# Specification

## Table of Contents – Specification

## 1 GENERAL

This Specification shall be read in conjunction with design drawings 420-DD-03 and 420-DD-02 and 420-CV-0. All documents are equally binding. Failure to seek clarification during the tendering process shall not be considered grounds for variations during the construction process. Seek clarification from Steve Dougan MIW on all design issues.

## 2 COMPETENCE

The Contractor shall have an experienced supervisor on site at all times during the construction period. Evidence of this experience shall be a minimum of a Restricted Water Licence (Irrigation) issued by the Victorian Plumbing Industry Commission. An “Open Water Licence” issued by the Victorian Plumbing Industry Commission is acceptable. (Refer to Schedule 3)

## 3 STANDARDS

The following standards apply to this contract:

| | |
|---|---|
| AS 1432 | Copper tubes for water, gas and sanitation |
| AS 3500 | National Plumbing and drainage – Water Supply\ |

| | |
|---|---|
| AS 1462 | Methods for testing uPVC pipes and fittings |
| AS 1477 | uPVC pipes and fittings for pressure applications |
| AS 2032 | Code of practices for installation of uPVC pipe systems |
| AS 2033 | Installation of polyethylene pipe systems |
| AS 3000 | SAA wiring rules and amendments |
| AS 2053 | uPVC wire conduits |

If there is a conflict between this Specification and the relevant Australian Standards, the Australian Standards shall be adopted in place of this Specification.

## 4 DELIVERY, HANDLING & STORAGE

The Contractor shall ensure materials are delivered to the project site in the original containers with the manufacturer's identification on each package. The Contractor must protect all materials on site from damage by weather, accidents and theft up to the date of practical completion. A copy of the relevant manufacturer's warrantee documents shall be made available for inspection by the Superintendent.

## 5 CHANGES TO EQUIPMENT SCHEDULE

Changes to the specified equipment will only be considered for items with 'or approved equivalent'. For alternative equipment to be approved it must be proven that the performance, durability and quality are not less than the original product specified.
If the Contractor wishes to offer an alternative product, the following must be supplied to the Superintendent for approval prior to construction commencement:

a) a working sample;

b) technical data;

c) distribution uniformity at the set pressure and flow rate; and

d) cost comparisons.

If the alternative product is approved, then the Contractor shall be notified in writing. Failure to comply with above requirements will result in the alternative product being removed from site at the Contractor's own expense.

## 6 CHANGES TO IRRIGATION DESIGN

Any proposed change to the irrigation design will require an accurate drawing showing the intended modification submitted to the Superintendent. Any modifications to the design drawings shall be at the Contractor's expense and the Contractor shall not be entitled to a variation for these works. No modification to the design drawings is permitted. Any variations must be applied for in writing and approved in writing by the Superintendent. Any modifications not approved in writing shall be rectified by the Contractor at its sole expense.

## 7 SCOPE OF WORKS

The Works comprise the provision of all plant, equipment, materials, labor and the performance of all operations of whatever kind needed for the complete and proper construction and testing of the irrigation system as specified herein, and as detailed on the design drawings, site specific specification and to the satisfaction of the Superintendent. The Superintendent's or their representative's decision is final.

The work site is located at Elwood Park, Elwood. There are two sites, Wattie Watson Oval and the 2 No Soccer fields located on Ormond Esplanade. Hours of work are Monday – Friday 8:00 to 4:30 pm. Weekend work and work on public holidays is permitted.

The site is available for commencement of Portion "A" of the works from the 21 March 2011. Portion "B" & "C" may be commenced from the 28 March 2011.

**ALL WORKS ARE REQUIRED TO BE COMPLETED BY COB Monday 2 May 2011.**

The works include the supply and installation of, but are not limited to:

a) supply and installation of 160 mm MDPE Pn 8.0 “LILAC” transfer main by open excavation;
b) supply and installation of 150 & 100 mm uPVC Pn 12.0 RRJ “LILAC” irrigation main by open trenching;
c) supply and installation of 80 mm uPVC Pn 12.0 RRJ “LILAC” sub main by open trenching;
d) location and connection to existing 80 dia uPVC Pn 12.0 “LILAC” irrigation mainline;
e) supply and installation of 150, 100 & 80 dia sluice valves for mainline isolation;
f) supply and installation of 80 mm tested gate valves for sub main isolation;
g) supply and installation of 80, 50 & 40 mm uPVC Pn 12.0 irrigation lateral lines;
h) supply and installation of Hunter HFS series flow meter and re-installation of existing flow meter;
i) supply and installation of Irritrol 200 series 50 & 40 mm automatic valves;
j) supply and installation of Hunter I-40 Ultra Series pop up sprinklers;
k) supply and installation of Hunter ACC 24 stn irrigation controller (Wattie Watson Oval);
l) supply and installation of 2 No master valves, complete with relay and 24 VAC plug pack to each controller;
m) removal of spoil from site, importation of 100 mm of sandy loam topsoil to all trenches;
n) testing and commissioning of system in the presence of the Superintendent; and
o) site clean and removal of spoil.

## 8 DOCUMENT SCHEDULE

**420-CV-01 Issue C – NTS – Site Plan and Extent of Works**
**420-DD-02 Issue C – 1:400 @ A1 – Irrigation Layout**
**420-DD-03 Issue C – 1:400 @ A1 – Irrigation layout**

**Schedule of rates – Tender**
**Irrigation Specification - Tender**

These Drawings shall be read in conjunction with this Specification. If there is a discrepancy between the Drawings or the Specification, bring it immediately to the attention of the Superintendent.

## 9 CONSTRUCTION INSPECTIONS

The Contractor shall attend joint field inspections/meetings with the Superintendent or his representative at each of the following HOLD points during the construction process.

The Contractor shall give 24 hours notice in writing to the Superintendent that they are approaching a HOLD point and request an inspection of the works to date. A HOLD point is a milestone in which no installation works are permitted to be carried out until satisfactory completion of the said tasks.
The Superintendent or his representative may conduct works inspections at any time during the construction process. As a minimum, the following tasks during the construction process shall be inspected:

a) (**HOLD** point) - to witness the setout of the system by a registered land surveyor including sprinklers, valves and pipework, i.e. flagging or pegging;

b) to witness trenching, installation of pipework, sand-bedding, backfilling, compaction;

c) (**HOLD** point) - to witness pressure testing of the mainline, sub main pipework to 1.5 times the operating pressure of the pipework or 1200 Kpa (whichever is the greater) for a period of 30 continuous minutes. Greater than 2% loss in pressure over the 30 minutes shall be deemed to be a failed test. Rectification any re-testing of the mainline and sub main shall be at the sole expense of the Contractor;

d) to witness the correct operation of the controller and moisture sensing devices;

e) to witness the correct operation of all valves, sprinklers;

f) to witness adjustment of automatic valves to maximum closing time possible;

g) to witness removal of spoil and construction materials from site; and

h) to witness air valve and gate valve location and correct operation.

