportation and nearby facility accidents

Generic Letter 88-20 also requests utilities to assess Generic Issue 103, "Design for Probable Maximum Precipitation (PMP)". Generic Letter 89-22, "Potential for Increased Roof Loads and Plant Area Flood Runoff Depth..." [18], refers to updated criteria which are to be reviewed by existing plants to determine whether a severe accident could occur at the plant due to on-site flooding and roof ponding. This issue is considered as part of the evaluation of external flooding.

These are evaluated in sections C.2.2 through C.2.4.

C.2.2 High Winds and Tornados

The design criteria for high winds are summarized in Standard Review Plan sections 3.3.1, "Wind Loadings," and 3.5.3, "Barrier Design Procedures". Nuclear power plant buildings should be designed to withstand sustained winds between 100-130 mph, depending upon an assumed gust factor, with a 100-year recurrence frequency.

For tornados and missiles, the applicable criteria are in Regulatory Guide 1.76, "Design Basis Tornado for Nuclear Power Plants" [11], Regulatory Guide 1.117, "Tornado Design Classification" [12], and Standard Review Plan sections 3.3.2, "Tornado Loadings," 3.5.1.4, "Missiles Generated by Natural Phenomena," and 3.5.2. ANSI Code A58.1 [13] also contains pertinent information.

Because the winds expected from a tornado are much higher than those classified as "high winds," it is assumed that plant structures that satisfy the design criteria for tornados will also satisfy those required for high winds. However, for completeness each of these topics is addressed separately here.

C.2.2.1 High Winds

Section 3.3.1 of the Standard Review Plan states that "...the procedures delineated in either the American Society of Civil Engineers (ASCE) Paper No. 3269 [5], 'Wind Forces on Structures'...or in ANSI A58.1-1972...are acceptable" for addressing wind velocity and effective pressure applied to exposed surfaces of structures. From the Monticello USAR, section 12.2.1.6, "Wind Loads," the Monticello design is based upon a maximum wind velocity of 100 mph thirty feet above ground, in accordance with ASCE Paper 3269. A gust factor of 1.1 was used, so that gusts up to 110 mph are included in the design bases.

Because wind velocity can vary with height, the effects of high winds were also applied to the offgas stack. For the offgas stack design evaluation, section 12.2.2.6.2 of the Monticello USAR indicates that ASCE Paper 3269 was again used with 100-mph winds. The stack is designed for

100-mph winds. Moreover, no class I structure or system is located within a radius of one stack height of the stack. Therefore, even in the unlikely event of stack collapse due to high or tornado-induced winds, no failure of any safety system is anticipated.

Based upon the evaluations performed using ASCE Paper 3269, the Monticello design meets the criteria in the SRP for high winds.

C.2.2.2 Tornados

According to Regulatory Guide 1.76, Monticello is located in tornado region I. For this region, Regulatory Guide 1.76 provides the tornado characteristics shown in table C.1 below. Monticello design basis tornado characteristics from USAR section 12.2.1.8 are shown for comparison.

Table C.1 Comparison of NRC Criteria to Monticello Design Criteria

Topic	NRC Reg. Guide 1.76	Monticello (USAR)
Rotational wind speed	290 mph	300 mph
Maximum wind speed	360 mph	unspecified (≥ 300 mph)
Pressure drop	3 psi	2 psi
Utility pole missile	1500 lbs	~ 1310 lbs
Utility pole missile	241 mph	200 mph
Utility pole missile	30 ft above grade	unspecified
Utility pole missile height/diam	35 ft/14"	35 ft/14"
Automobile	4000 lbs	2000 lbs
Automobile	100 mph	100 mph
Automobile	30 ft above grade	25 ft above grade
Automobile	20 sq.ft contact area	25 sq.ft contact area

Obviously, there are differences between the Monticello design criteria and those in Regulatory Guide 1.76 and SRP 3.5.1.4. Chief among these is that the maximum wind speed used for Monticello may be as much as 60 mph lower than the NRC criteria.

According to Figure 3.2-1 of ANSI/ANS-2.3-1983, "Standard for Estimating Tornado and Extreme Wind Characteristics at Nuclear Power Sites" [14], the Monticello plant site is in an area where the probability of experiencing tornado wind speeds of 320 mph or greater is 10^{-7} per year. That figure is reproduced here as figure C.2. Similarly, figure 3.2-2 of ANSI/ANS-2.3-1983 (reproduced in figure C.3) shows that the probability of experiencing maximum tornado wind speeds of 260 mph or greater is 10^{-6} per year. Thus, according to this information, the frequency of a tornado with 300 mph maximum wind speed at the Monticello site is no greater than 10^{-6} per year. This provides sufficient justification for eliminating structures designed for the 300 mph tornado from further consideration, based upon the low frequency of this maximum wind speed.

The peak pressure drop associated with the 260 mph wind speed (probability of 10^{-6} per year) can also be found in ANSI/ANS-2.3-1983, which cites 1.46 psid as the maximum differential pressure. Again, this value is less than the 2 psid included in the Monticello design basis. Structures designed for the 2 psid differential pressure can be excluded from further review.

The tornado missile design basis is similar to or slightly less than that recommended by the SRP. However, the ANSI/ANS-2.3-1983 document suggests a 750-pound wide-flange beam as its standard design "large, hard" missile. For the 10^{-6} per year tornado (260-mph maximum wind speed), the beam is specified to have a 75-mph impact velocity. Comparing the ANSI/ANS standard to the Monticello design basis shows that the Monticello design basis tornado is more severe than that associated with the 10^{-6}per year tornado, such that the effects of the design basis missiles are also likely to be more severe. Monticello structures that include the design basis tornado missile in their design are considered to provide adequate protection from these missiles and can be screened from further consideration in the IPEEE. Monticello structures that were subject to design basis requirements for tornadoes and tornado missiles include the external surfaces of the control building, the reactor building (with the exception of the refueling deck), the EFT building, portions of the turbine building, and the intake structure.

Though the Monticello design basis incorporated significant consideration of loads associated with tornadoes and tornado missiles, the plant staff has identified a number of penetrations in safety-related structures, such as doors and louvers, which are not subject to these load considerations. Failure or blowing open of these penetrations could expose structures and systems inside safety-related buildings to the effects of the tornado differential pressure or missiles. While not required as a part of the Monticello plant design basis, the remainder of this evaluation addresses these aspects of tornado hazards. The effects of differential pressures are considered first, followed by those associated with tornado missiles.

To determine the significance of tornado-generated differential pressures on structures inside safety-related buildings, a series of analyses was performed. The first was to determine the magnitude of the expected differential pressure for various tornado wind speeds. Table C.2 below is taken from ANSI/ANS-2.3-1983, which includes the following correlation for differential pressure versus wind speed:

$$\Delta P \text{ (psi)} = 3.546E\text{-}5\ V_t^2$$

where V_t is the difference between maximum and translational wind speeds expressed in miles per hour.

Table C.2 Induced Differential Pressures for Various Tornado Wind Speeds

Frequency (per year)	Maximum Wind Speed (mph)	Translational Wind Speed (mph)	Differential Pressure (psid)
10^{-5}	200	45	.85
10^{-6}	260	57	1.46
10^{-7}	320	70	1.96

To estimate the response of rooms within Monticello structures to tornado differential pressures, two types of rooms were evaluated. The first was the cable spreading room, which is located beneath the control room. The cable spreading room was assumed to be completely sealed, and a differential pressure of 1.49 psid was applied between the room and the atmosphere outside the room. This is the maximum differential pressure which this room can experience, because at 1.49 psid the latches to the cable spreading room door are expected to fail, equalizing the pressure and relieving stresses across the walls. The stresses due to this differential pressure were shown to be within the allowable stresses as stated in the Monticello USAR, chapter 12, for the room floor, including both expected live and dead loads. Thus, the cable spreading room can withstand more than the 1.46 psid differential pressure which would be induced by the 10^{-6} per year winds.

