

APPLICATION NOTE.

HOW TO DERIVE AN EFFICIENT RM-1 WATERING ORDER.

Abstract:

When a minimum overall watering time is required, care is needed in specifying the watering order in the RM-1. This application note provides a guide on how this may be done.

Background:

The RM-1 employs a powerful but simple method of flow management to allow multiple stations to water simultaneously. Parallel operation shortens the overall time to water and keeps the pump(s) operating efficiently.

There are two independent limitations on the number of stations that can be active at the same time; hydraulic and electrical. The former is set by the water carrying capacity of the pipes, whilst the latter is set by the voltage drop in the cables when solenoids are carrying current. Both are similar in concept. Too many stations will lead to an excessive hydraulic pressure drop and/or an excessive volt drop.

In the Tonick RM-1 and Translator combination, these limitations are specified to the watering software during installation. Any watering programs subsequently defined by the user will then be executed to respect these limitations.

Currently, the electrical limit per cable is a maximum of four solenoids. (Additionally, a Translator should not be asked to source more than 1.8A (1800mA)). During installation, each station is specified in the RM-1 to have an electrical load of between one and four solenoids. The program will never activate more than four at one time on each Translator (i.e. cable). Of course, with a maximum of four Translators with an RM-1, there can be a maximum of 16 solenoids active at any one time.

During installation, the hydraulic limitations are specified to the RM-1. This is done by dividing the pipe work into a maximum of 127 flow zones, each with a maximum carrying capability of so many litres per minute (l/min). Each station is specified to have a delivery of so many litres per minute and is assigned to a particular flow zone. The program will then never activate more stations in a common flow zone than that zone will carry.

How the RM-1 Flow Management Works:

Using the watering order as a starting basis, the watering program compiles a list of stations to be watered. To be included, the station must not have failed, and have a watering time greater than zero. For example, if Fairway 1 is the first entry in the watering order and has eight stations (F01B1...F01B8), each will be entered into a table called 'ToRun'. The next entry in the watering order, e.g. Fairway 9 with seven stations, will then be appended in the same way. Thus, the 'ToRun' table will look like:
F01B1, F01B2, F01B3, F01B4, F01B5, F01B6, F01B7, F01B8, F09B1, F09B2, F09B3, F09B4, F09B5, F09B6, F09B7.

APPLICATION NOTE.

When all stations have been compiled into 'ToRun', watering begins. F01B1 is turned on and its solenoid load is subtracted from the maximum of 4 for that cable. The delivery in litres/minute is also subtracted from the flow zone assigned to that station. For example, if the number of solenoids for F01B1 is specified to be one, those available after activation is $4 - 1 = 3$. Likewise if the litres/minute is 327 and its flow zone is number one with a maximum capacity of 327 l/min, then the remaining capacity is $327 - 327 = 0$ l/min.

Assume in the example that all Fairway 1 is assigned to flow zone number 1 which has a maximum handling capability of 327 l/min, and all Fairway 9 is assigned to flow zone 2 with the same maximum capacity. Further, assume all fairway stations deliver 327 l/min.

After turning on F01B1, the flow management inspects the next entry in 'ToRun', namely F01B2. There is enough capacity to run it electrically ($3 - 1 = 2$), but not enough hydraulic capacity $0 - 327 < 0$. The watering program defers turning it on and proceeds to successive entries, inspecting each in the same way. When the program comes to F09B1, the flow zone changes to zone 2, with a capacity of 327 l/min. Thus, the first station in Fairway 9, F09B1, is turned on in parallel with F01B1. This process is repeated up to 64 stations ahead in 'ToRun'. When the time for F01B1 expires, it is turned off and the next station F01B2 can now be run with zone capacity now back to 327 l/min available.

This example shows how it is possible to constrain just one station on a fairway operating at a time, but have many fairways active simultaneously.

How the Watering Order Can Help or Hinder:

An important consideration in designing the watering order to be used with a program, is the knowledge that the RM-1 only searches 64 stations ahead from the earliest still watering. This internal limitation is set by software execution times and is a compromise.

To illustrate the problem assume that Fairway 1 has 64 stations (unrealistic). The 'ToRun' table from the last example would then look like this:
F01B1, F01B2.....F01B64, F09B1, F09B2.....etc.

When F01B1 is turned on, the inspection of stations would stop at F01B64 (64 ahead), therefore F09B1 would not be turned on. Only when F01B1 had completed and F01B2 was active would F09B1 be inspected and turned on in parallel.

Similarly, when operating an RM-1 with multiple Translators, care must be taken to interleave stations with different cable paths in the watering order. Failure to do this may result in periods during the watering when not all the Translators are given stations to operate. This may be illustrated by the following example.

Assume two cables (Translators) each driving 9 Fairways. Cable 0 with Fairways 1-9, each with 10 stations, and cable 1 with Fairways 10-18, again with 10 stations each.

APPLICATION NOTE.

If the watering order was chosen to be GTAF (which is predefined), it would specify Fairway 1Fairway18 in ascending order. Thus, the 'ToRun' table would look something like:

...F01B1, F01B2,.....F01B10, F02B1, F02B2....F02B10,.....F10B1,.....F18B10.

Using the former example's electrical and hydraulic parameters, the watering program would run one station from F1, F2, F3 and F4 in parallel, but because F10B1 is more than 64 stations ahead of F01B1, no stations would water on cable 1 for some considerable time.

If however the watering order had been specified (in say Custom1) as Fairway 1, Fairway 9, Fairway 2, Fairway 10 etc., both Translators would drive 4 stations in parallel, significantly decreasing the overall time to water.

