



Member of the FM Global Group



American National Standard for Flood Mitigation Equipment

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Foreword

NOTE: This foreword is introductory only and is not part of American National Standard FM 2510.

This standard is intended to be used to evaluate the components and performance of flood mitigation equipment.

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1. INTRODUCTION

1.1 Purpose

- 1.1.1 This standard states the examination and test requirements for flood mitigation equipment for use in riverine, tidal, or rainfall/snowmelt related flood conditions.

1.2 Scope

- 1.2.1 This standard encompasses the design and performance requirements for flood mitigation equipment for use in controlling riverine, tidal, or rainfall related flood conditions. Flood mitigation equipment is categorized for specific flood protection applications which are designated by:

- Function (permanent or contingent)
- Operation (active or passive)
- For flood barriers, the intended application for protection (i.e. opening vs. perimeter)

- 1.2.2 This standard sets performance requirements for flood mitigation equipment in the following product categories:

- Flood Barriers for Opening Barrier Applications
- Flood Barriers for Perimeter Barrier Applications
- Flood Mitigation Valves
- Flood Mitigation Pumps
- Penetration Sealing Devices

1.2.2.1 Flood glazing, as defined in Section 1.7, is considered a type of flood barrier that may be evaluated for opening barrier or perimeter barrier applications. The evaluation of flood glazing shall include the seal made between the glazing panel and the structural frame as well as the seal made between the frame and the structural opening.

1.2.2.2 For the purposes of evaluation to this Standard and applying the appropriate protocol, sluice gates, as defined in Section 1.7, are considered a type of flood barrier for opening barrier applications.

1.2.2.3 Penetration sealing devices include products used to seal the area around a surface penetration or the area within the penetration itself, the later which includes pipe plugs.

- 1.2.3 Flood barriers for opening barrier applications are evaluated and tested for quasi-static flood conditions.

- 1.2.4 Flood barriers for perimeter barrier applications are evaluated and tested for quasi-static and riverine flood conditions.

- 1.2.5 Flood barriers for coastal applications are not included in the scope of this Standard. Protection from tidal-related flood events is included in the scope of the Standard only for applications away from the coast where only quasi-static flood conditions are present.

- 1.2.6 Wind loading effects on flood barriers are not included in the scope of the evaluation. A full engineering analysis must be conducted by persons acceptable by the Authorities Having Jurisdiction (AHJ) to determine possible wind loading, as well as combined hydrostatic and wind loading, on a barrier structure.

- 1.2.7 The certification of flood barriers applies only at water levels up to the maximum depth rating, as identified on the product label. Water levels exceeding this amount are outside the scope of this certification.

- 1.2.8 Flood mitigation pump types included in the scope of this standard consist of submersible and pedestal type sump pumps as well as self-priming pumps.

- 1.2.9 Flood mitigation pumps are evaluated and Approved as pump packages only, complete with pump, driver, controller, coupling, and other components listed in Appendix C.
- 1.2.10 Certification to this Standard is limited to the flood mitigation product. Flood waters may produce high hydrostatic or hydrodynamic loading on a protected structure. Appropriate measures must be taken to ensure that an external wall structure (or similar) is able to withstand anticipated flood loading, including any site specific concerns. Some wall construction assemblies often are able to withstand 3 ft (0.9 m) or less of flood loading without needing reinforcement or additional waterproofing. A full engineering analysis must be conducted by persons acceptable by the Authorities Having Jurisdiction (AHJ).
- 1.2.11 In addition to the general design requirements specified in this Standard, local construction codes and/or agency regulations must also be considered in the design of a flood mitigation product or system.

1.3 Basis for Requirements

- 1.3.1 The requirements of this standard are based on experience, research and testing, and/or the standards of other organizations. The advice of manufacturers, users, trade associations, jurisdictions and/or loss control specialists was also considered.
- 1.3.2 The requirements of this standard reflect tests and practices used to examine characteristics of flood mitigation equipment. Flood mitigation equipment having characteristics not anticipated by this standard may be tested if demonstrated performance is equal or superior to that required by this standard, or if the intent of the standard is met.

Alternatively, flood mitigation equipment that has met all of the requirements identified in this standard may not be acceptable if other conditions which adversely affect performance exist or if the intent of this standard is not met. It is the sole discretion of the testing laboratory.

