RECLAMATION
Managing Water in the West

Design Standards No. 6

Hydraulic and Mechanical Equipment

Chapter 12: Trashracks and Trashrack Cleaning Devices
Phase 4 (Final)

U.S. Department of the Interior
Bureau of Reclamation
December 2016

Mission Statements

The U.S. Department of the Interior protects America's natural resources and heritage, honors our cultures and tribal communities, and supplies the energy to power our future.

The mission of the Bureau of Reclamation is to manage, develop, and protect water and related resources in an environmentally and economically sound manner in the interest of the American public.

Design Standards Signature Sheet

Design Standards No. 6

Hydraulic and Mechanical Equipment

DS-6(12): Phase 4 (Final)
December 2016

Chapter 12: Trashracks and Trashrack Cleaning Devices

Foreword

Purpose

The Bureau of Reclamation (Reclamation) design standards present technical requirements and processes to enable design professionals to prepare design documents and reports necessary to manage, develop, and protect water and related resources in an environmentally and economically sound manner in the interest of the American public. Compliance with these design standards assists in the development and improvement of Reclamation facilities in a way that protects the public's health, safety, and welfare; recognizes needs of all stakeholders; and achieves lasting value and functionality necessary for Reclamation facilities. Responsible designers accomplish this goal through compliance with these design standards and all other applicable technical codes, as well as incorporation of the stakeholders' vision and values, that are then reflected in the constructed facilities.

Application of Design Standards

Reclamation design activities, whether performed by Reclamation or by a non-Reclamation entity, must be performed in accordance with established Reclamation design criteria and standards, and approved national design standards, if applicable. Exceptions to this requirement shall be in accordance with provisions of *Reclamation Manual Policy*, Performing Design and Construction Activities, FAC P03.

In addition to these design standards, designers shall integrate sound engineering judgment, applicable national codes and design standards, site-specific technical considerations, and project-specific considerations to ensure suitable designs are produced that protect the public's investment and safety. Designers shall use the most current edition of national codes and design standards consistent with Reclamation design standards. Reclamation design standards may include exceptions to requirements of national codes and design standards.

Proposed Revisions

Reclamation designers should inform the Technical Service Center (TSC), via Reclamation's Design Standards Website notification procedure, of any recommended updates or changes to Reclamation design standards to meet current and/or improved design practices.

Chapter Signature Sheet
Bureau of Reclamation
Technical Service Center

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Hydraulic and Mechanical Equipment

Chapter 12: Trashracks and Trashrack Cleaning Devices

DS-6(12): Phase 4 (Final)
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Chapter 12 – Trashracks and Trashrack Cleaning Devices is a new chapter within Design Standards No. 6. "Trashracks" was an existing subsection within chapter 1 of Design Standards No. 7 and was revised by adding:

- Updated trashrack design process (last update was 1956)
- Trashrack cleaning devices

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Chapter 12

Trashracks and Trashrack Cleaning Devices

12.1 General

Trashracks are used at powerplant intakes, pumping plant intakes, canal headworks and within canals, at turnouts, and at diversion structures to eliminate the passage of objectionably large floating and submerged debris that would cause damage or operational problems at downstream structures and equipment. Such debris can damage turbines, pumps, valves, gates, screens, etc. Trashracks have also been used as a type of fish barrier for discouraging and/or restricting fish passage.

Trashracks usually consist of rows of parallel trash bars. The usual practice is to provide a clear opening between trash bars that is as large as possible yet consistent with the features and equipment to be protected, to consider hydraulic head loss through the rack only when this loss is important, and to consider the ease of replacement in proportioning the rack so as to build long life into those racks which may not be readily replaced.

In addition to using a trashrack to prevent the passage of objectionably large debris, it may also be necessary to intercept and remove debris so that the flow of water will not be hindered. Therefore, the trashrack cleaning method will need to be determined, and a cleaning device capable of removing the debris from the trashracks may also be required. The cleaning device can vary from a manually operated, hand-held rake to a sophisticated, automated, mechanical cleaning machine. The type of cleaning device selected should depend on the particular needs at the site.

