CHAPTER 3 DESIGN OF STRUCTURES, COMPONENTS, EQUIPMENT, AND SYSTEMS

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Chapter 3 Design of Structures, Components, Equipment, and Systems

3.5.1.6 Aircraft Hazards

Airports and airways in the VEGP site vicinity are discussed in Section 2.2.2.6. Aircraft hazards related to these airports and airways (shown in Figure 3.5-1) have been evaluated in accordance with Regulatory Standard 002, *Processing Applications for Early Site Permits*, May 2004 (RS-002), and NUREG-0800, *Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants*, Draft Revision 3, 1996 (NUREG-0800), Section 3.5.1.6.

3.5.1.6.1 Airports

RS-002 acceptance criteria provide a distance threshold for evaluating aircraft hazards due to nearby airports.

All airports in the VEGP site vicinity are greater than 10 mi from the site. The hazard probability for these airports is considered acceptable if the projected annual number of operations is less than 1,000 D^2, where D is the site-to-airport distance.

Bush Field is the closest (17 mi) and largest commercial airport in the VEGP site vicinity. The Federal Aviation Administration (FAA) **(APO 2006)** has projected the number of aircraft that will be in operation at Bush Field for every year up to 2025 for each of the following four types of aircraft: general aviation, air taxi and commuter, commercial air carrier, and military. The projected flight data (which include landings and takeoffs) are provided in Table 3.5-1. As noted in the table, the total number of projected aircraft operations is substantially less than 1,000 D^2 (289,000).

The other airports in the vicinity are much smaller than Bush Field. Since they are all at least 10 mi from the VEGP site, their aircraft hazard threshold is greater than 100,000 operations, which significantly exceeds their annual traffic.

As discussed in Section 2.2.2.6.1, a small unimproved grass airstrip is located immediately north of the VEGP site (north of Hancock Landing Road and west of the Savannah River). This privately owned and operated airstrip has a 1,650-foot turf runway oriented 80° East – 260° West. The airstrip is for personal use and the associated traffic consists only of small single-engine aircraft. In addition, there is a small helicopter landing pad on the VEGP site. This facility exists for corporate use and for use in case of emergency. The traffic associated with either of these facilities may be characterized as sporadic. Due to the small amount and the nature of the traffic, these facilities do not present a safety hazard to the VEGP site.

3.5.1.6.2 Airway V185

The VEGP site is approximately 1.5 mi east of the centerline of Federal Airway V185, which runs between Augusta and Savannah. A more detailed review of aircraft hazards was performed because the VEGP site is within the 2 statute mile limit. This review is summarized below.

Airways are typically used by commercial flights and by general aviation for inclement weather and nighttime operations. In general, military aircraft do not use the federal airways. To be allowed to fly in a federal airway, an aircraft needs to have the proper communication equipment and the pilot needs to have specific qualifications. In addition, most general aviation flights do not use a federal airway in favorable weather conditions. When these factors are considered, along with the fact that there are no regularly scheduled direct commercial flights between Augusta and Savannah, it is expected that the total number of aircraft using Airway V185 is relatively small.

Although the FAA does not maintain records of air traffic in Airway V185, informal communications with air traffic control personnel at the Augusta airport revealed that the southeast quadrant of the air space around the airport (of which Airway V185 is a part) has the least air traffic compared to the other quadrants and that the total traffic in Airway V185 is a fraction of the total operations into and out of the Augusta airport.

Because of the unavailability of traffic data for Airway V185, the following evaluation calculates the maximum number of airway flights per year above which the acceptance guideline probability of 10^{-7} per year contained in RS-002 and NUREG-0800 is exceeded. Regulation 14 CFR 71 provides the criteria for determining the width of the airway. It is 4 nautical miles on either side of the centerline, for a total width of 8 nautical miles (9.2 mi).

$$P_{FA} = C \times N \times A / W$$

where:

P_{FA} = probability per year of an aircraft crashing into a VEGP Units 3 and 4 safety-related structure, 1×10^{-7}

C = in-flight crash rate per mile for aircraft using airway = 4×10^{-10} (RS-002)

N = number of flights per year along the airway

A = effective area of plant or site area in square miles, see below

W = airway width, 9.2 mi

By rearranging this equation, the maximum number of flights corresponding to the acceptance guideline probability of 10^{-7} may be calculated.