A second room was analyzed to determine a more realistic but still bounding estimate of the differential pressure expected across internal structures given that most rooms in the plant have penetrations through which the room can be vented (HVAC penetrations, for example). One example is the Division I and II DC battery rooms located in the control building. Two of the four external walls of these rooms are masonry block and would be expected to have a capacity less than that shown for the cable spreading room. HVAC ducting penetrates the walls of these room to provide ventilation. A 1.5 psid differential pressure was assumed to be applied across the walls of these rooms over the course of five seconds to simulate the gradual change in atmospheric pressure which would be expected in the event of a tornado strike. This particular differential pressure is more than that associated with a 10^{-6} per year tornado according to ANSI/ANS-2.3-1983, and ignores any effects that the surrounding building may have in reducing the differential pressure. The maximum differential pressure that occurs across the block walls of the battery room under these assumptions is less than 0.25 psid. An assessment was made of the margin that exists in the ultimate strength of these block walls over this differential pressure. The wall capacities were found to be limited by the out-of-plane moment, which would be expected for tornado differential pressure. The walls were found to have a net differential capacity of 0.38 psid, one-and-a-half times that expected for the 10^{-6} per year tornado.

The results of this analysis suggest that rooms sampled within the Monticello plant can withstand the differential pressures that may occur during tornadoes. Many rooms are expected to have capacities that exceed the differential pressure associated with a tornado strike. For those rooms which may have relatively low capacities, penetrations into these rooms would relieve internal pressure, so the differential pressure is not expected to be significant. The structures internal to Monticello are screened from further consideration on this basis.

To assess the threat of missiles penetrating the unprotected areas of the Monticello plant, drawings depicting the exterior faces of buildings were reviewed to identify potential penetration points. The review identified the opening area and the extent to which critical plant equipment could be adversely affected should a missile penetration occur. An analysis was performed using the methodologies and data presented in NUREG/CR-4416 [15] and EPRI Report NP-2005 [16] to determine for each of the identified openings the corresponding missile strike probability. A conditional core damage frequency (CCDF) was developed assuming damage to equipment in any areas that a missile may penetrate. Important equipment located in each of these areas was identified from the fire IPEEE. As the fire IPEEE deals primarily with potential damage to electrical equipment, it was necessary to supplement this information with the location of piping systems in each location to determine the total potential damage associated with a missile in each area. The tornado was also assumed to cause a loss of offsite power. Table C.3 below summarizes the results of the tornado missile assessment. The product of the missile strike probability and the CCDF gives the core damage frequency (CDF) associated with a particular missile penetration. The sum of the individual missile-induced core damage frequencies yields the core damage frequency for tornado missiles.

Table C.3 Effects of Tornado Missiles in Various Plant Locations

Penetration Location	Missile Strike Probability (per year)	Conditional Core Damage Frequency	Missile Core Damage Frequency (per year)	Comments
Walls/roof over turbine building 951′ level	~~4.2E-7~~ 7.2E-7	8.3E-2	~~3.5E-8~~ 6.0E-8	Southeast corner of turbine deck; cable chase containing Division II cabling running from ASDS panel to control room.
East face of reactor building 985′ level	~~4.8E-7~~ 8.2E-7	5.5E-3	~~2.7E-9~~ 4.5E-9	Missile penetrates through HVAC louver and interacts with normal reactor building HVAC equipment. CCDF reflects equipment in recirc pump MG set area one floor below (includes cabling for shutdown cooling valve MO-2030) which is not expected to be adversely affected by a missile penetrating the louver.
South face of reactor building ground level	~~3.8E-7~~ 6.5E-7	2E-2*	~~7.6E-9~~ 1.3E-8	Penetration through 2 sets of railway doors blown open by the tornado; equipment potentially affected include CRD hydraulic control units and scram discharge volume, Division I of RHR, CS, and SRV, and RCIC control cables.

Table C.3 Effects of Tornado Missiles in Various Plant Locations (continued)

Penetration Location	Missile Strike Probability (per year)	Conditional Core Damage Frequency	Missile Core Damage Frequency (per year)	Comments
South face of turbine building ground level	~~4.6E-7~~ 7.8E-7	5.9E-3	~~2.7E-9~~ 4.6E-9	Penetration through railway doors blown open by the tornado. Missile is not anticipated to have significant interaction with equipment; however, CCDF conservatively includes equipment located in the adjacent recombiner building, the turbine deck (one floor above), and the area immediately adjacent to the railway bay.
West face of reactor building ground level	~~2.4E-8~~ 4.1E-8	5E-2*	~~1.2E-9~~ 2.1E-9	Missile is assumed to penetrate two access doors in series, blown open by the tornado. Affected area includes CRD hydraulic control units and scram discharge volume. A conservative CCDF includes CRD equipment in addition to equipment in RHR valve room (shielded from missile by equipment hatch tunnel), and 480V MCCs and reactor building cooling water pumps located a floor above (not accessible to missile).
West face of reactor building 946′ level	~~3.7E-8~~ 6.3E-8	5E-2*	~~1.85E-9~~ 3.2E-9	Missile penetrates HVAC louver. The effect is the same as that described for west reactor building ground level access door.
West face of reactor building 955′ level	~~3.7E-8~~ 6.3E-8	5E-2*	~~1.85E-9~~ 3.2E-9	Missile penetrates HVAC louver. The effect is the same as that described for west reactor building ground level access door.
West face of turbine building 945′ level	~~1.0E-7~~** 1.8E-7	1.0E-1	~~1.0E-8~~ 1.8E-8	Missile intrusion through electrical penetration affects Division II essential power.
West face of turbine building 935′ level	~~1.1E-7~~** 1.9E-7	5.9E-3	~~6.5E-10~~ 1.1E-9	Missile intrusion through electrical penetration affects a minimal set of equipment. However, the CCDF conservatively includes equipment located in the adjacent recombiner building, the turbine deck (one floor above), and the area immediately adjacent to the railway bay.

Table C.3 Effects of Tornado Missiles in Various Plant Locations (continued)

Penetration Location	Missile Strike Probability (per year)	Conditional Core Damage Frequency	Missile Core Damage Frequency (per year)	Comments
Diesel generator building roof	** ~~1.9E-7~~ 3.3E-7	---------	---------	Diesel generator roof includes intake and exhaust lines for each of the two diesels. Subject of sensitivity study to estimate bounding CDF contribution associated with particular failure mode.
TOTAL:			~~6.4E-8~~ 1.1E-7	Total contribution from hazard to core damage frequency is less than IPEEE screening criteria of 10^{-6}/yr.

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* Principal damage is assumed to be associated with failure of the scram discharge volume piping leading to reactor inventory loss into the reactor building.

** Penetrations are obscured by intervening equipment in the yard, including transformers which are conservatively ignored in generating this missile strike frequency.

The assessment resulted in nearly all penetration scenarios yielding very low core damage frequencies, on the order of 10^{-9} per year or less. The scenarios associated with only three penetrations resulted in relatively higher core damage frequencies, near 10^{-8} per year.

