Chapter NR 333

DAM DESIGN AND CONSTRUCTION STANDARDS

Note: Chapter NR 333 as it existed on May 31, 1985 was repealed and a new chapter NR 333 was created effective June 1, 1985.

NR 333.01 Purpose. The purpose of this chapter is to ensure that dams are designed, constructed and reconstructed so as to minimize the danger to life, health and property. This chapter is adopted pursuant to ss. 31.02 (2), 31.19 and 31.33, Stats.

History: Cr. Register, May, 1985, No. 353, eff. 6-1-85.

NR 333.02 Applicability. The provisions of this chapter are not applicable to:

(1) Dams owned by the United States government.

(2) Dams having the following characteristics, unless the department determines that the dam is likely to endanger life, health or property if it is not designed, constructed or reconstructed in accordance with this chapter:

(a) All dams having a structural height of 6 feet or less, or a storage capacity of 15 acre-feet or less.

(b) All dams having a structural height of more than 6 feet but less than 25 feet and a maximum storage capacity of less than 50 acre-feet of water.

(3) All new and existing dams inspected, approved and licensed by a federal agency under 18 CFR Part 12, provided that the dam meets requirements which are at least as restrictive as the requirements of this chapter.

Note: Dams exempted from this chapter are still subject to the requirements of ch. 31, Stats.

History: Cr. Register, May, 1985, No. 353, eff. 6-1-85.

NR 333.03 Definitions. (1) "Base flow" means that part of the stream flow that is derived from groundwater and calculated as the 7-day low flow that occurs on an average of once in 2 years or has a 50% chance of occurring in any given year. The notation is $Q_{7,2}$.

(2) "Dam" means any artificial barrier, together with appurtenant works, which is built across a waterway and which has the primary purpose of impounding or diverting water.

(3) "Department" means the department of natural resources.

(4) "Emergency spillway" means a secondary spillway designed to pass water only during flows exceeding the capacity of the principal spillway.

(5) "Floodfringe" means that portion of the floodplain outside of the floodway, which is covered by flood water during the regional flood. The term, "floodfringe" is generally associated with standing water rather than flowing water.

(6) "Floodplain with the dam nonexistent" means that area of land downstream from a dam that would be inundated by water during the regional flood if the dam did not exist.

(7) "Floodway" means the channel of a river or stream and those portions of the floodplain adjoining the channel which are required to carry the regional flood discharge.

(8) "Government emergency service facility" means any structure that is used for the operation of emergency services or the housing of emergency service equipment, including, but not limited to, fire stations, police stations, government garages housing emergency equipment, and government buildings where emergency service operations are carried out.

(9) "Hydraulic shadow" means that area of land downstream from a dam that would be inundated by water upon failure of the dam during the regional flood.

(10) "Maximum headwater" means the maximum water surface elevation before overtopping would occur.

(11) "Maximum storage capacity" means the volume of water in acre-feet capable of being stored behind a dam at the maximum water surface elevation before overtopping would occur.

(12) "Minimum tailwater" means the water level downstream from a dam at base flow.

(13) "Overtopping" means the flow of water over parts of a dam which are not part of its spillway system.

(14) "Owner" means any individual, partnership, public utility, company, cooperative, trust, corporation, association, state or interstate agency, city, village, county or special purpose district such as a drainage district or a public inland lake protection and rehabilitation district which has title to a dam or to the specific parcel of land on which a dam exists.

(15) "Principal spillway" means the primary structure for the discharge of normal flow through a dam.

(16) "Q_{10}" means the flood flow having a recurrence interval of 10 years or a 10% chance of occurring or being exceeded in any given year.

(17) "Q_{25}" means the flood flow having a recurrence interval of 25 years or a 4% chance of occurring or being exceeded in any given year.

(18) "Q_{50}" means the flood flow having a recurrence interval of 50 years or a 2% chance of occurring or being exceeded in any given year.

(19) "Q_{100}" means the flood flow having a recurrence interval of 100 years or a 1% chance of occurring or being exceeded in any given year.

(20) "Q_{200}" means the flood flow having a recurrence interval of 200 years or a 0.5% chance of occurring or being exceeded in any given year.

(21) "Q_{500}" means the flood flow having a recurrence interval of 500 years or a 0.2% chance of occurring or being exceeded in any given year.

(22) "Q_{1000}" means the flood flow having a recurrence interval of 1000 years or a 0.1% chance of occurring or being exceeded in any given year.