1.4 Basis for ANSI Specification

- 1.4.1 Certification is based upon satisfactory evaluation of the product and the manufacturer. Examination and tests on production samples shall be performed to evaluate:
- The suitability of the product
 - The performance of the product as specified by the manufacturer
 - The durability and reliability of the product
- 1.4.2 Since each flood mitigation system is unique in its operation and design, component testing shall be performed on a case-by-case basis. If deemed necessary, additional tests which are not included in this standard may be required at the discretion of the test laboratory.
- 1.4.3 A satisfactory evaluation of the flood mitigation equipment's "Design, Installation, Operation and Maintenance Manual" is required. The evaluation shall be performed to ensure that the document is accurate and complete.

1.5 System of Units

Units of measurement used in this standard are United States (U.S.) customary units. These are followed by their arithmetic equivalents in International System (SI) units, enclosed in parentheses. The first value stated shall be regarded as the requirement. The converted equivalent value may be approximated. Conversion of U.S. customary units is in accordance with the Institute of Electrical and Electronics Engineers (IEEE)/American Society for Testing and Materials (ASTM) SI 10. Two units of measurement (liter and bar), outside of, but recognized by SI, are commonly used in the international scientific community and are used in this standard.

1.6 Normative References

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the cited edition applies. For undated references, the latest edition of the referenced document (including any amendments) applies:

ASME Publications

The American Society of Mechanical Engineers, Three Park Avenue, New York, NY 10016-5990 www.asme.org

ASME Boiler and Pressure Vessel Code, Section VIII- Rules for Construction of Pressure Vessels, Division 1

ASTM Publications

American Society for Testing and Materials, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959

ASTM A351 – *Standard Specification for Castings, Austenitic, for Pressure Containing Parts*

ASTM B16 - *Standard Specification for Free-Cutting Brass Rod, Bar and Shapes for Use in Screw Machines*

ASTM B117 - *Standard Practice for Operating Salt Spray (Fog) Apparatus*

ASTM D412 - *Standard Test Methods for Vulcanized Rubber and Thermoplastic Rubbers and Elastomers - Tension*

ASTM D395 - *Standard Test Methods for Rubber Property - Compression Set*

ASTM D572 - *Standard Test Method for Rubber – Deterioration by Heat and Oxygen* ASTM D573 - *Standard Test Method for Rubber - Deterioration in an Air Oven*

ASTM D1056 – *Standard Specification for Flexible Cellular Materials – Sponge or Expanded Rubber*

ASTM D5602 - *Standard Test Method for Static Puncture Resistance of Roofing Membrane Specimens*

ASTM G155 - *Standard Practice for Operating Xenon Arc Light Apparatus for Exposure of Non-Metallic Materials*

International Standards Organization

International Standards Organization, , 1 rue de Varembe, Case Postale 56, CH-1211 Geneve 20, Switzerland

ISO 17025 - *General Requirements for the Competence of Testing and Calibration Laboratories*

United States Department of Transportation (D.O.T.)

United States Department of Transportation, Washington, DC

Code of Federal Regulations, Title 49, Transportation, Parts 171 through 180

1.7 Definitions

For purposes of this Standard, the following terms apply:

Accepted

This term refers to installations acceptable to the authority having jurisdiction and enforcing the applicable installation rules. Acceptance is based upon an overall evaluation of the installation. Acceptance is not a characteristic of a product. It is installation specific. A product accepted for one installation may not be acceptable elsewhere.

Active Flood Barrier or Flood Mitigation Product

A flood barrier or other flood mitigation product which requires human intervention for manual deployment. Active flood barriers or flood mitigation products may either be permanent or contingent.

Automatic Flood Barrier or Flood Mitigation Product

A permanent, passive barrier or other flood mitigation product that automatically deploys without the need for human intervention when flood conditions are detected. Types of automatic barriers may include, but are not limited to, buoyancy driven (horizontal or vertical) and pneumatic or hydraulic activated by water sensors.

Backwater Valve

Backwater valves are a type of flood mitigation valve typically installed in drainage or sanitary systems and designed to prevent reverse flow into a protected structure and/or area. Standard flapper or swing type check valves are a common example. Backwater valves may be configured in either a normally open position or normally closed position and may be used for in-line or end of line applications.

Characteristic Curve

Graphic representation of the variation of a pump's total dynamic head, efficiency, and/or brake horsepower versus the pump's capacity at a constant speed. Multiple rated speeds may be represented with multiple curves on a single plot.