The dominant contributor (~~3.5E-8~~ 6.0E-8 per year) is the scenario in which a missile penetrates the turbine building wall or ~~the~~ roof over the turbine deck area and impacts a small area in the southeast corner. This area is defined by a block wall that protects cable trays that route cables between the ASDS panel (located in the EFT building), the control room (located in the control building) and the lower level of the turbine building. The block wall represents the target for the missile; the walls and roof of the turbine building above the 951′ elevation are completely neglected. Damage to these cables results in loss of RHR train B, RHRSW train B, core spray train B, and HPCI. The CCDF also conservatively includes the loss of the #14 air compressor and several MCCs that are located directly below the turbine deck in this corner, although these are not actually expected to be affected by the missile. Rev. 1

Another dominant contributor is the scenario in which a missile penetrates the doors which open to the rail car shelter area south of the reactor building. A second set of doors at the end of this area opens into the reactor building 935′ elevation. Both sets of doors are assumed to be either already open or blown open by the tornado. The missile was assumed to penetrate the first doorway, traverse the eighty-foot length of the shelter area, penetrate the second doorway, and continue into this open area of the reactor building. More than sixty feet in from the second doorway, on the east side of the reactor building at this elevation, are located half the CRD hydraulic control units, their CRD scram discharge volume, HPCI and RCIC instrument racks, standby liquid control piping, and shutdown cooling piping. Damage to this equipment will not result in a failure to trip and will also leave other unaffected systems available to provide core cooling. However, damage to the scram discharge volume piping could lead to a loss of reactor inventory. This would not necessarily lead to core damage. Nevertheless, it was conservatively assumed that core damage would occur whenever this missile strike occurs. Even with these conservative assumptions, the core damage frequency was calculated to be only ~~7.6E-9~~ 1.3E-8 per year. Rev. 1

The remaining dominant missile penetration scenario involves a strike of the electrical penetrations on the west side of the turbine building at the 945′ elevation. The missile is assumed to enter the upper 4KV area affecting Division II essential power. Division I equipment would remain available to provide adequate core cooling. Further, it should be noted that the missile strike frequency for this area conservatively ignores intervening equipment, such as the station transformers, which would shield this area from missiles. Even with this assumption, the core damage frequency for this area is calculated to be only ~~1E-8~~ 1.8E-8 per year. Rev. 1

During review, a fourth missile target was identified that was initially screened from further consideration but was later considered as the subject for a sensitivity study. The target consists of the intake and exhaust pipes located on the diesel generator building roof. In the initial assessment, the missile was assumed to shear off, puncture, or tear the pipes such that the air intake and engine exhaust could still function. In the sensitivity study, the missile was instead assumed to crimp the pipe such that the air supply and/or engine exhaust is obstructed, leading to diesel failure. This sensitivity analysis simply assumed that this missile strike will always crimp the lines, disable the diesel generators, and thereby cause core damage; that is, the CCDF was assumed to be 1.0. Even with these conservative assumptions, the CDF was calculated to be ~~2E-7~~ 3.3E-7 per year. Although this is higher than the result for all other missile strikes, it is still well below the screening criteria employed by Generic Letter 88-20 and NUREG-1407, so that further refinement is unwarranted. Rev. 1

With the result for the collective set of credible missile strikes producing a CDF of ~~less than 1E-7~~ 1.1E-7 per year, tornado missiles can be screened from further evaluation. Rev. 1

C.2.3 External Flooding and Probable Maximum Precipitation

External flooding as evaluated for the USAR is discussed in section C.2.3.1. The potential impact of revised probable maximum precipitation data upon external flooding and roof ponding assessments is discussed in section C.2.3.2.

C.2.3.1 External Flooding

The criteria for acceptable external flood protection are contained in Regulatory Guide 1.59 [17] and Standard Review Plan sections 2.4.2, "Floods," and 2.4.3, "Probable Maximum Flood (PMF) on Streams and Rivers."

Monticello is located on the Mississippi River. The finished plant grade is 930 feet above mean sea level (MSL), about twenty-five feet above the mean river level of 905′ MSL. According to the USAR, Rev. 0, this is fourteen feet above the record 1965 flood level of 916′ MSL, and nine feet above the predicted 1000-year flood level of 921′ MSL.

The probable maximum flood (PMF) for Monticello was determined in Appendix G of the USAR to be 364,900 cubic feet per second, corresponding to a peak elevation of 939.2′ MSL - roughly nine feet above plant grade. This flood height is higher than the expected worst case 1000-year flood. The probable maximum flood can occur only during the spring thaw by hydrological, hydrometeorological, and climatic conditions described in Appendix G of the USAR. The PMF includes within it the effects of estimated probable maximum precipitation (PMP). The flood is calculated to reach 930 feet MSL in approximately six-and-a-half days and remain above elevation 930′ MSL for approximately eleven days.

The method for calculating the PMP used in the flood evaluation for Monticello is reported in Appendix G of the USAR. Based upon the calculations in Appendix G, the summer storm drops up to twenty inches of rain in the drainage area, while the spring storm drops up to nine inches. These amounts are combined with other factors (spring thaw, sudden and dramatic temperature increases, etc.) to arrive at a probable maximum flood height. Section C.2.3.2 discusses the impact of revised PMP estimates upon the PMF calculations.

Because the predicted probable maximum flood is higher than the 1000-year flood and is above plant grade, Monticello chose to use the probable maximum flood height to implement external flood protection. During the flood, offsite power may not be available, and therefore onsite essential power is included among the systems that require protection. The external flood protection boundaries for structures and equipment located below 939.2′ MSL at Monticello include portions of the following:

- Reactor building (including HPCI structure)
- Control building
- Intake structure
- Turbine building
- EFT building
- Radwaste building
- Offgas storage building
- Offgas stack
- Diesel generator building
- Diesel fuel oil pump house
- Diesel oil storage tank

Section A.6 of the operations manual instructs the operating staff on the actions to take if flooding up to 939.2′ MSL occurs. Actions include preparation and use of sand bags, sand, portable pumps, grout, lumber, steel plates, etc. The actual actions included in the instructions vary for each room or building addressed. For example, sand bags are used to protect the radwaste building, while the intake structure is protected by bolting or welding steel plate covers over doors, floor drains, and other openings.

Based upon the above information, it is concluded that external floods pose no undue hazard to the Monticello site and can be screened from further consideration in the IPEEE. This conclusion is based upon the following:

1. The predicted 1000-year flood has a flood crest height of 921′ MSL, which is nine feet below plant grade.

2. The worst recorded flood near Monticello had a crest height of 916′ MSL, which is fourteen feet below plant grade.

3. The probable maximum flood, although predicted to crest at nine feet above plant grade, requires very specific climatic conditions. As described in Appendix G of the USAR, the probable maximum flood is "...derived from hydrometeorological and hydrological studies and is independent of historical flood frequencies. It is the estimate of the boundary between possible floods and impossible floods. Therefore, it would have a return period approaching infinity and a probability of occurrence, in any particular year, approaching zero." Plant flood and equipment protection procedures are based upon this probable maximum flood height, and ensure that all vital plant equipment is protected in the event of such an extremely unlikely flood.

4. The probable maximum precipitation for the Monticello drainage area, using the NRC's updated criteria (see section C.2.3.2), is less than the probable maximum precipitation used in the calculation of Monticello's probable maximum flood. Therefore, the probable maximum flood evaluation in Appendix G of the USAR is conservative, and the actual probable maximum flood height may be lower than that for which the plant is now protected.

C.2.3.2 Probable Maximum Precipitation

Generic Letter 89-22 [18] informed licensees of operating reactors that more recent probable maximum precipitation (PMP) criteria had been published by the National Oceanic and Atmospheric Administration (NOAA) and the National Weather Service (NWS) [References 19-23]. According to the generic letter, these new criteria may result in higher site flooding levels and greater roof ponding loads than may have been used previously. For the IPEEE, licensees are to review the new criteria against their design bases to determine if the criteria are satisfied.

The two issues of concern related to this topic are: (1) the impacts of the precipitation on the magnitude of floods from external sources, and (2) roof ponding. For Monticello, it is judged that the impacts of PMP on external flooding are bounded by the analyses performed and documented in the USAR on external flooding, as described in section C.2.3. The probable maximum flood from external sources was calculated by maximizing the effects of a probable maximum spring storm and a probable maximum summer storm. These storms were centered over the site and the maximum precipitation in the drainage basin was calculated. The methodology for calculating precipitation amounts is reported in Appendix G of the USAR. Based upon the Appendix G calculations, the summer storm drops up to twenty inches of rain in the drainage area, while the spring storm drops up to nine inches. These amounts are combined with other factors (spring thaw, sudden and dramatic temperature increases, etc.) to arrive at a maximum probable flood height.

