LENNTECH
info@lenntech.com Tel. +31-152-610-900
www.lenntech.com Fax. +31-152-616-289

/ Marley Sigma 1000/1200 Cooling Tower /

Engineering Data & Specifications

SPX
COOLING TECHNOLOGIES

Engineering Data

1000 Schematic 4
1000 Piping 5
1000 Support 6
1200 Schematic 8
1200 Piping 9
1200 Support 10
Energy Management 12
Environmental 13

Specifications / Base

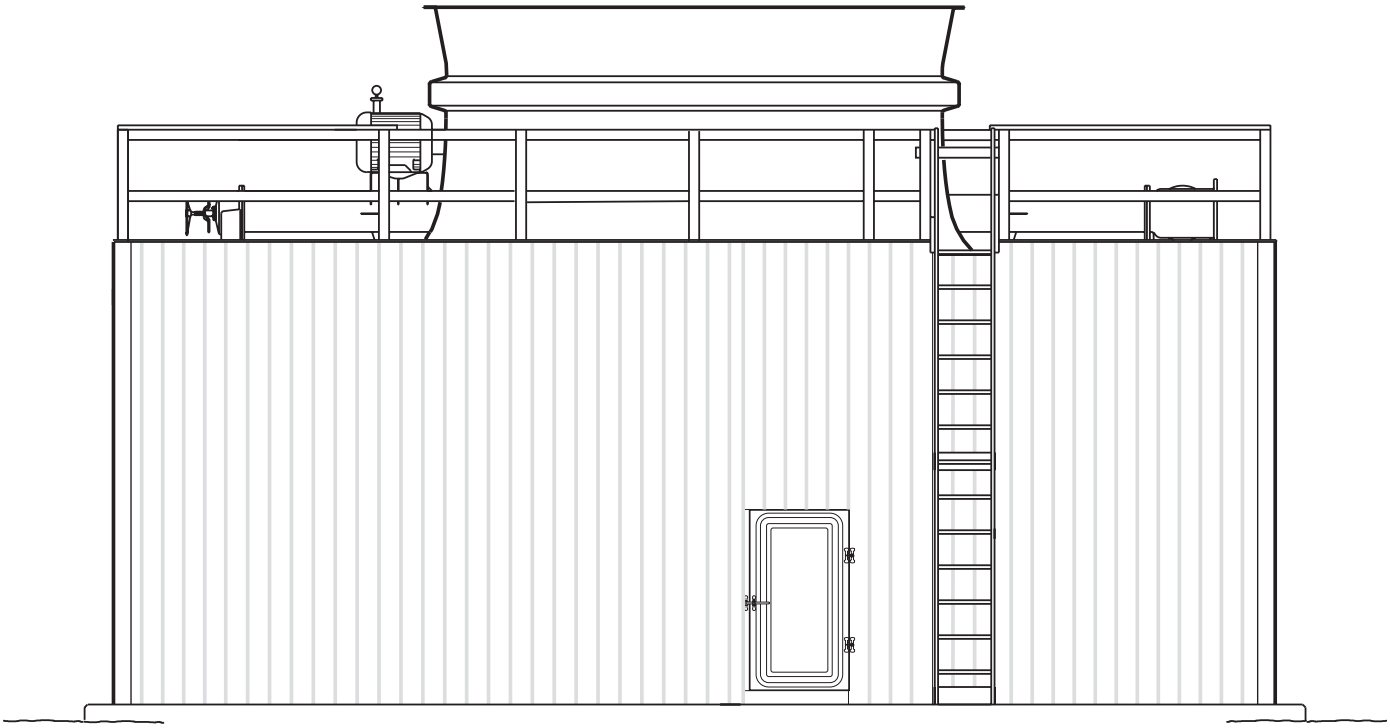
Base 14
Thermal Performance 15
Construction 16
Fan Deck and Fan Cylinder 17
Mechanical Equipment 18
Fill, Louvers and Drift Eliminators 19
Hot Water Distribution System 20
Casing 20
Access 20
Cold Water Collection Basin 21
Scope of Work 21

Specifications / Options

Control Options
Control System 22
Basin Heater 23
Fan Motor Variable Speed Drive 23
Marley Premium VFD System 24
Vibration Limit Switch 25

Convenience and Safety Options
Stairway 26
Plenum Walkway 26
Ladder Extension 26
Ladder Safety Cage 26
Oil Level Sight Glass 27

Miscellaneous Options
Wood Cold Water Basin 27
Redwood Components 27
Hot Water Basin Covers 27
Air Inlet Screens 27
Low Noise Tower 28
Watertight Partitions Between Cells 29
Fire Safety Options 29



Sigma 1000/1200 towers are field-erected, general purpose crossflow wood cooling towers, designed to serve normal air conditioning and refrigeration systems as well as medium sized industrial loads. They evolve from the crossflow concept of towers pioneered by Marley in 1938, and incorporate over 65 years of design advancements that our customers have found valuable. Sigma cooling towers represent the current state of the art in this cooling tower category.

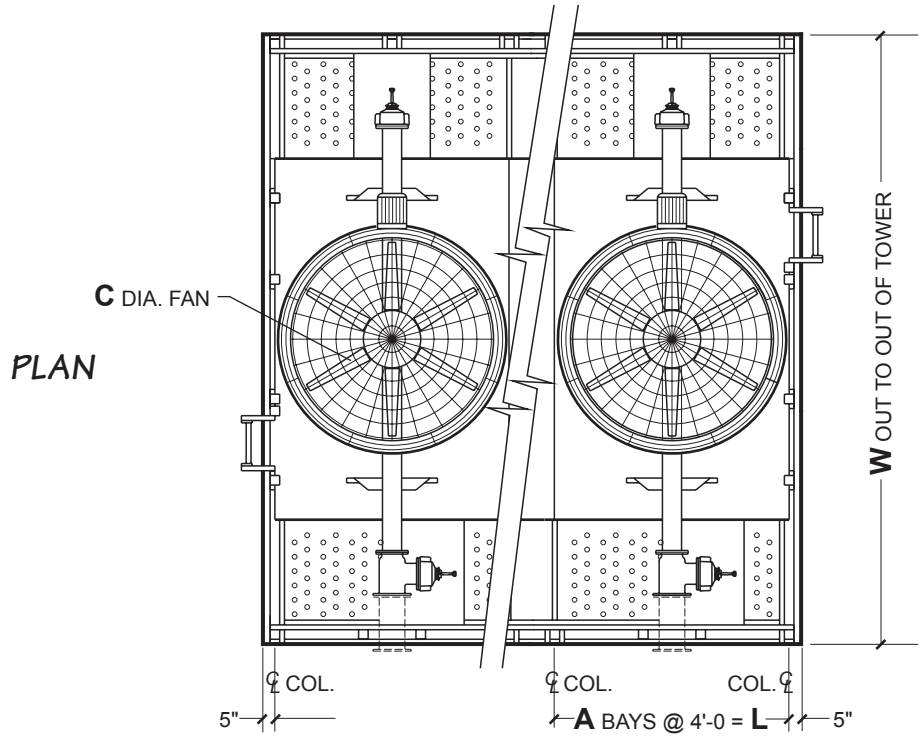
This publication not only relates the language to use in describing an appropriate Sigma cooling tower—but also defines why certain items and features are important enough to specify with the intention of insisting upon compliance by all bidders. The left hand column of pages 15 through 29 provides appropriate text for the various specification paragraphs, whereas the right hand column comments on the meaning of the subject matter and explains its value.

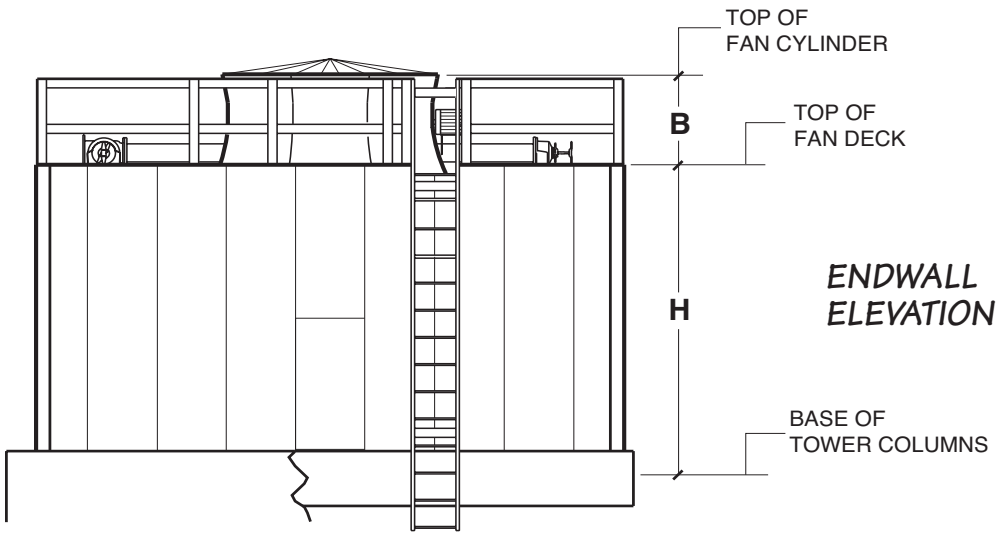
Pages 15 through 22 indicate those paragraphs which will result in the purchase of a cooling tower which will not only accomplish the specified thermal performance, but which will include normal operation and maintenance-enhancing accessories and features. It will also incorporate those standard materials which testing and experience has proven to provide best results in normal operating conditions.

Pages 23 through 29 provide some paragraphs intended to add those features, components, and materials that will customize the tower to meet the user's requirements.

Space does not permit definition and explanation of all of the possible options that can be applied to the Sigma. SPX Cooling Technologies realizes that you, the purchaser, must be happy with the tower's characteristics, and we are prepared to provide—or provide for—any reasonable enhancement that you are willing to define and purchase.

Your needs will become part of the continuing improvement of this Marley product line.

