



Switchboard Installation and Maintenance Manual

Industrial Electric Mfg™
48205 Warm Springs Blvd
Fremont CA 94539

dir 510.656.1600
fax 510.656.6250
www.iemfg.com

Tradition. Technology. Innovation.

CAUTION
UNPACKING THE SWITCHBOARD
KEEP THIS EQUIPMENT COVERED

This switchboard may have been packed to protect the finish and included apparatus. The switchboard consists of equipment, which may be protected from weather and extreme changes in the temperature.

If it is necessary to unpack the switchboard before final installation, it must be kept covered, dry and warm enough to prevent condensation until placed in service.

Great care should be exercised in uncrating and handling to prevent damage to the equipment and scratching the painted surface.

Note: Before putting this equipment into service, make sure that all bus and cable connections are tight.

INDEX

<u>Description</u>	<u>Page Number</u>
General Information.....	3
Inspection for Damage	3
Storage Before Installation	3
Moving and Lifting	4
Alignment of Foundation	4-7
Tightening Bolted Connections.....	8
Recommended Torque Values.....	8
Breaker Lifting Devices	8
Outdoor Equipment	8
Wiring.....	9
Getting Ready for Service	9-10
Dielectric Tests.....	10
Grounding	11
Ground Detection	11
Ground Fault Protection	12
Safety to Personnel.....	12
Operational Testing.....	12-13
Maintenance Program.....	13
Maintenance Records	14
Maintenance Tests.....	14
Maintenance Equipment.....	14-15
Frequency of Inspection	15
Safety Practices	15

PART I

SWITCHBOARD INSTALLATION & OPERATION GENERAL

SHIPMENT

The switchboard is assembled, wired, adjusted, and given complete tests at the factory, after which it is inspected and packed for shipment. Each crate is identified, and a complete list of its contents is included in the shipping papers. All instruments and relays are suitably blocked to prevent damage to bearings and movements.

REMOVAL FROM CARRIER & INSPECTION FOR DAMAGE

Immediately upon receipt of the shipment, identify all component parts and check them against the shipping list. Make a thorough examination to detect any damage that may have been incurred during transit.

If any damage is discovered, file a claim immediately with the carrier and send notice of the extent of damage to the Industrial Electric Manufacturing Company plant from which shipment was made, giving complete identification, carrier's name, and railroad car number if the shipment was made by rail.

The information will enable the company to supply necessary data in support of claim.

STORAGE BEFORE INSTALLATION

Protection against loss of equipment is an important precaution. Trouble and delay will be avoided by having good storage facilities arranged so that the apparatus will be accessible only to authorized persons so that it can be quickly located when required in the installation program.

Switchboard equipment, regardless of whether it is to be installed immediately or stored for a while before being installed, should be kept in a dry, clean place. Conditions such as dampness caused by rain or change in temperature, cement dust, etc., should be carefully guarded against. Covering the equipment with a temporary shelter or tarpaulin is frequently necessary both during storage and installation. The longer the period of storage, the greater must be the care taken for protection of the equipment.

It is advisable to place electric strip heaters or lamps within enclosures to raise temperature approximately 10 degrees above outside temperature at all times.

Crated apparatus, which is not to be installed immediately, should be left crated. It should, however, be inspected to make sure that no damage has been incurred during transit.

MOVING & LIFTING SWITCHBOARD

1. The importance cannot be over stressed regarding the care in handling, rigging, hoisting, rolling, or moving assembled switchboards into place. Switchboards are designed to be handled only in the upright position and should never be handled in any other way without first consulting with the factory.
2. When lifting shipping units with a crane, it is preferable to use two hooks simultaneously, one on each end. Each pair of lifting hooks should be equipped with a spanner bar to prevent excessive distortion. If only a single hook crane is available, arrange spanner to lifting rig. Lifting from front and rear of units permits placing shipping sections side by side for bolting without interference from lifting rig or hooks.
3. When cranes are not available, equipment can be rolled into place on shipping skids when provided. Pushing or pulling forces should be applied to the skid and not the switchboard.
4. Shipping skids can be removed by using a foot jack in each corner of the shipping section after the switchboards has been moved to its final location.

PART II

INSTALLATION

ALIGNMENT OF FOUNDATION (SEE SUPPLEMENT BELOW)

Your Industrial Electric switchboard is accurately built true and level. This care and accuracy insures ease of operation and interchangeability. Equal care in installation should be used.

SUPPLEMENT

Switchboards, which are generally rated 2500A or less, 36 to 48 inch deep, and do not contain breakers of the drawout design, do not require imbedded channels as shown on page 5. If installed on a firm level foundation the switchboards can be mounted and bolted directly to the concrete.

ALIGNMENT OF FOUNDATION (CONTINUED)

A true and level floor for this equipment is utmost importance. A little more than ordinary care in laying out and preparing the foundation will be repaid in reduction of cost and labor of installation.

The steel supporting members used in the floor should be held level until the concrete is set. The surface of the floor under the housing should not project above the supporting member.

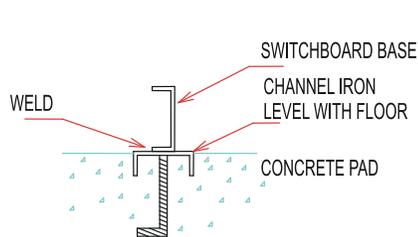
The floor in front of the housing should not vary more that 1/8" in any square yard.

When installing switchboards on existing floors, it will usually be desirable, to pour a new finish floor with embedded channels or cut slots for embedding and leveling the support channels.

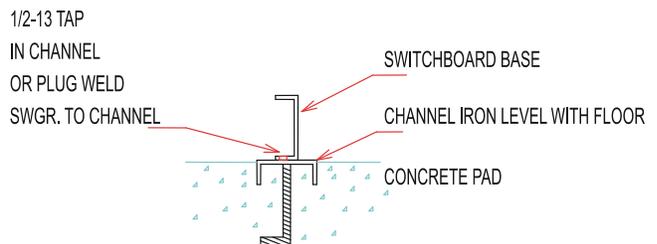
Encircling loops of reinforcing or building steel around single phase conductors should be avoided in the areas marked for main cables when these circuits are rated at 600 amperes or above.

To assure an accurate and level base floor, channels or their equivalent should be provided. Illustrated below are recommended methods of preparing the base for the switchboard. Although the switchboard can be bolted to the floor channel, it is recommended that the equipment be tack welded to the channel since this method does not require accurate lining up of bolts.

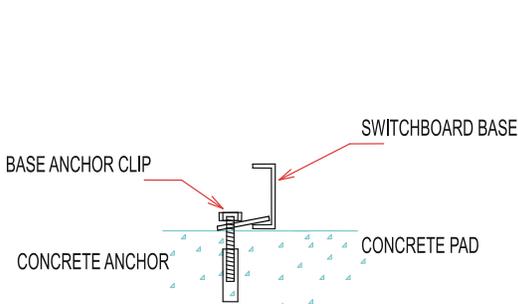
See the following page for typical anchor hole locations.



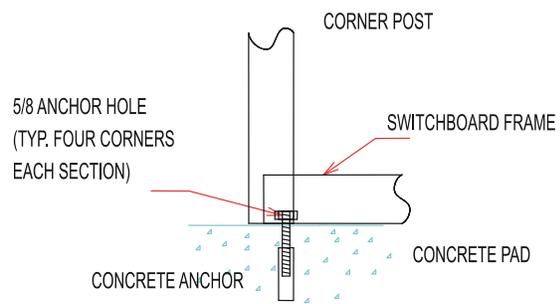
Suggested method of installing floor channels by installing contractor



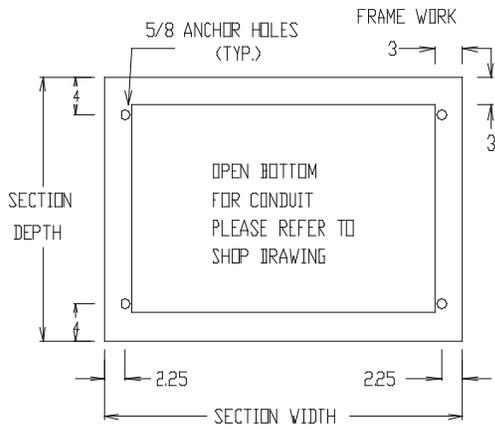
Suggested method of installing floor channels by installing contractor



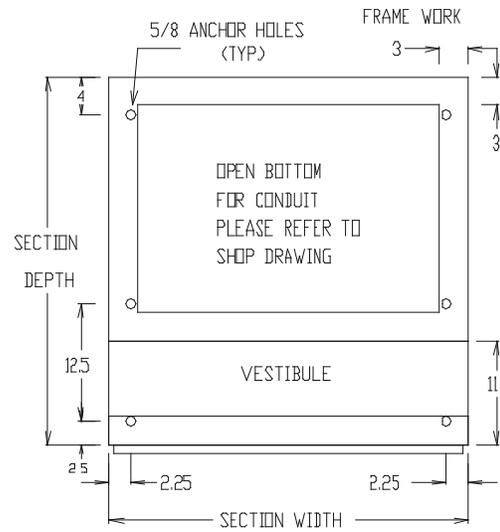
Suggested method of installing anchors front & back



Suggested method of installing to floor

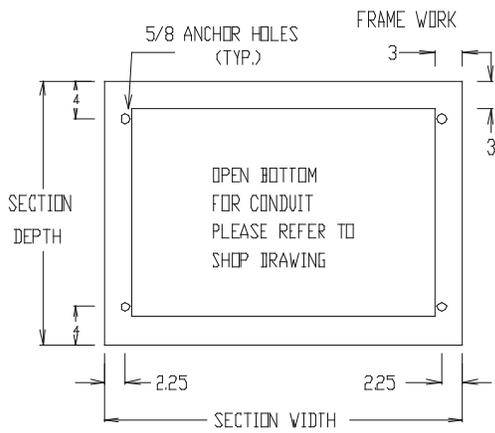


NEMA 1 - BASE DETAIL
INDOOR



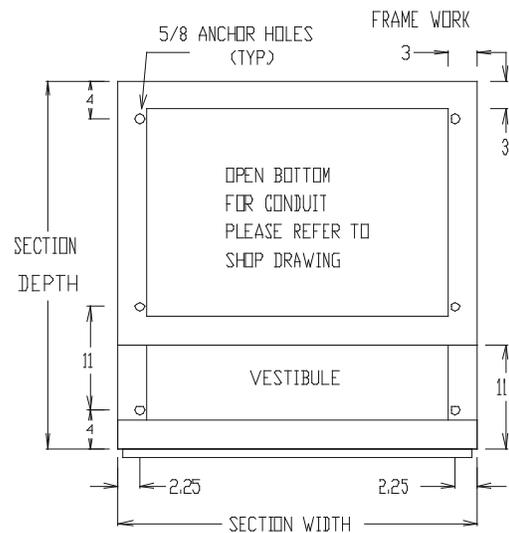
NEMA 3R - BASE DETAIL
OUTDOOR

TYPICAL ANCHOR HOLE DIMENSION FOR ANCHOR BOLTS



NEMA 1 - BASE DETAIL
INDOOR

WITH 1 1/2 H 11 GA. CHANNEL BASE



NEMA 3R - BASE DETAIL
OUTDOOR

WITH 1 1/2 H 11 GA. CHANNEL BASE

SUGGESTED METHOD OF INSTALLING FLOOR CHANNELS BY INSTALLING CONTRACTOR

PART II

Care should be taken to locate the switchboard in accordance with the latest edition of the National Electrical Code and any other local code requirements. Normally, a front accessible switchboard may be installed with its back against the wall; front and rear and rear accessible switchboards should be installed with the back sufficiently away from the wall to permit proper maintenance.

EQUIPMENT

1. Before setting equipment in place, refer to switchboard drawings and, after completely uncrating equipment, check permanent location to see that equipment will properly fit on channels and foundation location. Couple and bolt all shipping sections together so that continuous switchboard installation is obtained.

Bus splices at shipping break should be carefully inspected to be certain that good clean contact is obtained before bolting tight. It is important also to be sure that all outgoing connections are tightened in the same manner as bus splices. See page 8

2. Inspect cells to be certain that on drawout breakers male power contacts and secondary control contacts located in rear of cell are free of dirt and dust. It is also important that cell floor be clear of all dust and debris to facilitate easy handling of circuit breaker.
3. Carefully inspect all portions of the Air Circuit Breakers for possible damage. If drawout breakers are supplied, the respective circuit breaker instruction books or leaflets should be referred to before inserting breakers into cells.
4. The drawout breaker is provided with a maintenance closing handle for manually closing the breaker. It should not be used as a manual device to close the breaker when in the cell. This handle should be used only when the breaker is withdrawn from the compartment.
5. It is possible that vibration resulting from shipping and handling may have caused some of the screws, bolts, and nuts to become loose. Check and tighten all screws and bolts, particularly current carrying hardware. A loose current carrying connection can result in overheating or arcing, which could damage the equipment.

TIGHTENING BOLTED CONNECTIONS

Spot check bolted and screw connections for tightness or stripping. Also, check that locking devices are used on these connections

S.A.E. Grade # 2 torque figures are based on standard hardware and apply both to final structural assemblies, sub-assemblies, wiring connections.

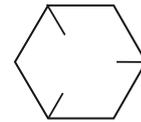
All bus connections to be made with S.A.E. Grade # 5 hardware and torqued to recommended values. Grade # 5 nuts are identified with a "2H" marking on the face and have a Rockwell C-10 rating.

RECOMMENDED TORQUE VALUES

<u>SIZE</u>	<u>S.A.E. GRADE # 2</u> <u>FT. LBS.</u>	<u>S.A.E. GRADE # 5 FT.</u> <u>LBS.</u>
1/4	6	9
5/16	11	22
3/8	20	39
1/2	45	60



GRADE #2



GRADE #5

BREAKER LIFTING DEVICES

For 600 volt drawout gear, it is recommended that the device for lifting and lowering air circuit breakers to and from the breaker compartments be used. For indoor switchboards, it is recommended that the purchaser install monorail crane over the front of the switchboard, or Industrial Electric can supply a hydraulically operated lift-truck as an additional item of equipment. For outdoor switchboards, a special hydraulic lift truck can be supplied.

OUTDOOR EQUIPMENT

If porcelain entrance or load bushings are mounted in the roof, use flexible connections from incoming and outgoing lines to reduce the strain on the porcelain.

Small-wiring underground conduit from the control buildings should terminate inside the switchboard at a level above any existing high-water marks.

Heaters are furnished in front and rear or each unit whenever specified in the order.

WIRING

All incoming and outgoing control connections should be made in accordance with the switchboard schematic and wiring diagrams. After wiring is completed, all connections should be carefully checked against the diagrams to insure that all connections are correct and proper.

A set of "as built" prints and instructions manuals covering the switchboards are furnished with the equipment. The prints should be consulted before connecting any external wiring to the switchboards.

If aluminum cables are used, it is recommended that the following procedure be followed to guard against overheating:

1. Check all lugs to ascertain that they are suitable for use with aluminum cable.
2. Strip the wire of its insulation to the desired length without ringing or nicking the wire.
3. Wire brush the stripped portion of conductor thoroughly.
4. Thoroughly coat stripped conductor with oxide inhibiting compound. (Two recognized compounds are Penetrox A and Alnox-UG. There may be others available, which do equally well).
5. Insert the conductor into the connector making certain all strands are contained and tighten the connector screws securely. This operation should result in the compound oozing out from between the individual strands of the conductor. If this does not happen, this is an indication an insufficient quantity of compound was used.
6. Wipe excess compound from area adjacent to connection because some compounds contain metallic particles and could reduce the dielectric strength of the insulating materials employed.

PART III

GETTING READY FOR SERVICE

Careful reference should be made to each component instruction leaflet before attempting to place the switchboard in service. If dry-type or oil askarel-filled power transformers are furnished as part of the switchboard equipment, consult their instruction books or leaflets, particularly regarding absorption of moisture, and effects of dust and sand, etc.

GETTING READY FOR SERVICE (CONTINUED)

Any indication of moisture will require that equipment be dried out before placing in service. Care should be exercised in drying out operations to be certain that the maximum temperature during the drying period does not exceed 70 to 75 degrees centigrade on switchboards. In the event it is desired to give the equipment a high potential test before placing in service, this test should only be made after the equipment is thoroughly dry, allowing approximately 10 days drying time.

DIELECTRIC TEST

The following dielectric test shall be made to determine the adequacy of insulation. Devices used, as part of switchboard assemblies shall be capable of meeting the following tests.

Exception-There is certain apparatus such as potential transformers, auto transformers, motor starting reactors, and motor operated devices, the standard for which call for lower test voltage than those given below. When such devices are used, they must be disconnected during these tests.

Alternating current test voltage shall have a crest value equal to 1.41 times the values specified. A sine wave shape is recommended. The frequency shall not be less than the rated frequency of the apparatus tested. The test voltage shall be applied for one minute.

Direct current test voltage, if used in lieu of alternating current test voltage, shall be 1.41 times the specified alternating current voltage.

A. Equipment rated 60 volts and below.

That part of assembled equipment rated 60 volts or less shall withstand an alternating current voltage test of 500 volts.

B. Equipment rated 31 to 600 volts.

Alternating current assembled equipment and alternating current circuits of equipment of higher rated voltage rated 61 to 600 volts shall withstand an alternating current voltage test of 1000 volts plus twice rated voltage, with a minimum of 1500 volts. When assembled in field and connected, test voltages should be 75% of factory test value.

The equipment should be checked to be certain no tools or any other equipment have been left in the switchboard. When connections are to be made to or from an Electric Utility, public or privately owned, consult their representatives very early in the construction period, as many of them have very strict requirements which must be met before service connections will be made.

GROUNDING Reference-NEMA Article 250

Each switchboard assembly may be provided with a ground bus extending the full length of the complete assembly. Sections of ground bus previously disconnected at shipping breaks must be reconnected when the units are installed. See recommended torque values.

The ground bus should be connected to the station ground with as direct a connection as possible and should not be run in metal conduit. The grounding conductor should be capable of carrying the maximum line-to-ground current for the duration of the fault.

A good reliable ground connection is necessary for every switchboard installation. It should be of sufficient capacity to handle any abnormal condition that might occur on the system and should be independent of the grounds used for any other apparatus.

A permanent low resistance ground is essential for adequate protection. A poor ground may be worse than no ground since it gives a false feeling of safety to those working around the equipment. Follow applicable sections of NEC Article #250.

GROUND DETECTION

On ungrounded low voltage systems (up to 600 volts AC) new switchboard equipment quite often does not include ground detection lamps or voltmeters. Nevertheless, it is quite important to check for grounds in the system at intervals.

The simplest method for single-phase, two-wire systems is to connect two clear filament lamps of the system voltage in series across the two wires with a ground connection between the two lamps. A ground on one side will short circuit and darken the lamp on that side. The same general scheme is used for multi-phase systems.

For higher voltages, use potential transformers or static ground detectors.

Upon completion of device settings and tests, the main incoming and feeder cables should be properly phased-out and connected to the switchboard. Incoming and outgoing cables should be braced so as to take mechanical strain off studs of circuit breakers and porcelain supports of various types.

GROUND FAULT PROTECTION

The entire switchboard structure should be carefully vacuum cleaned (preferred) or blown out, and all rear and side plates that have been removed should be rebolted in place. All secondary and power connections should be tested for grounds with high potential tester or merger. Megger readings of one megohm per thousand volts are acceptable. If readings are lower, equipment should be dried out until insulation resistance values improve to a minimum of one megohm per thousand volts.

Grounded systems where the voltage exceeds 150V to ground and has a capacity of 1000 A or more shall have ground fault relay protection in accordance with the National Electric Code. Consult the component instruction leaflet on the relay before attempting to place the switchboard in service. The relay settings should be made as recommended settings before turning the equipment over to the owner.

SAFETY TO PERSONNEL

Only authorized and properly trained personnel should be permitted to operate or handle any portion of the switchboard.

Do not work around live parts. Every precaution should be taken to guard against possible accidents. Tools should be insulated and rubber gloves and insulated mats used wherever possible.

All connections should be considered "live" until the men expecting to work on the equipment assure themselves personally that the circuits are dead. Every possible precaution should be taken to see that there is no chance of a circuit being energized while men are working on it. Switches that have been opened to de-energize a circuit to permit work on associated equipment should have warning devices placed on them and locked open.

Do not work on current-carrying parts until these parts have been disconnected from the system.

In case of fire, do not use fire extinguisher until all circuits have been de-energized.

OPERATIONAL TESTING

Upon completion of installation, an inspection of the circuit breakers and other components, together with their installation, should be done before any operational testing. Outgoing feeder cables should not be connected at start of test.

If it is a power center with power transformer and high voltage disconnect or interrupter switch ahead of the switchboard, lock the switch in the open position in order to protect the test operator.

OPERATIONAL TESTING (CONTINUED)

Similarly, if it is a generating station, the generator breaker should be locked open.

If there are low voltage drawout manual breakers, they may be checked in “test” and “operate” positions. Extreme care should be taken that all contacts and housing switches (if any) align properly.