The NOAA/NWS report, "Probable Maximum Precipitation Estimates, United States East of the 105th Meridian" [20], contains a procedure for calculating the PMP for a specific drainage area for a specified period of time. For PMF calculations, the appropriate drainage area for the Monticello site includes the Mississippi River drainage above the plant site, an area of about 13,900 square miles (see Appendix G of the USAR). Using the procedure on pages 42 and 43 of this report, with a drainage area of 13,900 square miles for the site and a duration of 24 hours, a PMP of approximately 8.6 inches is calculated (see figures C.4 and C.5 - the procedure for calculating the PMP is repeated with figure C.4). This PMP depth is less than the rainfall amounts used to calculate the probable maximum flood, and therefore the flooding calculations included in Appendix G of the USAR bound any impact the probable maximum precipitation may have.

With flooding dismissed as an issue of concern, the roof ponding issue is addressed. Most buildings at Monticello are designed for a snow loading of 40 pounds per square foot. One pound per square foot is equivalent to 0.016 feet of water; therefore, 40 pounds per square foot is equivalent to 0.64 feet, or 7.7 inches of water. Hence, if roof ponding in excess of 7.7 inches can occur due to the probable maximum precipitation, the design basis for roof loading will be exceeded for those buildings with the 40 pounds per square foot design limit.

For the reactor building expansion specifically, the structural steel and decking is designed for 150 pounds per square foot for accumulated snow. Thus, for this building only, 28.8 inches of water can accumulate before the design load is approached.

From chapter 12 of the USAR, the allowable stresses to yield for the buildings at Monticello are such that a safety margin of approximately 1.5 is included within the design loading. Thus, the actual level of ponding which must occur before yield stresses might be approached for most buildings is roughly 11.5 inches, or 43.2 inches for the reactor building expansion. Even at 11.5" of water, the actual probability of exceeding yield stresses is less than one; that is, there is still margin before ponding would cause roof collapse.

The PMP assumed for the roofs at the site was determined to be the smallest drainage area for which PMP values are estimated in the NOAA/NWS reports, one square mile. This assumption is consistent with the drainage area indicated as appropriate by Generic Letter 89-22. In order to maintain conservatism, a one-hour duration for the precipitation was used, since the data indicate that PMP values are maximum for this time period for a one-square-mile drainage area.

According to the NOAA/NWS report "Application of Probable Maximum Precipitation Estimates - United States East of the 105th Meridian" [21], figure 24, the one-hour, one-square-mile PMP for the Monticello site is approximately 16.75 inches. Figures 36 through 38 of the same report were used to develop a graph of PMP versus time for the one-hour PMP. These results are shown on figure C.6. This figure shows that 9 inches of precipitation falls within the first 15 minutes for this PMP estimate, which exceeds the 7.7-inch design limit for those buildings that have the 40 pounds per square foot capacity. Consequently, the drainage capability of these buildings was examined, and roof and building drawings were reviewed to identify design features which might mitigate the effects of roof ponding. These drawings were supplemented by a walkdown to confirm as-built dimensions.

Table C.4 below summarizes the building-by-building roof ponding evaluation using the PMP estimates derived from the NOAA/NWS reports. Roof ponding for the majority of structures is below their design loads, and in no case does ponding exceed the additional margin needed to reach yield stresses.

Table C.4 Roof Ponding for Probable Maximum Precipitation

Structure	Curb Height	Drainage	Maximum Depth from PMP	Comments
Turbine Building	22"	8-4" dia.	11"	Exceeds design but is less than yield.
Reactor Building:				
1073′ MSL	10"	4-6" dia.	7"	Less than design and would not exceed yield even if drains were plugged.
1001′ MSL	14"	3-4" dia.	6.8"	Less than design.
Vent Penthouse	16"	1-3" dia.	5.4"	Less than design.
Office and Control Building	< 7"			Less than design even without drains.
EFT Building:				
Roof	18"			Less than design even without drains.
Bathtub Area	---	1-3" dia. drain 1-3" dia. scupper	5"	Less than design.

Summary: The above analysis involves both a conservative approach and the use of conservative data. Most notable are the rainfall rates from the cited source documents. Nevertheless, only the calculation for the turbine building roof predicts a ponding height which could exceed the design loading, and even this was shown not to be a credible failure mechanism, since it does not approach the design margin. Based on these results, the external flooding and probable maximum precipitation issues are screened from further consideration for Monticello.

C.2.4 Transportation and Nearby Facility Accidents

Many factors must be taken into account when addressing this category of other external events. Among these are potential accidents resulting from the following:

- Transportation accidents
  - Aviation
  - Marine (ship/barge)
  - Pipeline (gas/oil)
  - Railroad
  - Truck
- Nearby industrial facilities
- Nearby military facilities
- Hazardous material releases from onsite storage
- Other onsite hazards

Chapter 5 of NUREG-1407 defines "nearby" as within 5 miles of the site.

C.2.4.1 Transportation Accidents

Each of the issues identified in Generic Letter 88-20, NUREG-1407, and NUREG-5042 that are associated with transportation accidents is addressed here.

C.2.4.1.1 Transportation Accidents due to Aircraft Activity

According to the NRC's SRP acceptance criteria for siting nuclear power plants near airports and/or airways, the probability of an aircraft accident resulting in radiological consequences greater than the exposure guidelines in 10 CFR Part 100 is considered to be less than 10^{-7} per year if the distances from the plant meet all of the following requirements:

1. The distance, D, from the plant to the airport is between five and ten statute miles and the projected annual number of operations is less than 500 D^2; or D is greater than ten statute miles and the number of operations is less than 1000 D^2;

2. The plant is at least five statute miles from the edge of military training routes, including low-level training routes, except for those associated with a usage greater than 1000 flights per year, or where activities (such as practice bombing) may create an unusual stress situation;

3. The plant is at least two statute miles beyond the nearest edge of a federal airway, holding pattern, or approach pattern.

The USAR states that the Monticello site is more than 45 miles from the nearest military defense installation, a National Guard facility at the Twin Cities International Airport. Site personnel report that there are no unusual situations involving military aircraft near the site - the site is not used as or located near a practice bombing run, nor is it located in or near a military flight training route.

Information gathered from the Federal Aviation Administration (FAA) verified that there is no military training route near the site. The FAA also indicated that the Monticello site is clearly included in all aviation maps as an obstruction, with the elevation of the obstruction (the plant stack) provided on the charts. In addition, the FAA stated that there is a flight route which parallels a highway located northeast of the plant. Depending on weather conditions and air traffic, the route's distance of closest approach to the plant site varies from four to six nautical miles; in all cases the route is more than two miles from the plant site. There is no holding pattern or other flight route which passes over or through the plant boundaries. Therefore, the NRC's second and third acceptance criteria above are satisfied.

To address the first criterion, airports were identified and flight information was obtained from each to evaluate the probability of an aircraft accident. A conservative analysis concluded that the probability of a crash which results in a release of radionuclides is no greater than 9E-7 per year. More reasonable assumptions would lower this value by at least a factor of ten, possibly as much as 100 or 1000. For these reasons it is concluded that the risk of core damage and radionuclide release from the Monticello site due to aviation accidents can be dismissed.

C.2.4.1.2 Transportation Accidents due to Marine (Ship/Barge) Activity

The Monticello plant is located on the right bank of the Mississippi River. Thus, it is necessary to investigate the potential for accidents on the river which may produce explosive forces or toxic chemical releases which could interfere with the safe operation of the plant. Collisions with structures such as the intake structure must also be considered.

Because the site is located close to the headwaters of the Mississippi River, the river is shallow and narrow as it passes the plant. This prevents the movement of large craft on the river, and activity is limited principally to pleasure craft. There is therefore no potential for significant collisions, explosions, or toxic chemical releases on the Mississippi River near the plant.