12.2 Trashracks

12.2.1 Types of Trashracks

The details and general construction of trashracks vary with the service required, configuration of the trashrack structure, depth of water, and accessibility for replacement and maintenance. Trashracks are usually constructed of rectangular shaped, vertical bars held together with lateral bars or structural shapes. Although round or streamlined trash bars may reduce hydraulic head loss, they are not commonly used because of the added expense and their tendency to vibrate. Trashracks with round bars and pipes are also more susceptible to clogging because objects can pass partially through the trashrack, then become firmly lodged, making it harder to clean. Trashracks are usually fabricated from structural steel, although they have also been fabricated from fiberglass, plastic, wrought iron, and stainless steel. If very small openings are required, prefabricated grating, perforated plate, and wedge wire screening are often used.

Trashracks may be divided into three types according to construction and installation requirements. These types are end bearing, side bearing, and integral trashracks.

12.2.1.1 End Bearing Trashracks

End bearing trashracks are the simplest (and usually the cheapest) of the three kinds of racks. The trash bars run from top to bottom and individually carry the loads into the trashrack structure. End bearing trashracks are commonly used for canal headworks and where the trashrack panel can extend from top to bottom of the rack-protected area (see figure 12.2.1.1-1). Due to the end bearing characteristics, these trashracks can be installed side by side to obtain the desired area. End bearing trashracks are ideal where low head conditions exist and large trashrack areas are necessary. End bearing trashracks are usually installed in an inclined position; however, they can be used in a vertical or near vertical position if proper care is taken to secure the racks with clips or expansion anchors. In installations where the trash bars are excessively long, it becomes economically advantageous to install one or more support beams laterally to the rack (see figure 12.2.1.1-2). The support beams, which bear and carry the trashrack loads to the sides of the trashrack structure, provide lateral support to the trash bars so that their loaded spans are shorter, thus reducing the size of the trash bars.

Figure 12.2.1.1-1. End bearing trashracks located within a canal. Trashracks were provided with automated trash rake and conveyor debris removal system.

Figure 12.2.1.1-2. End bearing trashracks with horizontal support beams being installed at canal turnout intake.

12.2.1.2 Side Bearing Trashracks

Side bearing trashracks are supported by the trashrack structure on both sides of the rack. The trash bars run from top to bottom and are supported by lateral bars or beams, which carry the loads into each side of the rack. The racks are supported or retained by guides or grooves provided in the trashrack structure. Side bearing trashracks are usually installed in a vertical position, but can be used effectively in an inclined position, and they are occasionally used in the prone position. Side bearing trashracks are used for high or low head conditions, and they are sometimes substituted for end bearing trashracks when the trashrack supporting structure cannot withstand high bearing loads at the top. The major limiting design concern for side bearing trashracks is the span, which is directly related to the economics. Side bearing trashracks may be stacked in tiers to obtain any designed height and may require alignment dowels to allow cleaning. Side bearing trashracks are shown in figures 12.2.1.2-1 and 12.2.1.2-2.