## 10 NOTICES

At the completion of each construction inspection the Superintendent shall issue a construction report in writing to the Contractor. All items listed for repair, removal or defective workmanship shall be rectified by the Contractor prior to further works progressing at the sole expense of the Contractor.

## 11 DEFECTS

Within 14 days of the project completion, the Contractor shall forward a written request to the Superintendent requesting an inspection of the works for practical completion.

The Superintendent shall then carry out an inspection of the works with the Contractor's site representative to witness the following:

a) the correct operation of the backflow prevention device and associated filters, pumps, telemetry operations;

b) the correct operation of the controller and moisture sensing devices;

c) the correct operation of all valves, sprinklers;

d) adjustment of automatic valves to maximum closing time possible;

e) removal of spoil and construction materials from site; and

f) gate valve location and correct operation.

Upon completion of this inspection, a report shall be issued by the Superintendent to the Contractor of items requiring rectification or replacement. The Contractor shall have 7 days to rectify the defects and shall then request in writing a further inspection of the works by the Superintendent or his representative.

## 12 **AS CONSTRUCTED DRAWINGS**

As required under AS 4000 the Contractor shall supply two copies of all drawings (full size) and one reduced (A3) size copy and a CD with the Auto CAD files (2004 or later) and PDF version 6.0 or later of all drawings shall be provide to the Superintendent for approval.

The drawings at a minimum shall include all:

a) sprinkler locations;

b) valve locations;

c) mainline locations including the depth (Z co-ordinate);

d) lateral line locations including the depth (Z co-ordinate);

e) controller and moisture sensor locations;

f) points of connection and associated items; and

g) all wiring and wire joints

## 13 MAINTENANCE MANUALS

The irrigation maintenance manuals (provide 2 copies) shall be presented in a hard covered two ring binder. As a minimum they shall include:

a) cover sheet stating project name and date of installation;

b) table of contents;

c) warranties and certificates;

d) contact details of contractor (include after hours details);

e) controller manuals and information;

f) sprinkler and drip emitter technical data and maintenance instructions;

g) Autocad 2004 or later drawing files on CD;

h) all drawings suitable for re-printing on PDF format (Version 6.0 or later); and

i) one copy of all drawings in hard copy inserted into the manual for viewing without removal.

## 14 MAINTENANCE – IRRIGATION SPECIFIC

The Contractor shall visit the site on a fortnightly basis once practical completion has been achieved and shall maintain a log book which must be signed off by either the Superintendent or their representative upon arrival and upon completion of works on site.

The irrigation specific irrigation maintenance period shall be 13 weeks. During this period the following items shall be tested at each site visit:

a) each solenoid valve operated from the controller and manually and check for opening / closing and automatic operation;

b) the controller shall be checked for correct date, time, start times, run times of individual stations;

c) sprinklers shall be operated from the controller and visually checked for operation. Min 2 mins operation of each station; and

d) run times of stations shall be adjusted to ensure precipitation rates and inline with the current climatic conditions.

At the completion of the specific irrigation maintenance period the Contractor shall request in writing an inspection of the site and their log book. It shall not be until this inspection and all defect items are complete that it shall be deemed the end of the maintenance period.

## 15 WARRANTY

The Contractor shall supply the Superintendent with a written guarantee that they will without charge to the Principal repair, replace or re-instate any part of the system that has failed due to defective equipment, unspecified equipment or poor workmanship within 12 months of the date of practical completion.

The guarantee shall include details of any extended warranties offered by manufacturers on any of the system components.

## 16 PRACTICAL COMPLETION

The Contractor must comply with the conditions in AS 4000 and prove the system works at practical completion. The followings items but be proved in order for the Contractor to be awarded practical completion:

a) the system has been operating successfully for 4 fully programmed cycles over a minimum of a 7 day period;

b) commissioning of the system in the presence of the superintendent or his representative comprising of the field testing of all individual valves, sprinklers, emitters from the controller for successful operation;

c) repair of damages or vandalism caused during construction;

d) submission of ‘As Constructed’ drawings and maintenance manuals;

e) successful completion of all notices and defects;

f) submission of warranty, trouble-shooting and materials information;

g) submission of typical summer/winter irrigation programs;

h) education of end users;

i) correct programming of the controller and moisture sensing devices;

j) re-instatement of trenches by leveling and or topdressing; and

k) all site sheds, materials, debris have been removed from the site.

A practical completion certificate shall be issued when ALL of the above requirements and the defects list have been successfully completed. From the time of site possession until practical completion is achieved, the Contractor shall maintain the risk of all materials, plant and equipment. Damage, theft or vandalism shall be the sole responsibility of the Contractor until practical completion is achieved.

## 17 MATERIALS & INSTALLATION

All the materials supplied shall be new and shall conform to the relevant Australian Standards. Installation of irrigation systems shall conform to AS 3500.1 “National Plumbing and Drainage Code”. Installation of MDPE pipes shall conform to AS “Installation of MDPE Pipe Systems”. Installation of valve wiring shall conform to AS 3000 1991 “SAA Wiring Rules”

## 18 SETOUT

Setout of the complete irrigation system including sprinklers, valves, meters, controllers, mainline and sub mains shall be performed by a **registered and licensed surveyor**. An electronic copy of the design drawings in AutoCAD 2008 format shall be provided to the Contractor for this purpose.

The Contractor shall permanently mark all sprinklers and valve locations with a 25 * 25 mm hardwood stake buried with only the surface of the stake showing. The surface shall then be painted with white marking paint for ease of location. The stakes shall only be removed when the pipework and sprinkler is installed.

## 19 CONDUITS

All required conduits are indicated on the design drawings. Where pipework is installed within gravel pathways, pathways shall be reinstated to match the existing surrounding levels and surface texture.

Irrigation mainline and potable water mainline shall be sleeved using uPVC Class 9.
Sleeves shall be installed in straight lines between irrigated areas. The ends of the sleeves shall protrude at least 100 mm past the hard edge. Size conduits so that the conduit is 1.5 times the diameter of the pipe to be enclosed.