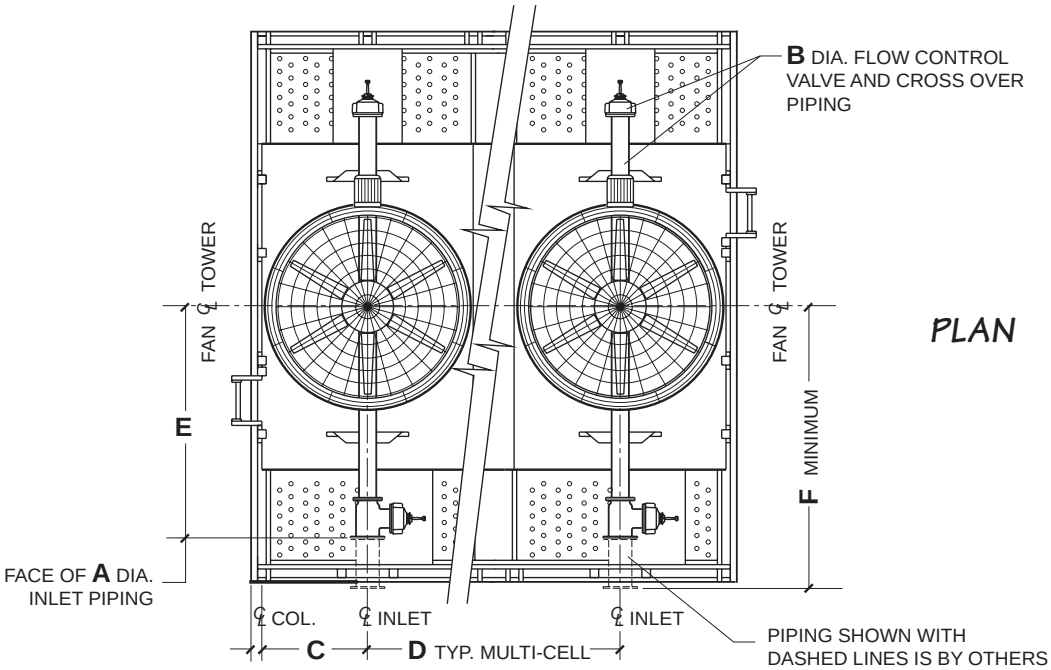




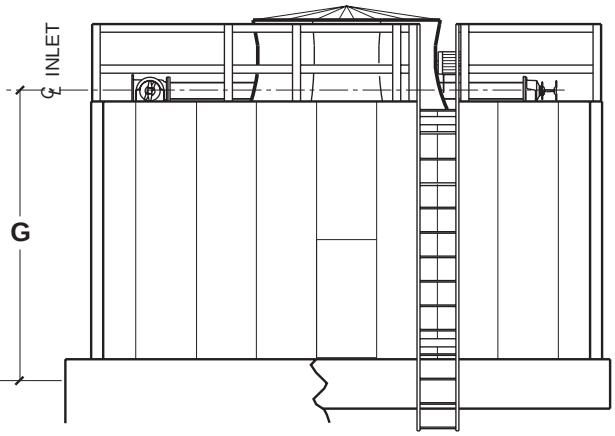
Tower Model	GPM per cell	Width W	Length L	Height H	A	B	C	Maximum Motor hp	Static Lift
1011	380 - 2140	21'-5"	8'-0"	11'-8⅝"	2	3'-8"	84"	30	11.7'
1021	580 - 3220	21'-5"	12'-0"	11'-8⅝"	3	3'-5"	96"	30	11.7'
1031	580 - 3220	23'-9"	12'-0"	11'-8⅝"	3	3'-8"	120"	50	11.7'
1041	790 - 4300	26'-0"	16'-0"	11'-8⅝"	4	4'-0"	144"	60	11.7'

NOTE

1 Last number of model indicates number of cells. Change as appropriate for your selection. Primary engineering data is per cell.
2 Fan hp is usually less than shown here.
3 Height shown is from base of tower columns to fan deck. Wood basin, if used, elevates tower 6¼". If concrete basin is used, subtract 1'-6" for height above top of basin curb.



PLAN

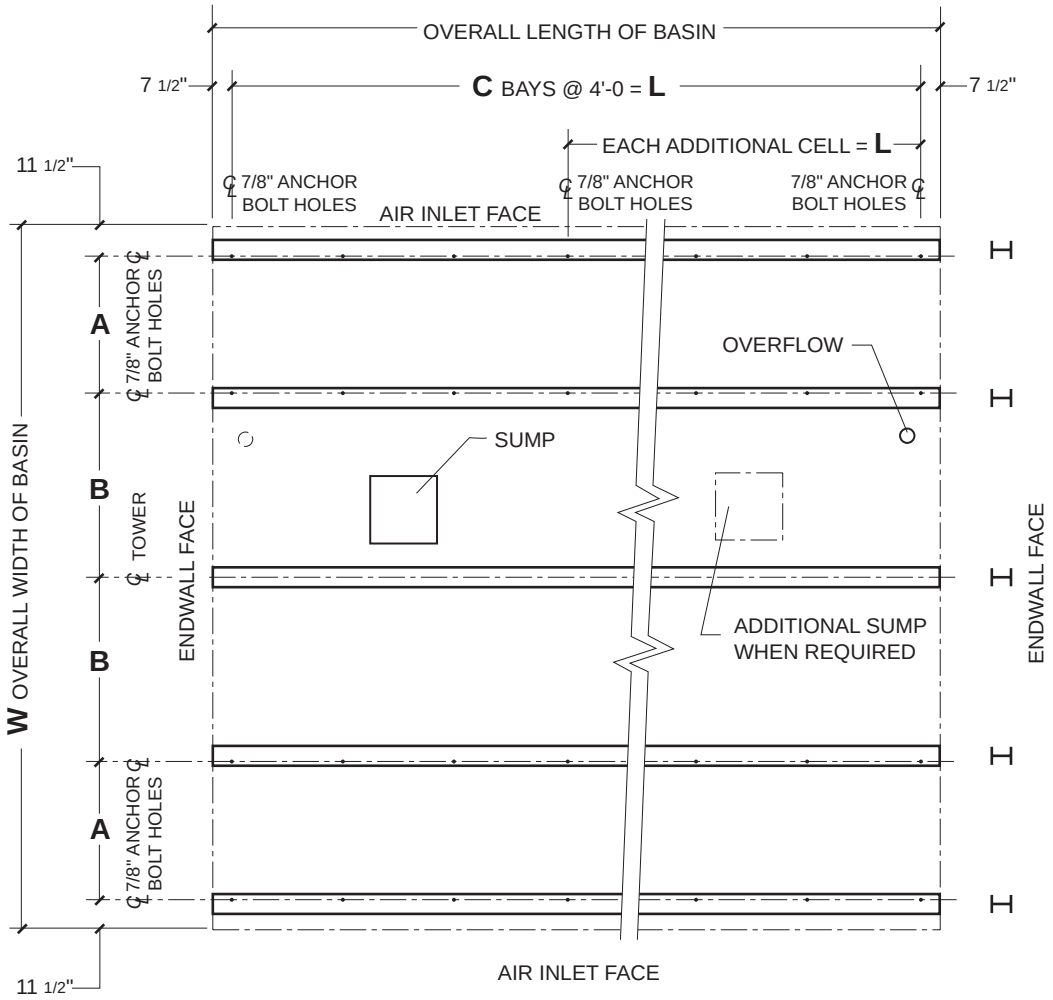


ENDWALL ELEVATION

Tower Model	GPM per cell	Dimensions						
		A	B	C	D	E	F	G
1011	380 - 2140	10"	8"	4'-0"	8'-0"	8'-11⅛"	11'-8"	12'-5⅞"
1021	580 - 3220	10"	8"	6'-0"	12'-0"	8'-11⅛"	11'-8"	12'-5⅞"
1031	580 - 3220	10"	8"	6'-0"	12'-0"	10'-1⅛"	12'-10"	12'-5⅞"
1041	790 - 3240	10"	8"	8'-0"	16'-0"	11'-2⅝"	13'-11½"	12'-5⅞"
1041	3241 - 4300	16"	12"	8'-0"	16'-0"	11'-5⅝"	13'-11½"	12'-8⅞"

NOTE

1 *Use this bulletin for preliminary layouts only.* Obtain current drawings from your Marley sales representative.
2 Pumping head contributed by the tower is static lift shown on page 5. Actual pumping head will vary according to tower circulating GPM. Total pumping head will be furnished at time of proposal.
3 If your application requires a bypass system, recommended location is through tower endwall into plenum area. Review of the system by SPX Cooling Technologies engineering is required.
4 Marley piping terminates at face of a cast iron flat face flange which conforms to class 125 lb ASME B 16.1 specifications.
5 Supports on tower for crossover piping are part of the tower design. Do not support the riser's dead load or operating load from the tower. Do not brace the riser's seismic or thrust loads against the tower.

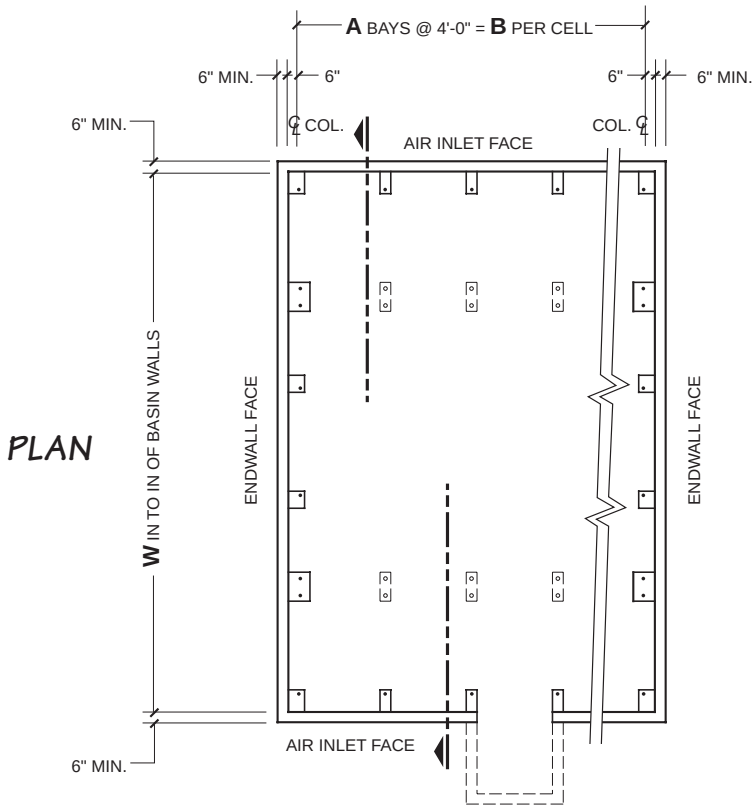


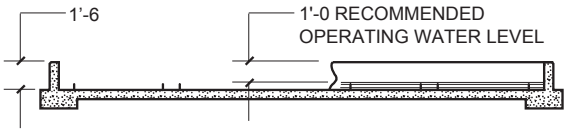
PLAN

Tower Model	Dimensions					Operating Weight lb	
	W	A	B	C	L	Single Cell	Each Cell Add
1011	22'-1"	4'-10"	5'-3"	2	8'-0"	23620	20500
1021	22'-1"	4'-10"	5'-3"	3	12'-0"	32140	28980
1031	24'-5"	4'-10"	6'-5"	3	12'-0"	34440	31020
1041	26'-8"	4'-10"	7'-6½"	4	16'-0"	47620	44000

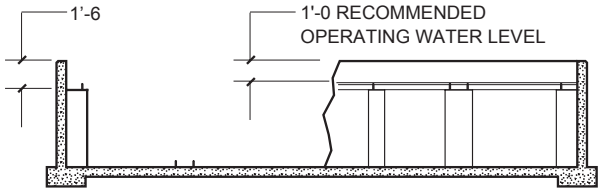
NOTE

1 *Use this bulletin for preliminary layouts only.* All dimensions show anchor bolt locations. Obtain current drawings from your Marley sales representative before designing supports.
2 Other contractors or purchaser must design and erect supporting steel.
3 If steel beams are used, they must include ⅞" dia. holes to accept anchor bolts provided. If concrete beams or pilasters are used, ¾" dia. anchor bolts embedded in the concrete must be provided by others.
4 Maintain no less than 2'-0" of clear space at endwall faces for construction purposes. Air inlet faces must have unobstructed air supply. Consult your Marley sales representative if nearby obstructions may interfere.
5 Operating weight is wet weight of tower and wood basin, including 6" of water in the collection basin. This is the recommended operating water level for all models.