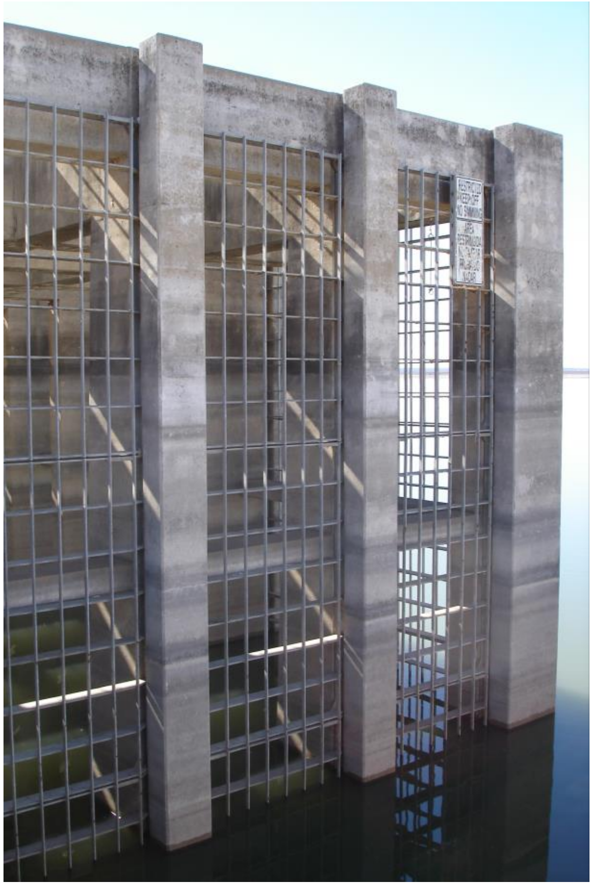

Figure 12.2.1.2-1. Side bearing trashracks at reservoir outlet structure. Note the vertical, stacked trashrack panels installed within the concrete structure grooves (slots).

Figure 12.2.1.2-2. Side bearing trashracks at river side intake. Note the inclined trashrack panels installed within metal trashrack side guides.

12.2.1.3 Integral Trashracks

Integral trashracks are a combination of several panels constructed of trash bars with lateral support beams or members. Integral trashracks can be circular, three sided, or box shaped. They can be designed with a superstructure having trashrack panels inserted into the structure or with reinforced panels welded or bolted together. The support members make up a multisided, rigid frame, which carries the loading into the trashrack supporting structure. Integral trashracks simplify the trashrack structure by eliminating most of the concrete supports that are usually required for trashracks. Integral trashracks are usually used in deeply submerged applications, such as penstocks or multilevel withdrawal outlet systems, and they are typically not intended to be replaced over the life of the structure. Integral trashracks are shown in figures 12.2.1.3-1 and 12.2.1.3-2.

Figure 12.2.1.3-1. Three-sided integral trashracks being reinstalled over dam outlet works.

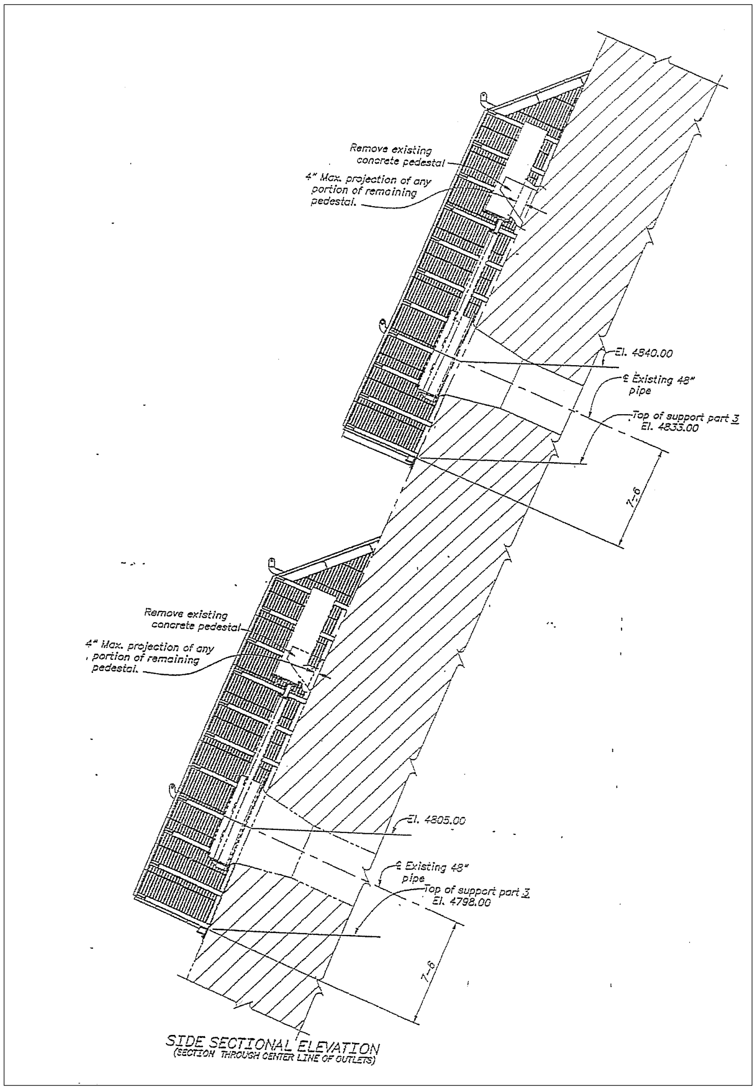

Figure 12.2.1.3-2. Three-sided integral trashracks for dam outlet works.