## 20 MASTER VALVE

A master valve shall be installed at each site within a 1320-VB directly downstream of the isolating sluice valve. The master shall be of bronze construction and be rated to min 14.0 bar. Master valves shall be installed unobtrusively in individual valve boxes.

Nominated Item: Bermad 410 series – 50 mm with Gemsol coil.

## 21 AUTOMATIC VALVES

Automatic control valves shall be 40 & 50 mm as nominated on the design drawings and shall be of stainless steel and industrial plastic construction, pressure rated to a min of 13.8 bar, 24 V AC solenoid operation, globe pattern and fitted with flow control and manual internal bleed.

Automatic valves shall be connected to the sub-main by the use of SWJ tees and reducers (or approved equivalent) sized to suit the PVC main.

Automatic valves shall be installed unobtrusively in individual valve boxes. Install a manually operated isolating valve upstream of the solenoid valve in all installations. Valve boxes shall be sized to suit individual stations. (See Valve Boxes). Install all valves in shrub / planter areas where practical. Locate the valve centrally for ease of maintenance. A typical automatic valves detail is provided on the design drawings. Install only 1 automatic valve assembly per valve box.

Identify each valve with its controller number on a 40*40*2 mm laser cut plastic tag attached with a zip tie to the active wire on the coil.

Nominated Item: Irritrol 200 Series – 40 & 50 mm (216 & 217-B-M)

## 22 ISOLATING VALVES

Isolating gate valves are to be of the same size as the remote valve to which they are connected. They shall be tested to a min static operating pressure of 1400 Kpa, be of glass reinforced plastic construction and have nitrile rubber sealing o-rings.

Nominated Item: Ball valves, Philmac or approved equivalent

## 23 VALVE IDENTIFICATION

All valves shall have a 40*40*2 mm laser cut plastic identification tag attached by a zip tie to the active control wire on automatic valves, to the isolating gate valve spindle on all isolating valves and to the stem on all air valves.

Valve identification tags shall be installed according to the following.

| | |
|---|---|
| Air Valve | AV |
| Automatic valve | V(number of valve in controller) |
| Isolating gate valve | IV |
| Wire Join | WJ |

Nominated Item: Treoflyte or approved equivalent

## 24 VALVE BOXES

Valve boxes shall be sized according to Table 1.0. They shall be installed over the automatic valve, isolating gate valve, filters, flow meters, wire joins. When installing over an automatic valve assembly or isolating gate valve assembly ensure the valve box lid when closed shall be level with surround grade in grassed areas and 20 mm above grade in garden or planter areas.

Provide a layer of A-12 geofabric under and around the outside of the valve box base and taped to the outside of the valve box. The valve box shall be supported by a single layer of 100*75 treated pine timber to prevent subsidence. Ensure the timber frame does not come into contact with the pipework.

| | |
|---|---|
| Automatic valve assemblies | 1419-B (lip over) or approved equivalent |
| Isolating gate valves | 910-B (lip over) or approved equivalent |
| Butterfly valves | 910-B (lip over) or approved equivalent |
| Flow meters | 1419-B (lip over) or approved equivalent |
| Wire joins | 910-B (lip over) or approved equivalent |

*Table 1.0 Valve boxes*

## 25 ISOLATING GATE VALVES

Manually operated isolating gate valves shall be installed for mainline and sub main isolation as nominated on the design drawings. Additional gate valves may be installed for staged installation as directed.

Isolating gate valves 50 mm and below shall be bronze, BSP threaded and tested.

Isolating gate valves 80 mm and larger shall be bronze, flanged to table D and tested.

All isolating gate valves shall feature a bronze T-bar style handle and spindle.

Isolating gate valves shall be installed in a valve box according to Table 1.0 (refer to above).

They shall be centrally located for ease of maintenance. Install 1 only isolating gate valve per valve box.

Nominated Item: Maxiflo or approved equivalent

## 26 FLOW SENSORS – NEW & EXISTING

Flow sensors shall be heavy duty, suitable for high flow rates covering a wide flow range. The magnetic transmission shall keep the register completely separate from water, so as the

impeller and transmission shaft contact the water. Meets or exceeds all relevant metrological standards including ISO 4064 class B, EEC.

It shall have a pressure rating of PN 16 and have a low pressure loss during operation.

It shall be a brass insert type to suit the PVC irrigation mainline.

Install with a minimum of 10 times the pipe diameter upstream and 5 times the diameter downstream of the flow meter clear pipe with no fittings.

The existing flow sensor installed at the pump discharge shall be removed and stored for re-installation on Wattie Watson Oval.

Nominated Item: Hunter HFS series to suit 80 mm PVC – 1:10 Pulse rate

## 27 SPRINKLERS

Where suitable, ground level turf areas shall be irrigated by fixed spray pop-up, stream rotors and single jet rotor sprinklers. Minimize overspray onto paths, roads and structures at all times. The sprinkler shall be of the gear-driven, rotary type. The sprinkler shall be available with six (6) nozzles discharging 26.5 to 106.7 l/min. The sprinkler shall have radius adjustment capabilities by means of a stainless-steel nozzle retainer/radius adjustment screw.

The sprinkler shall be both full-circle and adjustable part-circle operation in a single unit.

The sprinkler shall be minutely adjustable from 50° to 360°. It shall be adjustable in all phases of installation (i.e., before installation, after installation while static, and after installation while in operation). The sprinkler shall be equipped with a self-adjusting stator to ensure constant rotation speed regardless of nozzle installed.

The sprinkler shall have a non-strippable drive mechanism that allows the nozzle turret to be turned during operation, without damage. It shall also have an automatic arc return feature that returns the nozzle turret to its proper orientation if it is turned outside its intended arc of coverage.

The sprinkler shall:

a) be equipped with a drain check valve to prevent low head drainage, and be capable of checking up to 4.5 m in elevation change;

b) have a minimum of 9 cm pop-up stroke to bring the rotating nozzle turret into a clean environment. The sprinkler shall be available as a pop-up;

c) have a rubber cover firmly attached to the top of the riser. When specified, the sprinkler shall have a cover molded of purple Alcryn rubber to indicate the use of reclaimed water. The rubber cover shall be surrounded by a protective rubber boot when sprinkler is in the retracted position;

d) have an exposed surface diameter after installation of 5 cm and have an overall height of 20 cm. The unit shall have a 1-inch Female British Standard Pipe Thread inlet;

be serviceable after installation by unscrewing the body cap, removing the riser assembly, and extracting the inlet filter screen; and

e) have an optional turf-cup kit that, once installed, provides the means to grow living turf on top of the sprinkler riser.

