

TABLE OF CONTENTS

DIVISION 11 - EQUIPMENT

Section No.	Description
11005	General Process Provisions
11020	Process Equipment Installation
11205	Process Motors Less Than 150kW
11300	Process Pumps - General Requirements
11318	Self-Priming Solids Handling Pumps
11910	Identification

1. GENERAL

1.1 Description

- .1 Unless otherwise specified, this section specifies general requirements common to all process and mechanical equipment included in Division 11 to Division 15, inclusive.
- .2 Comply with all laws, ordinances, rules, regulations, codes, and order of all authorities having jurisdiction relating to this work.

1.2 Definitions and Interpretations

- .1 Where the term "Provide" is used herein, understand to include labour, materials, and services necessary to supply items or work referenced.
- .2 Where the terms "Instructions", or "As instructed", or "Where instructed" are used herein, understand to mean instruction by the Engineer, including supplementary instruction notices and all comments made regarding submittals of shop drawings and samples for review.
- .3 Where the term "Listed" is used herein, understand to mean that the material or equipment have been tested in accordance with applicable standards and methods, have been approved and listed for the intended use by a testing authority which itself has been approved by the authorities having jurisdiction.
- .4 Where the terms "Approved", or "Approval" are used herein, understand to mean approved by Authorities having jurisdiction as conforming to Codes, Standards, Bylaws, etc.
- .5 Where the terms "Acceptable", or "Acceptance" are used herein, understand to mean acceptable to the Engineer as generally conforming to the requirements of the Contract Documents.
- .6 Where the term "Submit for Review" is used herein, understand to mean submit to the Engineer.
- .7 Where the term "Subject to Review", etc. is used herein, understand to mean work shall be laid out for review by the Engineer. Do not proceed with this work until instructions have been obtained from the Engineer. Submit further information, shop drawings, samples, etc. as specified and/or as may be reasonable requested by the Engineer.
- .8 Where the term "Accessible" is used herein, understand to mean readily approachable by persons or tools as required and where obstacles may be removed and replaced without cutting or breaking out materials.
- .9 Where working pressure or pressure ratings are specified, or shown on the drawings for valves, piping, fittings, equipment, etc., design and fabricate these items to be suitable for operating at specified pressures and corresponding temperatures unless noted otherwise.

1.3 Shop Drawings

- .1 Refer to Section 01300 for the general requirements for shop drawings.
- .2 In addition to the requirements of Section 01300, submit the following specific information with shop drawings for each item of equipment specified in Division 11.
 - .1 Assembly drawings showing details of connections and terminations of equipment for connection by others.
 - .2 List of materials of construction, detailing the component parts and reference specifications (ASTM, CSA, ANSI, etc.) and equipment weights.
 - .3 Motor operating data, including motor and insulation ratings, start-up and operating current ratings, operating voltage and amperage tolerances, and description of construction, complete with illustrative drawings.
 - .4 Gearbox and drive data, including AGMA/AFBMA ratings for components, materials of construction, tolerances, and description of construction.
 - .5 Control schematics, text, and wiring diagrams as required to describe control operations.
 - .6 Required ancillary services including, but not limited to electrical, non-potable water and drains.
 - .7 Installation instructions indicating assembly and mounting requirements, alignment and assembly tolerances, and point of connection for ancillary services.
 - .8 Start-up instructions including lubricant requirements, electrical requirements, etc.
 - .9 Details of coating systems to be applied.
 - .10 Details of insulation provided to prevent galvanic corrosion between mating surfaces constructed of dissimilar metals.
 - A copy of the Contract Document mechanical layout drawings, control diagrams, and process and instrumentation diagrams, with addenda updates, that apply to the equipment marked to indicate special changes necessary for the supplied equipment. If no changes are required, mark the drawing(s) "no changes required".
 - .12 A copy of the related specification section with addenda updates, and all referenced sections with addenda updates, with each paragraph check-marked to show specification compliance or marked to show deviations.

1.4 Temporary Usage

.1 Temporary usage by the Owner of any process device, apparatus, machinery, or equipment prior to interim or final inspections is not to be construed as acceptance.

1.5 Owner Supplied Equipment

- .1 Where indicated in the drawings or noted in the specifications, install, test, and commission equipment provided by the Owner.
- .2 Review all information available for the Owner supplied equipment and ensure familiarity as to all requirements for storage, installation, testing, and commissioning.
- .3 Hand over of Owner supplied equipment to the Contractor will be made according to a schedule agreed upon by the Contractor, the Engineer, and the Owner.
- .4 Upon hand over, fully inspect the item of equipment in the presence of the Engineer. Where the equipment requires modification or repair to properly function, these items will be identified to and confirmed by the Engineer.