(23) "Reconstruction" means alteration of an existing dam in a manner which affects its hydraulic capacity or structural integrity.

(24) "Regional flood" means a flood determined to be representative of large floods known to have occurred in Wisconsin and which may be expected to occur on a particular stream once in every 100 years.

Note: The regional flood is based upon a statistical analysis of stream flow records available for the watershed or an analysis of rainfall or runoff characteristics in the watershed or both. The flood frequency of the regional flood is once in every 100 years. In any given year, there is a 1% chance that the regional flood may occur or be exceeded.

(25) "Structural height" means the difference in elevation in feet between the point of lowest elevation of the dam before overtopping and the lowest elevation of the natural stream or lake bed at the downstream toe of the dam.

(26) "Structure for human habitation" means any structure where persons would or could normally reside for a period of time longer than 24 hours, including, but not limited to, private homes, apartments, hospitals, hotels, motels, prisons, mobile homes, dormitories and nursing homes.

(27) "Submerged" means that the difference between the water surface elevations upstream and downstream from a dam is one foot or less.

(28) "Total spillway capacity" means the sum of the emergency spillway and principal spillway capacities of a dam.

History: Cr. Register, May, 1985, No. 353, eff. 6-1-85; am. (25), Register, April, 1987, No. 376, eff. 5-1-87.

NR 333.04 Compliance. (1) PRELIMINARY DAM HAZARD RATING. (a) The department shall determine a preliminary dam hazard rating according to the criteria in s. NR 333.06 for all existing dams. The preliminary dam hazard rating shall be determined using available data for the regional flood, structural stability of the dam, and downstream land use and land use controls.

(b) The department shall make its determination under par. (a) and notify the owner of its determination according to the following schedule:

1. Proposed dams: prior to granting permission or approval to construct;

2. Existing dams which are proposed to be reconstructed: prior to granting permission or approval to reconstruct;

3. Existing dams which are ordered to be reconstructed: prior to approving plans which are required to be submitted to comply with the order;

4. Other existing dams: after a floodplain zoning ordinance adopted and approved pursuant to s. 87.30, Stats., is in effect for the area downstream from the dam which is required to be regulated under ch. NR 116.

(c) Any dam owner may request that the department reconsider the preliminary dam hazard rating determination. The request shall be accompanied by data or analyses supporting the owner's objection to the preliminary dam hazard rating.

(d) The department shall determine whether or not to revise the preliminary dam hazard rating within 20 business days after receipt by the department of a request submitted pursuant to par. (b).

(2) NEW DAMS. The design and construction of all new dams with plans and specifications approved by the department after June 1, 1985 shall be in compliance with the requirements of this chapter.

(3) EXISTING DAMS. The owners of all existing dams shall bring their dams into compliance with the requirements of this chapter within 10 years after being notified of the dam's preliminary dam hazard rating pursuant to sub. (1), unless ordered to do so earlier under s. 31.19 (5), Stats.

(4) ENFORCEMENT. Administrative orders issued by the department under s. 31.19 (5) may be enforced under ss. 23.50, 23.79 (3), 30.03, 31.23 (2) and 31.25, Stats.

History: Cr. Register, May, 1985, No. 353, eff. 6-1-85.

NR 333.05 Submission of plans, specifications and analyses. (1) PLANS AND SPECIFICATIONS. Plans and specifications shall be submitted to and approved by the department prior to the construction of a new dam or reconstruction of an existing dam.

(2) HYDRAULIC, HYDROLOGIC AND STABILITY ANALYSES. Hydraulic, hydrologic and stability analyses prepared by a professional engineer registered in the state of Wisconsin shall be submitted to and approved by the department prior to the construction of a new dam or the reconstruction of an existing dam. These analyses shall be conducted according to accepted engineering practice and shall include the following, at a minimum:

(a) Regional flood flows calculated in conformance with the standards in s. NR 116.07 (3).

(b) Determination and delineation of the hydraulic shadow of the dam including the floodway, using the standards in s. NR 116.07 (4), assuming that the dam is in existence and fails during the regional flood, based on the site-specific worst case failure condition of either flood wave or tailwater depth analyzed by routing of the regional flood. Failure shall be considered to occur either at the maximum upstream water elevation, if overtopping does not occur during the regional flood, or at the point of overtopping.