C.2.4.1.3 Transportation Accidents due to Pipeline Activity

Of concern here are accidents to pipelines transporting gases under pressure, which could then have potentially negative consequences to the plant site. Applicable hazards include overpressure due to air blast, thermal load resulting from gas deflagration, missile hazards, and gas concentration within the plant. According to NUREG-5042, only pipelines going through or near the power plant exclusion area expose the plant to pipeline accident hazards. According to NUREG-5042, table 6.3.1, at Monticello this is an area with a radius of 1601 feet, centered at the reactor building.

From Northern States Power's construction department it was determined that no pipeline on the plant site carries volatile materials except for those associated with the diesel fuel oil system for the emergency diesel generators. The nearest natural gas pipeline transports natural gas to a rod and gun club located near Highway 75 about one mile south of the plant. There is a sewer tie-in on site, however, located about 1000 feet from the reactor building at its closest approach.

The likelihood of methane gas buildup of sufficient quantities to be of concern in the sewer tie-in is considered negligible. The distance from the reactor building to the closest approach of the sewer line is also sufficient to minimize the impacts of any explosion. The diesel fuel oil is also removed from further consideration because of its distance from the reactor building and the fact that the system is not under high pressure.

External surfaces of important Monticello plant structures are designed to withstand wind loadings from a design basis tornado (see sections C.2.2 and C.2.4.1.4). The overpressure due to a pipeline explosion located approximately one mile from the site is certainly bounded by the tornado loadings. Therefore, the plant is designed for potential pipeline explosions.

No pipe located near the site carries hazardous materials. Section C.2.4.4 discusses the potential threat of hazardous material spills to the site and Monticello's design features which mitigate the impacts of toxic releases.

C.2.4.1.4 Transportation Accidents due to Railroad Activity

According to the USAR, the only nearby railway is a railway spur located 2300 feet southwest of the reactor building. However, this railway spur was removed from operation several years ago. Occasional shipments are made to and from the plant by rail, but these do not contain explosive or toxic material to any extent. The remaining railway lines are near the town of Monticello, two or more miles from the site boundaries.

From Regulatory Guide 1.91, "Evaluations of Explosions Postulated to Occur on Transportation Routes Near Nuclear Power Plants" [24], explosive blasts generating 1 psi or less in overpressure on site buildings due to a shock wave can be dismissed from further consideration, if it can be verified that the site buildings of interest can withstand a 1-psi overpressure. Figure 1 from that regulatory guide concludes that a 132,000 pound boxcar load of TNT must be closer than 2500 feet to the buildings to generate a 1 psi shock wave. Since all railways are more than 2500 feet from the reactor site, it is concluded that any shock waves resulting from such an explosion will have overpressures of less than 1 psi.

To determine the ability of the buildings to withstand a 1-psi overpressure, the design criteria for tornado winds were reviewed. SRP 3.3.1, "Wind Loadings," provides a formula for calculating the dynamic pressure, q, on a structure as a result of wind velocity. The equation, taken from ASCE Paper No. 3269, is:

$$q = 0.00256\, V^2 \text{ psf} = 1.78\text{E-}5\, V^2 \text{ psi}$$

where V is the maximum wind velocity in miles per hour.

The SRP section further states that the value of q should be modified with shape or drag coefficients associated with the structures, as given in the ASCE paper. From equation 7 of the ASCE paper, for a typical building with vertical walls normal to the wind direction, the shape factor, C_D, is 1.3. Then,

$$q = 0.00333\ V^2\ psf = 2.29E\text{-}5\ V^2\ psi$$

The Monticello plant is designed for a maximum tornado wind of 300 mph (see section C.2.2). Using this value for V, the wind loading on the structures at Monticello is equal to 2.0 psi. Thus, it is apparent that if external surfaces of structures at Monticello are designed to withstand the loadings resulting from a tornado of 300 mph, they are also able to withstand a 1-psi overpressure due to an explosion's shock wave.

Finally, the superstructure of the reactor building, which is not designed for tornado winds but is designed for high winds (100 mph), must be addressed. This superstructure is not designed for a 2-psi differential pressure, and the wind loading from a 100-mph wind produces a dynamic loading less than 1 psi. Therefore, it is not obvious that the superstructure would withstand a 1-psi overpressure. However, the superstructure encloses equipment principally used to support refueling operations. There is no equipment required for safe shutdown that could be impacted by any siding that might dislodge from the superstructure. In addition, the postulated explosions occur far enough from the plant site that the actual overpressure at the buildings would be less than 1 psi. Also, the height of the superstructure would mitigate the pressure effects of a ground-level explosion. Thus, it is judged that the impacts of a postulated explosion upon the superstructure would have minimal, if any, impact upon the superstructure and plant equipment.

These factors show that the screening criterion from Regulatory Guide 1.91 can be used, and no further evaluation of explosive hazard from transportation accidents involving railways need be considered.

The response to toxic releases from rail cars is bounded by the discussion of hazardous materials release presented in section C.2.4.4.

C.2.4.1.5 Transportation Accidents due to Truck Activity

From the USAR, the Monticello site has the following roadways in proximity:

Wright County Road 75	3000 feet southwest of the reactor building
Wright County Road 75	3000 feet southeast of the reactor building
Interstate Highway I-94	3700 feet southwest of the site

From Regulatory Guide 1.91, explosive blasts generating 1 psi or less in overpressure on site buildings due to a shock wave can be dismissed from further consideration, if it can be verified that the site buildings of interest can withstand a 1-psi overpressure. Figure 1 from Regulatory Guide 1.91 concludes that a 50,000 pound truckload of TNT must be closer than 2000 feet to the buildings to generate such a shock wave. Since all roadways are greater than 2000 feet from the reactor building, it is concluded that any shock waves resulting from a postulated explosion will have overpressures of less than 1 psi.

As discussed for railway accidents in section C.2.4.1.4, external surfaces of the building walls at Monticello are designed for a 2.0-psi loading from tornado winds. Therefore, the building walls can withstand a 1-psi overpressure from an explosion. The discussion and conclusion in section C.2.4.1.4 for the superstructure are valid here as well, and no further evaluation of explosive hazard from transportation accidents involving trucks need be considered.

The response to toxic releases from trucks is bounded by the discussion of hazardous materials release in section C.2.4.4.

C.2.4.2 Nearby Industrial Facilities

Nearby industrial facilities may pose a threat to a plant by their potential for industrial accidents. Examples of such accidents include chemical plant fires and explosions, hazardous material release, etc. The effects of the accident upon the site would be similar to that of a transportation accident involving hazardous materials near the site, such as fire, explosion overpressure, or toxic material release.

Besides the threat of explosions and hazardous material release, nearby electrical generating facilities may also be capable of generating turbine missiles as well as electrical grid transients which could lead to a loss of offsite power. The Sherburne County coal plant is three to four miles from the site, so that the probability of missiles from that facility impacting the site is negligible. The effects of loss of offsite power are evaluated in the IPE for internal events.

Because the effects of nearby industrial facility accidents are similar to the effects of nearby transportation accidents involving hazardous materials, it is possible to use similar analysis techniques to address the issue. The first step in the process is to determine what facilities, if any, are within five miles of the site and could be a potential threat to the site.

The USAR identifies the nearby sources of potential industry-related hazards to the Monticello plant. Also, information was used from a separate effort by Northern States Power in which a survey of industrial facilities within a five-mile radius of the plant was conducted to obtain chemical hazards inventories.

This review concluded that there is no issue related to industrial accidents at nearby facilities which is not treated explicitly elsewhere within this evaluation of external events. The effects of explosions are discussed in section C.2.4.1 for transportation accidents; toxic material release is addressed in section C.2.4.4. Each of those discussions bounds any effects of similar accidents at nearby industrial facilities. Therefore, no specific evaluations are required here.