Contingent Flood Barrier or Flood Mitigation Product

A barrier or flood mitigation product that is not permanently installed and affixed to a structure and which requires some level of transportation and manual deployment. Some elements of the barrier/product may be permanently pre-installed (i.e. frame), but the main components are temporary and require manual deployment. Contingent flood barriers or flood mitigation products may only be classified as active protection.

Deflection

The distance a flood barrier has moved from its original location during an applied force event. Deflection may be movement/displacement or distortion of the barrier structure itself. Permanent deflection is the distance the flood barrier has moved from its original location after the applied force is removed.

Deployment Time

The amount of time required for deployment and/or operation of an active flood mitigation product.

Dry-Side (or Land-Side)

The side of a flood barrier or flood mitigation product that is protected from flood waters.

Flexible Rubber Type Valves

Flexible rubber type valves, also commonly referred to as duckbill check valves, are a type of flood mitigation valve which uses flexible rubber material to function as the valve mechanism. The position of the flexible rubber flap, or duckbill, is directly manipulated by the water and direction of flow. This provides for automatic open/close function resulting in flow only in the desired direction. Flexible rubber type valves may be constructed entirely of flexible rubber material or may be encased in a solid body.

Flood Doors

Any door, permanent or otherwise, which provides complete coverage of an exterior or interior door opening with the principle function of preventing flood waters into a structure.

Flood Glazing

A permanent, passive flood barrier constructed of reinforced glass material that is set and sealed within a structural frame. The frame is then installed and sealed within the structural opening. Flood glazing barriers may be configured

as single panels (i.e. windows) or as multiple panels in a modular series to form a wall structure of the desired length. Flood glazing may also be installed within another permanent barrier structure such as a flood wall. Flood glazing may be used for opening barrier and/or perimeter barrier applications.

Flood Mitigation Pumps

A pump used for the removal of unwanted flood water. Types of flood mitigation pumps include but are not limited to submersible, pedestal, and self-priming pumps. Flood mitigation pumps may be utilized in one or more of the following applications; as part of a flood barrier system to remove water resulting from leakage past the barrier, permanently installed in a building as part of a water removal system (i.e. drainage system with sump), and/or a portable device used for removal of unwanted flood waters from a desired location.

Flood Mitigation Valve

This term refers to any style of valve that is used to mitigate the passage of water into a protected area during flood events. These products may be installed in-line or at the end of line outflow locations. Backwater valves are a type of flood mitigation valve. Other non-standard designs may also be utilized for this intended purpose, such as flexible rubber type valves.

Flood Panel Barrier

A flood barrier consisting of a large rigid panel(s) as the main structural element. During a flood event, the panel is manually affixed to a pre-installed barrier frame, or other pre-installed receiver components, at the location of deployment.

Flood Plank Barrier

A flood barrier consisting of multiple rigid planks which are guided through a vertical frame and stacked on top of each other to form a wall structure.

Leakage Rate

The rate at which water moves past or through a flood barrier or other flood mitigation product from the wet-side to the dry-side of the barrier, expressed as gallons per hour per linear foot (liters per hour per linear meter) length of seal.

Major Repair

A repair made to a flood barrier during the performance test series that requires changes to barrier design by the manufacturer.

Maximum Load

Maximum radial hydraulic load on the impeller of a flood mitigation pump at any point on the performance curve based on a specific gravity of 1.0. This usually occurs at the point of maximum total discharge head.

Maximum Power

The greatest speed-corrected power required to drive a flood mitigation pump at rated speed and at any point along its characteristic curve, and through the pumps total run out condition.

Minor Repair

A small repair made to a flood barrier during the performance test series. A repair will constitute as a “minor repair” only if; (1) the repair can be easily replicated by the end user, and (2) the Design, Installation, Operation, and Maintenance Manual instructs how to conduct the repair. If a minor repair becomes part of the deployment procedure in the Design, Installation, Operation, and Maintenance Manual, it will no longer be considered a repair.

Nationally Recognized Testing Laboratory (NRTL)

A laboratory which is listed and recognized by the United States Department of Labor, Occupational Safety & Health Administration's (OSHA) Directorate of Science, Technology, and Medicine program. The program recognizes private sector organizations as NRTL's, and recognition signifies that an organization has met the necessary qualifications specified in the regulations for the Program. The NRTL determines that specific equipment and materials ("products") meet consensus-based standards of safety to provide the assurance, required by OSHA, that these products are safe for use in the U.S. workplace.

Normally Closed Backwater Valve

A backwater valve designed in such a manner that when installed, the backflow prevention element remains closed until flow causes it to open.