Note: Suggested dam breach parameters used for the breach analysis are given in Table I. The values in Table I are based on assuming failure by overtopping. In some cases, other values may be selected based on structural, geotechnical and hydrologic data. See "DAM BRK -

The NWS Dam Break Flood Forecasting Model"; Hydrologic Research Laboratory, National Weather Service, National Oceanic and Atmospheric Administration; Users Manual; Nov., 1981.

Table I. Suggested Typical Ranges of Dam Breach Parameters

Type of dam	Earth	Concrete Gravity	Concrete Arch
Breach width (BB)	1/2 - 4 dam heights	Some multiple of monolith widths	Total dam width
Side slope of breach (Z)	0 - 1	0	Valley wall slope
Failure time (TFH)	0.5 - 4 hrs	0.1 - 0.5 hrs	Near instantaneous (say TFH = 0.1 hrs)

(c) Determination of the dam hazard rating using the criteria in s. NR 333.06.

(d) Determination and delineation of the floodplain with the dam nonexistent, including the floodway, using the standards in s. NR 116.07 (4).

(e) Design flood flows, based on the hazard rating and the hydraulic design standards in s. NR 333.07.

(f) Calculations for routing of the design flood through the structure. Starting conditions for the routing shall be at the normal pool and minimum tailwater elevations.

(g) Stability analyses of the dam, which consider sliding, overturning and foundation failure during base flow conditions and at maximum headwater conditions during routing of the design flood through the dam.

(3) ESTIMATED COSTS. The estimated cost of construction of the new dam or reconstruction of the existing dam, and the estimated cost of restoring the reconstructed existing dam to a safe condition, shall be submitted to the department prior to the construction of a new dam or reconstruction of an existing dam.

History: Cr. Register, May, 1985, No. 353, eff. 6-1-85.

NR 333.06 Land use and land use control classifications and dam hazard ratings. (1) GENERAL. For the purpose of determining land use and land use control classifications and hazard ratings for dams under this section, the floodway and floodfringe downstream from the dam shall be delineated as specified in s. NR 333.05 (2) (b) for the floodway and floodfringe of the hydraulic shadow and as specified in s. NR 333.05 (2) (d) for the floodway and floodfringe of the floodplain with the dam nonexistent.

(2) LAND USE AND LAND USE CONTROL CLASSIFICATIONS. (a) *Land use classifications.* The existing land use downstream from an existing or proposed dam shall be classified according to the following criteria:

1. Class IA. Land use downstream from a dam shall be classified as class IA if:

a. There are no campgrounds in the floodway of the hydraulic shadow;

b. There are no campgrounds in the floodfringe of the hydraulic shadow that would be inundated to a depth greater than 2 feet upon failure of the dam during the regional flood;

c. All other development within the floodway of the hydraulic shadow is in conformance with the standards in s. NR 116.12 (1) and (2); and

d. All other development within the floodfringe of the hydraulic shadow is in conformance with the standards in s. NR 116.13 (2) to (10).

2. Class IB. Land use downstream from a dam shall be classified as class IB if:

a. There are no campgrounds in the floodway of the hydraulic shadow;

b. There are no campgrounds in the floodfringe of the hydraulic shadow that would be inundated to a depth greater than 2 feet upon failure of the dam during the regional flood;

c. All structures for human habitation and government emergency service facilities within the hydraulic shadow are in conformance with the standards in s. NR 116.12 (1) and (2) for development in the floodway of the hydraulic shadow and in conformance with s. NR 116.13 (2) to (10) for development in the floodfringe of the hydraulic shadow; and

d. All other development in the floodplain with the dam nonexistent is in conformance with the standards in s. NR 116.12 (1) and (2) for development in the floodway of the floodplain with the dam nonexistent and in conformance with the standards in s. NR 116.13 (2) to (10) for development in the floodfringe of the floodplain with the dam nonexistent.

3. Class II. Land use downstream from a dam shall be classified as class II if:

a. There are no campgrounds in the floodway of the floodplain with the dam nonexistent;

b. There are no campgrounds in the floodfringe of the floodplain with the dam nonexistent that would be inundated to a depth greater than 2 feet or subjected to velocities in excess of 2 feet per second upon failure of the dam during the regional flood;

c. All structures for human habitation and government emergency service facilities within the floodplain with the dam nonexistent are in conformance with the standards in s. NR 116.12 (1) and (2) for development in the floodway of the floodplain with the dam nonexistent and in conformance with the standards in s. NR 116.13 (2) to (10) for development in the floodfringe of the floodplain with the dam nonexistent; and either

