1. Program Changes

1.0 Inhibit Chop-over Pump 1 to Pump 2

Figure 1 (below): New rung added.

G431 = 300 (0.300 uS/cm)
G464 = 50 (0.050 uS/cm)
G465 = 10 (0.010 uS/cm)

G466.0 is used to inhibit chop-over from water cooling pump 1 to pump 2. If chop-over occurs while the water conductivity is above a certain level, the drive can trip from high conductivity do to the sudden inrush of water that has been sitting in the inactive pump (while water sits stagnant in a pump, it's conductivity level rises).

The instructions in **Figure 1** set bit G466.0 to TRUE when conductivity is greater than 0.35 uS/cm (G431 + G464). G466.0 is latched-in until conductivity falls below or equal to 0.31 uS/cm (G431+G465).

Only inhibit chop-over from pump 1 to pump 2 if pump 1 is running (B3.8).

G431(existing) is used elsewhere in the program as the point below which the de-ionizing solenoid valve is shut off and the high conductivity alarm is turned off.

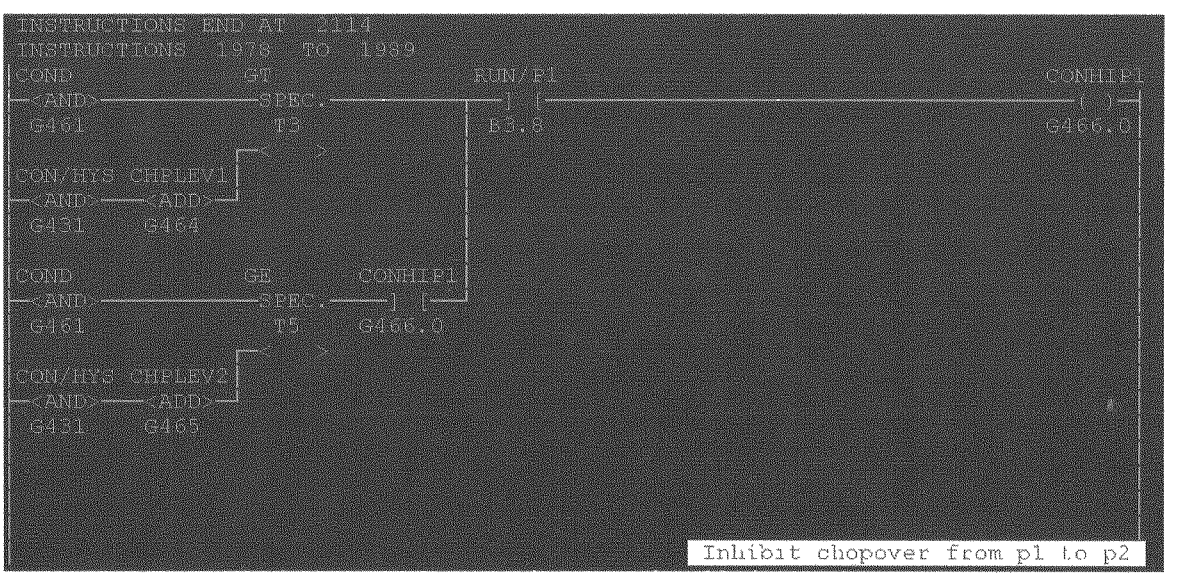

Figure 1

IP7_025458

1.1 Inhibit Chop-over Pump 2 to Pump 1

Figure 2 (below): New rung added.

Same principle as 1.0 above, but for chop-overs from Pump 2 to Pump 1.