1.6 Design Standards, Acceptable Products, and Acceptable Manufacturers

- .1 Equipment lists included in the specifications may be in two parts. The first part is the "Design Standard" equipment items. The second part of the list is comprised of "Acceptable Manufacturers" if the equipment of a specific vendor is specified.
- .2 The design has been based on the Design Standard. Quality of workmanship, dimensions, operating protocol, basic materials, and ancillary services have been defined on this basis and incorporated in the design.
- .3 Where Acceptable Products or Acceptable Manufacturers have been listed after a Design Standard, these products or ranges of products have been accepted by the Engineer as being capable of meeting the basic functional requirements of the equipment, but may not be the same as the Design Standard in detail. Provide all ancillary services, material upgrades, etc. as necessary to satisfy the functional and quality requirements defined by the Design Standard. Make all changes in fabrication, arrangement, piping, and/or electrical connections, etc. as necessary to suit the requirements of the Acceptable Products or Acceptable Manufacturers. Costs for any re-design or evaluation by the Engineer to assess the impact of the Acceptable Product or Manufacturer will be borne by the Contractor.
- Where Acceptable Products or Acceptable Manufacturers have been listed, but no Design Standard is listed, these products or ranges of products have been accepted by the Engineer as being capable of meeting the basic functional requirements of the equipment. Provide all ancillary services and modifications to arrangement, piping, and/or electrical connections, etc. as necessary to suit the functional requirements of the equipment.
- .5 Modify standard products as necessary to provide the specified features and to meet the specified operating conditions.

.6 No additional payment will be made for revisions or alterations made to accommodate the equipment supplied.

1.7 Abbreviations

.1 The following abbreviations are found in the Division 11 specifications:

	THE ANALOGY SALE OF ALASTIC MALE IN THE SALE OF STREET	
AFBMA	 Anti-Friction Bearing Manufacturers Association 	
AGMA	 American Gear Manufacturers Association 	
AISI	- American Iron and Steel Institute	
ANSI	- American National Standards Institute	
AMCA	Air Movement and Control Association	
ASCE	- American Society of Civil Engineers	
ASTM	American Society for Testing and Materials	
AWS	- American Welding Society	
BS	- British Standard	
CEMA	 Conveyor Equipment Manufacturers Association 	
CGA	 Canadian Standards Association 	
CGSB	- Canadian Government Standards Board	
CSA	- Canadian Standards Association	
DIN	- Deutsche Instustrie Norm	
EEMAC	- Electrical Equipment Manufactures Association of Canada	
ISA	- Instrumentation Society of America	
ISO	- International Standards Organization	
MSS		
	Industry.	
NACE	 National Association of Corrosion Engineers 	
NBC	- National Building Code	
NEC	- National Electrical Code	
NEMA	- National Electrical Manufacturers Association	
NFC	- National Fire Code	

1.8 Coordination

NPC

NSF

SSPC

1 Coordinate the requirements of the equipment supplied with piping, structural supports, drainage, ventilation/cooling, electrical service, instrumentation and control interface, and other ancillaries specified in other Divisions.

National Plumbing Code

National Sanitation Foundation

Structural Steel Painting Council

1.9 Shipment, Protection, and Storage

- .1 Ship and store equipment in accordance with Section 01600 unless otherwise specified.
- .2 Prior to installation, protect all equipment store on or off site against corrosion. Provide blanks, plugs, packing grease, special covering, moisture absorbing material, and/or other appurtenances necessary to preclude moisture from equipment interior spaces. Take special care with electrical and control panels.
- .3 During storage, turn shafts as required, run as necessary, and/or undertake all other special maintenance activities required to ensure that rotating equipment bearings are not subjected to excess wear.

1.10 Tagging Instructions

.1 Tag loose items associated with a particular unit with the equipment number. Make tagging materials of aluminum or stainless steel (no plastic) and securely attach to each item.