C.2.4.3 Nearby Military Facilities

According to the USAR, there is no military facility within five miles of the plant site. The nearest facility is 45 miles away at the Twin Cities International Airport. Therefore, this potential contributor to risk can be dismissed.

C.2.4.4 Hazardous Material Releases from Onsite Storage

Regulatory Guide 1.78, "Assumptions for Evaluating Habitability of a Nuclear Power Plant Control Room During a Postulated Hazardous Chemical Release" [25], provides guidelines on determining the quantities of hazardous chemicals that require consideration in control room habitability evaluations. These chemicals could be stored on site, such as chlorine for water purification purposes, or stored and used in nearby industrial facilities or shipped via rail or truck.

In response to NUREG-0737 [26], section III.D.3.4, "Control Room Habitability," the Monticello control room ventilation system was modified to include chlorine detectors to provide the ability to isolate the control room and warn the operators of the presence of chlorine gas at levels that could pose a threat of incapacitation. The source of the gas was onsite storage tanks containing liquified chlorine for use in treatment of the service water and circulating water systems. The chlorine additive was used to inhibit the growth of microbes in these systems.

A design change in the mid-1980s eliminated the onsite storage of liquified chlorine gas, substituting sodium hypochlorite as the water treatment agent to control microbiological growth. This eliminated the need to comply with a regulatory requirement for early warning of an onsite chlorine release; sodium hypochlorite is not considered a toxic substance and does not pose a risk to operators. However, a study done in 1986 concluded that truck shipments of chlorine on I-94 nearby still posed an unacceptable risk of control room operator incapacitation without the benefit of early warning. Therefore, it was decided that the chlorine detectors associated with the control room ventilation system must be maintained, with operability requirements as specified in the plant technical specifications.

A new toxic chemical study was performed in 1993 [27, 28] which considered the potential treat of toxic chemicals stored in sufficient quantity on site or in the vicinity of the site, or shipped by rail or road near the plant at sufficient frequency to warrant further evaluation. This study was conducted using the criteria of Regulatory Guide 1.78 and the analytical models presented in NUREG-0570, "Toxic Vapor Concentrations in the Control Room Following a Postulated Accidental Release" [29] and NUREG/CR-1741, "Models for Estimation of Incapacitation Times Following Exposures to Toxic Gases or Vapors" [30]. To account for potential sources of toxic chemicals from truck traffic on the nearby interstate, a probabilistic assessment was performed to determine if a release due to a highway accident was a credible event. Chemical sources were evaluated in this study to ensure a bounding treatment of the potential challenges to the Monticello site. The combined results of these analyses concluded that potential releases from all credible sources of toxic chemicals in the scope of the evaluation need not be considered in the plant's design, and that chemical detectors for any of the possible toxic materials considered, including chlorine, were not required to ensure control room habitability.

The chlorine detectors at Monticello were disabled as part of a design modification during the outage completed in November of 1994. The toxic chemical study confirmed that the Monticello design, emergency procedures and existing control room equipment meet the intention of the SRP and regulatory guides. The Monticello USAR is being updated to reflect the results of this recent analysis. Based on the above, the issue of hazardous material spills can be eliminated as a concern.

C.2.4.5 Other Onsite Hazards

In considering pipelines located off site (see section C.2.4.1.3), it was noted that propane and hydrogen are stored on site in bottles or tanks. The propane is used to heat a building at the site periphery. (Electric heat is used in most buildings; natural gas is not used in any building.) Propane bottle explosions are bounded by the building design for tornado overpressure. The hydrogen storage building is located sufficiently far from the reactor building that the reactor building walls will withstand an explosion from one hydrogen bottle.

Also located on site is a cryogenic tank to store liquid hydrogen for the hydrogen water chemistry system. The tank has a 9000-gallon capacity and is protected against overpressurization by dual full-flow safety valves and emergency backup rupture disks. The tank is located east of the cooling towers, at a point more than 1200 feet from the EFT building, which is the nearest building containing safety equipment. The cooling towers would shield the plant in the event of a rupture or explosion of the hydrogen tank.

Regulatory Guide 1.91, "Evaluations of Explosions Postulated to Occur on Transportation Routes Near Nuclear Power Plants," provides a methodology for assessing the hazard presented by this tank. The method determines the amount of explosive material (expressed in pounds of TNT) that will cause a 1-psi overpressure at the building face as a function of distance from that face. The relationship is:

$$R \geq 45\ W^{1/3}$$

where R is the distance in feet between the building and the blast source, and W is the quantity of explosive material in pounds of TNT. EPRI's "Guidelines for Permanent BWR Hydrogen Water Chemistry Installations" [31] provides a conversion factor of 1.37 pounds of TNT per gallon of tank size. With this factor, an explosion of the 9000-gallon hydrogen tank would correspond to 12,330 pounds of TNT. Using this value in the above equation yields a distance of 1040 feet for a 1-psi overpressure. Since the actual distance is in excess of 1200 feet, and since no credit has been taken for the shielding effect of the cooling towers, it is concluded that the hydrogen tank does not pose a credible threat to the plant.

C.3. CONCLUSIONS

Based upon the evaluations presented in section C.2, we conclude that there is no external event other than fire and seismic that may be a safety concern to the Monticello plant. No vulnerabilities were identified and the screening criteria contained in NUREG-1407 and Generic Letter 88-20, Supplement 4, are satisfied for all events. Simple walkdowns were performed to confirm the results of the evaluations.

C.4. REFERENCES

1. Generic Letter 88-20, Supplement 4, "Individual Plant Examination Of External Events (IPEEE) for Severe Accident Vulnerabilities," United States Nuclear Regulatory Commission, June 1991.

2. NUREG-1407, "Procedural and Submittal Guidance for the Individual Plant Examination of External Events (IPEEE) for Severe Accident Vulnerabilities," June 1991.

3. NUREG-75/087, "Standard Review Plan," September 1975.

4. Monticello Updated Safety Analysis Report (USAR), Revision 12.

5. American Society of Civil Engineers (ASCE) Paper No. 3269, "Wind Forces on Structures," Transactions of the ASCE, Vol. 126, Part II, 1961.