FLAT BASIN SECTION



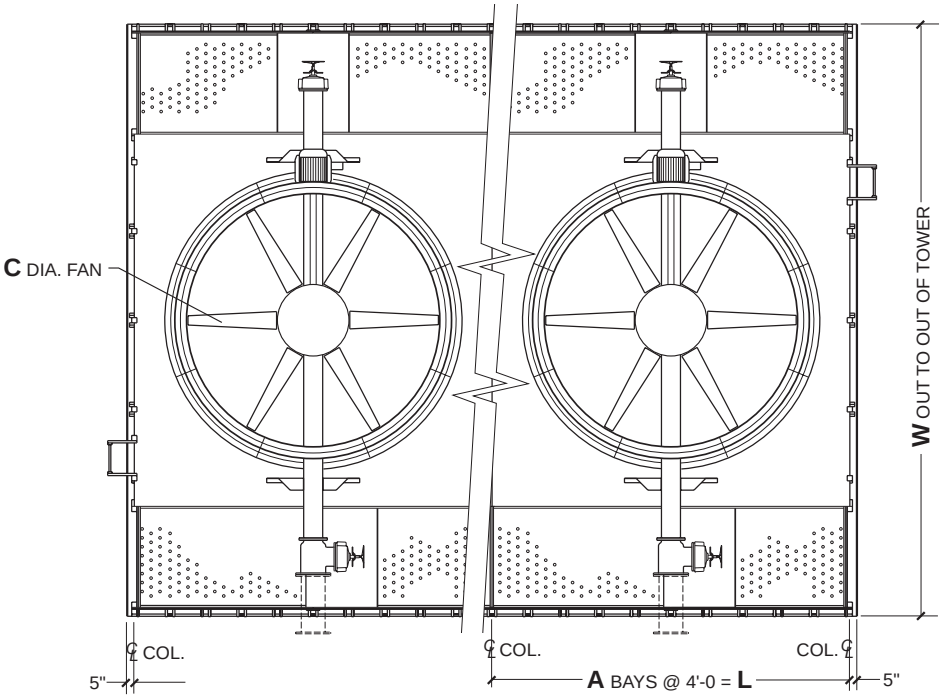
DEEP BASIN SECTION

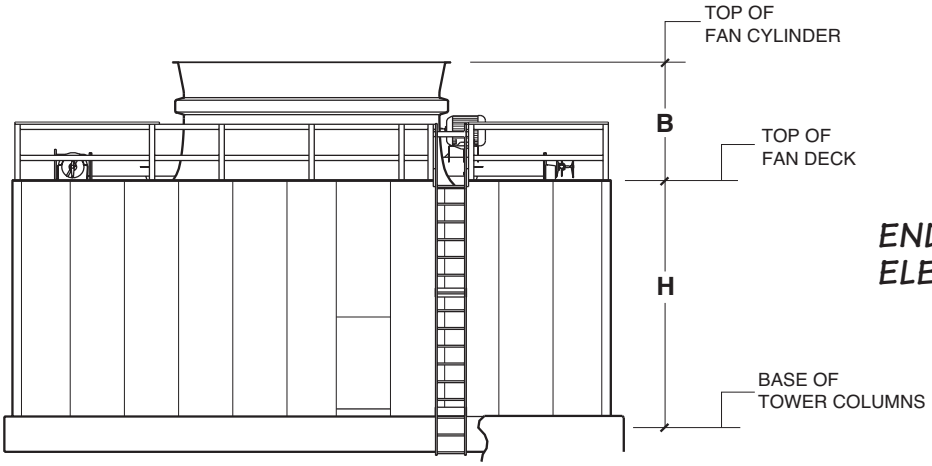
Tower Model	Dimensions			Operating Weigt lb	
	W	A	B	Single Cell	Each Cell Add
1011	21'-10"	2	8'-0"	15120	13500
1021	21'-10"	3	12'-0"	20160	18400
1031	24'-2"	3	12'-0"	21240	19500
1041	26'-5"	4	16'-0"	29020	27200

NOTE

1 *Use this bulletin for preliminary layouts only.* Do not use for construction. Obtain current drawings from your Marley sales representative. Concrete basin design and construction are by other contractors or purchaser.
2 Operating weight is total wet operating weight of tower only, excluding water in concrete basin.
3 Maintain at least 2'-0" of clear space at endwall faces for construction purposes. Air inlet faces must have unobstructed air supply. Consult your Marley sales representative for recommendations if nearby obstructions may interfere.
4 Minimum basin depth is 1'-6". Maximum basin depth is 5'-6". Extended interior columns for deep basins are available as an option. Perimeter columns remain at 1'-6" below top of basin curb.
5 All anchor bolts complete with nut and washer must be furnished by others. Bolts must be ¾"diameter with 2" all-thread projection.
6 Other contractors or purchaser must design, construct, and furnish sump and overflow to suit requirements.

PLAN



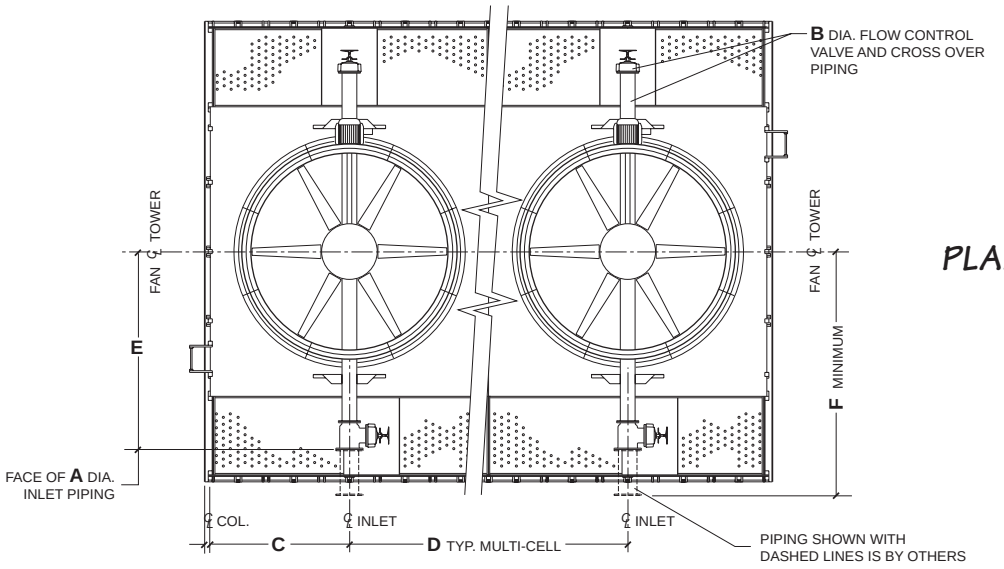


ENDWALL
ELEVATION

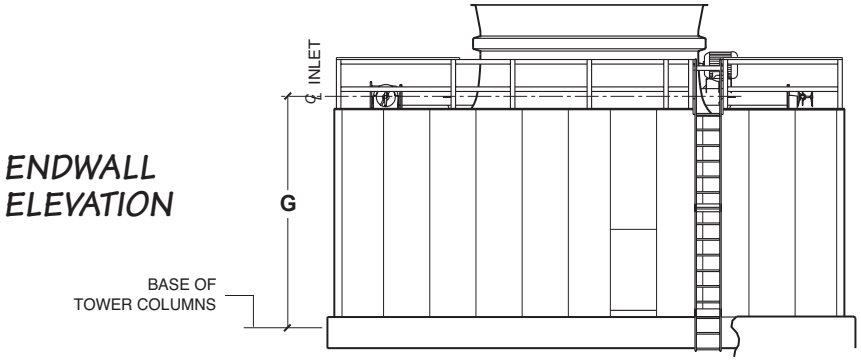
Tower Model	GPM Per Cell	Width W	Length L	Height H	A	B	C	Maximum Motor hp	Static Lift
1211	1050 - 5750	31'-2"	16'-0"	14'-5⅛"	4	6'-0"	144"	60	14.5'
1221	1050 - 5750	33'-2"	16'-0"	14'-5⅛"	4	7'-0"	168"	75	14.5'
1231	1320 - 7200	33'-2"	20'-0"	14'-5⅛"	5	7'-0"	168"	75	14.5'
1241	1500 - 8650	33'-2"	24'-0"	14'-5⅛"	6	7'-0"	168"	75	14.5'
1251	1500 - 8650	37'-2"	24'-0"	14'-5⅛"	6	7'-0"	216"	100	14.5'
1261	1850 - 10100	37'-2"	28'-0"	14'-5⅛"	7	7'-0"	216"	100	14.5'

NOTE

1 Last number of model indicates number of cells. Change as appropriate for your selection. Primary engineering data is per cell.
2 Fan hp is usually less than shown here.
3 Height shown is from base of tower columns to fan deck. Wood basin, if used, elevates tower 6¼". If concrete basin is used, subtract 1'-6" for height above top of basin curb.



