11331 - RECIPROCATING RAKE BAR SCREENS

City of San Diego, CWP Guidelines

PART 1 -- GENERAL

1.1 WORK OF THIS SECTION

A. The WORK of this Section includes providing mechanically cleaned bar screens for collection and removal of coarse solids from municipal wastewater. The equipment furnished under this Section shall be front cleaned by a single articulated rake arm. Designs employing multiple rakes and designs which have chains, sprockets, bearings, shafting or other moving parts permanently below the channel water surface at maximum design flow are explicitly excluded under this Specification.

B. The WORK also requires that one manufacturer accept responsibility for furnishing the WORK as indicated but without altering or modifying the CONTRACTOR'S responsibilities under the Contract Documents.

C. The WORK additionally requires that the one manufacturer who accepts the indicated responsibilities shall manufacture the bar screen.

D. The WORK also includes coordination of design, assembly, testing, and installation.

1.2 RELATED SECTIONS

A. The WORK of the following Sections applies to the WORK of this Section. Other Sections of the Specifications, not referenced below, shall also apply to the extent required for proper performance of this WORK.

1. Section 11000 Equipment General Provisions

1.3 CODES

A. The WORK of this Section shall comply with the current editions of the following codes as adopted by the City of San Diego Municipal Code:

1. Uniform Building Code
2. Uniform Mechanical Code
3. Uniform Plumbing Code
4. Uniform Fire Code
5. National Electrical Code

1.4 SPECIFICATIONS AND STANDARDS

A. Except as otherwise indicated, the current editions of the following apply to the WORK of this Section:

1. AISI 1018 Standard Carbon Steel Compositions

2.	AISI 1145	Re-Sulfurized Steel (Free-Machining)
3.	ASTM A 36	Specification for Structural Steel
4.	ASTM A 320	Specification for Alloys - Steel Bolting Materials for Low Temperature Service
5.	NEMA 250	Enclosures for Electrical Equipment

1.5 SHOP DRAWINGS AND SAMPLES

A. The following shall be submitted in compliance with Section 01300:

1. Drawings and descriptive information in sufficient detail to show the kind, size, weight, arrangements, operation, component materials and devices; external connections, anchorages, and supports required; performance characteristics; dimensions needed for installation and correlation with the belt conveyor.

2. Electrical data including control wiring.

3. Seismic calculations performed by a registered civil engineer in the State of California.

4. Information on at least one successfully performing installation of comparable size and complexity constructed in the recent past including contact name, addresss, and telephone number.

1.6 OWNER'S MANUAL

A. The following shall be included in the OWNER'S MANUAL in compliance with Section 01300:

1. The manufacturer shall provide a written report stating the screens have been properly installed and tested and each is ready for full-time operation.

2. Complete assembly and maintenance instructions including diagrams, drawings and parts list.

1.7 REGULATORY REQUIREMENTS

A. Equipment furnished under this Section shall be designed and selected for installation in areas designated in Section 16050. The equipment will be subjected to frequent hose down for cleaning purposes.

1.8 SERVICES OF MANUFACTURER

A. **Inspection, Startup, and Field Adjustment**: An authorized representative of the manufacturer shall visit the site for not less than [ ] day to furnish the indicated services.

B. **Instruction of OWNER'S Personnel**: The authorized service representative shall also furnish the indicated services for instruction of the OWNER'S personnel in the operation and maintenance of

the equipment including step-by-step troubleshooting procedures with necessary test equipment for not less than [one] day.

1.9 FIELD TESTING

A. **Testing**: Products shall be field-tested for compliance with the indicated requirements.

1.10 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. **Delivery of Materials**: Products shall be delivered in original, unbroken packages, containers, or bundles bearing the name of the manufacturer.

B. **Storage**: Products shall be carefully stored in a manner that will prevent damage and in an area that is protected from the elements.

1.11 QUALIFICATIONS

$# _____

NTS: In the paragraph below, define the terms "comparable size and complexity" for the equipment or system specified. Requiring experience of more than one successful project requires sound justification and prior written approval from the City Project Manager.