When the switchboard has electrically operated circuit breakers, they are operated in some installations from local battery or auxiliary control supply, and in other installations are operated from the switchboard bus of a connection ahead of the incoming master circuit breaker. In the event the primary source of power is locked open, it will be necessary to use an auxiliary source of power to operate the circuit breakers, lamps, bell-alarm switch, undervoltage devices, rectifiers, capacitor shunt trips, etc. Check circuit breakers in “test” and “operate” positions, paying particular attention to good contacts in both positions. Key interlocks should be operated manually to make sure that protection is complete. Remove spare keys to supervisory office.

Each relay and trip device or other component should be operated manually to be certain its contacts perform their required function. Remove any material that was installed at the factory to block relay contacts during the shipment. Preliminary settings for test purposes should be applied to relays. The various operational functions are indicated on the schematic and wiring diagrams of the switchboard equipment.

After completion of all operational tests, all relays should be set. All trip indicators on the relays should be checked to see that they function properly.

PART IV

GUIDE TO SWITCHBOARD MAINTENANCE

MAINTENANCE BENEFITS AND FACILITIES

A. Maintenance Program

A well-executed maintenance program can provide the following benefits:

1. Longer life of switchboard and fewer replacements;
2. Reduced time on repairs and overhauls, and the option of scheduling them at an opportune time;
3. Fewer failures with unexpected outages;
4. Timely detection of any undesirable operating conditions which require correction;
5. Improved plant performance and increased operating economies.

B. Maintenance Records

A maintenance file should be established which should include the following:

1. A record of all installed switchboards and their maintenance schedule;
2. Nameplate data of all the equipment and its major components, instruction books, renewal parts lists, bulletins and drawings;
3. A list of all items which have to be inspected and what adjustments are to be checked;
4. A record of past inspections and test results.

C. Maintenance Tests

Maintenance tests are applicable as indicated:

1. Insulation resistance tests of the switchboards' breakers and bus can be useful in determining the condition of the insulation if they are performed regularly. Since definite limits cannot be given for satisfactory insulation resistance, a record must be kept of the readings and comparisons made. Deterioration of insulation and the need for corrective action can be recognized if the readings are progressively lower after each test.
2. High potential tests are not required and are not recommended except in special circumstances, such as after repairs or modifications to the equipment that included the primary circuit (bus assemblies). When such tests are necessary, they may be conducted using 75% of the standard 60-cycle test voltage for new equipment.
3. After the switchboard has been serviced and adjusted, its operation should be checked before it is returned to service. This can best be done by putting the breaker in the test position (if drawout) and operating it with its associated control and protective devices from a separate source or supply.

D. Maintenance Equipment

Adequate maintenance equipment should include:

1. Spare parts for at least those parts of the switchboard that are vital to operation. The manufacturer's recommended list of spare parts can be used as a guide in combination with operating experience to determine variety and quantity of parts to be stocked.
2. A well equipped shop with the following:
 - a) A test cabinet or inspection rack for power circuit breakers;
 - b) A source of control power for checking the operation of electrically-operated breakers;
 - c) A selection of test instruments – multimeters, clamp-on ammeters, instrument transformers;
 - d) Lifting means for handling large breakers;
 - e) An insulation resistance tester (Megger™ or equivalent).

MAINTENANCE BENEFITS AND FACILITIES (CONTINUED)

E. Safety Considerations

Only authorized and properly trained personnel should be permitted to operate or handle any part of the switchboard.

Maintenance employees must follow all recognized safety practices such as those contained in the National Electrical Safety Code and in Company or other local safety regulations during maintenance. All of the units of the switchboard to be maintained must be de-energized, tested for potential, grounded and tagged out before removing covers and barriers for access to primary circuits.

Keep in mind that power circuit breakers are also capable of storing mechanical energy in the form of contact closing springs. Make sure breakers are open and springs are properly discharged and/or blocked before working on the mechanism. Always refer to the breaker's maintenance manual for specific safety considerations.

F. Frequency of Inspection & Test

It is generally good practice to inspect equipment three to six months after it is first put in service and then inspect and maintain it every one to three years depending on its service and operating conditions. This suggested schedule is only a guide. Conditions that can make more frequent maintenance necessary are:

1. High humidity and ambient temperatures;
2. Corrosive atmosphere;
3. Excessive dirt and dust;
4. High repetitive duty;
5. Frequent interruption of faults;
6. Older equipment;
7. History on preceding inspections.

For additional guidance in planning inspection & maintenance intervals, refer to NETA publication MTS-2001 Appendix B, available as a free download at www.netaworld.org