The body of the sprinkler shall be constructed of corrosion resistant, impact resistant, heavy-duty A.B.S. It shall have a stainless steel spring for positive retraction of the riser when irrigation is complete. The riser and nozzle-turret assembly shall be encased in stainless steel. The sprinkler shall carry a five-year, exchange warranty (not prorated).

Nominated Item: Hunter I-40 Ultra series – Non Potable
Articulated Risers

Sprinkler to piping connections shall be by articulated riser, using 3 off M+F poly elbows for pop up sprinklers and 2 off M + F poly elbows for shrub or stake type sprinklers. The riser shall be schedule 80 PVC (Grey) sized according to Table 2.0.

| | |
|---|---|
| LR type sprinklers pop up | 200 mm * 25 mm |

*Table 2.0 Articulated risers*

Nominated Item: Spears or approved equivalent

## 28 PIPEWORK

Mainline pipe work shall be uPVC Pn 12.0 to Australian Standard AS 1477. All lateral line pipework shall be up uPVC Pn 12.0 to Australian Standard As 1477.

All pipework shall be installed to AS 3500.1.2 – 2003. Particular attention shall be paid to AS 3500.1.2 – 2003 section 5.1 (Depth of cover in public areas) and section 5.12 (Bedding and Backfill).

All mainlines and sub mains shall be surrounded with not less than 75 mm of compacted white washed free flowing sand, with no hard-edged object permitted to come in contact with or rest against any pipe or fitting.

Any backfill within 300 mm of the top of the pipe shall be free from builders waste, bricks, concrete pieces, rocks or similar material which would be retained on a 75 mm sieve. All mainline pipework shall have “Tapex – Buried Irrigation Main” Blue color marker tape installed 150 mm below finished surface level.

All mainline and lateral line trenches shall be wheel rolled and compacted in 150 mm layers immediately after pipe installation. The Contractor must ensure the mainline and lateral line trenches are finished flush with the surrounding ground surfaces. It is a requirement of this contract to re-seed the trenches. The Contractor is responsible for any rectification works of the trenches due to subsidence.

The Contractor shall at his own risk and expense, carry out tests and provide all labor together with pumps, engines and temporary valves, plug, flanges and all other equipment as may be

necessary. Such plant shall remain the property of the Contractor and shall make no charge for the use, installation and dismantling thereof.

All mainline and submain shall satisfactorily withstand the pressure test for a period of thirty minutes with less than 2% loss over that time. The Superintendent or his representative shall witness the test.

The Contractor shall locate the existing 50 & 80 mm PVC irrigation (pumped) supply pipework and make connections to the new 80 dia PVC Pn 12.0 irrigation sub main on the touch football field. This works shall be co-ordinated with the Council's maintenance contractor as the existing irrigation shall be maintained at all times.

## 29 TRENCHING

Mainline and sub main trenches shall be excavated to a depth of 500 mm plus the diameter of the pipe. The trench shall be free from hard edged objects, rocks, stones or similar material which would be retained in a 25 mm sieve. The trench shall be 3 times the diameter of the pipe which is to be installed in it.
(Refer to DWG. 420-DD-03 for detail).

If mainline and lateral line is to be installed in a common trench there shall be a minimum of 100 mm between the lines. This area shall be compacted white washed free flowing sand.
(Refer to DWG. 420-DD-03 for detail).

**All trenches shall be backfilled in 150 mm layers and compacted to achieve 90 % compaction.**

Trenches shall be finished flush with the surrounding levels. Each trench shall have the top 100 mm as imported sandy loam topsoil.
(Refer to DWG. 420-DD-03 for detail).

Ensure that irrigation trenches are top dressed at 3-4 weeks after works have been complete re-filling areas where the soil has sunk and resubsided. Reseed top dressed trenches with a similar species to existing.

Ensure irrigation boxes and lids are level with the playing surface.

Excess trench spoil shall be removed from site at the contractor expense and disposed of at a legal dumping facility.

## 30 MELBOURNE WATER DRAINAGE PIPEWORK

Within the boundary of the works area Melbourne water have a substantial asset. When trenching within the area of this asset, a min cover of 100 mm to a max cover of 200 mm to pipework is acceptable. The Contractor shall clearly identify the extents of the drainage culverts prior to commencement of trenching. Any damage to the infrastructure shall be repaired by the contractor to the satisfaction of Melbourne Water.

## 31 GAS SUPPLY PIPEWORK

Within the boundary of the works area there is a low pressure natural gas supply to the recently constructed pavilion, noted on drawings as “GAS”. The Contractor shall clearly identify the location of this asset prior to commencement of trenching. Any damage to the infrastructure shall be repaired by a specialist sub contractor at the sole expense of the Contractor.

## 32 ELECTRICAL SUPPLY TO LIGHTS

Within the boundary of the works area there is a low voltage electrical conduit and cable to the recently installed field lights. The Contractor shall clearly identify the location of this asset prior to commencement of trenching. Any damage to the infrastructure shall be repaired by a specialist sub contractor at the sole expense of the Contractor.

## 33 PIPE FITTINGS

PVC pipe fittings sized 50 mm or less shall be manufactured to AS 1477. PVC pipe fittings sized 80 mm or larger shall be ductile iron or gun metal.

Fitting selection must be in accordance with pipe fittings in table 3.0. (Refer to table 3.0).

| | |
|---|---|
| Sprinkler risers to laterals 80 mm or less | uPVC Cat 18 Faucet tee |
| Screwed connections to MDPE | Compression type end connector – Plasson or equal |
| Flanged connections | Galvanized bolt, washers & nuts with rubber insertion gaskets |

*Table 3.0 Pipe fittings*

Ensure pipe cutting and fittings are performed in a workman like manner. The cuts shall be square, the burrs removed and the inside of the pipe left as free of debris as possible.

## 34 MARKER TAPE

PVC marker tape shall be installed on all mainline and sub main pipework. The marker shall be installed 150 mm below finished level of the soil in continuous lengths directly on top of the pipework it relates to.

Nominated Item: Tapex (Non detectable) or approved equivalent

## 35 CONTROLLER - NEW

The automatic irrigation controllers shall be of an advanced commercial design, with a large, backlit, 8 line by 20 character display, and user-friendly dial-and-button type programming. The controller shall have a removable facepack (containing the user interface and all program memory) which can be easily removed without tools for programming and diagnostics outside the controller enclosure. The controller facepack shall have non-volatile memory, with 9 VDC battery power to enable programming when removed from the enclosure. The controller interface shall have an Info button to provide text help instructions for each dial position.