Normally Open Backwater Valve

A backwater valve designed in such a manner as not to interfere with the movement of the air through the connected pipework. When installed, the backflow prevention element is in a normally open position.

Opening Barrier Applications

Applications in which a flood barrier is used to protect against water entering through an opening in a structure between two linear points (i.e. doorway, window, receiving bay, etc.). The barrier is supported by the permanent structure on both sides or along the full perimeter of the barrier/opening. Typical products used in opening barrier applications include flood doors, flood panels, and flood planks. Other products may include, but are not limited to, flexible membrane barriers, sluice gates, and flood glazing. Flood barriers certified for opening barrier applications are evaluated/tested to withstand quasi-static flood conditions.

Overtopping

The action of water flowing over the top of a flood barrier.

Passive Barrier or Flood Mitigation Product

A permanent barrier or other flood mitigation product that, after its initial installation, either requires no deployment or requires no human intervention for deployment. Examples of passive protection are engineered flood walls, flood glazing, penetration seals around pipes/cables, and automatic flood barriers. Passive barriers or flood mitigation products may only be classified as permanent.

Pedestal Pump

A pump that is comprised of; a pumping element in a sump, pit, or a low point, and a motor mounted on a column or pedestal extended vertically above the pumping element. The motor is not be exposed to the water in the sump, pit, or low point.

Perimeter Barrier Applications

Applications in which a flood barrier is used to prevent flood water from entering an area surrounding a protected structure or other asset. Flood barriers evaluated for perimeter barrier applications may be contingent or permanent. The barrier is installed at some distance away from the protected structure allowing for additional flood mitigation methods (i.e. flood mitigation pumps) to be used to control any seepage before it reaches the protected structure. Perimeter barriers may be configured as a full perimeter wall or a terminating wall which may or may not be supported by a permanent structure. Flood barriers Approved for perimeter barrier applications are evaluated/tested to withstand quasi-static and riverine flood conditions.

Permanent Flood Barrier or Flood Mitigation Product

A barrier or flood mitigation product that is pre-installed and permanently affixed to a structure. Permanent barriers or flood mitigation products may or may not require manual deployment. Examples of permanent barriers requiring manual deployment include flood doors, hinged gates, sluice gates, etc.

Rated Capacity

The rate at which a flood mitigation pump delivers water, in gal./min. (L/min), at rated pressure and rated speed.

Rated Pressure

The outlet pressure in pounds per square inch - psi (kilopascals -kPa) developed by a flood mitigation pump when operating at rated capacity and suction pressure.

Riverine Flood Conditions

Flooding of or produced by a river causing water, debris, and sediments to be transported onto a flood plain. Riverine flood conditions include various degrees of wave action and water currents, as well as the potential for large debris impact.

Seal

The location on a barrier where the product meets the ground or wall of the structure to prevent water from moving from the wet-side to the dry-side. A seal can also be made between different components or sections within a flood barrier. The linear length of seal, as determined based on the product type, is used for calculation of the leakage rate.

Self-Priming Pump

A flood mitigation pump which, when activated, will evacuate its passages of air and automatically draw in water to the suction side to commence pumping without the need for human intervention.

Shutoff Pressure

The net pressure in psi (kPa) developed by a flood mitigation pump at rated speed with zero flow.

Sluice Gate

A gate installed at the end of a sluice used to control water level and the flow from one area to another.

Structural Opening

Any opening in a structure where water can flow through, such as doors, windows, air bricks/vent bricks, portals, garage entrance/loading dock entrance, utility penetrations, etc.

Submersible Pump

A pump that consists of both the pumping element and the motor in a protective housing which allows the system to run properly when submerged in a liquid.

Sump Pump

A pump powered by an electric motor used for the removal of ground water drainage from a sump, pit or low point in a foundation. Types of sump pumps include, but are not limited to, pedestal and submersible.

Total Discharge Head

The gauge reading in psi (kPa) at the discharge of a flood mitigation pump, converted to feet of liquid and corrected to the pump centerline elevation.

Total Dynamic Head

The difference between the total discharge head and the total suction head, or between the total discharge head and the total suction lift, whichever is applicable.

Total Suction Head

The gauge reading in psi (kPa) at the suction of a flood mitigation pump, converted to feet of liquid and corrected to the pump centerline elevation. This condition is present when the liquid supply level is above the pump centerline and the suction pressure is above atmospheric.

Total Suction Lift

The gauge reading in inHg (mmHg) at the suction of a flood mitigation pump, converted to feet of liquid and corrected to the pump centerline elevation. This condition is present when the liquid supply level is below the pump centerline and the suction pressure is below atmospheric.