6. NUREG/CR-5042, "Evaluation of External Hazards to Nuclear Power Plants in the United States," December 1987.

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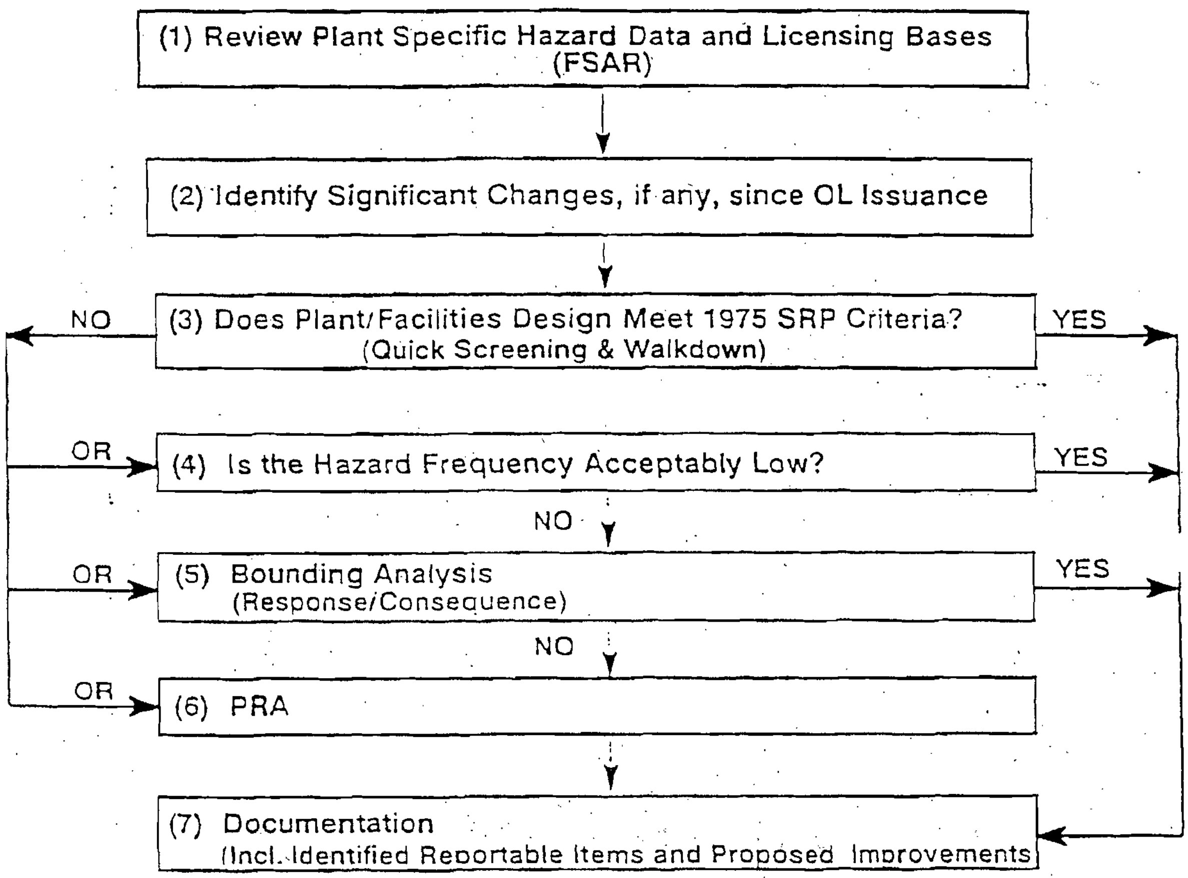


Figure C.1 Flow Chart of Screening Process For External Events Other Than Seismic and Fire

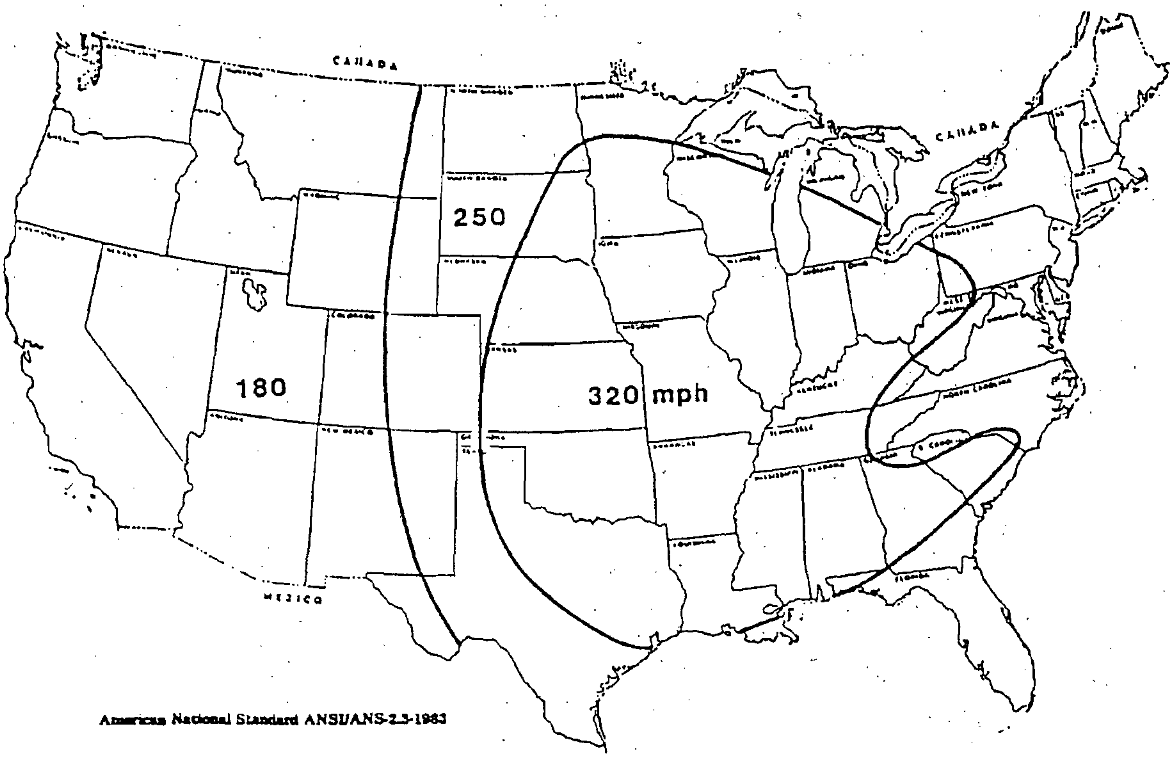
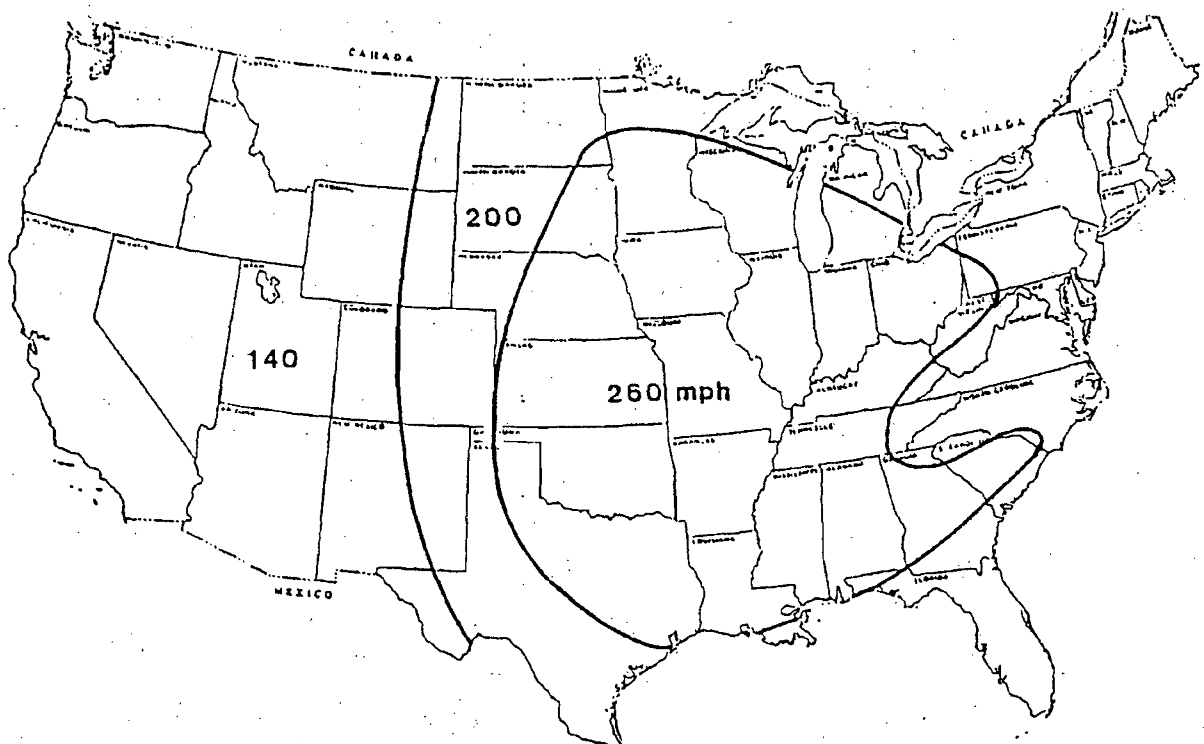


Figure C.2 Tornadic Windspeeds Corresponding to a Probability of 10^{-7} Per Year