The controller shall also have two independently programmable Pump/Master Valve outputs, which may be configured as either Normally Open or Normally Closed.

Pump/Master Valve activation combinations shall be programmable by station; each station may have one, two, both, or neither P/MV output configured whenever the station is activated for any reason. Each Pump/Master Valve output shall have a capacity of .325 A @24VAC.

The controller shall have an internal 120/230 VAC transformer of at least 120 volt-amp capacity, and shall have sufficient output capacity (4A @ 24V secondary) to operate up to 14 standard 24 VAC solenoids (12 solenoids plus 2 Pump/Master Valve outputs) simultaneously.

For primary electrical wire sizing assume 2 amp max in 120V installations, 1 amp max in 230V installations. The controller shall have a self-diagnostic circuit breaker to prevent harmful overloads due to field wiring. The controller shall have a replaceable fuse, 6x20mm, 2A, 250V fast blow, and shall be supplied with one spare fuse.

The irrigation controllers shall have 6 automatic programs with 10 automatic start times, each. Start times shall be set in one-minute increments, and may be set in 24-hour clock or AM/PM time formats. Each program and station may be uniquely named with alphanumeric characters.

Automatic programs shall be individually configurable for overlapping, stacked, or programmable SmartStacked operation (including SSG/SmartStack operation if this feature is used). SmartStack operation shall permit the operator to specify the number of programs permitted to overlap before stacking commences.

Automatic programs shall have programmable water day schedules with optional Day of Week, Interval Day (1 to 31 days), or Odd or Even days, by program. Automatic programs shall have user-programmed Non-Water windows to except certain time windows from watering, regardless of the water day schedule.

Automatic programs shall also permit the designation of non-water days, even when Odd/Even or Interval Day patterns have been set. Non-water window violations shall be detected and the operator shall be warned when programming irrigation into non-water windows. If the program changes are kept despite the warning, the irrigation shall automatically stop when the non-water window is reached.

The controller shall:

a) permit run times per station start of between 1 second and 6 hours, in one-second increments. Automatic irrigation shall be capable of Cycle and Soak programming, by station, to minimize runoff;

b) offer programmable delay between stations of up to 6 hours in one-second increments;

c) have a programmable rain shutdown delay of up to 31 days. Individual programs, or the entire controller, may be adjusted with season adjust from 0 to 300% in one percent increments;

d) have additional custom manual programs for specialty applications that allow any stations to run in any order, with programmable pauses between stations. Custom manual programs shall not run automatically but can be started by the operator at any time from the dial controls;

e) have a quick check test program, permitting all stations to run sequentially for a user-entered period of time, programmable in one-second increments up to 10 minutes each, for system startup and diagnostics;

f) have an easy retrieve program which stores all original programming settings. The Contractor shall be able to restore the system to this saved state at any time after initial installation. The stored easy retrieve settings may also be updated at any time by the Contractor;

g) save and display programmable contact information for the manufacturer, and shall be reprogrammable in the field to display the contact information for the installing or maintaining contractor, to assist future operators in obtaining assistance with the controller;

h) have a one-button manual station advance in test mode for quick diagnostics checks; and

i) permit stations to be grouped into Simultaneous Station Groups (SSG) for simultaneous activation and programming, in clusters of 2 to 4 stations.

SSGs shall be used to reduce programming time and to consolidate irrigation times when flow and pressure permit. SSGs shall be included in automatic programs with a single run time, in the same fashion as individual stations, but representing the electronic group of similar stations. SSGs may also be assigned alphanumeric names.

The controller shall permit connection of up to 4 switch closure sensors, with programmable response to each sensor, by program.

The sensor response may consist of:

a) suspend, wherein the controller ceases irrigation, but continues counting “irrigation time” so that it resumes where it should be with no violation of the end of the water window; or

b) pause, wherein the program ceases irrigation but will resume where it left off at time of the pause input. Each program may respond to each sensor regardless of other programs’ status or responses.

The controller shall permit connection of a true flow meter which connects via the master power module of the controller (or via the two-wire path in two-wire decoder configurations) and which is calibrated by the operator for the pipe diameter in which it is installed.

The flow meter shall measure actual flow in gallons or litres. The controller shall have a learning mode in which the controller operates each single station for a short period, learns the actual flow for each station, and stores the information internally by station.

When the learned flow is exceeded during normal operations the controller shall record a flow alarm event, cease irrigating the station or stations contributing to the high or low flow readings, and resume irrigation with any stations which do not cause alarms. The controller shall have the ability to determine high or low flow conditions when multiple stations are operating, and shall perform diagnostics to identify stations which contribute to the problem flow.

Allowable limits and duration of incorrect flow shall be preset, but reprogrammable by the operator for unique local conditions. The flow meter shall be a Hunter Industries HFS in an appropriately sized FCT fitting. It shall also be possible to except certain stations from flow monitoring, for non-irrigation devices.

## **36** CONVENTIONAL **STATION OUTPUTS**

The basic controller shall have a minimum of 12 stations in two modular outputs of six stations each, and shall expand at any time in modular increments of six stations to a maximum capacity of 42 stations.

The controller shall be packaged in a powder-coated metal wall-mount enclosure, with an optional powder-coated steel pedestal mount. The controller shall also be available in a pre-assembled plastic pedestal enclosure. All enclosures shall be suitable for outdoor installation.

Each station output shall have a capacity of up to .56 A @ 24VAC.

Station expansion shall be effected via 6-station modules requiring no tools to install, and only a screwdriver to attach field wiring. All station output modules shall feature transparent plastic housings with colored indicator LEDs showing station status (OK, running or faulted).

Station output modules shall be furnished with built in fully encased Metal Oxide Varistor (MOV) surge protection components. Extreme Service (AGM600) output modules shall be furnished with fully encased heavy-duty surge protection, consisting of spark gap and induction coil protection on each output.

Earth grounding shall be connected via a factory supplied copper ground lug inside the controller, for connection to earth ground hardware via 6 AWG(4mm dia.) copper wire ***(Refer to the Attachment for the ASIC Earth Grounding Guideline 100-2002 for details of earth grounding irrigation control systems).***

Ground wire shall be extended underground, at right angles to any communications wiring, to approved direct burial earth grounding hardware at least 6 ft/2m from the controller location. Earth ground shall be have an impedance of 10 Ohms or less, or shall meet the standards of the Earth Grounding Guideline cited above.