_____ #$

A. **Manufacturer**: Company specializing in reciprocating rake bar screens with a minimum of one successfully performing installation of comparable size and complexity constructed in the recent past. Screens of comparable size and complexity shall have the following characteristics: [ ]

PART 2 -- PRODUCTS

2.1 EQUIPMENT IDENTIFICATION

A. **Equipment Name**: Reciprocating rake bar screen(s).

B. **Identification Number**: [ ] through [ ].

C. **Number of Units**: [ ].

D. **Location**: [ ].

2.2 DESIGN CONDITIONS

A. **General**: Equipment furnished under this Section shall be suitable for operation in wastewater from a sanitary sewer system containing domestic and industrial wastes. The wastewater may be expected to contain gross waste solids, vegetable parts, small sections of lumber, rocks, sand, silt,

petroleum products, industrial solvents, and animal fats and oils. The wastewater will have a temperature of [55] degrees F to [80] degrees F and will have a pH which may range from [6 to 8].

B. **Design Requirements**: The following shall apply to each bar screen furnished under this Specification:

1.	Peak capacity, mgd	-	[ ]
2.	Normal peak flow, mgd	-	[ ]
3.	Average flow, mgd	-	[ ]
4.	Minimum flow, mgd	-	[ ]
5.	Channel width, feet	-	[ ]
6.	Channel depth, feet	-	[ ]
7.	Max. upstream water depth, feet	-	[ ]
8.	Min. motor horsepower, hp	-	[ ]
9.	Bar rack openings, inches	-	[3/4]
10.	Bar size, inches	-	[1/2] x [3]
11.	Max. screen height, feet (above operating floor level)	-	[ ]

C. **Operation**: The bar rack shall be cleaned by a cogwheel drive rake arm assembly which shall function in the following manner: The rake arm shall be held in front, away from the bar rack as it traverses into the channel to begin raking motion. When the rake arm approaches the channel invert, it shall mesh with the bar rack and travel up the rack cleaning and collecting trapped material. The rake arm shall transport the material up out of the sewage flow, across a deadplate and discharge to a flat belt conveyor. Reversing of the drive motor during normal operating, shear pins for overload protection, and hydraulic cylinders are explicitly excluded under this Section. Designs which employ the use of cables, wire rope, or chain-driven rake assemblies shall not be allowed.

D. **Access**: The bar rack must be completely accessible for manual cleaning in the event of power outage or other emergency shut down of the mechanical rake. To allow for manual cleaning, there shall not be any mechanical cross-channel obstructions (such as support beams, shafts, etc.)

2.3 MATERIALS

Bars	ASTM A 320, Type 304 stainless steel
Apron	ASTM A 320, Type 304 stainless steel
Rake arm	ASTM A 320, Type 304 stainless steel
Fasteners and hinges	ASTM A 320, Type 316 stainless steel
Side frame	ASTM A 36 steel, 3/8-inch thick minimum
Pins	Hardened and ground AISI 1018 with 475 Brinell minimum hardness

Cogwheels	AISI 1145 steel, tooth bearing surface to be flame hardened to 475 Brinell minimum, depth 0.04 to 0.06 in.
Shafting	Finished steel
Wiper	2 inches x 2 inches x 1/4 inches structural tubing with Type 304 stainless steel plate
Safety Guard	3/4-inch, 16 ga, expanded metal screen of Type 304 stainless steel
Connecting arms	ASTM A 36 galvanized steel

2.4 CONSTRUCTION

A. **General**: The bar rack shall be inclined 80 degrees from horizontal and shall withstand, without deflection, damage or distortion, the loads imposed by an at least 5-foot water differential between the upstream and downstream side of the bar rack at maximum water depth in the downstream channel. The only obstructions in the channel shall be the bar rack and rake arm. All structural supports and fasteners, except bar rack supports, shall be above the maximum water level to avoid interference with flow.