Wet-Side (or River-Side)

The side of a flood barrier or flood mitigation product that is subjected to flood waters.

2. GENERAL INFORMATION

2.1 Product Information

2.1.1 Flood mitigation equipment is designated and categorized by function (permanent vs. contingent) and operation (active vs. passive). This standard defines protection with the following types of flood mitigation equipment.

- Flood barriers for perimeter barrier applications
- Flood barriers for opening barrier applications
- Flood mitigation valves
- Penetration sealing devices
- Flood mitigation pumps

2.1.2 In order to meet the intent of this standard, flood mitigation equipment shall be examined on a model-by-model, type-by-type, manufacturer-by-manufacturer, and plant-by-plant basis. This is predicated on the basis that identical designs, fabricated in identical materials by different manufacturers have been seen to perform differently in testing. Sample flood mitigation equipment, selected in conformance to this criterion, shall satisfy all of the requirements of this standard.

2.2 Application Requirements

The manufacturer shall provide the following preliminary information that gives a full description of the construction of the flood mitigation equipment. All documents shall identify the manufacturer's name, document number or other form of reference, title, date of last revision, and revision level.

Test programs will be scheduled only upon receipt of all material listed herein. All foreign language documents shall be provided with English translation.

2.2.1 Marketing/Ordering Literature - Showing general specifications and functions of the system.

2.2.2 Model Number Breakdown - A specification or drawing showing all system variations and options to be examined.

2.2.3 The Design, Installation, Operation, and Maintenance Manual.

2.2.4 Quality Control Procedures - Document(s) detailing routine testing and final inspection procedures: receiving inspection; in-process inspection; final inspection, and calibration of measuring and testing equipment used. In addition, procedures must detail the system acceptance testing once the flood mitigation equipment system is installed.

2.2.5 Documentation Control Specification - Proposed method of controlling critical documents which may be identified in the Documentation Section of the Test Report. These drawings shall be listed in the report issued at the conclusion of the test program. The testing laboratory shall be notified of changes to these documents.

2.2.6 Production Drawings - The following drawings shall be provided:

- Electrical schematic(s)
- Final assembly drawings and parts lists sufficient to detail primary components (all), operator controls, and their locations
- Complete set of mechanical drawings for all machined parts
- Complete part specifications (including manufacturer's model numbers, size, ratings, etc.) for all purchased parts
- Specification sheets for all parts/components
- Drawings showing all construction details
- Product label drawing(s) showing all required marking information. The label drawing shall show the proposed label location on the equipment and artwork showing the manufacturer's name, address, model and serial numbers, equipment ratings, and warning markings.

2.2.7 The number and location of manufacturing facilities.

2.3 Requirements for Samples for Examination

Sample requirements are to be determined by the testing laboratory following review of the preliminary information. Sample requirements may vary depending on design features and/or the results of any testing. It is the manufacturer's responsibility to submit samples representative of production. Any decision to use data generated utilizing prototype components or prototype systems is at the sole discretion of the testing laboratory.

3. GENERAL REQUIREMENTS

3.1 Review of Documentation

During the initial investigation and prior to testing, the manufacturer's specifications, technical data sheets, and design details shall be reviewed to assess the ease and practicality of installation and use. The system and its components shall be capable of being used within the limits of the investigation.