The controllers shall:

a) be equipped with an integrated, pre-wired SmartPort input to permit connection of wireless remote controls and other devices as specified by the manufacturer. Wireless remote control shall permit individual start of individual stations and Programs and shall also enable remote shut down of all irrigation at the controller; and

b) be adaptable to compatible computerized central control systems through an optional communications module, with a selection of common communications media including hardwired cable, UHF radio, dial-up modem, and cellular telephone.

When configured for operation within a central system, the controller shall feature full two-way communications with the central computer. The compatible control system shall be Hunter Industries Model IMMS 2.0 Irrigation Management and Monitoring System.

The controller shall:

a) be installed in accordance with the manufacturer's published instructions;

b) carry a conditional five year exchange warranty. The automatic controller(s) shall be the ACC series controller as manufactured for Hunter Industries Incorporated, San Marcos, California; and

c) UL and c-UL listed. The controller shall be CE and C-tick approved and shall have WEEE recyclability markings as required.

The wall mount controller shall be model ACC-1200.

Station expansion modules (6 stations each) shall be Hunter Model ACM-600.

Compatible flow meter shall be Hunter Industries Model HFS, with appropriately sized FCT fitting for the pipe.

The controller shall have a 24 V relay and 24VAC plug pack installed for activation of the Bermad master valve. The relay shall be installed within a PVC enclosure mounted on DIN rail.

This controller shall be for the sole use of Wattie Watson Oval.

Nominated Item: Hunter ACC – 2400

## 37 CONTROLLER – EXISTING

The existing Hunter ACC 30 Stn controller shall have an additional 6 stn module supplied and installed by the Contractor. The existing valve wiring V1-15 (Elwood Touch) shall be maintained with the remaining active and common cables removed and disposed of.

The controller shall have a 24 V relay and 24VAC plug pack installed for activation of the Bermad master valve. The relay shall be installed within a PVC enclosure mounted on DIN rail.

## 38 CONTROL CABLE

Installation of cables shall conform to AS 3000 1991 "SAA Wiring Rules"

Active and common wire shall be multi core 1.0 $mm^2$ ,0.4 mm H.D.P.E insulated, 0.7 mm PVC sheathed with a nominal O.D of 4.2 mm for 3 core and 6.4 mm for 5 core.

The cables shall be installed in a HD orange conduit when not installed with mainline and sub main.

A 500 mm loop of cable shall be left at each automatic valve assembly and a 300 mm loop of cable at each change of direction.

Any field joints shall be housed in a valve box according to table 1.0 and located by a registered and licensed surveyor on the as constructed drawings.

Nominated Item: Tycab or approved equivalent

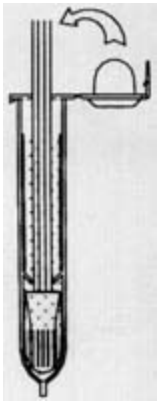
## 39 WIRE JOINTS

All wire joints shall be 3M DBY suitable for direct burying into the soil. They shall feature an insulating gel already contained in the tube which does not set hard, allowing the splice to be re-worked without cutting the wires.

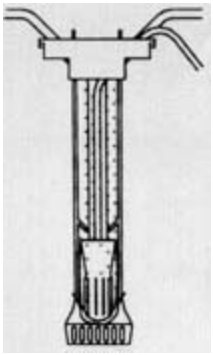
The device is UL listed and suitable for splices which can have up to a 600 v maximum in the system.

All wire jointing shall be performed according to the following illustration.

**1.** Strip wires, apply the Scotchlok electrical connector and twist in a clockwise direction.



**2.** Insert the splice into the gel-filled insulator tube. Push past the locking fingers to hold the Scotchlok connector in place.



**3.** Position wire channels and snap insulator tube cover closed.

Nominated Item: 3M DBY or approved equivalent

## 40 RAIN SENSOR - EXISTING

The rain sensor shall:

a) be adjustable from 3 mm to 25 mm for local sensing of rainfall and come with a 5 year manufacturer warranty;

b) be mounted in a stainless steel vandal resistant enclosure bolted to the typical rain sensor mounting assembly; and

c) be set to terminate programs in the event of 6 mm of precipitation in any one event or as directed by the superintendent or his representative. The existing rain sensor shall be shared between the 2No controllers. A 24 V relay shall be installed on a DIN rail within a PVC enclosure (Refer Controller).

Upon completion of installation, the Contractor shall notify the Superintendent and MIW to test the pressure of the mainline and the sub main.

**Mainline / Sub Main Pressure test certificate**

Date:_____

Time:_____

Starting Pressure: _____Kpa

Pressure at 15 minutes:_____Kpa

Pressure at 30 minutes:_____Kpa

Pass / Fail : _____

*Test Performed by:*

| (Print Name) | (Signed) | (Date) |
|---|---|---|
| (Company) | (Position) | |

*Test Witnessed by:*

| (Print Name) | (Signed) | (Date) |
|---|---|---|
| (Company) | (Position) | |

# AMERICAN SOCIETY OF IRRIGATION CONSULTANTS


# ASIC Guideline 100-2002 (January 2, 2002)
# For Earth Grounding Electronic Equipment in Irrigation Systems

**For the latest rev. go to**
**http://www.asic.org/design_guides.htm**

**American Society of Irrigation Consultants**

**P.O. Box 426, 125 Paradise Lane, Rochester, MA 02770**

**Phone: (508) 763-814**

**Fax: (508) 763-8102**

**Website: www.asic.org**

**E-mail: info@asic.org**

**1.0 Scope**
Defines minimum requirements for earth grounding electronic equipment in irrigation systems based on the requirements of the National Electrical Code (NEC) and sound practices of the Institute of Electrical & Electronics Engineers (IEEE), to ensure personnel safety and equipment reliability.

**1.1 Purpose**
A guide for irrigation industry persons who are involved in the design, manufacturing, distribution, installation and maintenance of electronic equipment in residential, commercial, institutional, golf course, and agricultural projects.

**1.2 Implementation**
Specifications for earth grounding of electronic equipment shall be written and administered by the irrigation professional, herein referred-to as "the designer."

**2.0 References**
The following documents and references were used as a basis for this guideline. This material is subject to revisions.


NFPA 70, *National Electrical Code*®, National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02269, USA, http://www.nfpa.org/, 1999.

NFPA 780, *Standard for the Installation of Lightning Protection Systems*, National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02269, USA, http://www.nfpa.org/, 1997.

IEEE Std 142-1991, *IEEE Recommended Practice for Grounding of Industrial and Commercial Power Systems (IEEE Green Book)*, The Institute of Electrical and Electronics Engineers, Inc., 345 East 47th Street New York, NY 10017, USA, http://www.standards.ieee.org/, 1991.