2. PRODUCTS

2.1 Spare Parts

- .1 As required in the various specification sections, supply spare parts required for the various items of equipment. The lists in these sections are intended to include all parts that normally would be required within the warranty period for normal preventative maintenance and where fabrication requirements for special parts would delay delivery and could keep an item of equipment out of service for a period exceeding one week.
- .2 Identify any spare parts not listed that would be required to meet this criteria, with a price list.
- .3 In addition, provide a list of all spare parts, not including lubricants, which normally would be required through the first five (5) years of operation. Provide prices for each part, guaranteed for six (6) months.
- .4 Assume responsibility to replenish the spare parts used within the warranty period at the end of the warranty period for the related item(s) of equipment.

2.2 Welding

.1 Conform to Section 05500 and 15050.

2.3 Flanges and Pipe Threads

.1 Provide flanges on cast iron equipment and appurtenances that conform in dimension and drilling to ANSI B16.1, Class 125 and flanges on steel equipment and appurtenances that conform in dimension and drilling to ANSI B16.5, Class 150 unless otherwise specified.

- .2 Provide pipe threads that conform in dimension and limits of size to ANSI B1.1, coarse threaded series, Class 2 fit.
- .3 Provide flange assembly bolts that are heavy pattern, hexagonal head, carbon steel machine bolts with heavy pattern, hot pressed, hexagonal nuts conforming to ANSI B18.2.1 and B18.2.2. Provide threads that conform to Unified Screw Threads, Standard Coarse Thread Series, Class 2A and 2B, ANSI B1.1.

2.4 Bearings

- .1 Unless otherwise specified, provide oil or grease lubricated, ball or roller type equipment bearings, designed to withstand the stresses of the service specified. Rate each bearing in accordance with AFBMA Methods of Evaluating Load Ratings of Ball and Roller Bearings.
- .2 Provide equipment bearings that have a minimum L-10 rating life of 50,000 hours, as determined using the maximum equipment operating speed, unless otherwise specified.
- .3 Fit grease lubricated bearings, except those provided factory-sealed and lubricated, with easily accessible grease supply, flush, drain, and relief fittings. Use extension tubes where necessary. Provide standard hydraulic alemite type grease supply fittings.
- .4 Ensure that all grease fittings on the project are the same size, North American standard.
- .5 Extend grease fittings to an accessible location.
- .6 Equip oil lubricated bearings with either a pressure lubricating system, or a separate oil reservoir type system. Provide each oil lubrication system to be of sufficient size to absorb the head energy generated in the bearing under a maximum ambient temperature of 40°C.
- .7 For pressure lubricating systems or oil reservoirs, provide a filler pipe and an external level indicator gauge. Provide a cap, complete with retention chain, for the oil inlet.

2.5 Critical Speed

.1 For rotating equipment, ensure that operating speed is no more than 80 percent of the first critical speed unless otherwise specified.

2.6 V-Belt Assemblies

- .1 Select belt for not less than 150 percent of rated driver power. Where two sheave sizes are specified, ensure belt sizing is appropriate for both sets.
- .2 For explosion-proof equipment, use anti-static type belts.
- .3 Statically balance sheaves and bushings. Where sheaves and bushings are to operate at peripheral speeds greater than 1650 m/min., dynamically balance the assembly.

.4 Separately mount sheaves on their bushings by means of three pull-up grub or cap tightening devices. Key seat bushings to the drive shaft.

2.7 Couplings

- .1 For equipment with drives over 0.375 kW and less that 120 kW, and where the driver is directly connected to the driven unit, provide a flexible coupling. Couplings shall accommodate angular misalignment, parallel misalignment, and end float and shall cushion shock loads and dampen torsional vibrations.
- .2 The flexible member of flexible couplings shall consist of a tire, with synthetic tension members bonded together in rubber. Attach the flexible member to flanges by means of clamping rings and cap screws, and attach the flanges to the stub shaft by means of taperlock bushings. Provide the equivalent of a shrunk-on fit. There will be no metal-to-metal contact.
- .3 For larger couplings, provide continuous sleeve flexible gear type, forged steel couplings.
- .4 Size each coupling as recommended by the coupling manufacturer for the specific application, considering applied power, speed of rotation, type of service, and other pertinent details.

2.8 Guards

- .1 On moving parts, provide sheet steel guards in accordance with workplace safety regulations. Fabricate of galvanized 14 gauge steel.
- .2 Paint guards after fabrication to the same standard as the attached equipment.
- .3 Guards shall be removable to facilitate maintenance of moving parts.
- .4 Make provision for extension of lubrication fittings through the guards.

2.9 Equipment Installation

- .1 Provide nameplate for all equipment in accordance with Section 11910.
- .2 Provide nameplates for all electrical and control panels supplied with equipment, in accordance with Section 11910, Division 16, and Division 17 requirements.