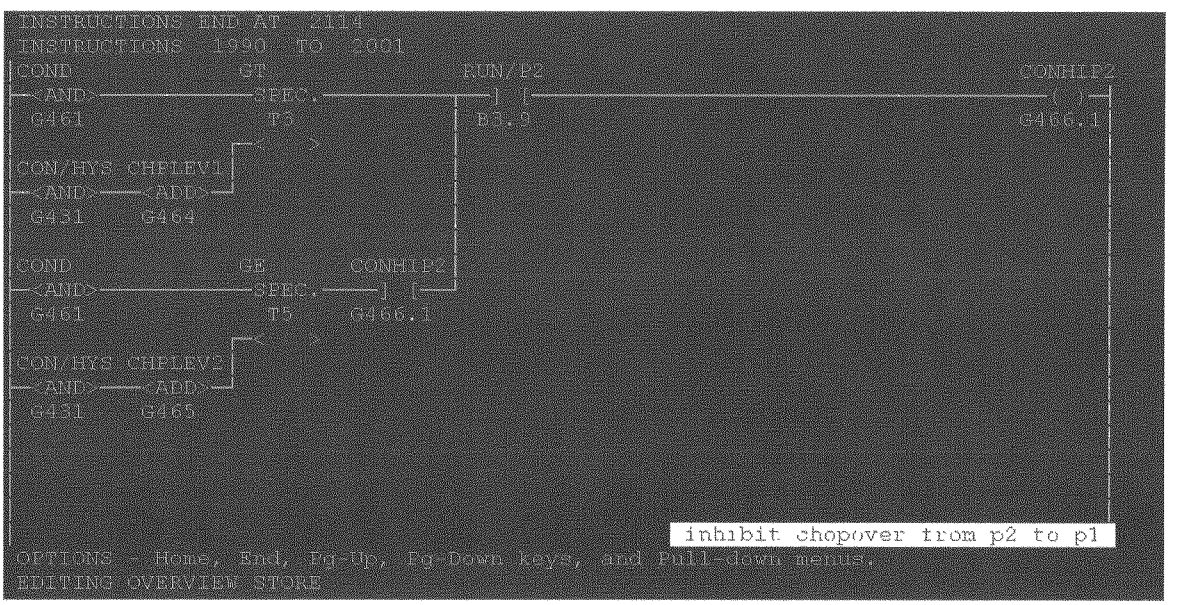

Figure 2

1.2 Pump Timers Equal – reset

Figure 3 (below): New rung added.

Concept from previously existing rung shown in **Figure 5** (see below). The rung in **Figure 5** was removed from the program (see explanation below at **Figure 5**).

This rung will reset the pump run-timers incase the pumps run longer than the chop-over time due to pump fault or conductivity inhibit.

The output is latched-in until reset occurs after the timers are equal (or past being equal) incase the running pump has to run longer than the not-running pump while the conductivity level is being lowered enough to allow chop-over.