d. There are structures for human habitation or government emergency service facilities within the hydraulic shadow outside the floodplain with the dam nonexistent which are not in conformance with the standards in s. NR 116.12 (1) and (2) for development in the floodway of the hydraulic shadow or are not in conformance with the standards in s. NR 116.13 (2) to (10) for development in the floodfringe of the hydraulic shadow; or

e. There is development other than campgrounds, structures for human habitation, or government emergency service facilities within the floodplain with the dam nonexistent which is not in conformance with the standards in s. NR 116.12 (1) and (2) for development in the floodway of the floodplain with the dam nonexistent or in conformance with the standards in s. NR 116.13 (2) to (10) for development in the floodfringe of the floodplain with the dam nonexistent.

4. Class III. Land use downstream from a dam shall be classified as class III if:

a. There are campgrounds in the floodway of the floodplain with the dam nonexistent; or

b. There are campgrounds in the floodfringe of the floodplain with the dam nonexistent which would be inundated to a depth greater than 2 feet or subjected to velocities in excess of 2 feet per second upon failure of the dam during the regional flood; or

c. There are structures for human habitation or government emergency service facilities in the floodplain with the dam nonexistent which are not in conformance with the standards in s. NR 116.12 (1) and (2) for development in the floodway of the floodplain with the dam nonexistent or not in conformance with the standards in s. NR 116.13 (2) to (10) for development in the floodfringe of the floodplain with the dam nonexistent.

(b) *Land use control classifications.* Existing land use controls in the area downstream from an existing or proposed dam shall be classified in accordance with the following criteria:

1. Class IA. Future land use within the hydraulic shadow is required to conform to the criteria specified in par. (a) 1. through a zoning ordinance adopted and approved pursuant to s. 87.30, Stats., or through restrictive covenants, easements, or other appropriate legal arrangements between the owner of the dam and the owners of all property within the hydraulic shadow.

2. Class IB. Future land use within the hydraulic shadow is required to conform to the criteria specified in par. (a) 2. through a zoning ordinance adopted and approved pursuant to s. 87.30, Stats., or through restrictive covenants, easements, or other appropriate legal arrangements between the owner of the dam and the owners of all property within the hydraulic shadow.

3. Class II. Future land use within the floodplain with the dam nonexistent is required to conform to the criteria specified in par. (a) 3.a to c through a zoning ordinance adopted and approved pursuant to s. 87.30, Stats., or through restrictive covenants, easements, or other appropriate legal arrangements between the owner of the dam and the owners of all property within the floodplain with the dam nonexistent.

4. Class III. Future land use within the hydraulic shadow or the floodplain with the dam nonexistent is not required to conform to the criteria specified in par. (a) 1., 2. or 3.a to c through a zoning ordinance adopted and approved pursuant to s. 87.30, Stats., or through restrictive covenants, easements, or other appropriate legal arrangements between the owner of the dam and the owners of all property within the hydraulic shadow or the floodplain with the dam nonexistent.

(3) DAM HAZARD RATINGS. (a) A hazard rating of IA, IB, II, or III for all existing and proposed dams shall be determined in accordance with Table II.

Table II

LAND USE CLASSIFICATION	LAND USE CONTROL CLASSIFICATION	HAZARD RATING
IA	IA	IA
IA	IB	IB
IB	IA	IB
IA, IB, or II	II	II
II	IA, IB or II	II
IA, IB, II or III	III	III
III	IA, IB, II or III	III

(b) The owner of a dam may request that the department change the hazard rating of an existing or proposed dam by submitting information which demonstrates that the land use and land use controls downstream from the dam meet the requirements for a different hazard rating. The department shall advise the owner of its action on the requested change within 30 business days after receiving the request.

History: Cr. Register, May, 1985, No. 353, eff. 6-1-85.

NR 333.07 Hydraulic design and safety requirements. (1) SIZE CLASSIFICATION. All proposed and existing dams shall be classified by size according to the following:

(a) Minor dams are those dams with less than 15 feet of structural height and less than 300 acre-feet of maximum storage capacity.

(b) Major dams are those dams with 15 feet or more of structural height, or 300 acre-feet or more of maximum storage capacity.

(2) MINIMUM HYDRAULIC CAPACITY. Except as provided in sub. (3), all proposed and existing dams shall have the minimum hydraulic capacity shown in Table III.