12.2.2 Selection of Type

The appropriate type of rack for an installation must be suitable for the trashrack structure, for the size and quantity of debris and trash expected, and for the method of cleaning (raking), if needed. In addition, the type of rack selected will depend on its accessibility for maintenance or replacement. The design of the rack, including spacing of the bars, should be discussed with the engineers responsible for the design of the structure and equipment being protected. The need for a trashrack cleaning device should be identified in the Design Data Request because it can affect the designs of the trashracks and the supporting structure. When selecting a type of trashrack, the following trends are common:

(1) At canal headworks and for pumping plants where a single line of laterally spaced rack sections extend from above the water surface to the bottom of the rack-protected area, end bearing trashracks have usually been selected and installed in an inclined position.

(2) Where a portion of the racks is deeply submerged, side bearing trashracks have usually been selected and installed in the vertical position.

(3) At completely submerged intakes, integral type trashracks are well suited.

12.2.3 Design Considerations

The approach velocity (maximum flow divided by the overall trashrack area) for each structure must be determined on a case-by-case basis. Most trashrack structures are sized to provide a maximum approach velocity of 1 to 2 feet per second (ft/s) for normal flows. This slow approach velocity reduces the tendency to collect debris against the racks, minimizes the possibility of trashrack vibration, and provides a relatively safe condition for unauthorized personnel such as boaters or swimmers. Trashracks with low velocities are easier to clean, and debris is not prone to lodge between the trash bars. Hydraulic head loss through trashracks can be effectively reduced by minimizing the approach velocity. Trashracks designed with low velocities generally do not have destructive vibration problems and can be designed without taking into account the individual trash bar and trashrack panel vibration. According to tests and field observations, velocities are not always uniform through the trashrack area. Consideration should always be given to a trashrack structure’s location, size, and the sites flow patterns to help design the best flow distribution across the trashracks.

The trashrack area necessary to achieve a 1- to 2-ft/s approach velocity is desirable but not always practical. Higher approach velocities have been used to size the trashrack area in order to limit the physical size of the structure and, thus, decrease the capital cost. Tests on trashracks reveal nonuniform velocities will occur over the trashrack area. Localized velocities can be as much as twice the average velocity, depending on the geometry of the trashrack structure. In addition, at intakes with more than one opening per unit, the flow of water is not uniformly distributed between the openings. With two openings per unit, the trashrack design should allow two-thirds of the water to flow through one of the two openings. With three openings per unit, trashrack design should allow 45 percent of the water to flow through one of the three openings. At higher approach velocities (typically greater than 5 ft/s), vibration can be a problem.

Many factors must be considered when deciding how large to design an approach velocity, such as:

- Economics
- Safety considerations
- Preservation of fish
- Location of the trashrack structure within the system
- Amount of expected debris
- Submerged conditions
- Age of the structure; for example, a new structure would probably have more debris than an old structure
- Type of usage; for example, a canal outlet versus a river intake structure
- Intake hydraulics and eddy currents
- Types and expected quantity of debris and sediment that the water may be carrying
- Whether the trashracks will be cleaned and, if so, what cleaning method will be used?

If a trashrack is to be raked, special consideration must be made. Different raking methods require different slopes for the trashrack. Generally, hand raked trashracks are designed with a slope that is as flat (horizontal) as possible (typically 45 degrees or flatter) and an approach velocity of 1 ft/s. Trashracks that will be raked mechanically should typically have a slope angle between 5 to 30 degrees from the vertical and an approach velocity of 2 ft/s; however, some rakes can also clean vertical trashracks. Trashrack panels that will be raked and are stacked in tiers (usually side bearing type trashracks) must be kept in alignment, usually by providing large dowel pins between the panels. Lateral members of the trashrack should also be recessed a minimum of 1.50 inches from the face of the trash bars, if possible, to prevent interference with the teeth of the cleaning device. A trashrack extension or an increased length of the trashrack trash bars may also be required if the cleaning device needs to rake the debris into a debris conveyance system located above the deck.