B. **Bar Rack and Apron**: The bar rack shall consist of stainless steel bars, as indicated, formed straight and true and held firmly and accurately in place with openings by means of welded spacers at each end. The bar rack shall be firmly anchored to the channel floor and extend to the operating floor. A 10-gauge Type 304 stainless steel apron shall be provided from the floor level to the discharge lip.

C. **Side Frames**: The side frames shall be securely fastened to the channel walls to provide an unobstructed path for the rack cleaning mechanism. The side frame shall be constructed of steel plate suitably reinforced to support the required loads. The frame shall be spliced to facilitate installation. The side frame width shall be 34 inches minimum. Backbracing is specifically excluded.

D. **Base Frame**: The base frame is to fit in an opening of the size indicated to be flush with the operating door. No additional supports spanning across the channel are allowed, except that a member is to be provided to support the checkered plate with a configuration as indicated.

E. **Anchor Bolts**: The anchor bolts shall be designed by the manufacturer in accordance with Sections 05500 and 11000. Anchor bolts are to meet minimum requirements as indicated. Anchor bolts and base details are to be compatible with the configuration indicated or the CONTRACTOR shall redesign and submit calculations at no additional cost to the OWNER.

F. **Raking System**:

1. General: Reciprocating rake bar screens shall employ a cogwheel and pin rack to power the rake arm. The motor and drive unit shall be mounted on the cogwheel shaft and shall move up and down the pin rack with the rake arm. All appurtenances associated with the raking system, except the gear reducer, shall be designed for not less than one hundred and fifty (150) percent of the motor's full load. The mechanism shall be capable of being reversed completely out of the channel to allow for unobstructed manual removal of screenings. The rake shall be parked outside the channel during normal intermittent operation. The rake shall have a removal capacity of [200] lbs/ft of rake width per cycle not including the weight of the rake mechanism.

2. Rake Arm Assembly: The rake arm assembly shall include guide rollers, cogwheels, rake arm spring and drive components (including motor). The entire system shall move up, around and down a set of pin racks mounted in each side frame. The debris shall be removed from the bar rack by the rake arm. The rake arm shall consist of two structural members and a shaped perforated plate cleaning rake with teeth designed to mesh with the bar rack. The teeth shall penetrate the bar rack a minimum of 1/2 the bar rack depth. The rake arm shall be supported by the main drive shaft which in turn shall be attached to two cogwheels which shall rotate on and be supported by the pin rack. The rake arms shall be held against the bar rack by a set of Bellville springs and shall be kept in proper alignment by guide rollers which shall travel in channel-type tracks attached to the side frame.

   Cleaning rakes shall be of reinforced steel plate and shall have teeth suitably shaped to effectively clear the top and side of the bars. The rake shelf shall be not less than 11 inches deep and shall be from 3/8-inch Type 304 stainless steel plate section.

   To meet mandatory requirements for rugged heavy duty design and positive overload response under all conditions, the rake carriage assembly must incorporate the following features:

   a. The follower rollers shall travel in guide roller tracks that are completely separate from the tracks used to guide the cogwheel rollers. All tracks must be formed of welded angle; use of any part of the side frame flange as a track surface is unacceptable.

   b. Positive lubrication reservoirs must be installed for all roller bearings.

   c. The follower roller shaft must be supported by a minimum of two tubular steel supports. Each support shall lie in the same vertical plane as the rake arms.

   d. Each rake arm is to be connected to both the gear motor drive shaft housing and the follower roller shaft support. Each connection will use two connecting arms designed to allow pivoting at each end of the connecting arm (double pivoting connection). This linkage between the rake arms and the rake carriage shall be designed to allow rake rotation away from obstructions encountered, up to 10 inches in depth, during forward travel either down into or up out of the channel. This rake rotation in the upward direction is to be initiated by the rotation of the drive shaft housing and motor support in response to an overload condition. Rigid or fixed connections between the rake arms and rake carriage are specifically excluded.

   e. The points of connection between the follower roller shaft supports and the rake arms must be at least 30 percent of the rake arm length below the drive shaft.