NUREG-0800 and RS-002 also provide alternate guidance on the acceptable method for calculating area *A*. RS-002 specifies the use of the site area because, for ESP Applications where the type of power plant has not been selected, the plant cross-sectional area cannot be defined. However, because the Westinghouse AP1000 design has been selected, the effective area of the plant was used in this analysis.

The effective plant area (*A*) depends on the length, width, and height of the facility, as well as the aircraft's wingspan, skid distance, and impact angle **(DOE 1996)**.

The safety-related structures of the AP1000 design include only the containment and the auxiliary building; the remainder of the structures is not safety related. The AP1000 containment height is about 234 ft above grade, and the diameter is about 146 ft **(Westinghouse 2001)**.

For traffic in Airway V185, the fractions of the types of aircraft using the airway were assumed to be the same as the fractions of the types of aircraft using Bush Field. Representative values for wingspan, skid distance, and impact angle for each aircraft type follow those suggested in DOE (1996). For military aviation, large aircraft are conservatively used in the estimates. The effective areas for general aviation, air taxi and commuter, commercial air carrier, and military aircraft are 0.025, 0.061, 0.073, and 0.086 sq mi, respectively. Using these effective areas and the fractions of aircraft types (52.9, 29.3, 12.8, and 5 percent for general aviation, air taxi and commuter, commercial air carrier, and military aircraft, respectively), the average of the weighted effective plant area, 0.045 mi^2, is determined for the calculation.

Among the representative wingspans, the large military aircraft has the longest wingspan of 223 ft **(DOE 1996)**. The physical separation of the new reactor buildings is about 650 ft. Since this distance is longer than the largest representative wingspan (223 ft), the estimate of the effective area involves only one unit. In addition, Section 3.5.1.6 of NUREG-0800 also suggests the use of an effective area of one unit of the plant.

To reach the permissible crash probability of 1 x 10^{-7}, the total number of flights traveling along Airway V185 would need to be about 51,100 per year. This value is higher than the total of all projected itinerant flights for 2025 at Bush Field (see Table 3.5-1).

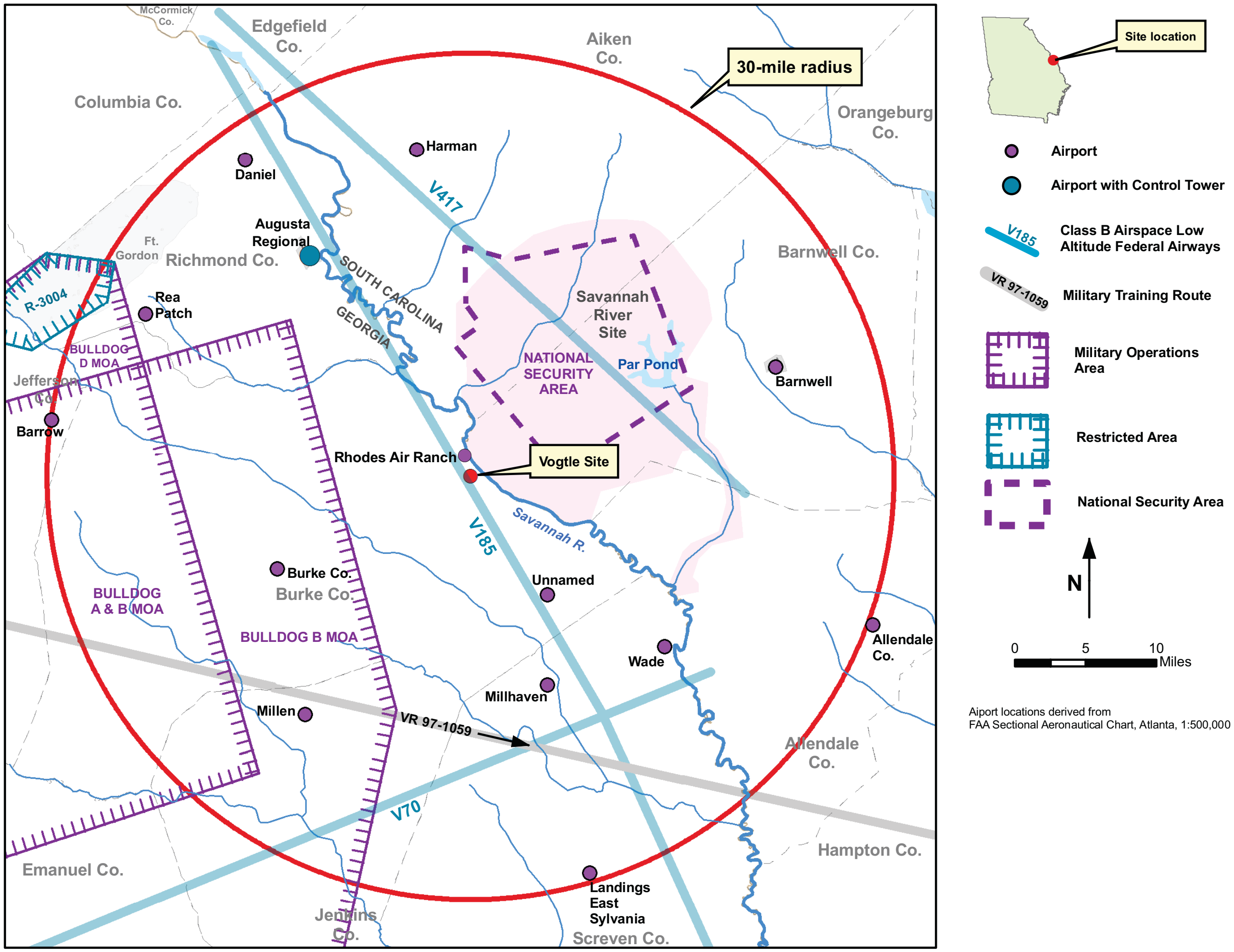
Although the flight data associated with Airway V185 are not available from the FAA, the number of flights in this airway is expected to be only a fraction of the total Bush Field flights. Therefore, the presence of Airway V185 is not a safety concern for the VEGP site.