Trashracks are not usually designed to be escape devices or safety features, but they can perform that function at times. Whenever a trashrack is intended primarily as a safety (escape) rack to protect humans or animals from being drawn into the structure, siphon, or conduit, the following aspects shall be considered: (1) approach velocity should be less than 2 ft/s with a minimal current force; (2) trashrack slope of 4:1 (horizontal to vertical ratio) or flatter (6:1 preferred); and (3) the spacing of the lateral (cross bars) supports should be spaced at 15 to

18 inches to facilitate climbing for escape. The maximum spacing between the trash bars should not be greater than 8 inches; however, the spacing must be large enough to enable a hand to reach between the trash bars to grab the cross bars. Flattening the slope of the trashrack and providing sufficient cross bars to facilitate climbing for escape are modifications that could make the safety rack an escape device. Safety racks will require additional maintenance, so they should only be used where maintenance problems associated with debris are not severe.

12.2.4 Trash Bar Spacing

The spacing of the trashrack's individual trash bars should be selected to suit the equipment being protected. The usual practice is to provide a clear opening that is as large as possible, while still protecting the downstream equipment. Closer spacing of trash bars than needed will result in unnecessary hydraulic head loss and will cause premature clogging of the racks.

Clear openings of 1.5 to 2 inches are commonly used for canal applications and where the trashracks are upstream of traveling water screens and fish screens. The largest spacing of trash bars is normally 6 inches. The lateral supports are typically spaced between 18 and 30 inches.

For a Francis, Kaplan, or propeller turbine, the spacing has to be smaller than the minimum opening in the turbine runner or maximum opening of the wicket gates, whichever is smaller. For a Pelton turbine, a minimum spacing of 1.5 inches is usually used because debris cannot readily pass through the needle valve nozzles.

Clear openings greater than 6 inches may be required by the responsible fish resource management and regulatory agencies at some installations to allow for passage of large fish (i.e., adult salmon at a fish ladder).

Clear openings less than or equal to 1 inch have also been used to discourage fish passage. Note: Trashracks are not intended to be used as fish screens; therefore, it is necessary to check the appropriate criteria of the responsible fish resource management and regulatory agencies because these small openings may still not meet their criteria for the size and fish species at the site. The small openings may also result in excessive debris buildup, loadings, and cleaning requirements.

12.2.5 Design Loads

To design a trashrack, the working design loads must first be determined. Trashracks must be designed to support forces applied by the raking and cleaning equipment, debris, and ice. Stresses should always include the dry dead weight of the trashracks. Knowing the loads, the working stresses can be determined and compared with acceptable allowables.

Totally submerged trashracks and trashracks that are submerged more than 20 feet of head should be designed to fail at approximately 20 feet of differential head; assuming that the trashrack structure is designed to withstand greater than 20 feet of differential head.

Trashracks submerged 20 feet or less are usually designed to fail at a differential head that is at least two-thirds of the maximum depth of submergence (based on the depth at the bottom of the trashrack). If, however, these racks are intended to serve as supports for flashboards, they should be designed for a safe stress under maximum load conditions.

All trashracks that are installed must be designed to yield before any damage is sustained to the support structure if they ever become totally obstructed.

Trashracks can be designed for a lower differential head (typically designed with a safe stress at a 5-foot differential head) if the trashracks will be equipped with an automatic trash cleaning system and/or water differential sensors that will inform the operators that the trashracks require cleaning.

Care should be taken to avoid heavy loadings from trashracks near or on the exposed edges of concrete structures. The normal practice is to connect the horizontal beam members on the side bearing trashracks to an angle which will disperse and carry the concentrated load farther back into the guided slot of the concrete support structure.

In locations where freezing is a problem, trashracks must take into account the loads resulting from ice. Ice loading can induce much greater loads than would be expected from other trash loadings. In addition to designing for high load stresses, the trashracks should be properly secured to prevent floating ice from lifting the trashrack from the supporting structure. Where ice loading has been an identified problem, trashracks have typically been designed to withstand 20 feet of differential head (or designed for the safe stress at the maximum/plugged load condition), and the thickness of the individual trash bars has been not less than 3/4 inch.