      The structural member which connects the cleaning rake to the main drive shaft shall be designed to handle all anticipated loads utilizing a factor of safety of 5. The mechanism shall be so designed that the rake can climb over and be free of an object encountered that cannot be removed. This motion shall be powered by the rotation of the drive to swing the rake away from the bar rack. Designs which rely on the upward travel of the rake drive to pull the rake over obstructions are not allowed. After the object has been bypassed, the rake shall again mesh with and continue to clean the bar rack. Positive overload protection against an object which is too large to be bypassed shall be provided by mounting the drive on a spring restrained motor support. If the load

on the rake carriage mechanism increases beyond a predetermined value, the motor shall impart a torque to the rake arm to force the arm, driver and linkage to rotate away from the bar rack, causing a proximity limit switch to stop the motor. The motor will then automatically reverse and the rake assembly shall be designed to be reversed by manually operated electrical control, to free the mechanism of the object which has caused the overload. The mechanism shall be capable of being reversed completely out of the channel and parked at the top of the machine to allow for unobstructed removal of the object by other means. When the overload condition has been corrected, the drive may again be operated by manual activation. Designs employing the use of shear pins for overload protection are not acceptable. The mechanism shall be so designed that the rake can pivot out of the way (upstream) of an object which is encountered on its own downward travel.

3. Rake Arm Drive: The rake arm shall be driven by two (2) cogwheels and a pin rack system in each side frame. The system shall withstand all loads and stresses to which it is subjected during operation. There shall always be a minimum of two teeth of each cogwheel in contact with the rollers at all times. The cogwheels shall be stress relieved before machining and shall be firmly keyed to the rake arm drive shaft.

   The pin rack shall consist of Type 316 stainless steel bolts fitted with hardened and ground AISI 1018 steel bushings and rollers with 475 Brinell minimum hardness.

4. Drive Unit and Motor: The motor shall drive the cogwheels through a hollow shaft worm reduction gear directly mounted to the cogwheel shaft. To provide overload protection and prevent motor damage, thermistors shall be placed in the motor windings. The drive system shall provide a lineal rake arm velocity of 20 fpm.

G. **Shafting**: All shafting shall be straight, true and of sufficient section to transmit the power required. Keyways with fitted keys shall be provided at sprocket or cogwheel connections.

H. **Wiper**: The rake shall be guided 4 inches over the discharge point and the accumulated debris shall be removed by the wiper. The wiper shall be designed to pivot to allow efficient cleaning of the rake on each pass, and it shall be cushioned during travel to the rest position by two self-contained shock absorbers. The wiper assembly shall be fabricated of Type 304 stainless steel plate welded to structural tubing for pivot arms. The wiper shall be so designed that the screenings cannot wrap around the rake on the wiper during the process of screenings removal. Counter-weighted wiper assemblies, and designs in which the rake does not swing out over the discharge chute apex a minimum of 4 inches, are not acceptable.

I. **Electrical**:

1. Electrical power to the screen drive motor shall be provided by a suitably mounted electrical cable. The electrical power cable shall be protected by a rectangular cable track, flexible in one direction, consisting of a series of interconnected links of corrosion resistant material. The cable track components shall be designed for durability, repetitive articulation, and smooth, non-abrasive support and protection for the electric cable. The cable track shall be installed in an aluminum guide trough mounted to the side frame of the bar screen.

2. The manufacturer of the bar screen shall provide the following limit switches for each unit:

a. End of travel limit switch.
b. Reverse motion limit switch.
c. Torque overload limit switch.

All switches to be SPDT and rated not less than 10 amps at 120 volts AC. Limit switches and all other electrical devices shall have enclosures with NEMA ratings in accordance with the area designations of Section 16040. Limit switches shall be totally enclosed magnetic proximity switches.

3. Limit switches are to be provided only to terminate operation of the cleaning cycle in order to "park" the rake carriage, or to prevent damage from occurring to the mechanism. Designs which rely upon limit switches, proximity switches, or limit stops in order to reverse the direction of rake travel are not acceptable.