Table 3.5-1 Augusta APO Terminal Area Forecast Summary Report – Itinerant Operations

Year	General Aviation	Air Taxi & Commuter	Commercial Air Carrier	Military	Total
1990	22,023	14,941	6,495	4,522	47,981
1991	19,175	9,462	6,576	3,242	38,455
1992	17,872	9,393	7,196	3,221	37,682
1993	16,902	8,821	6,455	4,068	36,246
1994	16,896	5,961	6,473	3,727	33,057
1995	16,597	8,876	5,024	3,511	34,008
1996	17,016	9,325	4,225	2,780	33,346
1997	18,995	8,304	4,599	2,561	34,459
1998	19,611	7,518	5,028	2,271	34,428
1999	22,653	6,954	5,183	2,841	37,631
2000	21,975	6,663	4,969	3,354	36,961
2001	19,961	7,378	4,929	2,954	35,222
2002	20,085	7,164	4,286	3,082	34,617
2003	17,622	9,058	4,393	2,843	33,916
2004	18,658	9,441	4,934	2,528	35,561
2005	13,307	8,226	4,585	1,799	27,917
2006	13,618	8,328	4,585	1,799	28,330
2007	13,937	8,432	4,585	1,799	28,753
2008	14,263	8,537	4,585	1,799	29,184
2009	14,597	8,644	4,585	1,799	29,625
2010	14,939	8,751	4,585	1,799	30,074
2011	15,288	8,860	4,585	1,799	30,532
2012	15,646	8,971	4,585	1,799	31,001
2013	16,012	9,083	4,585	1,799	31,479
2014	16,387	9,196	4,585	1,799	31,967
2015	16,611	9,310	4,585	1,799	32,305
2016	16,837	9,426	4,585	1,799	32,647
2017	17,067	9,544	4,585	1,799	32,995
2018	17,300	9,663	4,585	1,799	33,347
2019	17,536	9,783	4,585	1,799	33,703
2020	17,776	9,905	4,585	1,799	34,065
2021	18,018	10,028	4,585	1,799	34,430
2022	18,264	10,153	4,585	1,799	34,801
2023	18,514	10,280	4,585	1,799	35,178
2024	18,766	10,408	4,585	1,799	35,558
2025	19,023	10,538	4,585	1,799	35,945

Source: APO 2006

Table 3.5-2 Deleted in Revision 2



Source: Atlanta 2005

Figure 3.5-1 Airports Within 30 Miles of Vogtle Facility

Section 3.5 References

(APO 2006) *APO Terminal Area Forecast Summary Report*, Federal Aviation Administration, http://www.apo.data.faa.gov/wtaf/, issued February 2006, accessed 5/2/2006.

(Atlanta 2005) *Atlanta Sectional Aeronautical Chart*, 74th Edition, U.S. Department of Transportation, Federal Aviation Administration, March 17, 2005.

(DOE 1996) *Accident Analysis for Aircraft Crash into Hazardous Facilities*, DOE Standard, DOE-STD-3014-96, US Department of Transportation, October 1996.

(Westinghouse 2001) *Nuclear Island General Arrangement, AP1000 Advanced Passive Light Water Reactor*, Rev. 0, Section B-B, DCD Number APP 1000 P2 902, Westinghouse Electric Company, 08/06/2001.

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3.8 Design of Category I Structures

3.8.5 Foundations

3.8.5.1 Description of Foundations

This section of the DCD Revision 15, along with references to other DCD Revision 15 sections necessary to support the scope of the LWA request, is incorporated by reference. This section is modified as identified by the below documents:

Westinghouse document APP-GW-GL-700, AP1000 Design Control Document (DCD), Revision 15 as modified by the following Technical Reports:

- APP-GW-GLN-105, "Building and Structure Configuration, Layout, and General Arrangement Design Updates," (Technical Report 105)
  - APP-GW-GLR-005, "Containment Vessel Design Adjacent to Large Penetrations," (Technical Report 9)
  - APP-GW-GLR-021, "AP1000 As-Built COL Information Items," (Technical Report 6)
  - APP-GW-GLR-044, "Nuclear Island Basemat and Foundation," (Technical Report 85)
  - APP-GW-GLR-045, "Nuclear Island: Evaluation of Critical Sections," (Technical Report 57)
  - APP-GW-GLR-130, "Editorial Format Changes Related to "Combined License Applicant" and "Combined License Information Items," (Technical Report 130)
  - APP-GW-S2R-010, "Extension of Nuclear Island Seismic Analysis to Soil Sites," (Technical Report 03)

The scope of the LWA foundation work includes: placing the mud mats, water proofing membrane, concrete forms, reinforcing bars, embedments, drains and other items necessary to prepare the Nuclear Island base slab for the first concrete pour.

After backfill beneath the NI (Nuclear Island) has been placed and compacted to roughly the required elevation for the first mud mat, the construction of the retaining wall will begin. The retaining wall will be a vertical mechanically-stabilized earth (MSE) wall with smooth-faced concrete panels. This wall will function as both a retaining wall as the backfill outside the NI volume is brought up to plant grade and as the exterior concrete form for the outer walls of the NI. Section 2.5.4.5, Excavation and Backfill, provides additional information on the backfill and MSE wall.

The construction of the MSE wall begins with installation of a concrete footer. The top surface of the MSE wall footer will be installed below the bottom elevation of the first mud mat. The size and reinforcement for the concrete footer will be as required by the designer of the MSE wall. The MSE wall footer is a relatively thin concrete structure that provides a stable, level surface for construction of the MSE wall. It provides no structural support for the mud mats or the NI itself.

The first course of the MSE wall will be placed on top of the footer at the surveyed locations required to outline the NI footprint. Inspections will be performed as required to assure that the outer dimensions of the NI are properly set.

Backfill around the outer sides of the MSE wall will commence as required by the designer of the MSE wall, with the standard large compaction equipment being used away from the wall, and smaller equipment providing the required compaction at the edges of the wall. During backfill placement and compaction, the backfill surface will be sloped away from the NI to drain surface water away from the NI excavation volume. Additional courses of the MSE wall will be added until final plant grade is reached.

In parallel with the construction of the MSE wall, work within the NI footprint will continue. Temporary features to provide removal of surface water within the confined area of the NI will be installed as required. These features may include plastic sheeting, temporary sumps and pumps. In addition, the surface may be sloped to provide adequate drainage.

After the first few courses of the MSE wall have been placed, the backfill within the NI volume will be prepared for placement of the mud mat. Temporary drainage features will be removed, and material will be removed or added as required to establish the final elevation for the mud mat placement.

The first mud mat will consist of a 6-inch layer of non-reinforced concrete placed uniformly within the confines of the MSE wall. No additional formwork will be required. When this lower mud mat slab has reached the specified strength, a layer of waterproof membrane will be applied to the entire top of the slab, and extended vertically up the face of the MSE wall surface. The top portion of the mud mat slab (also a 6-inch layer of non-reinforced concrete) will then be placed, sandwiching the waterproof membrane. Additional detail concerning the waterproof membrane is provided in following Section 3.8.5.1.1. Figure 2.5.4-17 provides an illustration of the location of the waterproof membrane. Rebar and foundation embedments are not incorporated in either of these mud mats; therefore installation of such elements will not puncture the waterproofing membrane.

An engineered rebar support system will be installed on top of the mud mat to support the weight of the NI base slab rebar structure. When the support is in place, the rebar will be installed in accordance with approved construction drawings and established procedures. There will be a second engineered rebar support system installed to support the upper rebar framework. Subsequent rebar layers and shear reinforcement will then be installed in accordance with approved construction drawings and established procedures. These construction drawings will correspond to the AP1000 Design Control Document Figure 3.8.5-3, Sheets 5, 6, and 7. Embedments in the NI base slab will be installed in accordance with the approved construction drawings. Inspection attributes will be in accordance with the established Quality Assurance Program and procedures for reinforcing steel installation and concrete pour preparation activities.

3.8.5.1.1 Waterproof Membrane

DCD Subsection 3.4.1.1.1 describes protection of seismic Category I structures from external flooding. The DCD indicates that this protection is provided by a waterproofing system that is provided by the introduction of a cementitious crystalline waterproofing additive to the mud mat and to the retention wall. The configuration of this waterproofing is shown in DCD Figure 3.4-3. Alternate waterproofing approaches for MSE and step back configurations using high density polyethylene (HDPE) double-sided textured waterproof membrane are described and presented in DCD Figures 3.4-1 and 3.4-2.

For Vogtle Electric Generating Plant (VEGP) Units 3 and 4 an alternate waterproofing system is presented as a departure from the DCD design. The alternate waterproofing system is an elastomeric "spray-on" waterproof membrane. The membrane is applied as a high-viscosity liquid that cures after exposure to air. This material may be applied by brush, roller or airless spray equipment.

Prior to procurement of the membrane material, a qualification program will be developed to demonstrate that the selected material will meet the waterproofing and friction requirements. This qualification program will address, as a minimum, the following:

- chemical properties of the membrane material,
- physical properties of the membrane material,
- surface finish requirements for the lower mudmat, and
- installation procedures necessary to achieve the required properties and coefficients of friction.

The qualification program will include testing to demonstrate that the ITAAC design commitment in Table 3.8.5.1 for friction coefficient has been met. Testing methods will simulate field conditions to demonstrate that a minimum 0.7 coefficient of friction is achieved by the mudmat waterproof membrane structural interface. A technical report will be provided for the ITAAC to document the basis for determining that the material will meet the required friction factor. Application procedures will be developed based on the results of qualification testing to assure that the conditions and assumptions of the qualification tests are maintained during product application.

Based upon the qualification program requirements, it is concluded that the installed waterproof membrane will provide a level of protection from external flooding and meet the coefficient of friction at the waterproof membrane-mudmat interface that is consistent with that of the existing DCD design.

The elastomeric waterproof membrane will be applied to the entire surface of the lower mudmat and the inner face of the MSE wall. Final thickness of the membrane will be specified based on the physical properties of the selected material but is expected to be on the order of 80 to 120 mils. The membrane may be applied in multiple coats to achieve the required thickness.

The surface of both the mudmat and the MSE wall will be prepared in accordance with procedures that are consistent with the surface preparation requirements determined during the material qualification testing program. At the transition between the lower mudmat and the MSE wall, a small transition (chamfer or fillet) between the mudmat and wall will be provided to allow a smooth transition for the membrane.

The surface of the MSE wall will be prepared as necessary to assure that the waterproof coating application can bridge the small gaps and corners of the MSE blocks. This preparation process will likely include attaching a geo-textile material to the wall prior to application of the membrane material. It should be noted that the cured membrane has a degree of flexibility which allows it to accommodate thermal expansion and other minor movements between substrate members.

The application procedures will address all aspects of the coating application including batch qualification, surface preparation, application techniques, film thickness, cure time, and repair procedures.

The final mudmat will be placed on top of the waterproof membrane. Procedures will address inspection and testing as required to assure that the membrane surface will meet the required coefficient of friction.

After the NI walls are extended above grade, the gap between the MSE wall and the NI wall will be sealed to prevent surface water intrusion.

Table 3.8.5.1-1
Waterproof Membrane Inspections, Tests, Analyses, and Acceptance Criteria

Design Commitment	Inspections, Tests, Analyses	Acceptance Criteria
1) The friction coefficient to resist sliding is 0.7 or higher.	Testing will be performed to confirm that the mudmat-waterproofing-mudmat interface beneath the Nuclear Island basemat has a minimum coefficient of friction to resist sliding of 0.7.	A report exists and documents that the as-built waterproof system (mudmat-waterproofing-mudmat interface) has a minimum coefficient of friction of 0.7 as demonstrated through material qualification testing.