2.10 Caution Signs

- .1 For caution signs, use vinyl stick-on type decals placed onto clean, smooth surface of equipment to be posted.
- .2 Where sufficient space exists, use decal applied to galvanized mild steel, fibreglass, or plastic sheet fastened to equipment.

- .3 Provide signs that read "CAUTION AUTOMATIC EQUIPMENT MAY START AT ANY TIME".
- .4 Make letters 25 mm in height, red, on a yellow background.
- .5 Provide mounting posts and hardware and mount close to guarded moving parts.

2.11 Gauge Taps and Test Plugs

- .1 Refer to SectionS 15050 and 11300 for general requirements.
- .2 Provide gauge taps on the suction and discharge side of pumps, blowers, and compressors.
- .3 Install gauges at each location indicated.
- .4 Tap and install plugs at locations indicated in the drawings and as required to practically complete testing of piping and equipment.

2.12 Concrete Pads

- .1 Coordinate location of concrete pads for equipment.
- .2 Ensure that, unless otherwise shown, concrete pads are a minimum of 150 mm above finished floor elevation and extend a minimum of 100 mm outside of the equipment base.
- .3 Ensure that pads drain way from base.
- .4 Ensure that conduit, drains, piping, etc. required for the equipment, rise through the pad.

2.13 Equipment Bases

- .1 Structural Steel Bases
 - .1 Make bases of structural steel shapes with thickened steel pads for dowelling.
 - .2 Fabricate bases in a rectangular pattern. "T" and "L" patterns may be used where required to accommodate the equipment drive and accessories.
 - .3 Make perimeter members of structural beams with a minimum depth equal to 0.10 of the longest dimension of the base. Beam depth need not exceed 350 mm provided that the deflection and misalignment is kept within the manufacturer's recommendations.
 - 4 Provide grout holes where vibration isolation is not specified.

.2 Cast Iron Bases

- .1 Seal in accordance with the requirements of Section 09905 for bleeding surfaces, prior to grouting.
- .2 Terminate fasteners requiring connection to the base by nuts welded to the bottom of the base and plugged with cork, plastic plugs or grease, or acorn nuts.

2.14 Anchor Bolts

- .1 For all permanently or intermittently submerged services and for all exterior mounting locations, provide stainless steel anchor bolts conforming to Section 05500, and ASTM A320.
- .2 For all other anchor bolts, provide cadmium plated or galvanized steel anchor bolts conforming to ASTM A307, unless noted otherwise.
- .3 For rotating equipment over 35 kW, provide anchor bolts with sleeves and washers to permit adjustment during installation of the equipment.
- .4 Do not use drilled expansion or adhesive anchors for anchor bolts unless submitted and reviewed by the Engineer.
- .5 Design anchor bolts for lateral forces for both pullout and shear in accordance with the requirements of Section 05500.

2.15 Equipment Base Templates

- .1 For rotating equipment where shown in the drawings, or specifically called for in the specifications for that equipment, provide an equipment base template for location of equipment anchor bolts to be embedded in concrete.
- .2 Manufacture the equipment base template of structural steel with stops or holes placed for the anchor bolts.
- .3 Shop finish the templates in accordance with Section 09905 for items to be embedded in concrete.
- .4 Provide access holes for the placement of grout or concrete, as applicable.

2.16 Jacking Screws

- .1 On all base mounted rotating equipment larger that 7.5 kW, provide jacking screws for the driver and the driven end to facilitate alignment.
- .2 Provide jacking screws consisting of a 12 mm nut welded to the frame of the equipment with the hole in a horizontal plane.

- .3 Provide a 12 mm bolt that fits through the nut and extends to the mounting feet.
- .4 Two jacking screws are required at each end of the equipment, one parallel to the axis of the equipment and one perpendicular.

3. EXECUTION

3.1 Operator Training

.1 Arrange for the attendance of manufacturer's representative for training of the Owner's staff. As a minimum, training will include operating requirements, maintenance procedures, troubleshooting, and repair procedures for all electrical and mechanical components. Refer to Section 01670 for further details.

END OF SECTION

1. GENERAL

1.1 Description

.1 Installation, including the supply of anchor bolts, and testing of equipment supplied under other sections in Division 11.