PLAN

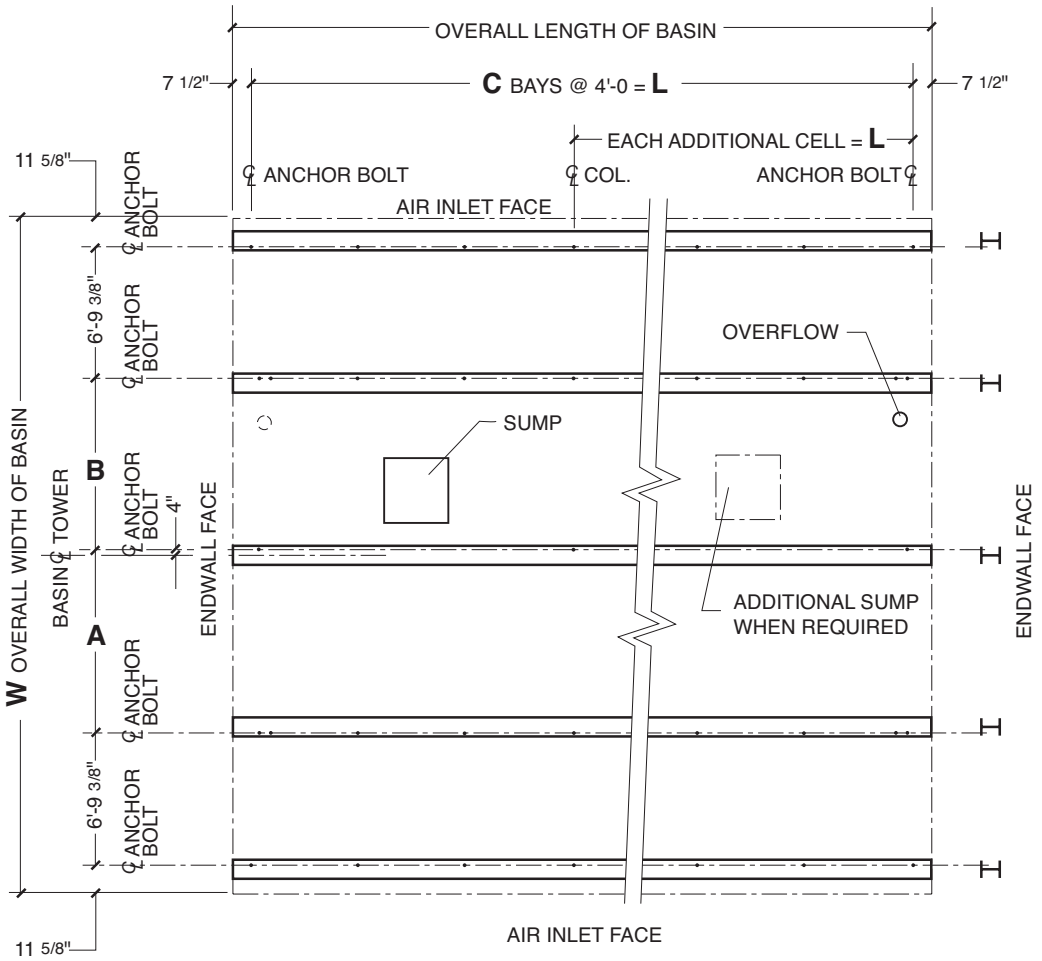


ENDWALL ELEVATION

Tower Model	GPM Per Cell	Dimensions						
		A	B	C	D	E	F	G
1211	1050 - 5750	16"	12"	8'-0"	16'-0"	13'-2¾"	16'-6⅜"	15'-6⅜"
1221	1050 - 5750	16"	12"	8'-0"	16'-0"	14'-2¾"	17'-6⅜"	15'-6⅜"
1231	1320 - 7200	16"	12"	10'-0"	20'-0"	14'-2¾"	17'-6⅜"	15'-6⅜"
1241	1500 - 7050	16"	12"	12'-0"	24'-0"	14'-2¾"	17'-6⅜"	15'-6⅜"
1241	7051 - 8650	20"	16"	12'-0"	24'-0"	14'-5¾"	17'-6⅜"	15'-8⅜"
1251	1500 - 7050	16"	12"	12'-0"	24'-0"	16'-2¾"	19'-6⅜"	15'-6⅜"
1251	7051 - 8650	20"	16"	12'-0"	24'-0"	16'-5¾"	19'-6⅜"	15'-8⅜"
1261	1850 - 7050	16"	12"	14'-0"	28'-0"	16'-2¾"	19'-6⅜"	15'-6⅜"
1261	7051 - 10100	20"	16"	14'-0"	28'-0"	16'-5¾"	19'-6⅜"	15'-8⅜"

NOTE

1 *Use this bulletin for preliminary layouts only.* Obtain current drawings from your Marley sales representative.
2 Pumping head contributed by the tower is static lift shown on page 9. Actual pumping head will vary according to tower circulating GPM. Total pumping head will be furnished at time of proposal.
3 If your application requires a bypass system, recommended location is through tower endwall into plenum area. Review of the system by SPX Cooling Technologies engineering is required.
4 Marley piping terminates at face of a cast iron flat face flange which conforms to class 125 lb. ASME B 16.1 specifications.
5 Supports on tower for crossover piping are are part of the tower design. Do not support the riser's dead load or operating load from the tower. Do not brace the riser's seismic or thrust loads against the tower.

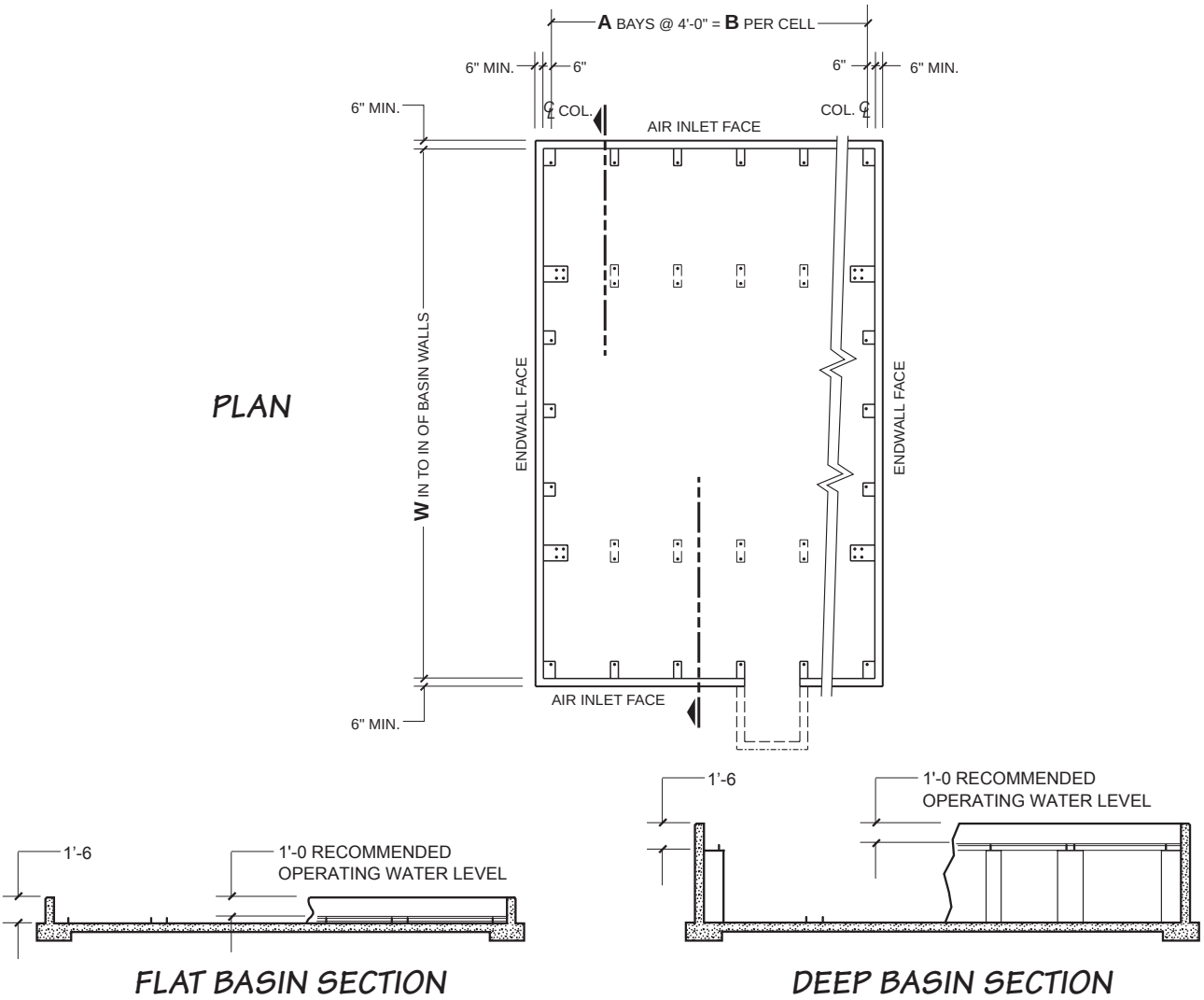


PLAN

Tower Model	Dimensions					Operating Weight lb	
	W	A	B	C	L	Single Cell	Each Cell Add
1211	31'-10"	8'-6"	7'-10"	4	16'-0"	61250	55900
1221	33'-10"	9'-6"	8'-10"	4	16'-0"	65530	60660
1231	33'-10"	9'-6"	8'-10"	5	20'-0"	77960	73110
1241	33'-10"	9'-6"	8'-10"	6	24'-0"	93790	88940
1251	37'-10"	11'-6"	10'-10"	6	24'-0"	101020	95740
1261	37'-10"	11'-6"	10'-10"	7	28'-0"	116260	111000

NOTE

1 *Use this bulletin for preliminary layouts only.* All dimensions show anchor bolt locations. Obtain current drawings from your Marley sales representative before designing supports.
2 Note carefully anchor bolt location relative to beam orientation. See plan above.
3 Other contractors or purchaser must design and erect supporting steel.
4 If steel beams are used, they must include ⅞" dia. holes to accept anchor bolts provided. If concrete beams or pilasters are used, ¾" dia. anchor bolts embedded in the concrete must be provided by others.
5 Maintain no less than 2'-0" of clear space at Endwall Faces for construction purposes. Air Inlet Faces must have unobstructed air supply. Consult your Marley sales representative if nearby obstructions may interfere.
6 Operating weight is wet weight of tower and wood basin, including 6" of water in the collection basin. This is the recommended operating water level for all models.



Tower Model	Dimensions			Operating Weight lb	
	W	A	B	Single Cell	Each Cell Add
1211	31'-6¾"	4	16'-0"	39040	35910
1221	33'-6¾"	4	16'-0"	41960	39420
1231	33'-6¾"	5	20'-0"	49100	46560
1241	33'-6¾"	6	24'-0"	59020	56470
1251	37'-6¾"	6	24'-0"	61200	58530
1261	37'-6¾"	7	28'-0"	70900	68240

NOTE

1 *Use this bulletin for preliminary layouts only*. Do not use for construction. Obtain current drawings from your Marley sales representative. Concrete basin design and construction are by other contractors or purchaser.
2 Operating weight is total wet operating weight of tower only, excluding water in concrete basin.
3 Maintain at least 2'-0" of clear space at endwall faces for construction purposes. Air inlet faces must have an unobstructed air supply. Consult your Marley sales representative for recommendations if nearby obstructions may interfere.
4 Minimum basin depth is 1'-6". Maximum basin depth is 5'-6". Extended interior columns for deep basins are available as an option. Perimeter columns remain at 1'-6" below top of basin curb.
5 All anchor bolts complete with nut and washer must be furnished by others. Bolts must be ¾" diameter with 2" all-thread projection.
6 Other contractors or purchaser must design, construct, and furnish sump and overflow to suit requirements.

Cooling towers are usually selected to produce a specific cold water temperature at the higher summer-time wet-bulb temperatures. During the remainder of the year, the cooling tower is capable of producing much colder water. Unless your system will benefit from the coldest possible water temperature, you should consider controlling cold water temperatures to higher levels. You'll also save energy by using such control. See *Marley Technical Report #H-001A*, "**Cooling Tower Energy and its Management**".

Always control leaving water temperature by manipulating the quantity of air that the fan moves through the tower. Varying the quantity of water flow is not normally recommended and can be harmful in freezing weather. You can alternately start and stop single-speed motors to maintain water temperatures within an acceptable range. However, exceeding a total acceleration time of 30 seconds per hour can overheat the motor, causing the insulation to fail. Limiting the number of motor starts, on the other hand, can produce significant variations in the temperature of the water delivered to the process.

Increased flexibility can simplify your operating procedures and save you money in the long run, both on operation and on maintenance. Here are two of the more popular options.

Two-Speed Motors

Two-speed motors improve operating flexibility by increasing the number of potential operating modes. Users in northern climates will find that the tower can carry winter loads at half-speed; reducing fan power requirements by 85+% during that time. Two-speed motors also help to control icing during wintertime operation. See *Marley Technical Report #H-003*, "**Operating Cooling Towers During Freezing Weather**".

Normally, two-speed motors are provided in 1800/900 RPM, single winding configuration, which is the least expensive two-speed option. They are also available in other combinations including the more expensive double winding.