3.2 Physical or Structural Construction Features

3.2.1 Flood Barriers for Opening Barrier and Perimeter Barrier Applications

- 3.2.1.1 All materials used in flood barriers shall be suitable for the intended application. Flood barrier components shall be constructed of corrosion resistant materials. When unusual materials are used, additional testing may be necessary to verify their suitability.
- 3.2.1.2 Flood glazing is considered a type of flood barrier that may be configured for opening barrier or perimeter barrier applications, and shall be evaluated as such.
- 3.2.1.3 Flood glazing shall be constructed with laminated glass designed to crack but not shatter, when subjected to debris impact. The flood glazing system shall demonstrate the ability to withstand debris impact without compromising structural integrity while maintaining an acceptable amount of leakage.
- 3.2.1.4 Air / Nitrogen / other gas cylinder(s) for pressurized seal systems shall meet the applicable requirements of either the ASME Boiler and Pressure Vessel Code, Section VIII or Code of Federal Regulations, Title 49, Transportation, Parts 171 through 180; or equivalent national standard of the country of use, reference section 4.9.
- 3.2.1.5 Manually operated caps, valves, and other mechanisms required for proper functioning of the barrier, must have a securing, locking, and/or supervising component.
- 3.2.1.6 The design of automatic barriers shall be such that major debris that could impact the barrier's functionality is prevented from entering the system prior to deployment. Other debris shall be able to be flushed from the system during periodic maintenance.
- 3.2.1.7 Automatic barriers shall have a method for manual deployment.
- 3.2.1.8 Automatic barriers shall be evaluated for reliability when any component is exposed to an outside load condition (i.e. vehicular, personnel traffic, etc.) while in the open position. The manufacturer shall provide a complete analysis which illustrates the product's ability to withstand any anticipated load conditions over the expected life of the barrier. The analysis shall include at a minimum; maximum deflection under load, permanent deflection based on simulated live loads, and a failure analysis of the deployment equipment. The analysis shall be reviewed for accuracy and completeness by the testing laboratory.
- 3.2.1.9 Flood barriers for opening barrier and perimeter barrier applications shall be constructed so as to be reasonably watertight and shall mitigate seepage to a level within the maximum requirement. Maximum seepage rates of flood barriers for opening barrier applications are provided in Appendix D for various opening widths and design water heights.

3.2.2 Flood Mitigation Valves

- 3.2.2.1 Flood mitigation valves shall be designed and evaluated for in-line and/or end of line applications.
- 3.2.2.2 Backwater valves designed to be normally closed shall be constructed that when the device is installed at the required 1:48 slope (1/4 in. per foot) with respect to the direction of flow, the check member

will be in a closed position when no fluid is discharged. The valve shall be designed so that any solids accumulated under low flow conditions are flushed through the valve during full design flow conditions.

- 3.2.2.3 Backwater valves designed to be normally open shall be constructed that when the device is installed at the required 1:48 slope (1/4 in. per foot) with respect to the direction of flow, the check member will be in an open position but will close when fluid backflow occurs.
 - 3.2.2.4 The internal working parts of a backwater valve, such as valve seat, flap, hinge pins, and stems, shall be copper alloy in accordance with ASTM B16, stainless steel in accordance with ASTM A351, or equally corrosion resisting material.
 - 3.2.2.5 A backwater valve shall be designed and constructed that when installed in its proper operating position, the upper face of the device shall be parallel to the invert of the outlet so that the slope of the device can be readily determined by placing a level on the top of the face.
 - 3.2.2.6 Flood mitigation valves shall be designed to provide access to working components for repair or replacement. The size of the access shall be based upon the requirements necessary to perform the repair or maintenance. The access cover shall be water and air tight once installed. This does not apply to flexible rubber type flood mitigation valves with no mechanical moving parts requiring maintenance and/or replacement.
 - 3.2.2.7 Parts that are used to affect sealing in flood mitigation valves shall be secured in a manner that will maintain proper alignment of mating surfaces. Movement of any stationary parts shall not loosen or detach them during handling or operation of the unit. All seals and parts used to affect sealing shall be replaceable.
- 3.2.3 **Flood Mitigation Pumps**
- 3.2.3.1 **Flood Mitigation Pump Packages**

A flood mitigation pump manufacturer shall be able to supply the necessary pump accessories (See Appendix C) to provide a complete pump package installation. This responsibility includes control for: design, component sourcing, manufacturing, certification testing, production testing, proper operation and sizing of the pump and the accessories (Appendix C), quality control, and assembly locations.
 - 3.2.3.2 **Physical or Design Features**
 - 3.2.3.2.1 Connections to suction and discharge piping shall be made with flanged or threaded connections that are compliant to a recognized national or international standard. The use of other styles of connections will be at the sole discretion of the testing laboratory.
 - 3.2.3.2.2 Manufacturers must provide a characteristic curve for each flood mitigation pump. Characteristic curves of discharge pressure (total dynamic head) vs. capacity shall be provided for all rated pump speeds. For submersible pumps, discharge pressure shall be in terms of total dynamic head. For self-priming pumps with suction lift capabilities, multiple performance curves shall be generated for varying degrees of suction lift, up to the maximum rated suction lift.
 - 3.2.3.2.3 A flood mitigation pump shall have solids handling capability to protect against clogging caused by potential floating debris in flood waters. The solids handling capability, expressed as a maximum solid diameter, shall be clearly stated in the manufacturer's technical literature. Pumps shall be fitted with a means of protection from clogging by use of a strainer, or screening, sized to limit the maximum solid size entering the pump to within the stated capability.