1.2 Definitions and Interpretations

- Testing: In this Division, testing is defined as the operation of a specific item of equipment under actual and/or simulated conditions for the purpose of ensuring the equipment satisfies its basic design criteria. Provide all materials, labour, power and equipment necessary to conduct all required tests.
- .2 Commissioning: In this Division, commissioning is defined as the operation of equipment systems under actual and/or simulated conditions for the purpose of ensuring the system performs its intended functions.

1.3 Submissions

- .1 Check all the shop drawings relative to the equipment and materials, dimensions, measurements, size of members, type of materials, controls, list of equipment being supplied, names of manufacturers, and other details to ensure that they are correct and conform to the requirements and intent of the Contract.
- .2 Where the shop drawings are submitted with coordination information missing, such as dimensions of structures, the Engineer will return the submission as soon as practicable marked "Revise and Resubmit".

2. PRODUCTS

2.1 Equipment List

- .1 Unless indicated otherwise, supply and install all equipment listed on the Equipment List (see list following this Section), detailed on the equipment specification sheets, or shown on the drawings.
- .2 Determine the extent of equipment to be supplied from the specifications, list of equipment and materials and manufacturer's drawings covering the equipment. Furnish and install all additional materials necessary to complete the installation.
- .3 Incorporate all ancillary devices in the installation including those providing for cooling water, seal water, lubricant supply, process drains, electrical connection, and instrumentation and control requirements.

2.2 Mounting Requirements

- .1 Provide all supports, anchorage, and mounting of all equipment in accordance with the manufacturer's recommendations, the NBC, and industry standard requirements.
- .2 Design and provide all elements required to resist the calculated forces described herein or required by the element manufacturer.

3. EXECUTION

3.1 Coordination

- .1 Coordinate the work specified under this Section with the work of other Sections to produce a complete and workmanlike job.
- .2 Coordinate the placement of equipment bases and housekeeping pads with Division 3.
- .3 Coordinate the arrangement of conveyance equipment with Division 14.
- .4 Coordinate the routing of ancillary piping with Division 15.
- .5 Coordinate the routing of electrical and control wiring and conduit with Division 16 and Division 17.

3.2 Preparation

- .1 Before commencing installation of the work, inspect and take field measurements and ensure that work conducted previously in the area is not prejudicial to the proper installation of the works.
- .2 Refer to the equipment specifications and specification sheets for assistance in determining the form in which equipment is to be shipped and the extent of field assembly required.
- .3 Dimensions shown on the Contract Documents for equipment bases, piping connections, etc., are approximate. Correct to suit the exact dimensions of the equipment provided for each application. Arrange any necessary modifications to piping connections, pipework, or other ancillaries at no cost and after acceptance by the Engineer.
- .4 Schedule the visits to the site of the manufacturer's representative for the times and periods specified in other sections. Cooperate in his supervision of the installation and start-up. Follow all reasonable instructions of the manufacturer's representative. Should the Contractor require the manufacturer's representative to attend for longer or more frequent periods, he shall arrange this, at his own expense, with the manufacturer.

3.3 Installation of Equipment

- .1 Install all equipment specified in other sections, detailed on the equipment specification sheets, or shown on the drawings.
- .2 Supply and install all necessary shims, gaskets, etc., required to complete the installation.
- .3 Provide for the use of all necessary lifting and loading equipment and all tools required to complete the installation.
- .4 Comply with the specific requirements for installation noted in other sections of this specification and with the instructions of the Manufacturer. Where there is a conflict in these requirements, identify the conflict to the Engineer and proceed as directed.

3.4 Equipment Bases and Anchorage

- .1 For rotating equipment of 7.5 kW or above and for equipment requiring structural anchoring, set anchor bolts in advance. Where required, set anchor bolts in sleeves to permit minor adjustment during installation. Use machine base templates where shown. Tie anchor bolts to reinforcing steel to resist tensile forces, as shown.
- .2 Prepare grout as specified in Division 3 and provide full contact with the equipment bases unless otherwise recommended by the equipment manufacturer and accepted by the Engineer. Neatly bevel, form, or trim the grout.
- .3 Where equipment is supplied with a plate steel base, provide access holes in the top of the plate and use a pour grade, non-shrink, non-metallic grout as specified in Section 03300 to fill the entire void under the base.