For many structures, it is easier to prevent ice buildup against the trashracks than to design for the loadings that result from ice that accumulates on them. In some situations, air blast or bubbler systems are used to draw and circulate warmer waters from below the surface (depths for bubbler systems to work properly require at least 10 feet of water depth) to prevent ice formation in the trashrack area. Occasionally, heaters are used inside of hollow trash bars, near the trashracks, or at the guides to allow removal of trashrack panels. In some cases, the right design will provide good flow patterns that will discourage freezing around the trashrack. Lower approach velocities may allow formation of ice cover and, thus, reduce frazil ice formation. In addition, periodically vibrating trashracks with an exterior exciter has been used to control formation of frazil ice on the trash bars. Also, certain materials or coatings on metal trash bars are able to discourage the formation of frazil ice or allow operation at a lower water temperature before ice forms. Designing discontinuities into the metal trash bars to prevent cold air temperatures from penetrating deep into the water has been partially successful for controlling ice formations. The discontinuity is either a physical gap of several inches in each trash bar or a material along the trash bar that has poor heat transfer properties. Either of these methods prevents colder temperatures from being transferred to the lower portions of the trash bars from the colder surface of the water or exposed surfaces of the trash bars. In some cases, depending on operating conditions, and where shallow depths make a bubbler system ineffective, the solution for ice problems may be to simply remove the trashracks during extreme cold weather.

12.2.6 Design Stresses and Codes

Metal trashracks can be designed, detailed, and fabricated according to the standards set by the American Institute of Steel Construction (AISC) Steel Construction Manual.

12.2.7 Design for Nonvibrating Loads

Typically, most trashracks are designed to fail before failure of the structure occurs. The stresses should always include the dead weight (dry) of the trashrack. A member of a trashrack is assumed to fail when the stress in the member reaches the following value:

$$SF = 1.10FY \tag{1}$$

where:
SF = failure stress
FY = minimum yield stress of material

For end bearing trashracks, the trash bars are usually designed to fail if the rack becomes overloaded. For side bearing trashracks, the lateral support beams or their connections to the structure are usually designed to fail if the rack becomes overloaded.

Similarly, a trashrack's safe working stress should not exceed the following value:

$$SS = 0.6FY \tag{2}$$

where:
SS = safe working stress
FY = minimum yield stress of material

Trashrack trash bar sections should be rectangular. The depth of a trash bar section should be at least 4 times, but less than 12 times, its thickness. The trash bar section depth to thickness is called the aspect ratio (i.e., trash bar 2 x ½ has an aspect ratio 2/0.5 = 4). The lateral unsupported length of a trash bar should not exceed 70 times its thickness. Lateral supports are normally spaced between 18 and 30 inches.

For many structures, the designer must consider more parameters than simply the design loads and allowable stresses when sizing members of a trashrack. It is also necessary to consider things like corrosion, ease of fabrication and welding, economics, stresses due to handling, operation, likelihood of obtaining maximum design loads, etc.

12.2.8 Design for Vibrating Loads

Trashracks used in pump-generating intake/discharge structures usually experience higher velocities than 2 ft/s. In the past, individual trash bars or whole trashrack panels in the inlet and discharge of pump-turbines have experienced failures. These failures were largely attributed to vibration resulting from the dynamic interaction between nonuniform, high-velocity water flowing through the trashracks. The trashracks at some of these pump-generating intake/discharge structures experienced localized velocities as large as 15 to 20 ft/s. The load stresses were normally low, but the racks had to be analyzed for vibration and designed for fatigue loading.

As a general rule, trashracks with approach velocities greater than 5 ft/s should be analyzed for vibration. Followup field testing and inspections may also be required.

It has been discovered that round trashrack bars should not be used because they are subject to vortex shedding, which can lead to failure of the bar. It is recommended that trash bars be rectangular bars with an aspect ratio of at least 4, which provides a stable cross sectional area in the flowing water.

Vibration is usually not a concern when designing canal trashracks, due to the low approach velocity. If a problem is suspected, a vibration analysis must be performed on a case-by-case basis.