American National Standard ANSI/ANS-2.3-1983

Figure C.3 Tornadic Windspeeds Corresponding to a Probability of 10^{-6} Per Year

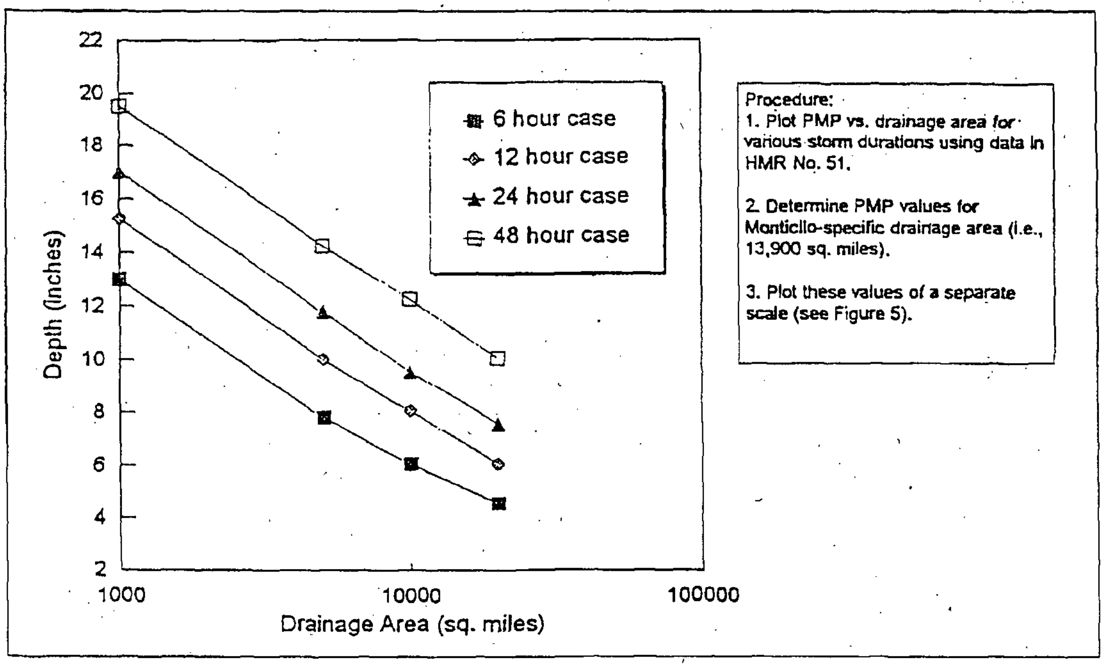


Figure C.4 Probable Maximum Precipitation vs Time (Various Drainage Area Sizes)

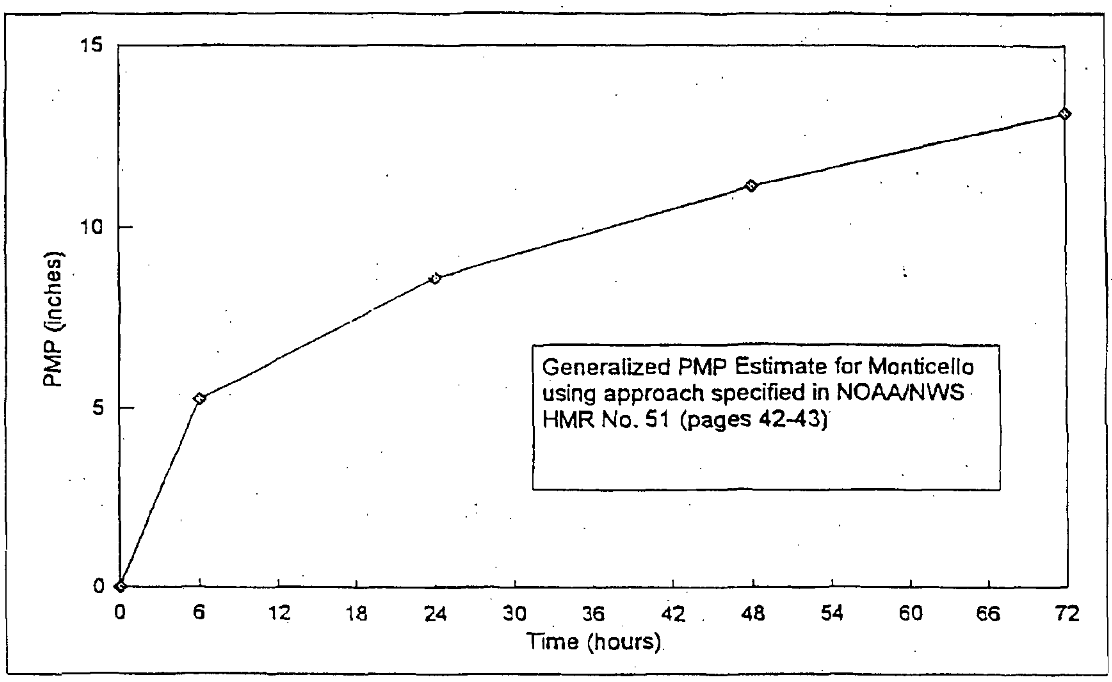


Figure C.5 **Probable Maximum Precipitation vs Time (13900 square mile drainage area)**

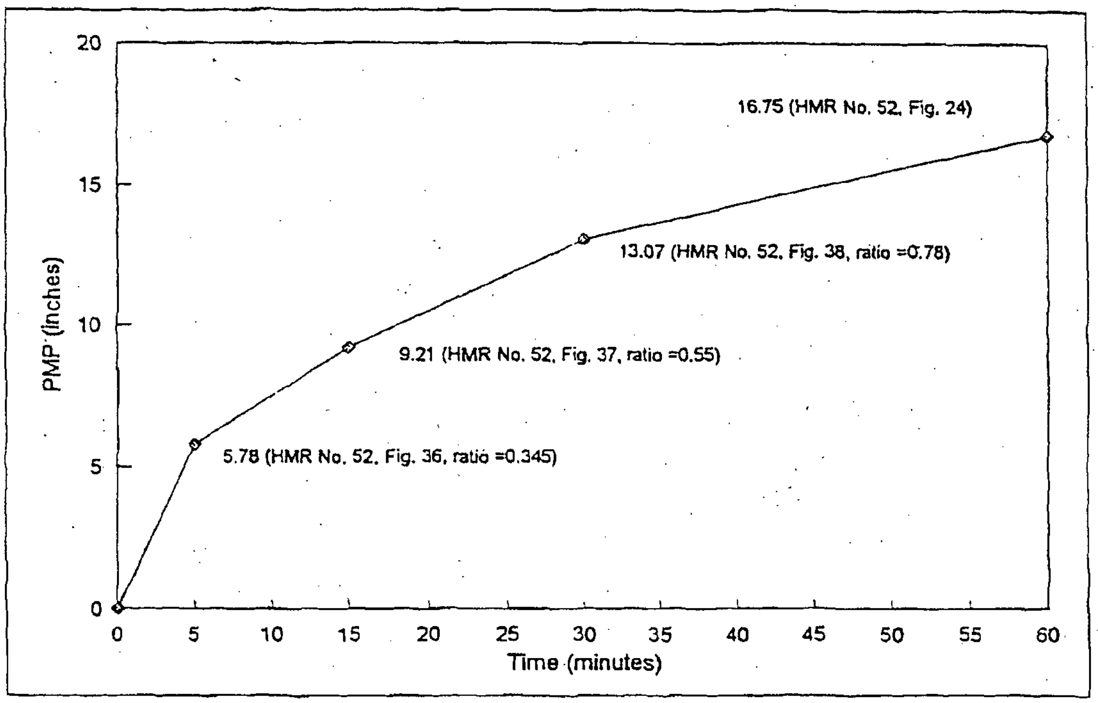


Figure C.6 Probable Maximum Precipitation vs Time (1 square mile drainage area)

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