3.5 Alignment

- .1 Set and align all rotating equipment in accordance with the more stringent requirements of either the manufacturer's requirements or the following:
- Level base, use machinists level on all machined bases.
- .2 Align couplings to satisfy the following criteria:

Allowable Coupling Speed Misalignment	Allowable Angular Misalignment	Parallel 0.25 mm
Under 100 rpm, below 50 hp	4'00"	
Under 100 rpm, 50 hp and over	3'00"	0.12 mm
100 to 600 rpm	2'00"	0.12 mm
600 to 1800 rpm	1'00"	0.10 mm
1800 to 3600 rpm	0'35"	0.5 mm

- .3 Check for soft foot, maximum permissible 0.002 mm.
- .2 Where equipment undergoes a substantial differential temperature rise (equal to or exceeding 30°C between driver and driven unit), provide precision benchmarks in foundation and on equipment. Perform alignment at operating temperatures.
- .3 Demonstrate the final alignment to the Owner, Engineer, and Manufacturer's Representative.

3.6 Lubricants

- .1 Extend any inaccessible lubrication points and lubrication drains to convenient locations.
- .2 Remove storage lubricant and provide the initial fill of new lubricants for the equipment. Lubricant grade to be as recommended by the manufacturer.

3.7 Vibration Survey

- .1 Conduct a vibration survey under normal operating conditions for all equipment with a motor size exceeding 37 kW and for smaller units where specified.
- .2 Use a calibrated vibration sensor, accepted by the Engineer, and capable of measuring unfiltered vibration velocities and peak-to-peak amplitudes. Select a sensor capable of measuring velocities at a precision of 0.1 mm/s and an accuracy of plus or minus 0.2 mm/s.
- .3 Monitor vibration in all three dimensions at the head and tail end of both the driver and driven units, at intermediate bearing points, and at other critical locations that may be specified by the Engineer.
- .4 Record the vibration velocities for each item of equipment and submit a report to the Engineer detailing the findings. Include a description of the measuring equipment, identification of equipment on which vibration monitoring was completed, description of conditions under which the test was conducted, and a listing of all of the collected data.
- .5 Unless specified otherwise, use unfiltered velocities as the vibration criteria. Unfiltered velocities less than 5 mm/s shall be considered acceptable. Correct unfiltered velocities that exceed 5 mm/s.

3.8 Noise Survey

- .1 Conduct a noise survey for all equipment over 37 kW and for smaller units where specified.
- Use a calibrated noise meter, accepted by the Engineer, and capable of measuring noise in the A Scale at a precision of 0.5 dBA and an accuracy of 1.0 dBA.
- .3 Measure noise levels at an elevation similar to the major noise emitter from the equipment (bearing housing, muffler, etc.) and at a horizontal distance of 1.0 metres.

- .4 Record the noise levels for each item of equipment and submit a report to the Engineer detailing the findings. Include a description of the measuring equipment, identification of equipment on which noise level monitoring was completed, description of conditions under which the test was conducted, and a listing of all of the collected data.
- .5 Equipment is to operate at a noise level less than 85 dBA, when measured in free field at 1.0 metre. Noise requirements may be more stringent in areas where more than one item of process equipment is intended to operate concurrently. Specific requirements for equipment that differ from 85 dBA are listed in the sections related to those items of equipment.
- .6 Noise abatement features (acoustic panels, acoustic insulation, etc.) are specified in other sections.
- .7 In any process area, recommend whatever measures necessary to maintain a composite noise level below 90 dBA. Where directed by the Engineer, undertake those corrective actions.

END OF SECTION

1. GENERAL

1.1 Description

- .1 This Section specifies alternating current induction motors, 150 kW or less, to be provided with the driven equipment.
- .2 This Section does not specify medium voltage (2300 V and greater) and specialty motors such as submersible motors, valve operator motors or torque rated motors.
- .3 Unless specified otherwise, the manufacturer of the driven equipment is to provide electric motors as an integral component of the driven equipment, as specified in Section 11005.
- .4 This Section specifies motors suitable for driving centrifugal pumps, fans, blowers, compressors, gears, progressive cavity pumps or other loads fed via the variable frequency drive or connected across-the-line.

1.2 Reference Standards

- .1 Conform to the following reference standards:
 - .1 CSA C22.2 No. 100, Motors and Generators.
 - .2 CSA C22.2 No. 145, Motors and Generators for Use in Hazardous Locations.
 - .3 CSA C390, Energy Efficient Test Methods for Three Phase Induction Motors.
 - .4 EEMAC M1-7, Motors and Generators.
 - .5 NEMA Std. MG1, Motors and Generators.
 - .6 IEEE 112, Polyphase Induction Motors and Generators Testing.
 - .7 IEEE 114. Single Phase Induction Motors Testing.