- 3.2.3.2.4 Pump casings shall be designed for easy clean out/flushing in case of clogging, without the use of specialized tools.
- 3.2.3.2.5 Sealing at the pump shaft may be accomplished with either traditional packing, or mechanical seals.
- 3.2.3.2.6 Flood mitigation pumps shall be capable of turning on and off manually. In addition, pumps can have the capability of an optional automatic start and stop feature. Automatic operation shall turn on or off by responding to the appropriate water levels in a sump as indicated by the operation of a mechanical float switch, liquid level sensor, or pressure transducer.
- 3.2.3.2.7 Flood mitigation pumps shall be provided with a manual means for stopping the equipment. This may be located on the control panel on the assembly itself, or via a remote switch.
- 3.2.3.2.8 Flood mitigation pumps that may be installed in different orientations, shall be tested in each orientation, or it shall be stated which orientation for which the Approval has been granted.
- 3.2.3.2.9 Electrical devices used as part of a flood mitigation pump package intended for hazardous (classified) locations, requiring explosionproof or submerged service, the examination of electrical components is to include applicable Hazloc evaluations per applicable Standards.
- 3.2.3.2.10 Submersible pumps require a minimum submergence level for continuous operation. Operation under conditions outside of this range may cause significant damage to the pump. Performance ratings for submersible pumps shall be in reference to the pump while at the minimum submergence level and minimum total suction head.
- 3.2.3.2.11 Self-priming pumps may be designed to utilize various means of drawing water into the pump casing. The manufacturer's literature shall clearly outline the proper operation of the equipment in order to establish prime within the pump. It shall also indicate the amount of lift that each model of pump can produce.
- 3.2.3.2.12 Skid mounted or frame encased units shall have lifting points clearly marked in order to avoid damage to the unit during transportation.
- 3.2.3.2.13 Trailer mounted units shall be identified as compliant for over the road travel, or not. All trailer mounted units shall be provided with adjustable supports that may be used to level the unit for operation.
- 3.2.3.2.14 In order to account for the application, flood mitigation pumps may be driven by electric motors or internal combustion engines.
- 3.2.3.2.15 Due to the range of pumps considered for flood mitigation applications, the requirements for internal combustion engine drivers have been written around the use of gasoline powered engines up to 15 hp, and diesel engines from 15 hp and larger. Evaluation of engines utilizing other fuels will be on a case-by-case basis at the sole discretion of the testing laboratory.
- 3.2.3.2.16 Internal combustion engines may be started either by electrical or mechanical means. Where practical, smaller internal combustion engines units with electric start shall also have a manual recoil starting method as a back-up in case of low battery level. Larger engines shall be fitted with an integral starter motor, storage battery, and alternator / generator as a means for cranking the engine.

3.2.3.3 Internal Combustion Engines – Gasoline Engines

- 3.2.3.3.1 Gasoline engines shall be designed to close-couple to the pump only.
- 3.2.3.3.2 A manual starting method shall be provided as a means to start the engine. Electric start is permitted, but only with manual recoil as a back-up means for starting the equipment. The addition of electric start shall also be accompanied by a starter motor, solenoid, battery provided to crank the engine, and a means to recharge the battery while the engine is running.
- 3.2.3.3.3 Gasoline engines may be provided as air cooled or liquid cooled. Any integral fans used to draw cooling air over the engine shall be guarded to provide protection for personnel operating the equipment. Liquid cooled engines shall be provided with a fill port and expansion reservoir in order to reduce the loss of primary coolant due to thermal expansion.
- 3.2.3.3.4 Gasoline engines may be provided as single speed, or with an adjustable throttle. If provided with an adjustable throttle, markings shall be provided to indicate the direction for increase and decrease of engine speed in proximity to the point of adjustment. Gasoline engines shall not be designed to operate above 3600 rpm.
- 3.2.3.3.5 Gasoline engines shall be internally lubricated with engine oil that is mechanically circulated throughout the engine. Oil fill and drain ports shall be readily identified either by color, marking, or symbol. The engine oil lubrication path shall pass through a readily replaceable engine oil filter that is readily identifiable, and requires no specialized tools to access or change during maintenance.
- 3.2.3.3.6 Gasoline engines shall draw their fuel from a fuel tank provided as part of the entire pump assembly. The fuel tank shall be mounted so that fuel is fed to the carburetor via gravity, or with a manual push bulb initial priming assistance. The fuel line between the storage tank and the carburetor shall have a quarter turn valve in it with markings for OPEN and CLOSE clearly marked. The fuel pick-up within the tank shall be located above the lowest point in order to reduce chances for debris making it into the combustion chamber or shall be fitted with a strainer / screen.
- 3.2.3.3.7 Gasoline engines shall draw their combustion air through a readily replaceable filter media in order to prevent air borne debris from entering the combustion chamber.
- 3.2.3.3.8 Gasoline engines shall be provided with a muffler to reduce the sound generated. The exhaust and muffler shall be guarded to provide protection from operators of the equipment.
- 3.2.3.3.9 Gasoline engines shall be designed for use in outdoor environments. Therefore, the electrical connections, air intake, and fuel system shall be designed to operate in dry and rainy environments.