Variable Speed Control

Frequency modulation devices work well on induced draft, propeller fan cooling towers such as the Sigma. However, their design must include the capability to lock out any critical fan speeds and the very low fan speed ranges.

Marley VFD drive systems are designed to combine absolute temperature control with ideal energy management. The cooling tower user selects a cold water temperature and the drive system will vary the fan speed to maintain that temperature. Precise temperature control is accomplished with far less stress to the mechanical equipment components. The improved energy management provides fast payback. Indeed, many utilities offer generous rebates for users having installed VFD drives.

Enclosures

Occasionally, cooling towers are located inside architectural enclosures for aesthetic reasons. Although Sigma towers adapt well to enclosures, a poorly designed enclosure can impair proper operation. An effective design includes generous air inlet paths, with the tower's fan cylinder discharge at or above the top of the enclosure. See *Marley Technical Report #H-004*, "**External Influences on Cooling Tower Performance**," for design recommendations.

It may also be advisable to increase your design wet-bulb temperature by 1°F to compensate for potential recirculation initiated by the enclosure. You'll benefit from discussing your project with your Marley sales representative.

Sound Control

A Sigma tower operating in an unobstructed environment will meet all but the most restrictive noise limitations – and will react favorably to natural attenuation. Where the tower will operate within an enclosure, the enclosure itself will usually have a damping effect on sound. Distance will also reduce sound – by about 5 dBA each time the distance is doubled. Where noise at a critical point is likely to exceed an acceptable limit, you have several options, listed below in ascending order of cost impact:

Noise concerns are often limited to nighttime, when ambient noise levels are lower and neighbors are trying to sleep. You can usually resolve these situations by using two-speed motors in either 1800/900 or 1800/1200 RPM configuration; and operating the fans at reduced speed without cycling "after hours". This relatively inexpensive solution pays for itself quickly in reduced energy costs.

Where the problem can exist at all times (such as near a hospital), the best solution is to oversize the tower so it can operate continuously at reduced (1200 or 900 RPM) motor speed. Typical sound reductions are 7 dB at 2/3 fan speed or 10 dB at 1/2 fan speed.

Extreme cases may require inlet and discharge sound attenuator sections; however, the static pressure loss imposed by attenuators may necessitate an increase in tower size. This is the least desirable approach because of its significant cost impact – and because it obstructs normal maintenance procedures.

Your Marley sales representative can help you meet your sound requirements.

System Cleanliness

Cooling towers are very effective air washers. Atmospheric dust able to pass through the relatively small louver openings will enter the circulating water system. Increased concentrations can intensify system maintenance by clogging screens and strainers; and smaller particulates can coat system heat transfer surfaces. In areas of low flow velocity (such as the cold water basin), sedimentary deposits can provide a breeding ground for bacteria.

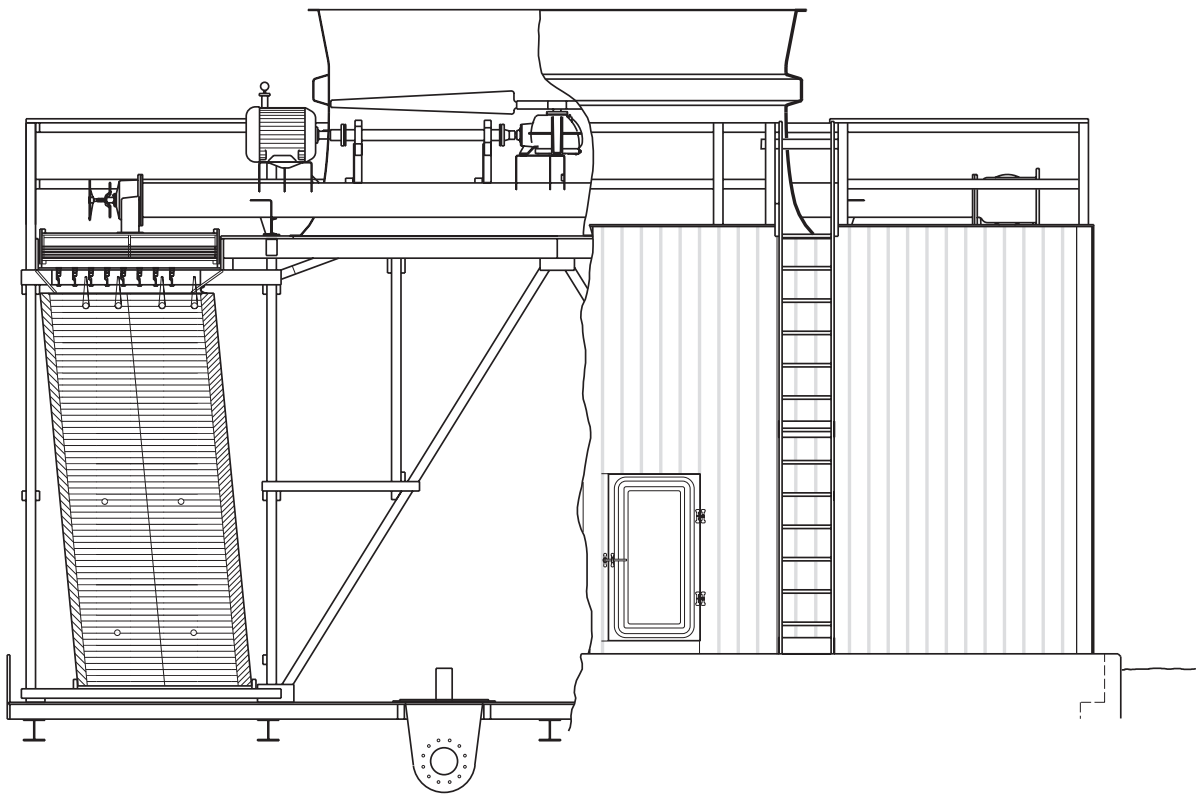
In areas prone to dust and sedimentation, you should consider installing some means for keeping the cold water basin clean. Typical devices include side stream filters and a variety of filtration media.

You should also plan ahead to develop a consistent, effective program of water treatment. A good water treatment program will help to assure long service life, while keeping your tower free of potentially harmful biological growths.

⚠ CAUTION

The cooling tower must be located at such distance and direction to avoid the possibility of contaminated discharge air being drawn into building fresh air intake ducts. The purchaser should obtain the services of a Licensed professional Engineer or Registered Architect to certify that the location of the cooling tower is in compliance with applicable air pollution, fire and clean air codes.

Specifications	Specification Value
1.0 **Base:**	
1.1 Furnish and install an induced-draft, crossflow-type, field-erected, wood-framed, PVC fill, industrial-duty cooling tower of _____ cell(s), as shown on Plans. The limiting overall dimensions of the tower shall be _____ wide, ____ long, and _____ high to the top of the fan cylinder. Total operating horsepower of all fans shall not exceed ____ hp, consisting of ___ @ _____ hp motor(s). Tower shall be similar and equal in all respects to Marley Model _____.	■ Your specification base establishes the type, configuration, base material, and physical limitations of the cooling tower to be quoted. During the planning and layout stages of your project, you will have focused your attention on a cooling tower selection that fits your space allotment, and whose power usage is acceptable. Limitations on physical size and total operating horsepower avoid the introduction of unforeseen operational and site-related influences. Specifying the number of cells, and the maximum fan hp/cell will work to your advantage. Crossflow towers are noted for the accessibility and maintainability of all operating components. The spacious interior provides easy access to fill, drift eliminators, all basin accessories—and is one of two primary accessways to the fan, Geareducer, and other mechanical components. At the fan deck level, the hot water distribution basins are easily inspected and cleaned—while the tower is operating, if you wish. The mechanical equipment can also be readily accessed from this level. Except for the cold water basin, no counterflow tower component requiring routine maintenance is as easily accessed. The confined areas that typify counterflow designs can make difficult work for maintenance personnel!



Specifications	Specification Value

2.0 **Thermal Performance:**

2.1 The tower shall be capable of cooling _____ GPM of water from ____ °F to _____ °F at a design entering air wet-bulb temperature of _____ °F. The cooling tower manufacturer shall guarantee that the tower supplied will meet the specified performance conditions when the tower is installed according to plans.

2.2 The purchaser will arrange for an on-site thermal performance test, to be conducted in the presence of the manufacturer and owner, and under the supervision of a qualified, disinterested third party in accordance with CTI (Cooling Technology Institute) ATC-105 standards during the first full year of operation. If the tower fails to perform within the limits of test tolerance, then the cooling tower manufacturer will install additional cells and/or make such corrections as are agreeable to the owner and shall pay for the cost of a retest. If the tower still fails to perform as specified, then the manufacturer shall make such reimbursements as are appropriate and agreeable to the owner to compensate for the performance deficiency.

■ Your reason for purchasing a cooling tower is to obtain a continuing flow of cooled water as defined in the first paragraph at left. If the tower that you purchase is incapable of performing as specified, then you will not have received full value for your money.

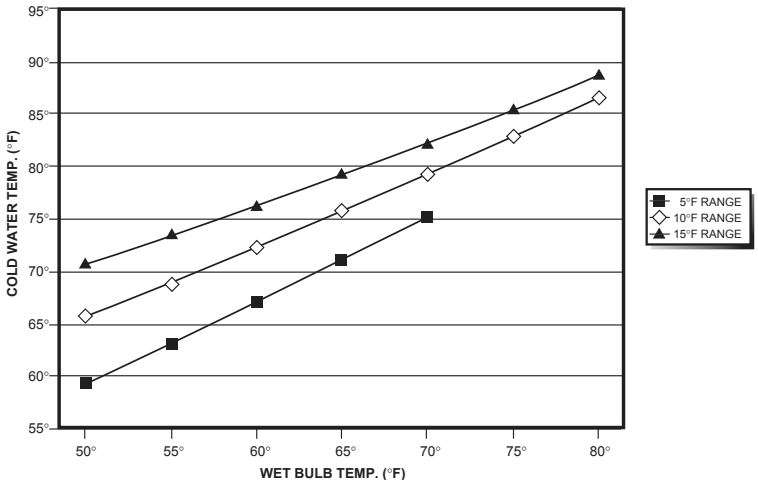
Bear in mind that the size—and cost—of a cooling tower varies directly with its true thermal capability. This paragraph is intended to protect you against either intentional or inadvertent under sizing of the tower by the manufacturer. Judging the level of performance of a cooling tower on critical processes is never easy, and the potential risk of a non-performing cooling tower usually causes the requirement for a mandatory acceptance test to be very desirable.

Your contract with the successful bidder should establish the acceptable remedies for missed performance, which might include:

- The addition of one or more cells of tower, as necessary, to bring the cooling tower to the specified level of performance. This is usually limited to the scope of work as defined in the specs, which means that you (the owner) will have to pay for the additional basin, wiring, starters, piping, etc.

- The reimbursement of a portion of the total contract price equal to the percentage deficiency in performance.