1.3 Submittals

- .1 Shop Drawings: Submit with the related items of equipment in accordance with Section 01300 and Section 11005. In addition, submit the following details: Provide the specified information for each typical size or type of motor driven equipment.
 - .1 Shop drawings and product data in accordance with Division 16.
 - .2 Overall dimensions of motor.
 - .3 Shaft centreline to base dimension.
 - 4 Shaft extension diameter and keyway, coupling dimensions and details.

- .5 Fixing support dimensions.
- .6 Terminal box location and size of terminals.
- .7 Arrangement and dimensions of accessories.
- .8 Diagram of connections.
- .9 Speed/torque characteristic.
- .10 Weight of motor
- .11 Installation data.
- .12 Rotation direction.
- .13 Starting restrictions (time between starts).
- .14 Terminal leads marking.
- .15 Bearing data (including part numbers).
- .16 Recommended lubricant.
- .17 Design ambient temperature and temperature rise ratings.
- .18 Torque characteristics including rated starting torque and breakdown torque.
- .19 The AFBMA L-10 rated life for the motor bearings.
- .20 The nominal efficiency of all motors.
- .21 Class, division, group, and UL frame temperature limit code for explosion-proof motors.
- .2 Operating and Maintenance Data: Provide for incorporation in Operation and Maintenance Manual of the related item of process equipment as specified in Section 01300.

1.4 Coordination

.1 For motors fed via variable frequency drives (VFD), communicate motor requirements to, and comply with drive requirements of, the VFD manufacturer in accordance with Division 16.

1.5 Quality Assurance

.1 Build motors in accordance with CSA C22.2 No. 100, CSA C22.2 No. 145, NEMA Standard MG1, and to the requirements specified.

1.6 Shipment, Protection and Storage

- .1 Ship, protect and store equipment in a manner that prevents damage or premature aging.
- .2 Handle motors with suitable lifting equipment.
- .3 Store motors in heated, dry, weather-protected enclosure.

2. PRODUCTS

2.1 Description

- .1 Unless specified otherwise, provide motors suitable for continuous operation at sea level.
- .2 Provide motors suitable for continuous operation in a 20°C ambient temperature.

2.2 Acceptable Manufacturers

- .1 Baldor
- .2 General Electric
- .3 GEC Alsthom
- .4 Reliance
- .5 Siemens
- .6 Toshiba
- .7 U.S. Motors
- .8 Westinghouse.

2.3 Materials

- Motors: to EEMAC M1-6.
- .2 Lead markings: to EEMAC M2-1.
- .3 Unless specified otherwise, provide all motors with:
 - .1 Cast iron frame
 - .2 Cast metal fan blades and shrouds
 - .3 Stainless steel hardware
 - .4 Non hygroscopic windings.

2.4 Components

.1 Bearings

- .1 Provide sealed ball bearing type on motors less than 37.5 kW.
- .2 Bearings on 37.5 kW motors or larger to be greasable ball bearing type, rated for a minimum L-10 life of 100,000 hours at the ambient temperature specified herein.
- .2 Provide adequately sized, diagonally split, gasketted, EEMAC 4 terminal boxes complete with threaded hub for conduit entry for ODP and TEFC motors.
- .3 Provide adequately sized, diagonally split, gasketted EEMAC 7 terminal boxes complete with threaded hub for conduit entry for explosion-proof motors.
- .4 Provide a ground connection and lifting eyes or lugs.

- .5 Align and balance the motor with the related equipment in the shop to minimize vibration and undue stresses.
- .6 Where specified, equip motors with anti-condensation heaters suitable for connection to 120 volts, single phase, 60 Hz power supply.

.7 Current Imbalance

- .1 Do not exceed the values listed below when the motor is operating at any load within its service factor rating and is supplied by a balanced voltage system:
 - .1 Under 37.5 kW: 25% .2 37.5 kW and above: 10%.
- .2 Base imbalance criteria upon the lowest value measured

.8 Winding Over Temperature Protection

- .1 Provide stator winding over temperature protection on all motors rated 45 kW and larger.
- .2 Provide stator winding over temperature protection on motors rated less than 45 kW, when required by the specific equipment specification section, or if recommended by the driven equipment manufacturer.
- Over temperature protection for motors rated 45 kW and larger and other motors, where specified, to be NEMA MG1-12.53, Type 1, winding running and locked rotor over temperature protection. Provide one detector per phase. Detectors to be positive thermal protection (PTC) thermistor type, with leads brought out to a terminal strip in a NEMA 4 enclosure in Type 2 motors and a NEMA 7C or 9 enclosure for Type 3 motors.