Another useful technique is to specify the early holes first in the order so that if play starts before the watering is finished in the morning, it is the last holes that are being watered. This is especially important where reclaimed water is used and needs to soak in before players use the grass.

APPLICATION NOTE.

How to Construct a Watering Order:

Draw a number of boxes, one for each cable path. In each, place the area, hole number and in brackets, the number of stations for that area. Sort the names into ascending hole order. For example:

Cable 0.

F1 (8)
G1 (2)
T1 (2)
F16 (1)
G16 (2)
F17 (7)
G17 (2)
T17 (2)
F18 (13).....etc.

Cable 1.

G0 (2)
F9 (7)
G9 (2)
T9 (2)
F10 (9)
G10 (2)
T10 (2)
F12 (6)....etc.

Cable 2.

F2 (8)
G2 (2)
T2 (2)
F3 (7)
G3 (2)
T3 (2)
F4 (10)
G4 (2)
T4 (1)....etc.

Cable 3.

T11 (1)
G13 (2)
F14 (7)
G14 (2)
T14 (2)
F15 (8)
G15 (2)
T15 (2)
T16 (1).....etc.

Thus in the box for cable 0, the first entry is Fairway 1 with 8 stations.

Now pick the first entry in cable 0, F1 and enter it in the order list. Strike it through in the box to show it has been assigned. Then choose an entry in cable 1 that has a similar number of stations, Fairway 9 with 7 stations would be a good choice and enter it next. Likewise Fairway 2 in cable 2 and Fairway 14 in cable 3.

APPLICATION NOTE.

Cable 0.

<u>F1 (8)</u>
G1 (2)
T1 (2)
F16 (1)
G16 (2)
F17 (7)
G17 (2)
T17 (2)
F18 (13).....etc.

Cable 1.

G0 (2)
<u>F9 (7)</u>
G9 (2)
T9 (2)
F10 (9)
G10 (2)
T10 (2)
F12 (6)....etc.

Cable 2.

<u>F2 (8)</u>
G2 (2)
T2 (2)
F3 (7)
G3 (2)
T3 (2)
F4 (10)
G4 (2)
T4 (1)....etc.

Cable 3.

T11 (1)
G13 (2)
<u>F14 (7)</u>
G14 (2)
T14 (2)
F15 (8)
G15 (2)
T15 (2)
T16 (1)....etc.

Thus the order list would look like this:

Order	Name	Cable
1.	F1	0
2.	F9	1
3.	F2	2
4.	F14	3

Then assuming Greens may be watered early, choose G1 (2), G0 (2), G2 (2) and G13 (2) as the next four items in the watering order.

Order	Name	Cable
1.	F1	0
2.	F9	1
3.	F2	2
4.	F14	3
5.	G1	0
6.	G0	1
7.	G2	2
8.	G13	3

APPLICATION NOTE.

Where an area on one cable with many stations needs to run in parallel with an area on another cable with less, choose successive areas in the latter to roughly make up the same number of stations. For example if Fairway 17 on cable 0, F17 (7), needs to run with Green 10 on cable 1, consider entering G10 (2), T10 (2) and F12 (6), which totals 8 stations on that cable.

Order	Name	Cable
10.	3
11.	F17	0
12.	G10	1
13.	T10	1
14.	F12	1
15.	...	2 etc.

Conclusions:

This technique will result in a quite well balanced use of Translators with the early holes watered nearer the start of the program. However, individual adjustments can be made to entries after a fast run of say 2 minutes/station has been tried and observed.

Footnote:

Run the RM-1 Without Translators.

To allow testing of programs and programming the configuration away from the site, the RM-1 can be made to simulate communications rather than have to be connected to Translators. To enter this temporary mode, power up the RM-1 with the number 3 key held down. A message will announce when the key can be released. Normal communications mode will be restored on next power-up.

When in communications simulation mode, the commands normally destined for the Translators are instead transmitted blind in ASCII form to the Remote Control Port. These can be displayed using a terminal emulator (e.g. HyperTerminal) and a suitable serial RS232 cable (available from Tonick).

J.A. Ware B.Sc.
10-09-00

The following page shows a typical printout of watering order from an RM-1 driving four Translators on an 18 hole Greens, Tees and Fairways course.

APPLICATION NOTE.

Printed on 10 Sep '00 09:18 Order= Custom 2

0 Fairway	1
1 Fairway	9
2 Fairway	2
3 Fairway	14
4 Green	1
5 Putting1	
6 Green	2
7 Green	13
8 Tee	1
9 Tee	9
10 Tee	2
11 Tee	11
12 Fairway	16
13 Green	16
14 Green	9
15 Green	3
16 Tee	3
17 Green	14
18 Tee	14
19 Fairway	17
20 Fairway	3
21 Fairway	10
22 Fairway	15
23 Green	17
24 Tee	17
25 Green	10
26 Tee	10
27 Green	4
28 Tee	4
29 Green	15
30 Tee	15
31 Fairway	12
32 Green	12
33 Fairway	4
34 Fairway	5
35 Tee	5
36 Tee	16
37 Green	18
38 Tee	18
39 Tee	12
40 Fairway	13
41 Tee	13
42 Green	5
43 Fairway	6
44 Green	6
45 Fairway	18
46 Tee	6
47 Fairway	7
48 Green	7
49 Tee	7
50 Fairway	8
51 Green	8
52 Tee	8
53 Fairway	11
54 Green	11