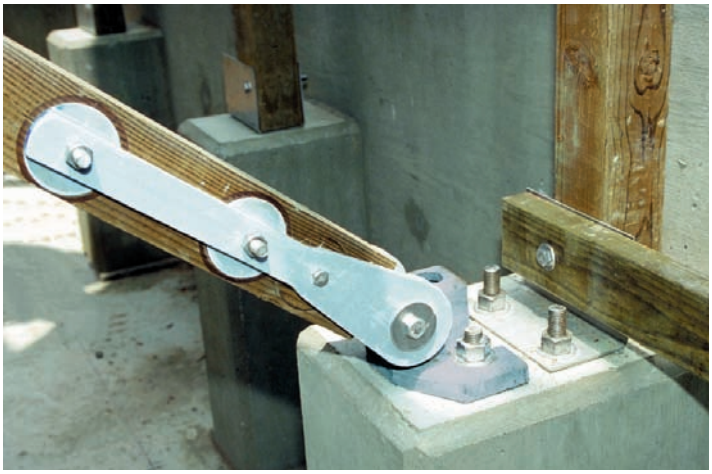
Under no circumstances should you allow the manufacturer to re-pitch the fans to increase motor brake horsepower above that shown in the proposal. That creates additional operating costs that will continue for the life of the tower—and imposes no penalty on the manufacturer.



Typical cooling tower performance curve.

Specifications	Specification Value
3.0 **Construction:**	
3.1 The tower shall be capable of withstanding water having a pH of 6.5 to 8.0; a chloride content (NaCl) up to 750 ppm; a sulfate content (SO_4) up to 1200 ppm; a sodium bicarbonate content ($NaHCO_3$) up to 200 ppm; a calcium content ($CaCO_3$) up to 800 ppm; silica (SiO_2) up to 150 ppm; and design hot water temperatures up to 120°F. The circulating water will contain no oil, grease, fatty acids, or organic solvents.	■ The limiting water quality values indicated are those which are acceptable for the normal materials of construction specified. **If water of more aggressive quality is anticipated please change hardware material requirement to 300 Series stainless steel, as indicated below and following.**
3.2 The structural framework of the tower shall be Douglas Fir, designed in accordance with CTI STD-114. Nylon shear plates shall be utilized to transmit loads at critical joints, and all fasteners shall be in accordance with CTI STD-119. Basic design criteria shall be 30 psf wind load and 5%g seismic load.	Cooling Technology Institute standards take into account the hot, humid environment in which a cooling tower normally operates. This environment can render the limits of customary construction standards inadequate for cooling tower design.
3.3 All wood components shall be treated after fabrication with chromated copper arsenate (CCA) by the full-cell process to a chemical retention of 0.4 lbs/ft^3.	The importance of shear plates is discussed at length in *Marley Difference*, "**Item S-3**". Ask your Marley representative for a copy.
3.4 Structural columns and diagonals shall be 4"x4". Framing girts may be 2"x4", except for those supporting the hot water basins and fill. Those girts shall be 2"x6" minimum, located both sides of the support columns.	**See notes on page 27 regarding the use and availability of redwood.**
3.5 Multicell towers shall include treated Douglas Fir plywood partitions between cells in the plenum area. Partitions shall extend the full height of the tower from the base of fill to the underneath side of the fan deck.	Specification of minimum member sizes assures that all offerings will conform to an industrial level of construction.
3.6 Column lines shall be on no greater than 4'-0" longitudinal centers, and the base of all perimeter columns shall be firmly anchored to galvanized steel base plates. Framing joints shall be made with 1/2" diameter or larger series 300 stainless steel machine bolts, nuts and washers.	Multicell towers must have plenum partitions between cells. Otherwise, air will be induced downward through an inoperative fan, bypassing the fill entirely. Without these partitions, part-load or off-season operation of the tower would be completely unsatisfactory.

Specifications	Specification Value
4.0 **Fan Deck and Fan Cylinder:**	
4.1 The fan deck shall act as a working platform for maintenance personnel. It shall be fabricated of no less than 1" thick, 7 ply, exterior grade, treated Douglas Fir plywood, and shall be designed for a uniform live load of 60 psf or a concentrated load of 600 pounds.	■ The indicated design values for framing and decking not only give you assurance that the tower can withstand long term operation in a hostile environment—but that it will accept many years of inspection and maintenance traffic by your operating personnel.
4.2 Fan cylinders shall be molded FRP. They shall be anchored to the fan deck structure to provide a consistently stable operating shroud for the fan. Fan cylinders less than 72" in height shall be equipped with a heavy gauge, removable, hot-dip galvanized steel fan guard for the protection of operating personnel.	Fiberglass-reinforced polyester fan cylinders provide the close tip clearances and smooth airflow contour necessary for good fan performance. The inert, noncorroding nature of FRP assures that these characteristics will persist. **Even in aggressive water conditions, the heavy construction of the fan guard normally precludes the need for stainless steel.**



Diagonal and Column Anchorage

Diagonal Connector

Specifications	Specification Value

5.0 **Mechanical Equipment:**

5.1 Fan(s) shall be propeller-type, incorporating heavy duty blades of cast aluminum or high strength, inert composite material. Blades shall be individually adjustable and replaceable. Fan(s) shall be driven through a rightangle, industrial-duty, oil-lubricated, geared speed reducer. Speed reducers employing pulleys and belts will not be accepted.

5.2 Motor(s) shall be ____ hp maximum, TEFC, 1.15 service factor, and specially insulated for cooling tower duty. Speed and electrical characteristics shall be 1800 (1800/900) RPM, single winding, ___ phase, ___ hertz, ___ volts.

5.3 Motor shall be located outside the fan cylinder at the fan deck, and shall be connected to the speed reducer by a tubular stainless steel, dynamically balanced driveshaft equipped with neoprene flexible coupling elements.

5.4 A galvanized oil gauge and drain line shall extend from the gear reducer to the vicinity of the motor, and shall be equipped with a dip stick for oil level measurement.

5.5 The complete mechanical equipment assembly for each cell shall be supported by a rigid, unitized support that resists misalignment between the motor and the gear reducer. Support shall be heavy-wall tubular steel, to which heavy plate platforms for the motor and gear reducer have been welded and the assembly shall be hot-dip galvanized after fabrication. The support assembly shall also provide an inlet connection for incoming hot water, and shall serve as a crossover pipe to deliver water to both sides of the tower.

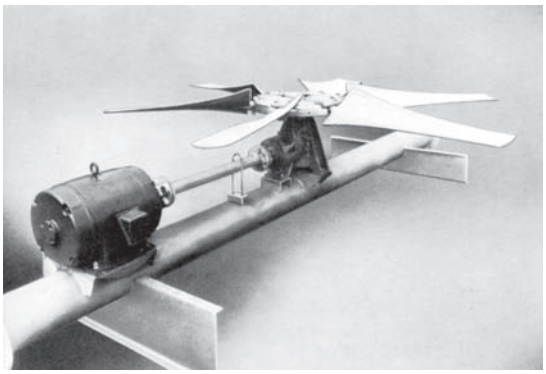
5.6 The mechanical equipment assembly shall be warranted for no less than five (5) years. This warranty shall cover the fan(s), speed reducers, driveshafts and couplings, and the unitized supports.

■ Standard fan drives of other manufacturers may use V-belts. Considering the size of fans involved—and the horsepowers applied—this is not good design practice. Geareducer® drive is far more reliable and trouble free, and is currently offered as an option by at least two other cooling tower manufacturers.

Unless otherwise specified, motor speed will be 1800 RPM in 60 Hertz areas and 1500 RPM in 50 Hertz areas. If you prefer the operating flexibility of two-speed operation, please specify the RPM to be 1800/900 (1500/750 in 50 Hertz regions).

The driveshaft turns at the motor speed and is, therefore, most sensitive to operational imbalance. Stainless steel manufacture assures that the driveshaft will not become unbalanced as a result of corrosion.

The extended oil line to an external dip stick provides a convenient means of checking the level of oil in the Geareducer. As indicated on page 27, a sight glass is also available in lieu of the dip stick.

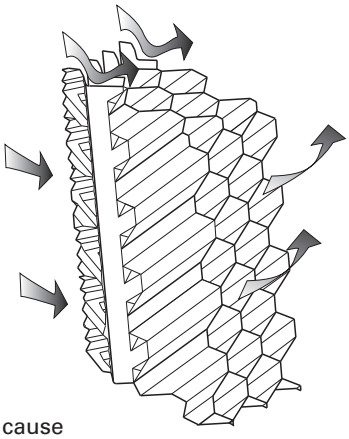


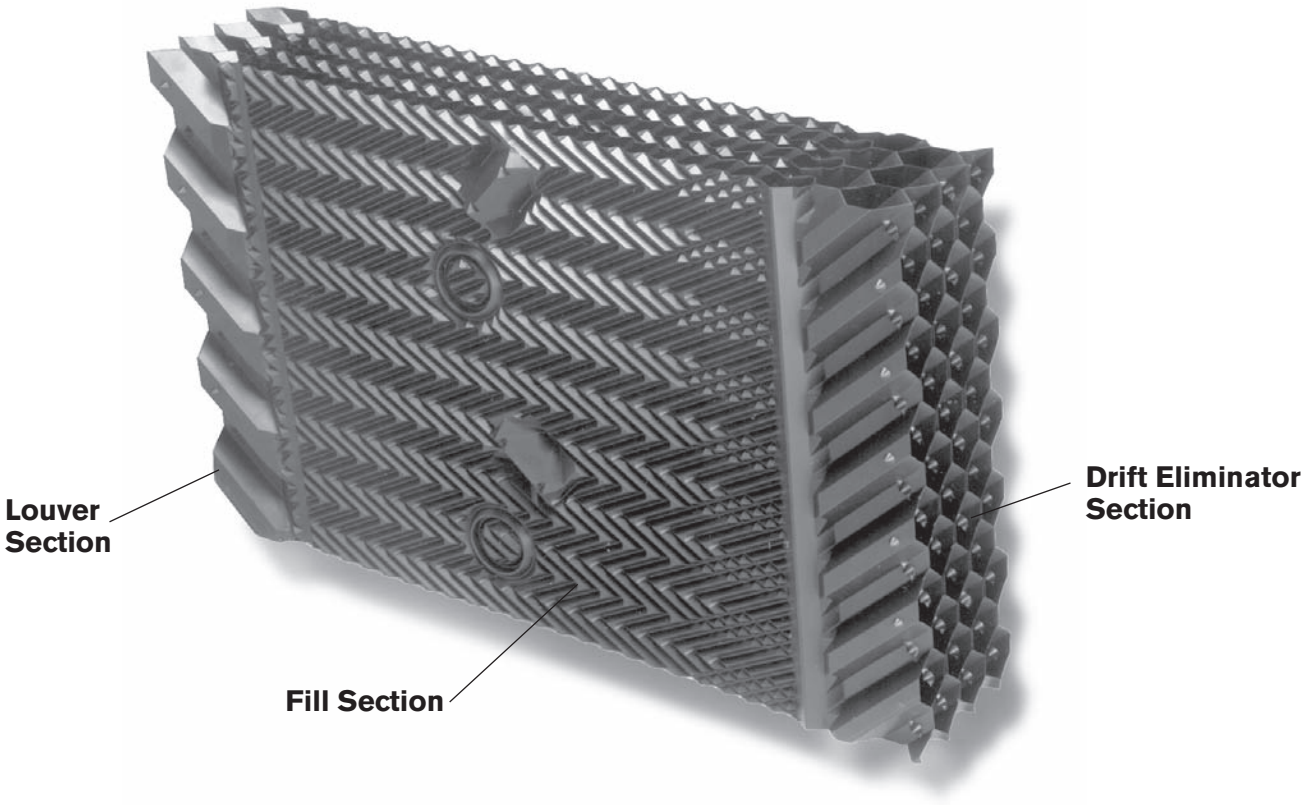
Fans of the size used on large cooling towers are applied at speeds and horsepowers that generate considerable torque—and structural tubular steel resists this torque very effectively. The Marley torque-tube assures that all of the mechanical equipment remains aligned, and that the rotating fan is properly positioned within the fan cylinder. Hot-dip galvanizing after fabrication assures that all steel surfaces will be heavily coated with zinc for long-term protection against corrosion.

Even in aggressive water conditions, the heavy construction of the unitized support normally precludes the need for stainless steel.

The value of a 5 year mechanical equipment warranty speaks for itself. Except for the motor, all of the mechanical equipment on a Marley tower is made by SPX Cooling Technologies. Cooling tower vendors who purchase commercial fans, gear boxes, driveshafts, etc. may require that you deal directly with those commercial suppliers for warranty satisfaction.

Specifications	Specification Value
6.0 **Fill, Louvers and Drift Eliminators:**	
6.1 Fill shall be film-type, 15 mil thick, thermoformed PVC, with louvers formed as part of each fill sheet. Fill shall be suspended from stainless steel structural tubing supported from the upper tower structure, and shall be elevated above the floor of the cold water basin to facilitate cleaning. Air inlet faces of the tower shall be free of water splash-out.	■ Louvers integral with the fill keep the flowing water within the confines of the fill. The separate external louvers used by others permit water to escape the fill and form ice or produce an unsightly situation adjacent to the tower. If you plan to use your tower in the wintertime, particularly for free cooling, integral louvers will put your operating concerns to rest.
6.2 Drift eliminators shall be PVC, triple-pass, and shall limit drift losses to no more than 0.010% of the design GPM flow rate.	Vertical blade-type eliminators, as well as misdirected cellular types, cause much of the fan power to be wasted in turning the horizontal flow of air vertical for its exit through the fan cylinder. This power is, of course, not available for contribution to thermal performance. Drift rate varies with design water loading and air rate, as well as drift eliminator depth and number of directional changes. The indicated rate of 0.010% or less is easily achievable without premium cost. If a lower rate is required, please discuss with your Marley sales representative.





Specifications	Specification Value
7.0 **Hot Water Distribution System:**	
7.1 The mechanical equipment support/crossover pipe shall deliver water to two open hot water basins per cell at the fan deck elevation. Water shall exit these basins to the fill by gravity through metering orifice-type polypropylene nozzles situated in the basin floor. Nozzles shall be easily removable and replaceable.	■ Gravity-flow distribution basins are a feature of crossflow type towers. These basins are out where they can be easily inspected—even maintained—while the tower is in operation. Spray systems of counterflow towers, sandwiched between the top of the fill and the drift eliminators, are extremely awkward to access and maintain. Marley flow-control valves remain serviceable for the life of the tower, and provide a continuing means of flow-regulation between hot water basins—and between cells of multicell towers as well. Towers without valves do not provide this valuable operating flexibility.
7.2 Heavy-duty, industrial grade flow-control valves shall be provided at the inlet to each basin. These valves shall permit both flow balancing and maintenance shut-off to selected cells, or portions of cells. Valves shall have machined cast iron bodies, with stainless steel operating stems, and heavy-duty locking handles.	
8.0 **Casing:**	
8.1 Tower endwalls shall be cased with ribbed FRP panels, lapped and sealed to prevent leakage. Tower corners shall be finished with FRP corner rolls.	
9.0 **Access:**	
9.1 Single cell towers shall include a 33" wide by 61" high molded FRP access door in one endwall casing for access to the interior of the tower. Casing access door shall be hinged and equipped with a latch operable from both inside and outside the tower. Multicell towers shall have an access door in both endwalls, and shall include a lift-out door in each transverse partition to give free access through the tower.	■ The access doors on other towers may be unreasonably small. Specifying the size of the door will cause those bidders to take exception, alerting you to a potential maintenance headache. Good maintenance practice requires periodic access to the top of the tower to inspect the distribution basins, as well as the structural integrity of the fan deck, fan cylinder, and fan—especially the fan blade securing hardware. And there are no induced-draft cooling tower designs that are immune to this need!
9.2 The top of the tower shall be equipped with a sturdy 42" high wood guardrail system; top rails, intermediate rails, and toeboards; conforming to OSHA standards. Posts shall be 4"x4", on no greater than 8'-0" centers. Guardrails shall be 2"x4". Single 2"x4" top rail will be acceptable up to 6'-0" span. Above 6'-0" span, an additional 2"x4" cap strip shall be included.	

Specifications	Specification Value
9.3 Each endwall of the tower shall be equipped with a 20" wide aluminum vertical ladder, through-bolted to the endwall structure. Ladder shall rise from the cold water basin level to the top of the fan deck guardrail, and shall be designed and installed in conformance with OSHA standards.	For the comfort and safety of your operating personnel, the Sigma tower includes a ladder and guardrail of the quality and design indicated—and we strongly recommend that you require it of all bidders! Portable ladders and other "make-do" access means are inappropriate for equipment of this size and complexity.
10.0 **Cold Water Collection Basin**:	
10.1 The cold water collection basin shall be of poured-in-place concrete, provided under scope of work done by others. The concrete basin design shall be based upon certified loads and dimensions provided by the cooling tower manufacturer.	■ This basic specification assumes that the tower will be erected over a concrete basin at grade level. If the tower is to be installed on an elevated supporting platform, the plywood cold water collection basin indicated on page 17 should be included in the specifications.
11.0 **Scope of Work**:	
11.1 The cooling tower manufacturer shall be responsible for the design, fabrication, and delivery of materials to the project site, and for the erection of the tower over supports provided by others. Unless otherwise specified, all external piping, pumps, controls, and electrical wiring will be outside the cooling tower manufacturer's scope of work.	■ Please be clear in your specifications and inquiry documents regarding the full scope of work expected. That will help assure that your bid comparisons will be made on as equal a basis as possible—and will help to avoid any misunderstandings during the execution and implementation of the contract.

Specifications	Specification Value
Control Options	
Control System:	
5.7 *Add the following paragraph in the Mechanical Equipment section:* Each cell of the cooling tower shall be equipped with a UL listed control system in a NEMA 3R or 4X outdoor enclosure capable of controlling single-speed or two-speed motors as required, and designed specifically for cooling tower applications. The panel shall include a main fused disconnect with an external operating handle, lockable in the off position for safety. Across-the-line magnetic starters or solid state soft-start starters as required shall be controlled with a thermostatic or solid state temperature controller. Door mounted selector switches shall be provided to enable automatic or manual control and wired for 120VAC control. Control circuit to be wired out to terminal blocks for field connection to a remote vibration switch and for access to extra 120VAC 50VA control power, overload trip alarms and remote temperature control devices. The temperature controller shall be adjustable for the required cold water temperature. If a thermostatic controller is used it shall be mounted on the side of the tower with the temperature sensing bulb installed in the cold water basin using a suspension mounting bracket. If a solid state temperature controller is used the controller will be door mounted on the control panel. The temperature controller will display two temperatures, one for outgoing water and the other for set point. Water temperature input shall be obtained using a three-wire RTD with dry well in the outlet water piping and wired back to the solid state temperature controller in the control panel.	■ If it is your opinion that the control system for the cooling tower should be part of the tower manufacturer's responsibility, we are in wholehearted agreement with you. Who better to determine the most efficient mode and manner of a tower's operation—and to apply a system most compatible with it—than the designer and manufacturer of the cooling tower?

Specifications	Specification Value
Basin Heater:	
10.2 *Add the following paragraph in the Cold Water Basin section:* Provide a system of electric immersion heaters and controls for each cell of the tower to prevent freezing of water in the collection basin during periods of shutdown. The system shall consist of one or more stainless steel electric immersion heaters installed in a galvanized steel heat shield provided in the floor of the basin. A NEMA 4 enclosure shall house a magnetic contactor to energize heaters; a transformer to provide 24 volt control circuit power; and a solid state circuit board for temperature and low water cutoff. A control probe shall be located in the basin to monitor water level and temperature. The system shall be capable of maintaining 40°F water temperature at an ambient air temperature of __ °F. Wiring of the heaters and controls shall be the responsibility of the purchaser.	■ The basin heater components described at left represent our recommendation for a reliable automatic system for the prevention of basin freezing. They are shipped separately for installation at the jobsite. If aggressive operating conditions are anticipated, change "galvanized" in paragraph 10.2 to "Series 300 SS". The ambient air temperature that you fill in should be the lowest 1% level of winter temperature prevalent at site. Ask for Marley drawing 92-3627.
Fan Motor Variable Speed Drive: **Marley All Weather ACH550 System**	
6.4 *Add the following paragraph in the Mechanical Equipment section when VFD is used with customers Building Management System:* A complete UL listed Variable Speed Drive system in a NEMA 1 indoor, NEMA 12 indoor or NEMA 3R outdoor enclosure shall be provided. The VFD shall use PWM technology with IGBT switching and integrated bypass design. VFD out put switching shall not cause mechanical issues with gearbox teeth or drive shafts. The VFD shall catch a fan spinning in the reverse direction without tripping. The panel shall include a main disconnect with short circuit protection and external operating handle, lockable in the off position for safety. The VFD system shall receive a speed reference signal from the Building Management System monitoring the tower fluid temperature. As an option to receiving the speed reference signal from a building management system, the drive must have the capability to receive a 4-20 ma temperature signal from an RTD transmitter. The VFD shall have an internal PI regulator	■ Marley VFD drive systems are designed to combine absolute temperature control with ideal energy management. The cooling tower user selects a cold water temperature and the drive system will vary the fan speed to maintain that temperature. Precise temperature control is accomplished with far less stress to the mechanical equipment components. The improved energy management provides fast payback. Indeed, many utilities offer generous rebates for users having installed VFD drives.

Specifications	Specification Value

to modulate fan speed maintaining set point temperature. The drive's panel display shall be able to display the set-point temperature and cold-fluid temperature on two separate lines. The bypass shall include a complete magnetic bypass circuit and with capability to isolate the VFD when in the bypass mode. Transfer to the bypass mode shall be manual in the event of VFD failure. Once the motor is transferred to the by-pass circuit the fan motor will run at constant full speed. The bypass circuit will not modulate ON and OFF based on fluid temperature. The application must be able to handle very cold fluid temperatures while the VFD is in a by-pass mode. Operator controls shall be mounted on the front of the enclosure and shall consist of start and stop control, bypass/VFD selection, Auto/Manual selections, manual speed control. To prevent heating problems in the fluid cooloer fan motor and to assure proper gear reducer lubrication the VFD system shall de energize the motor once 25% motor speed is reached and cooling is no longer required. The fluid cooler manufacturer shall supply VFD start-up assistance. Tower vibration testing throughout the speed range is required to identify and lockout any natural frequency vibration levels which may exceed CTI guidelines.

Marley Premium VFD System

6.4 *Add the following paragraph in the Mechanical Equipment section when VFD is used as a stand alone system:*
A complete UL listed Variable Speed Drive system in a NEMA 12 indoor or NEMA 3R outdoor enclosure shall be provided. The VFD shall use PWM technology with IGBT switching and integrated bypass design. VFD output switching shall not cause mechanical issues with gearbox teeth or drive shafts. The VFD shall catch a fan spinning in the reverse direction without tripping. The panel shall include a main disconnect with short circuit protection and external operating handle, lockable in the off position for safety. The system shall include a solid state, PI temperature controller to adjust frequency output of the drive in response to the tower fluid temperature. The temperature of the fluid and

Specifications	Specification Value
set point shall be displayed on the door of the control panel. The bypass shall include a complete magnetic bypass circuit with capability to isolate the VFD when in the bypass mode. Transfer to the bypass mode shall be automatic in the event of VFD failure or for specific trip conditions allowing safe transfer of utility voltage to the motor. Automatic bypass with an earth ground condition is not allowed. The bypass contactor shall be cycled on and off while operating in bypass, to maintain the set-point temperature of the cold water. The drive design shall be operated as a stand-alone system without the need for a BMS system. Operator controls shall be mounted on the front of the enclosure and shall consist of start and stop control, bypass/VFD selector switch, Auto/Manual selector switch, manual speed control, and solid-state temperature controller. An emergency bypass selector switch internal to the panel allowing the fluid cooler fan motor to be run at full speed shall be furnished. To prevent heating problems in the fluid cooler fan motor and to assure proper gear box lubrication the VFD system shall de energize the motor once 25% motor speed is reached and cooling is no longer required. The VFD shall include de-icing logic with auto canceling and adjustable time. Speed in De-Ice mode shall not exceed 50% motor speed. The fluid cooler manufacturer shall supply VFD start-up assistance. Tower vibration testing throughout the speed range is required to identify and lockout any natural frequency vibration levels which may exceed CTI guidelines.	
Vibration Limit Switch:	
5.8 *Add the following paragraph in the Mechanical Equipment section:* A single-pole, double-throw vibration limit switch in a NEMA 4 housing shall be installed on the mechanical equipment support for wiring into the owner's control panel. The purpose of this switch will be to interrupt power to the motor in the event of excessive vibration. It shall be adjustable for sensitivity, and shall require manual reset.	■ Unless specified otherwise, a Marley M-5 vibration switch will be provided. The requirement for manual reset assures that the tower will be visited to determine the cause of excessive vibration.

Specifications	Specification Value

Convenience and Safety Options

Stairway:

9.3 *Replace paragraph 9.3 with the following:* A 30" wide, column supported, 45° stairway with 8" rise and run of treated Douglas Fir shall be provided at the tower endwall rising from grade (roof) to the fan deck elevation. Stair columns shall be 4x4. Guardrails shall be 2"x4". The upper guardrail shall have an eased edge for the protection of operating personnel. Stairway foundation shall be by others, designed in accordance with drawings provided by the cooling tower manufacturer. The stairway shall conform to OSHA standards.

■ Although they are not necessary for routine operation and maintenance, stairways do provide a safe and comfortable means of access to the top of the tower that is often overlooked in the initial cooling tower purchase. They are designed in straight-run or double-back configurations to accommodate your site requirements.

Plenum Walkway:

9.1 *Add the following to the end of this paragraph:* Provide a 30" wide walkway extending from one endwall access door to the other through the length of the tower. Walkway shall be constructed of treated Douglas Fir, and the top of the walkway shall be above the cold water basin overflow level. If the cold water basin is deeper than 4'-0", the walkway shall be equipped with guardrails.

■ This option permits freedom of movement for inspection or maintenance within the tower without the need for wading boots or tower drainage. It also helps prevent maintenance personnel from damaging submerged accessories in the cold water basin (such as screens, probes, basin heaters, etc.).

Ladder Extension:

9.4 *Add the following paragraph in the Access and Safety section:* Provide a ladder extension for connection to the base of the ladder attached to the tower casing. This extension shall be long enough to rise from the roof (grade) level to the base of the tower. Anchorage and lateral bracing of the ladder extension shall be by others.

■ Many towers are installed such that the base of the tower is 2′-0″ or more above the roof or grade level. This makes it difficult to get up to the base of the attached ladder. The ladder extension alleviates this problem. Marley ladder extensions are available in standard 5′-0″ and 11′-0″ lengths, and will be field-cut to fit.

Ladder Safety Cage:

9.3 *Add the following to the end of this paragraph:* A heavy gauge galvanized steel safety cage shall surround the ladder, extending from a point approximately 7'-0" above the base of the ladder to the top of the guardrail surrounding the fan deck.

■ To meet OSHA guidelines, towers whose fan decks are 20'-0" or more above roof or grade, and which are equipped with ladders, are required to have safety cages surrounding the ladders.

Specifications	Specification Value
Oil Level Sight Glass:	
5.4 *Replace paragraph 5.4 with the following:* A galvanized oil gauge and drain line shall extend from the gear reducer to the vicinity of the motor, and shall be equipped with a bronze-bodied oil level sight glass.	■ The oil level sight glass is a convenience item that is preferred by many users. The same purpose is, of course, served by either the dip stick or the sight glass.
Miscellaneous Options	
Wood Cold Water Basin:	
10.1 *Replace paragraph 10.1 with the following:* Include a cold water collection basin constructed of pressure treated Douglas Fir plywood. Basin floor shall be 3/4" thick 5-ply, supported by 6" deep joists on 2'-0" centers. Basin sides shall be 1" thick, 7 ply. The basin floor shall lock into a dado groove in the sides to form a watertight seal. A depressed, side outlet sump of either FRP or hot-dip galvanized steel having a 1/4" thick faceplate drilled for a standard class 125 ASME flange connection will be included. An appropriately sized (4" diameter or larger) galvanized standpipe overflow shall be provided. The standpipe shall be removable for flush-out cleaning of the basin. A float-operated, mechanical makeup valve shall also be included, installed adjacent to the endwall access door.	■ Marley basins are used to permit the installation of towers on elevated platforms or foundations. The cross section drawing on page 4 shows the relationship of the optional basin, sump and overflow to a typical steel I-beam support platform.
Redwood Components:	■ Most of the wood components in the tower are available of pressure treated redwood. However, redwood lacks the strength of Douglas Fir, which may require structural modifications of the tower. Please discuss the available redwood options with your Marley sales representative.
Hot Water Basin Covers:	
7.3 *Add the following paragraph in the Hot Water Distribution System section:* The distribution basins shall include treated Douglas Fir plywood covers at least 3/4" thick. These covers shall be designed to withstand 60 psf live load, and shall be easily removable for maintenance.	■ These covers are designed to keep leaves and debris out of the circulating water system. They also serve to suppress algae formation by shielding the incoming hot water from direct sunlight.
Air Inlet Screens:	
6.3 *Add the following paragraph to the Fill, Louvers and Drift Eliminators Section:* The air inlet faces of the tower shall be covered by 1" mesh hot-dip galvanized welded wire screens. Screens shall be mounted in galvanized steel U-edging and shall be removable.	■ In wooded or windy areas, these screens help to keep leaves or blowing debris out of the cooling tower and circulating water system.

Specifications

Low Noise Tower:

1.1 *Add the following at the end of this paragraph:* The cooling tower shall be quiet operating, and shall produce an overall level of sound no higher than ____ dBA at the critical location indicated on the Plans.

Specification Value

■ Sound produced by a Sigma Steel tower operating in an unobstructed environment will meet all but the most restrictive noise limitations – and will react favorably to natural attenuation. Where the tower has been sized to operate within an enclosure, the enclosure itself will have a damping effect on sound. Sound also declines with distance – by about 5 or 6 dBA each time the distance doubles. Where noise at a critical point is likely to exceed an acceptable limit, you have several options – listed below in ascending order of cost impact:

- Where only a slight reduction in noise will satisfy — and the source of concern is in a particular direction — merely turning the tower may be the answer. Less sound emanates from the cased face of the tower than does from the air intake face.

- In many cases, noise concerns are limited to nighttime, when ambient noise levels are lower and neighbors are trying to sleep. You can usually resolve these situations by using two-speed motors in either 1800/900 or 1800/1200 RPM configuration; and operating the fans at reduced speed without cycling "after hours". (The natural nighttime reduction in wet-bulb temperature makes this a very feasible solution in most areas of the world, but the need to avoid cycling may cause the cold water temperature to vary significantly.)

- Variable speed drives automatically minimize the tower's noise level during periods of reduced load and/or reduced ambient without sacrificing the system's ability to maintain a constant cold water temperature. This is a relatively inexpensive solution, and can pay for itself quickly in reduced energy costs.
- Where noise is a concern at all times (for example, near a hospital), the best solution is to oversize the tower so it can operate continuously at reduced (1200 or 900 RPM) motor speed even at the highest design wet-bulb temperature. Typical sound reductions are 7 dBA at 2/3 fan speed or 10 dBA at 1/2 fan speed, but larger reductions are often possible.

- Extreme cases may require inlet and discharge sound attenuator sections; however, the static pressure loss imposed by attenuators may necessitate an increase in tower size. This is the least desirable approach because of the significant cost impact – and because of the obstruction to normal maintenance procedures.

Your Marley representative can help you meet your sound requirements.

Specifications	Specification Value
Watertight Partitions Between Cells:	■ In addition to the normal partition function of preventing air bypass (page 17), this option allows you to use each partitioned cell of your tower independently. This is valuable where a single multicell tower is serving several separate systems—or where winter operation may require less than full tower capability.
3.5 *Replace the last sentence in this paragraph with the following:* Partitions shall be 3/4" x 5-ply, factory-fabricated, grooved and splined treated Douglas Fir plywood sheets, installed and sealed watertight to permit independent cell operation.	
Fire Safety Options:	■ Occasionally, critical processes or local codes may require you to install a fire-protection sprinkler system on a wood tower—or pay higher insurance premiums—or both. Our first recommendation in such a case would be for you to consider using a Sigma Steel cooling tower, as listed in the Factory Mutual Approval Guide. Another alternative that could be acceptable to your insurance carrier, and which you may wish to evaluate, would be to make your Sigma tower as fire resistant as possible. This can be done by any or all of the following measures: • FRP casing having a flame spread rating of 25 or less. (Para. 8.1) • Fan cylinders of fire-retardant FRP having a flame spread rating of 25 or less. (Para. 4.2) • ¼" thick fireproof fiber reinforced cement overlay over the fan deck—and will provide FRC overlaid distribution basin covers. (Para. 4.1) • ¾" thick plywood partitions both sides of the column line between cells to achieve a fire rating of at least 30 minutes. (Para. 3.5 and this page.)

LENNTECH
info@lenntech.com Tel. +31-152-610-900
www.lenntech.com Fax. +31-152-616-289

SPX
COOLING TECHNOLOGIES

7401 WEST 129 STREET
OVERLAND PARK, KANSAS 66213
UNITED STATES
913 664 7400
spxcooling@spx.com
spxcooling.com

In the interest of technological progress,
all products are subject to design and/or
material change without notice.
©2010 SPX Cooling Technologies, Inc.
Printed in USA | SIG-TS-10