12.2.9 Corrosion Protection

Corrosion is a major design concern for trashracks. The thickness of metal to be used in trashracks depends, to some extent, on the nature and probable permanence of the rack installation. The design of trashracks should allow for some deterioration, due to corrosion, without sacrificing structural integrity. The typical minimum thickness of low head, removable type trashracks is 3/8 inch.

It is customary to use a 1/2-inch minimum thickness on deeply submerged racks. When it is practical, the recommended minimum trash bar size used in trashrack design is 2 inches by 1/2 inch.

Welds are very vulnerable to corrosion. When determining weld size, it should be recognized that the allowance for corrosion of the weld is of equal importance as the strength of the weld. Welds that are highly stressed or in pure shear are usually oversized by 1/16 inch for corrosion. The recommended minimum size of the fillet weld should be the same size as the thickness of the metal in the trashrack, or 3/8 inch, whichever is less. It is also recommended that the horizontal beam members in side bearing rack sections have 1/2-inch welds at their end connections.

It is recommended that trashracks be painted with a protective coating. Current practice, based on past performance, has been not to recoat trashracks after initial installation (i.e., economic analysis has shown that replacing the structurally weakened racks is more cost effective than periodically repainting them). On some installations, cathodic protection systems have been considered for protecting the racks; however, at this time, only a few systems have been installed. When selecting a protective coating type for trashracks, it may be necessary to consider whether marine growth, such as zebra and/or quagga mussels, exists in the area. Under normal water conditions, galvanizing the trashrack is not an acceptable method of protection. During shipping and installation, care should be taken not to damage the protective coating. If the coating does get scratched or chipped, it should be properly repaired. If a rack has to slide a considerable distance on a concrete surface during installation, a wearing bar should be considered to protect the coating.

12.3 Trashrack Cleaning

12.3.1 General

Many trashracks, especially deeply submerged trashracks in reservoirs, never require cleaning. The debris deteriorates or never accumulates. Some type of cleaning method is required, however, for trashracks if a debris problem exists that could cause an overload of the trashrack or associated structure, an undesirable head loss, or a reduction in the water delivery capability. The details and type of cleaning method will vary according to the service required, configuration of the trashrack and structure, depth of water, debris types, debris quantity, availability of power, and economics. The need for a trashrack cleaning device should be identified in the Design Data Request because it can also affect the designs of the trashracks and supporting structure.

Although debris booms are not covered in this section, they are often provided upstream of trashrack intakes and headworks for public safety, as well as to collect or divert large floating debris before it can reach the trashracks or gates.

12.3.2 Debris

Debris can be placed into the following two categories:

- Natural debris: tree trunks, branches, bushes, grasses, plants, weeds, aquatic plant growth (floating and submerged), etc.
- Manmade debris (trash): tires, plastics, cans, bottles, lumber, etc.

Natural debris is the most common debris trashracks are required to catch. Natural debris is most prevalent during flood conditions for reservoir intakes and on river intakes (i.e., pumping plant, powerplant, and canal intakes). Aquatic plant growth and tumbleweeds are the most prevalent problem in canals. Manmade debris, although not as common as natural debris, can still be a problem that requires protection at the intake.

Other natural considerations include ice, sediment, and rocks, which can create a problem in large quantities if not controlled. Marine growth has also become more prevalent in waterways. Marine life, such as zebra and quagga mussels, multiply and attach to water structures, which can block water intakes and trashracks.

12.3.3 Methods and Types of Trashrack Cleaning Devices

There are three general methods of cleaning trashracks: (1) sluicing, (2) air burst, and (3) raking. Raking is the most common method for cleaning trashracks; however, raking devices typically cannot operate during winter ice conditions.

12.3.3.1 Sluicing

Sluicing gates that open and allow collected debris (typically from a debris boom) to pass by the trashracks can be very effective in canals and diversion dams. This method can only be used where it is appropriate and lawful. Sluicing gates are also often used for passing ice and sediment.

12.3.3.2 Air Burst

For some submerged trashracks, an air burst cleaning method has proven effective for certain situations. Generally, a crossflow is required so that when air lifts the debris off of the trashrack face, the current will sweep the debris away. Prior to operating the air burst systems, it may be necessary to shut down the intake flow through the trashracks to prevent air from being drawn into the intake. The air burst can be hazardous to boaters and swimmers, so special precautions should be taken.