IEEE Std 1100-1999, *IEEE Recommended Practice for Powering and Grounding Electronic Equipment (The Emerald Book),* The Institute of Electrical and Electronics Engineers, Inc., 345 East 47th Street New York, NY 10017, USA, http://www.standards.ieee.org/, 1999.

Sunde, E.D., *Earth Conduction Effects in Transmission Systems*, Dover Publications, 1968.

Morrison and Lewis, *Grounding and Shielding in Facilities*, John Wiley & Sons, 1990.

Morrison, *Grounding and Shielding Techniques*, John Wiley & Sons, 1998.

Rufus and Gibilisco, *Principles and Practices of Impedance*, McGraw-Hill Professional Publishing, 1987

*Lightning Protection and Grounding Solutions for Communication Sites*, Polyphaser Corp., 2225 Park Place, Minden, NV 89423, USA, http://www.polyphaser.com/, 2000

"*The Link"* (Technical Bulletin, Issue 5), ERICO, Inc., 34600 Solon Road, Solon, OH 44139, USA, www.erico.com, 1999

*Earth Resistance Calculators* (from web-site), LORESCO INTERNATIONAL, P.O. Box 1089, Hattiesburg, MS 39403, USA, www.loresco.com, 2000.

**3.0 Safety**

The requirements of the National Electrical Code shall prevail, to ensure safety. Local electrical codes may apply additionally as determined by the designer. Prevailing local codes shall only enhance requirements of the NEC.

**4.0 Definitions**

Should - As used in this guideline, designates a suggestion or recommendation.

Shall - As used in this guideline, designates a mandatory requirement.

Approved Equal - "Approved equal" shall mean approved by the designer.

Ground - A conducting connection, whether intentional or accidental, between an electrical circuit or equipment and the earth, or to some conducting body that serves in place of the earth.

Service Entrance/Switch Gear Panel - Equipment for delivering electric energy from the serving utility to the wiring system of the premises served, commonly known as the circuit breaker or fuse box.

Service Entrance Ground - Ground circuit installed at the service entrance by the utility company.

Supplementary Ground - A ground circuit for irrigation equipment located away from the Service Entrance.

Bonding - Permanent joining of metallic parts to form an electrically conductive path that will ensure electrical continuity and the capacity to conduct safely any current likely to be imposed.

Bonding Conductor - A solid bare copper wire or copper strap connecting supplementary grounds to each other and to the service entrance ground.

Exothermic Welding – Chemical/molecular bonding of two metals using a "Cadweld One-Shot"®[1], or approved equal.

Brazing/Welding – Chemical/molecular process for bonding two metals using a torch. Welding rods shall contain a minimum of 5% silver.

Ground Rod Clamp - A copper alloy device used to mechanically connect a copper conductor to a ground rod.

Grounding Conductor - Solid bare copper wire or copper strap used to connect equipment or the grounded circuit of a wiring system to a grounding electrode or electrodes.

Electrode - A ground rod or ground plate

[1]CADWELD One-Shot is a registered trademark of ERICO Electrical Products

Ground Rod - A UL listed "copper clad" grounding electrode having minimum dimensions of 5/8" diameter and 8' of length. Construction is high tensile steel with a 10 mil copper skin, manufactured to the requirements of NEC article 250-52 (c). Usually installed in a vertical position.

Ground Plate - An electrode made to the requirements of NEC article 250-52 (d). The material used shall be a copper alloy intended for the purpose with a minimum thickness of 0.060". Each plate shall expose a minimum of 5 $ft^2$ of surface area to contact the soil. Grounding conductors shall be attached to the plate using a welding process. Splices made to the grounding conductor shall be made using a welding process. Dissimilar metals and solder connections shall not be allowed. Usually installed in a horizontal position.

Impedance - Opposition to electrical flow in an alternating current circuit. It is the sum of the effects of opposition to electrical flow caused by resistance, capacitance, inductance, and the frequency of the lightning discharge signal. In grounding grids, inductance causes the majority of the impedance.

Inductance - A phenomenon that opposes the flow of electricity as a function of signal frequency and the geometry of the electrodes and grounding conductors. The higher the frequencies of the lightning pulse, the higher the opposition. As the geometry of the grounding grid becomes more complex, its inductance increases.

Grounding Circuit – A combination of copper clad ground rods, copper ground plates, and copper conductors. Several typical designs are given in figures 2 to 8.

Grounding Grid - An installed grounding circuit, which may include bonding and shielding copper conductors.

Shielding - A technique that employs shallowly installed copper conductors to intercept lightning energy from being induced onto underground wires and cables connected to equipment.

**5.0 Designer**
The design of the earth grounding system shall be provided by a competent irrigation professional and shall comply with the requirements of national and local electrical codes.

**6.0 Installer**
An individual, contractor, licensed electrician, or organization deemed qualified by the designer, to install and test the grounding grid while meeting all applicable local and national electrical codes.

**7.0 Measuring Resistance**
Earth resistance shall be measured and recorded after the installation of the grounding grid(s), and every three months thereafter for the first year. This data should be used to determine the most critical times of the year, based on soil moisture content and lightning frequency. The resistance shall be tested and recorded every six months thereafter, at these most critical dates, to ensure that proper contact with the soil is maintained at all times. Resistance measurement shall be made using commercially available instruments, in accordance with the latest requirements of NFPA 780. Follow instrument manufacturer's specific operating instructions.

Readings of 5 to 10 ohms are desirable. The effectiveness of the circuit is a function of its impedance, which cannot be measured in the field in a practical manner. Sound practices and proper installation are more important in assuring quality results than this reading. The minimum requirements of the NEC shall be met, which are:

a) a resistance reading of no more than 25 ohms, or

a) a two electrode ground grid.

In installations with multiple equipment locations, the resistance readings of like grounding circuits should be compared for consistency. Large variances in readings point to different soil conditions, or soils with varying degrees of moisture content, or improper installation.

**8.0 Grounding Electrodes**

Irrigation system grounding circuits consist of ground rods, ground plates, copper strips, straps, and solid copper wire. Ground rods are usually adequate for safety and for protection of electro-mechanical equipment. However, when protecting electronic equipment, ground plates shall be used by themselves or in conjunction with ground rods. Plates exhibit low inductance/impedance characteristics and are better suited for the protection of electronic equipment. It may be necessary to use access boxes and to label grounding conductors at the equipment for the convenience of electrical inspectors.

**9.0 Moisture Content**

Soil needs moisture to conduct electricity. Moisture content within the sphere of influence, as defined in paragraph 11.3 below, of the electrodes shall be a minimum of 15% by weight. If this minimum level of moisture is not present, it shall be added by using irrigation products such as bubblers, sprinklers, drip emitters, etc.