J. **Safety Guard**: An expanded metal Type 304 stainless steel safety guard, 6'-6" high, shall be provided to enclose the three open sides of the screen channel and all rotating equipment. The guard shall be readily removable for maintenance and repair, suitably reinforced to prevent damage to the guard during removal and replacement, and designed to prevent interference with the operation of the bar screen.

K. **Controls**:

1. General: Each bar screen shall be provided with a local control panel designed by the manufacturer. All controls and electrical components shall be suitable for a Class I, Division I, Group D environment. The control panels shall be provided with enclosures with NEMA ratings in accordance with the area designations of Section 16050. The CONTRACTOR shall coordinate all control power.

2. Operating Modes: Each bar screen control panel shall be provided with HAND-OFF-AUTO and REVERSE-FORWARD controls. In automatic mode, the bar screen shall be activated by timer control with a high differential level override. High differential level switches shall be located on the bubbler panels.

3. Control Stations: Each control station shall be provided with REMOTE-LOCAL and REVERSE-OFF-FORWARD switches. REVERSE-OFF-FORWARD switch shall be lockable in the OFF position. Setting the REMOTE-LOCAL switch to the LOCAL position shall override all start controls from the control panel.

4. Timer and Lead Loss Differential Control: Each mechanically cleaned bar screen shall be provided with a time controller designed for variations in operation over a 24-hour period, adjustable to 5-minute increments. When in the automatic control mode, a differential controller shall override the timer controller to initiate operation of the bar screen.

5. Alarms and Status Lights: Each bar screen shall be provided with local indicating lights for alarm and status. Status lights shall be provided to indicate run and ready conditions. Alarm lights and an alarm buzzer shall be provided to indicate the following conditions:

Rake arm stall/overtorque
Motor high temperature

High channel water level

A status output and common trouble alarm output shall be provided for remote indication and alarm. A dry set of contacts shall be provided for each output and wired to a labeled terminal within each control panel. The trouble alarm contacts shall open when any alarm condition occurs and shall close after all alarm conditions have passed and manual alarm reset button has been depressed. Manual alarm reset buttons as well as alarm buzzers shall be surface mounted on each local control panel. Status signal contacts shall close during the run cycle, maintain closure during the entire run cycle, and open after the cycle is complete and the drive mechanism is in its normal parked position.

2.5 SPRAY SYSTEM

A. Two spray systems complete with solenoid valves shall be provided for each reciprocating rake bar screen. A screenings washing spray system shall be provided to wash the screenings as the rake travels up the dead plate and shall consist of spray nozzles with header mounted on the rake arm. The sprays shall be directed downward to the rake and deadplate and within the side frame while minimizing spray carryover or splashing. A discharge chute spray system shall be provided to flush the screenings down the discharge chute and onto the conveyor belt. The discharge chute spray system shall consist of one or more flat-spray type stainless steel nozzles with headers which are directed at and will provide full-width spray coverage of the discharge chute while minimizing splashing and carryover at a maximum spraying rate of 10 gpm per chute. The CONTRACTOR shall provide utility water piping as indicated with strainers, manual valves and solenoid valves for each spray system.

2.6 SPARE PARTS

A. The WORK includes the following spare parts for each unit:

1. 1 set of all bearings
2. 2 sets of cogwheels
3. 1 set of rollers and bushings for 10 feet of pin rack
4. 2 sets of limit switches
5. 1 wiper blade
6. 1 set of all spray nozzles
7. 1 set of solenoid valves

2.7 MANUFACTURERS

A. Bar screens shall be manufactured by the following, or equal:

1. Infilco Degremont

2. FMC

PART 3 -- EXECUTION

3.1 INSTALLATION

A. **General:** The bar screen unit(s) shall be installed at the locations indicated in accordance with the manufacturer's written instructions. Each unit shall be securely anchored in a concrete channel as indicated.

3.2 FIELD TESTING

A. Field testing shall be performed as follows: The bar screen unit(s) shall be tested in place to assure conformance with performance requirements. Equipment supplier shall certify proper installation prior to startup.

** END OF SECTION **