12.3.3.3 Raking

There are two general categories of trashrack raking devices: manual and mechanical. Manual raking is often used for small trashrack structures and for trashracks that collect very little debris. Large structures and trashracks that accumulate a large amount of debris usually require some type of mechanical cleaning device.

12.3.3.3.1 Manual Raking

The most common type of manual cleaning device for trashracks is the hand-held rake, which consists of a rake head (similar to a garden rake) connected to a long pole. Manual raking requires a person to physically lower and position the rake against the trashrack, drag the rake and debris to the top of the rack, and then pull the debris over the rack onto the deck or into a debris bin. Other variations of this basic concept include squeegee-type rake heads, in lieu of teeth, or portable pool-type vacuum cleaners. The squeegee-type rake has been used successfully at canal turnouts where debris can be pushed off a perforated plate type of trashrack to continue downstream in the canal.

12.3.3.3.2 Mechanical Raking

Mechanical cleaning devices are commercially available. Some common types of mechanical cleaning devices include hydraulic-type trash rakes, overhead monorail-type trash rakes with hoist and controlled gripper claw, backhoe-type rakes, and trashrack cleaners built integral to or over each trashrack bay.

Several factors must be taken into account when selecting the appropriate type of mechanical cleaning device. For example, can a single cleaning unit be used to clean multiple trashrack bays or a wide trashrack bay, or will multiple cleaning units be required? Can the cleaning unit(s) supply the desired control functions? Will a separate debris conveyance system be required? Will the trashracks, or a separate extension rack, need to extend above the deck to allow debris to be deposited into a debris conveyance system. Additional considerations may also apply, depending on site-specific circumstances.

Mechanical rakes are often automated to begin a trashrack cleaning cycle when head losses across the racks become excessive, when a predetermined differential head has been exceeded, and/or when a specified time interval has been reached. Many systems use both timers and differential water level sensors to start the cleaning cycle.

When selecting a trash rake, operational considerations must be made and/or restrictions applied if cleaning is required during winter/icing conditions. Special designs may also be required if flows approaching the trashracks are not perpendicular to the rack (i.e., crossflows), or approach velocities are greater than 4 feet per second.

12.4 Checklist for Trashracks and Cleaning Devices

12.4.1 Trashracks

1. Has the debris/trash load been determined?
2. Have the types, sizes, and quantities of debris been identified?
3. What trash bar spacing is required?
4. Will the trashrack support structure carry the loaded trashrack?
5. What approach velocity to the trashracks is being used, and is this acceptable?
6. What corrosion factor should the trashrack be designed to?
7. What forcing vibrations from the rotating machinery can be transmitted through the water to the trashrack?
8. What forcing vibrations from equipment in the powerhouse can be transmitted through the support structure to the trashrack?
9. Will trash bar vibration occur at the average velocity or local higher velocities through the trashrack?
10. Will trashrack cleaning be required?
11. Will ice loading or ice prevention be required?

12.4.2 Trashrack Cleaning Devices

1. What type of trashrack cleaning device is needed?
2. Is electrical power available at the site, and what voltages are available?
3. Should the cleaning device be automatically or manually operated?
4. Does the trash have to be conveyed automatically away from the area, or will it be stockpiled and then carried away manually?

5. Is there room for a debris conveyance system with the trash rake, or will the trash rake system need to transport the debris to the dumping area?

6. Are the trashracks to be cleaned (either new or existing) designed to accommodate cleaning by the trash rake? To determine the answer, a number of questions must be considered, such as the following: Are the trash bars aligned if stacked trashrack panels are used? Are the lateral support members sufficiently recessed for the trash rake teeth? Are the trash bar openings large enough to rake? Are the trash bar spacings consistent to accommodate the trash rake teeth? What is the slope of the trashracks? Are the trashracks accessible for cleaning by the trash rake? What is the approach velocity?

7. Will operational considerations and/or restrictions be required during winter/icing conditions and is this acceptable?

8. Will high approach velocities and/or crossflows be present at the trashracks that would require special designs for the trash rake?