2.5 High Efficiency Motors

- .1 Use motors that have efficiencies that conform to or exceed the requirements of EPACT.
- .2 Where vertical motors are specified or provided, ensure efficiency is within 0.5% of the values specified for horizontal motors.
- .3 Test motor efficiency in accordance with CSA C390 and NEMA MG1, accounting for stray load losses, measured indirectly based on the IEEE method.

2.6 Motors Smaller Than 0.25 kW

.1 General

.1 Unless otherwise specified, provide squirrel cage, single phase, capacitor start, induction run type motors 0.25 kW and smaller.

- .2 Provide single phase motors with Class F insulation.
- .3 Small fan motors may be split-phase or shaded pole type.
- .4 Provide copper windings.

.2 Rating

.1 Unless specified otherwise, provide motors rated for operation at 115/1/60 VAC, and continuous-time rated in conformance with NEMA Standard MG1, paragraph 10.35.

.3 Enclosures

- .1 Unless otherwise specified, provide motors with totally enclosed fan cooled (TEFC) or totally enclosed non-ventilated (TENV) enclosures.
- .2 Where explosion-proof motors are specified or required, provide explosion-proof motors bearing the UL label for Class I, Division 1, Group D hazardous locations.
- .3 Provide advice in the enclosure to detect over temperature and automatically deenergize the motor.

2.7 Motors 0.25 kW to 150 kW

.1 General

.1 Unless otherwise specified, provide 3-phase, squirrel cage, full voltage start, high efficiency induction type motors 0.25 kW to 150 kW.

.2 Rating

- .1 Unless otherwise specified, provide heavy duty, high efficiency, and TEFC motors for all motors which run continuously.
- .2 Unless otherwise specified, provide squirrel cage induction type motors, with a service factor of 1.15 at 40°C ambient, Class F insulation and non hygroscopic windings.
- .3 Provide motors with EEMAC Design B torque characteristics. Size motors to satisfy the driven equipment's starting torque requirements. For special high torque applications such as sweep arm drives, motors with Design C characteristics may be specified or provided subject to the Engineer's acceptance.
- .4 Rated for 600/3/60 VAC service unless otherwise specified.
- .5 Design motors for full voltage starting, capable of running successfully when terminal voltage is from +10% to -10% of nameplate voltage.

- Motors with a service factor of 1.0 to operate at no more than 90% of their nameplate current rating and motors with a service factor of 1.15 to operate at not more than 100% of their nameplate current rating.
- .7 Ensure sufficient capacity to operate the driven load and associated devices under all conditions of operation without overloading.

3 Enclosure and Insulation

- 1 Classify motors as:
 - .1 Type 1 (General Duty)
 - .2 Type 2 (Process)
 - .3 Type 3 (Explosion-proof).
- .2 Enclosures and insulation systems are specified in the following clauses. Temperature rise for all motor types not to exceed that permitted by Note II, paragraph 12.42, NEMA MG1.
- .3 Provide non hygroscopic insulation.
- .4 Type 1 Motors (General Duty): Unless specified otherwise, provide TEFC enclosures with Class F insulation.
- Type 2 Motors (Process): Provide TEFC enclosures, with Class F insulation, suitable for moist and corrosive environment. Provide Class F insulation with Class B temperature rise for motors rated 7.5 kW and larger. Coat all internal surfaces with an epoxy paint. Aluminum frame motors are permitted. Steel frame motors are permitted for motors with frames 184 and smaller.
- .6 Type 3 Motors (Explosion-proof): Provide motors to be rated for operation in a Class 1, Division 1, Group D hazardous location in accordance with CSA C22.1. Provide a Class F insulation. Steel frame motors are not permitted. Provide an approved breather/drain device in the motor drain hole.

2.8 Motors for Variable Frequency Drives

- .1 Comply with the requirements of the intended variable frequency drives and Division 16.
- .2 Select premium efficiency units, inverter duty rated, in conformance with NEMA MG1.
- .3 Use Type 2 or Type 3 motors.
- .4 Insulation: Class F insulation with Class B temperature rise, suitable for moist and corrosive environments and in accordance with NEMA MG1, Part 30 and Part 31.