**10.0 Soils and Soil Amendments**

Soil resistivity (with at least 15% moisture) varies considerably depending on soil type. Generally speaking, clay soils give low resistance and sandy soils high resistance.

Soil resistivity can be significantly reduced with proper soil amendments, which are commonly referred to as “Earth contact” or “Ground enhancement” materials. Only soil amendments such as PowerSet®, PowerFill®, and GEM®[2], which are specifically made for the application, shall be allowed. Corrosive soil amendments such as salts, minerals, fertilizers, concrete, etc. shall not be used. “Bentonite clay products” shall not be used because of their swelling/shrinking characteristics.

**11.0 Lightning and Grounding Theory**

11.1 - Path of lightning - Lightning is a high voltage-high current electrical discharge made up of a broad range of frequencies. It follows the path of least impedance, not the path of least resistance. In order for a grounding grid to be effective it should provide a discharge path to earth that has much lower impedance than the path to the electronic equipment. A large portion of the impedance of a grounding circuit is due to its inductance. Circuits containing flat electrodes give lower impedance and the best results. Round electrodes and conductors should be minimized.

---

[2] PowerSet® and PowerFill® are registered trademarks of LORESCO International. GEM® is a registered trademark of ERICO Electrical Products

11.2 - Skin Effect – This is a phenomenon that explains the behavior of electrical flow in conductors at various frequencies of current. At low frequencies (direct current and 60 cycles per second), electricity flows through the complete cross-section of the conductor. At higher frequencies, it flows only on the skin of the conductor or grounding electrode. For example, at 1 Mega-Hertz, which is about the midrange of lightning frequencies, the skin of a conductor/electrode that carries electrical flow is only 0.026" thick. Ground rods and wires offer very little skin for conducting, while plates are all skin.

11.3 - Sphere of influence - Electrodes need a certain amount of the soil surrounding them to effectively dissipate lightning energy. This space is known as the sphere of influence and is shown in figures 1A and 1B for ground rods and ground plates, respectively. This is the basis for determining proper electrode spacing, so they do not compete for the same soil.

**12.0 Installation Requirements**

12.1 Electronic equipment and wires/cables connected to the electronic equipment shall be installed outside of the sphere of influence of the ground grid. This is necessary, to avoid re-injecting the discharged lightning energy into the equipment and the underground wires and cables.

12.2 Space grounding electrodes to prevent overlapping of spheres of influence. Rod spacing shall be twice the rod length. Examples – space 8-foot rods 16 feet apart, space 10-foot rods 20 feet apart. See figures 2 to 8 for spacing of electrodes in various ground grids.

12.3 During the installation process, it is usually necessary to bend grounding conductors as they are installed inside the equipment, through conduit, and inside buildings. Sharp bends in conductors create complex ground geometry that shall be avoided. Straight wire runs and simple geometry provide significantly better grounding.

These bends must have a minimum included angle of 90° and a minimum radius of 8", which equates to a standard 1 ½" PVC sweep ell. Bonding/shielding conductors shall be installed 12" to 15" below the ground surface, directly over the major bundles of wires/cables, and shall be connected to all the grounding grids at the equipment locations.

12.4 Ground rods shall be driven a minimum of 8' into the ground in a vertical or oblique position. The angle of the rod relative to the vertical shall be no more than 45°.

12.5 Ground plates shall be installed in a horizontal position a minimum of 30" below ground level and below the frost line. The plate shall be installed flat at the bottom of the trench.

12.6 "Earth contact materials", as referenced in 10.0 above, may be poured in the trench in powder form or they can be mixed with water to create a slurry. The latter minimizes dust particles in the air and makes for a cleaner installation. When mixing earth contact material, use 3.5 gallons of water with 50 pounds of material. Proper protective equipment shall be worn per the manufacturer's instructions.

12.7 Conduit and sweep ells used in grounding grids shall be plastic, as metallic types increase the inductance of the grounding conductors.

12.8 Ground clamps should be used to connect grounding conductors to ground rods on a temporary basis. Once satisfactory results are achieved, the clamps shall be replaced by permanent welded connections. Solder shall never be used in making connections as it melts during a lightning discharge.

12.9 The basic tools necessary for installing a grounding grid are:

a) A machine capable of cutting a trench that is 6" wide and 36" deep;
b) A sledgehammer or power hammer to drive ground rods into the soil;
c) A ground rod sleeve that prevents the top of a ground rod from mushrooming when it is being driven into the soil; and
d) A flint igniter to start the exothermic reaction in a Cadweld One-Shot.

**13.0 Grounding Circuit Designs**
Varying types of installations, site conditions, and lightning frequency shall dictate the optimum grounding circuit to be used. Ground rods may not be practical in job sites with rocky soils.

**14.0 Typical Grounding Grids**
The type of grounding grid designed for a piece of electronic equipment is a function of the total length and size of the wires connected to it. Ground rods and plates can be used in sand and clay soils. Ground plates and bare copper wires are used in rocky soils. Typical grids for various pieces of electronic equipment and soil conditions are shown in figures 2 to 8.

14.1 - Irrigation Controllers - A 64-station controller has many more wires connected to it than does a 12-station controller. As more wires are connected to a piece of electronic equipment, more lightning energy enters the equipment, and a more substantial grounding grid must be used. Use the following chart to determine the appropriate design from figures 2 to 8.

| | **Use Figure Shown for:** | |
|---|---|---|
| **Stations per Controller Location** | **Non-Rocky Soils** | **Rocky Soils** |
| 64 | 2 or 3 | 3 |
| 96 | 4 or 5 | 5 |
| 128 | 6 or 7 | 7 |
| 256 | 8 | 8 |

14.2 – For Irrigation Central Computer, Weather Stations and Pump Station Control Panels - Choose from figures 2 or 3, depending on soil conditions.

14.3 – If after following the guidelines of the above charts and ensuring that the installation and soil moisture content are correct, the resistance readings are more than 10 ohms, the grounding grid shall be upgraded to a recommended figure of the next number of stations.

Example: A 48-station controller is grounded as in figure 3. The moisture content is confirmed to be at least 15%, the installation is correct, and the resistance is measured to be 18 ohms. In this case the grounding grid must be upgraded to figure 4 or 5.

**********

# Drawings

**DRAWINGS**

Drawings provided as separate pdf attachments:

- 420_CV_01.pdf
- 420_DD_02.pdf
- 420_DD_03.pdf