Table III
Required Spillway Design Capacities

Dam Hazard Rating	Size Classification	Minimum Principal Spillway Capacity	Minimum Total Spillway Capacity
Class IA (Low)	Minor	Q_{10}	Q_{50}
	Major	Q_{10}	Q_{50}
Class IB (Low)	Minor	Q_{10}	Q_{100}
	Major	Q_{25}	Q_{200}
Class II (Significant)	Minor	Q_{25}	Q_{200}
	Major	Q_{50}	Q_{500}
Class III (High)	Minor	Q_{50}	Q_{500}
	Major	Q_{100}	Q_{1000}

(3) REDUCED REQUIREMENTS. (a) Unless the department determines that public safety requires full compliance with the substantive requirements of this rule, all dams which will be submerged by flows less than the minimum hydraulic capacity specified in Table III shall be designed to pass the flow of the river at submergence.

(b) Any owner may provide documentation to justify a different spillway capacity from that specified in Table III. The department shall review such documentation and may approve the spillway capacity proposed by the owner if it determines that such capacity will not result in an additional hazard to life, health or property when compared to the capacity specified in Table III.

(4) SAFETY MEASURES. The owners of all new and existing dams shall comply with the following safety measures:

(a) The owner shall have an adequate operation, inspection and maintenance plan for the dam.

(b) The dam shall be structurally stable for any flow condition up to and including the design flood flow.

(c) An adequate emergency action plan shall be prepared for the area downstream from the dam in consultation with the local unit of government and concurred in by the division of emergency government.

(d) Documentation showing that the requirements of pars. (a) to (c) have been met shall be submitted to the department for approval. The department shall review and approve or disapprove of the documented safety measures in writing within 45 business days after the department receives the documentation.

History: Cr. Register, May, 1985, No. 353, eff. 6-1-85.

NR 333.08 Construction. (1) Construction of a new dam or reconstruction of an existing dam may not begin until the department approves the plans and specifications submitted under s. NR 333.05.

(2) Alterations to any plans or specifications that were approved by the department under s. NR 333.05 which will affect the flood flow capacity or structural integrity of a dam shall be approved by the department before construction or reconstruction of the dam.

(3) All dams shall be constructed or reconstructed under the supervision of a professional engineer registered in the state of Wisconsin or a representative of an engineering company licensed to do business in the state of Wisconsin. The supervising engineer shall, within 10 days after completing the construction or reconstruction of a dam, submit a statement indicating that the dam was constructed or reconstructed in accordance with the plans and specifications approved by the department under s. NR 333.05.

(4) As-built plans shall be submitted to the department within 30 business days after the completion of construction or reconstruction of a dam.

History: Cr. Register, May, 1985, No. 353, eff. 6-1-85.

NR 333.09 Bonding. (1) GENERAL REQUIREMENT. (a) Except as provided in par. (b), the owner of a dam shall file a bond with the department prior to the commencement of construction or reconstruction of the

dam. The bond amount shall equal the estimated cost of restoring a reconstructed dam to a safe condition or the cost of constructing or reconstructing the dam, whichever is less, based on the cost estimate submitted by the owner under s. NR 333.05 (3).

(b) Where the owner is a state or interstate agency or a city, county, village, special purpose district or other unit of government, a bond is not required if the owner demonstrates to the department's satisfaction that it has made or will make sufficient funds available to construct or reconstruct the dam or to restore the reconstructed dam to a safe condition, whichever is less expensive.

(2) NOTIFICATION. As part of its approval of the plans and specifications submitted pursuant to s. NR 333.05, the department shall notify the applicant of the required bonding level.

(3) BOND REQUIREMENTS. (a) The bond filed with the department in the required amount shall be conditioned upon faithful performance of all of the requirements of ch. 31, Stats., the provisions of this chapter, and the conditions of any permit or order issued to the applicant for the dam pursuant to ch. 31, Stats.

(b) At the option of the applicant, either a performance bond or a forfeiture bond may be filed.

(c) The bond shall be issued by a surety company licensed to do business in the state of Wisconsin.

(d) Each bond shall provide that it may not be canceled by the surety company or the owner without the department's consent.

(e) The bond shall be made payable to the department.

(4) RELEASE. The department shall release or authorize the release of the applicant's bond within 20 business days after the receipt of a request for release if the department finds that the construction or reconstruction has been completed in accordance with the plans and specifications approved by the department.

History: Cr. Register, May, 1985, No. 353, eff. 6-1-85.