3.2.3.4 Internal Combustion Engines – Diesel Engines

- 3.2.3.4.1 Diesel engines used with flood mitigation pumps are generally long-coupled to the pump shaft via a power transmission coupling or drive-shaft. Smaller diesel engines (1 or 2 cylinders) however can be supplied as close-coupled to the flood mitigation pump.
- 3.2.3.4.2 Diesel engines may be supplied as naturally aspirated, turbocharged, or twin turbocharged, and those fitted with after coolers.

- 3.2.3.4.3 This document does not address the National or Local Codes which require specific emission levels to be met by diesel engines.
- 3.2.3.4.4 Diesel engines shall be provided with electric starting as the primary means of cranking engines for all engines 3 cylinders and larger. All diesel engines with electric start shall be provided with starter motor, solenoid, storage battery provided to crank the engine, and means to recharge the battery when the engine is running. Single and dual cylinder close-coupled diesel engines may be provided with manual recoil starting as primary means of cranking the engine. Electric start is permitted on single and dual cylinder engines, but only with manual recoil as back-up means for starting the equipment.
- 3.2.3.4.5 Diesel engines shall be provided as liquid cooled or radiator cooled for all engines 3 cylinders and larger. All liquid cooled and radiator cooled diesel engines shall be provided with a fill port and expansion reservoir in order to reduce the loss of primary coolant due to thermal expansion. Any integral fans used to draw cooling air over the engine, across air heat exchanger, or through a radiator shall be guarded to provide protection for personnel operating the equipment. Single and dual cylinder close-coupled diesel engines may also be provided as air cooled.
- 3.2.3.4.6 Diesel engines shall be provided with an adjustable throttle for all engines 3 cylinders and larger. Markings shall be provided to indicate the direction for increase and decrease of engine speed in proximity to the point of adjustment. It shall be designed to provide positive locking for any setting. Single and dual cylinder close-coupled diesel engines may be provided as single speed, or with a manually adjustable throttle. Diesel engines shall not be designed to operate above 3600 rpm.
- 3.2.3.4.7 All diesel engines shall be internally lubricated with engine oil that is mechanically circulated throughout the engine. Oil fill and drain ports shall be readily identified either by color, marking, or symbol. The engine oil lubrication path shall pass through a readily replaceable engine oil filter that is readily identifiable, and requires no specialized tools to access or change during maintenance.
- 3.2.3.4.8 Diesel engines with 3 cylinders or more shall draw their fuel from a fuel tank provided as part of the entire flood mitigation pump assembly. For assemblies that do not rely on gravity feed of fuel to the engine, a fuel pump shall be provided. The fuel pickup shall not be at the lowest point within the fuel tank in order to reduce the chances of debris from entering into the combustion chamber. As an additional means of protection, fuel will be passed through a minimum of one filter prior to entering the engine. The fuel level shall be indicated either by mechanical fuel gauge or by electrical fuel gauge in the case of pump assemblies fitted with a control panel.
- 3.2.3.4.9 Diesel engines shall draw their combustion air through a readily replaceable filter media in order to prevent air borne debris from entering the combustion chamber.
- 3.2.3.4.10 Diesel engines with 3 cylinders or more shall be either provided with a muffler to reduce the sound generated, or shall state the requirements for a silencer if supplied by others. The exhaust and muffler shall be guarded to provide protection from operators of the equipment.
- 3.2.3.4.11 Diesel engines shall be designed for use in outdoor environments. Therefore, the electrical connections, air intake, and fuel system shall be designed to operate in dry and rainy environments.
- 3.2.3.4.12 Diesel engines with 3 or more cylinders shall be provided with an engine controller as part of the pump assembly. The engine controller shall provide the operator with the following minimum information and have the following construction features: