# DCR Dam Safety Technical Advisory

# Table 1 Briefing

## by

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Department of Conservation & Recreation

CONSERVING VIRGINIA'S NATURAL & RECREATIONAL RESOURCES

- State Parks • Soil and Water Conservation • Natural Heritage
- Outdoor Recreation Planning • Land Conservation
- Dam Safety and Floodplain Management
- Chesapeake Bay Local Assistance

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# History of Dam Safety

From the Department of the Army, Office of the Chief of Engineers, Washington, D.C.

Engineering Regulation ER 1110-2-104, dated 11 May 1973

Title: Engineering and Design- National Dam Safety Program

"The inventory of all Federal and non-Federal dams for each State should be completed and furnished by April 1974."

# USACE Dam Safety History

(From Chief of NAD USACE – January 3, 1979)

"The rare possibility of extreme storms occurring above dam sites has long been an argument against their use in spillway design. However, most experts in hydrologic engineering recognize the large uncertainties connected with estimating the percent chance of exceeding any rare floods. Therefore, the probability of floods has generally not been a guiding influence in the selection of spillway design floods where dam failure could cause loss of life. The probable maximum flood concept for spillway design has been used by Federal agencies for many years. It should be noted that other countries have followed the U.S. lead and adopted the probable maximum flood as their standard. England is a relatively recent example."

# USACE Dam Safety History

(From Chief of NAD USACE – January 3, 1979)

"The Hydrometeorological Branch of the National Weather Service has been reviewing some 500 experienced large storms in the U.S. The purpose of the review is to ascertain the relative magnitude of experienced large storms to probable maximum precipitation (PMP) and their distribution throughout the country. Thus far, their review reveals that at least 25 percent of the major storms have exceeded 50 percent of the PMP for one or more combinations of area and duration. In fact some storms have very closely approximated the PMP values." Smethport, PA storm of July 4-5, 1939 was 97 percent of the PMP for 10 square miles and 6 hour duration. Hurricane Agnes June 19-23 resulted in 78 percent of the PMP for 72 hours over 20,000 square miles.

# USACE Dam Safety History

(Engineering Regulation ER 1110-2-106 26 Sept 1979)

2.1.1. Size. The classification for size based on the height of the dam and storage capacity should be in accordance with Table 1. The height of the dam is established with respect to the maximum storage potential measured from the natural bed of the stream or watercourse at the downstream toe of the barrier, or if it is not across a stream or watercourse, the height from the lowest elevation of the outside limit of the barrier, to the maximum water storage elevation. For the purpose of determining project size, the maximum storage elevation may be considered equal to the top of dam elevation. Size classification may be determined by either storage or height, whichever gives the larger size category.

# USACE Dam Safety History

(Engineering Regulation ER 1110-2-106 26 Sept 1979)

## TABLE 1

SIZE CLASSIFICATION

| | Impoundment | |
|---|---|---|
| Category | Storage (Ac-Ft) | Height (Ft) |
| Small | < 1000 and ≥ 50 | < 40 and ≥ 25 |
| Intermediate | ≥ 1000 and < 50,000 | ≥ 40 and < 100 |
| Large | ≥ 50,000 | ≥ 100 |

# USACE Dam Safety History

(Engineering Regulation ER 1110-2-106 26 Sept 1979)

TABLE 2

HAZARD POTENTIAL CLASSIFICATION

| Category | Loss of Life (Extent of Development) | Economic Loss (Extent of Development) |
|---|---|---|
| Low | **None** expected (No permanent Structures for human habitation) | Minimal ( Undeveloped to occasional structures or agriculture) |
| Significant | **Few** (No urban developments and no more than a small number of inhabitable structures) | Appreciable (Notable agriculture, industry or structures |
| High | **More than few** | Excessive (Extensive community, industry or agriculture) |

# USACE Dam Safety History

## (Engineering Regulation ER 1110-2-106 26 Sept 1979)

TABLE 3
HYDROLOGIC EVALUATION GUIDELINES
RECOMMENDED SPILLWAY DESIGN FLOODS

| Hazard | Size | *Spillway Design Flood (SDF) |
|---|---|---|
| Low | Small | 50-Yr to 100-Yr |
| | Intermediate | 100-Yr to ½ PMF |
| | Large | ½ PMF to PMF |
| Significant | Small | 100-Yr to ½ PMF |
| | Intermediate | ½ PMF to PMF |
| | Large | PMF |
| High | Small | ½ PMF to PMF |
| | Intermediate | PMF |
| | Large | PMF |

# USACE Dam Safety History

(Engineering Regulation ER 1110-2-106 26 Sept 1979)

***The recommended design floods in this column represent the magnitude of the spillway design flood (SDF), which is intended to represent the largest flood that need be considered** in the evaluation of a given project, regardless of whether a spillway is provided; i.e., a given project should be capable of safely passing the appropriate SDF. Where a range of SDF is indicated, the magnitude that most closely relates to the involved risk should be selected.

# TABLE 1 - Impounding Structure Regulations

| Class of Dam | Hazard Potential If Impounding Structure Fails | SIZE CLASSIFICATION<br>Maximum Capacity (Ac-Ft)[a] | <br>Height (Ft)[a] | Spillway Design Flood (SDF)[b] |
|---|---|---|---|---|
| I | Probable Loss of Life; Excessive Economic Loss | Large ≥ 50,000<br>Medium ≥ 1,000 & < 50,000<br>Small ≥ 50 & < 1,000 | ≥ 100<br>≥ 40 & < 100<br>≥ 25 & < 40 | PMF[c]<br>PMF<br>½ PMF to PMF |
| II | Possible Loss of Life; Appreciable Economic Loss | Large ≥ 50,000<br>Medium ≥ 1,000 & < 50,000<br>Small ≥ 50 & < 1,000 | ≥ 100<br>≥ 40 & < 100<br>≥ 25 & < 40 | PMF<br>½ PMF to PMF<br>100-YR to ½ PMF |
| III | No Loss of Life Expected; Minimal Economic Loss | Large ≥ 50,000<br>Medium ≥ 1,000 & < 50,000<br>Small ≥ 50 & < 1,000 | ≥ 100<br>≥ 40 & < 100<br>≥ 25 & < 40 | ½ PMF to PMF<br>100 – YR to ½ PMF<br>50 – YR[d] to 100 – YR[e] |
| IV | No Loss of Life Expected; No Economic Loss to Others | ≥ 50 (nonagricultural)<br>≥ 100 (agricultural) | ≥ 25 (Both) | 50 – YR to 100 – YR |

a. **The factor determining the largest size classification shall govern**.

b. **The spillway design flood (SDF) represents the largest flood that need be considered in the evaluation of the performance for a given project.** The impounding structure shall perform so as to safely pass the appropriate SDF. Where a range of SDF is indicated, the magnitude that most closely relates to the involved risk should be selected. The establishment in this chapter of rigid design flood criteria or standards is not intended. Safety must be evaluated in the light of peculiarities and local conditions for each impounding structure and in recognition of the many factors involved, some of which may not be precisely known. Such can only be done by competent, experienced engineering judgment, which the values in Table 1 are intended to supplement, not supplant.

c. PMF: Probable maximum flood. **This means the flood that might be expected from the most severe combination of critical meteorologic and hydrologic conditions that are reasonably possible in the region.** The PMF is derived from the current probable maximum precipitation (PMP) available from the National Weather Service, NOAA. In some cases local topography or meteorological conditions will cause changes from the generalized PMP values; therefore, it is advisable to contact local, state or federal agencies to obtain the prevailing practice in specific cases.

d. 50-Yr: 50-year flood. **This means the flood magnitude expected to be equaled or exceeded on the average of once in 50 years.** It may also be expressed as an exceedence probability with a 2.0% chance of being equaled or exceeded in any given year.

e. 100-Yr: 100-year flood. **This means the flood magnitude expected to be equaled or exceeded on the average of once in 100 years.** It may also be expressed as an exceedence probability with a 1.0% chance of being equaled or exceeded in any given year.

# Example –Using Table 1

Consider a Class I Dam that is 32.5 feet high and has a maximum capacity of 810 acre-feet.

For Height of 32.5 feet is the mid point between 25 and 40 feet that represents a Small dam; therefore by height the SDF is the mid point between 50% PMF and 100% PMF or **75% PMF**

For maximum Capacity of 810 AF is 80 percent between 50 and 1000 AF that represents a Small dam: therefore by capacity the SDF is 80 percent between 50% PMF and 100% PMF or **90% PMF**

**The required SDF would be 90% PMF**

# Potential SDF Reduction

Section 4VAC50-20-130

A. 1. Operation and maintenance is determined by the director to be satisfactory and up to date;

2. Annual owner's inspection reports have been filed with and are considered satisfactory by the director;

3. The applicant proves in accordance with the current design procedures and references in Section 4VAC50-20-320 to the satisfaction of the board that the impounding structure as designed, constructed, operated and maintained does not pose an unreasonable hazard to life and property, and

4. The owner satisfies all special requirements imposed by the board.

# Potential SDF Reduction

B. When appropriate with existing impounding structures only, the spillway design flood requirement may be reduced by the board to the spillway discharge at which dam failure will not significantly increase the downstream hazard existing just prior to dam failure provided that the conditions of Section 4VAC50-20-130 A have been met.

# Dams by Certificate Type
# Listed in Virginia's Dam Inventory

| | |
|---|---|
| Construction Permit | 41 |
| Agriculture | 96 |
| **Federal licensed or owned** | **113** |
| Conditional Certificates | 121 |
| **Mining Dams** | **19** |
| Class IV Dams | 22 |
| Regular Certificates | 395 |
| Out of Compliance | 9 |
| **Pre-2002 Size Exempt** | **852** |
| Dams breached or removed | 6 |
| Unknown | 13 |

# Pre-2002 Size Exempt Dams

Need to be brought into Regulation (by class)

| | |
|---|---|
| I | 14 |
| II | 108 |
| III | 723 |
| IV | 7 |

# Distribution of Dams by Height

Results based on March 2006 (1687 dams)

| | | |
|---|---|---|
| less than 6 feet | 3 | |
| 6 ft – 24.9 ft | 926 | |
| 25 ft – 39.9 ft | 465 | 1391 Small Dams |
| 40 ft – 99.9 ft | 259 | Medium Dams |
| 100 ft – 381 ft | 26 | Large Dams |
| Unknown | 8 | |

# Distribution of Dams by Maximum Capacity

Results based on March 2006 ( 1687 dams)

| | | |
|---|---|---|
| Less than 15 acre feet | 21 | |
| >15 AF and <50 acre feet | 126 | |
| 50 AF – 999 AF | 1263 | 1389 Small Dams |
| 1000 AF – 49999 AF | 253 | Medium Dams |
| Greater than 50000 AF | 14 | Large Dams |
| Unknown | 10 | |