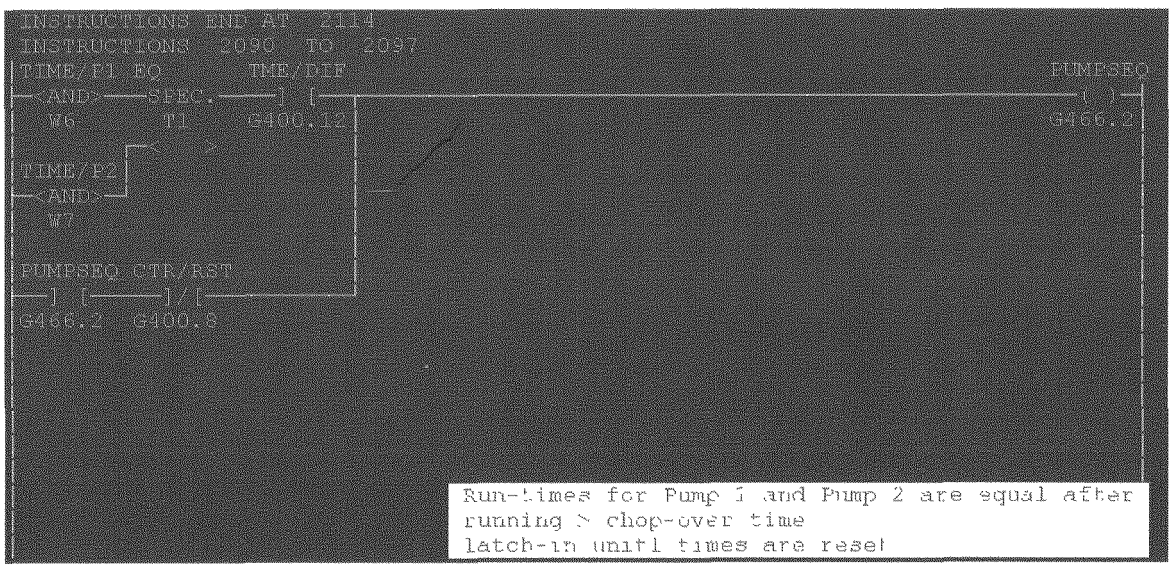

Figure 3

1.3 Pump Counters Reset

Figure 4 below: Existing rung modified.

G400.8 resets the pump run time counters (as before).

Added NC (normally closed) G466.0 and NC G466.1 so we don't reset the pump run-timers while chop-over is being inhibited due to conductivity level.

G400.12 (existing) is on when either of the pump run-timers is greater than the chop-over time. Moved G400.12 NC from rung right before G400.8 to branch added below with G466.2 (output of **Figure 3** above). This allows the timers to get reset when the pumps have run longer than the chopover time due to pump fault or conductivity inhibit and the timers have equalized.

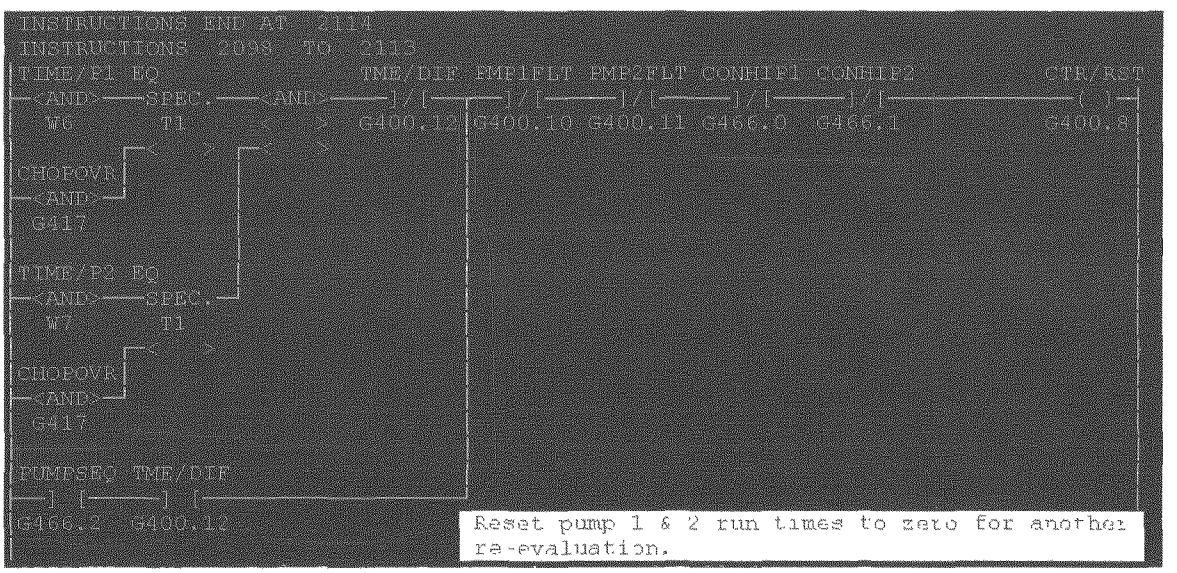

Figure 4

1.4 Pumps Counters Reset - Old

Figure 5 (below): Existing rung deleted.

The rung in **Figure 5** was positioned in the program directly below the original rung in **Figure 4** above. Because of this, the results of the instructions in **Figure 4** were superceded by the instructions in **Figure 5.**

The instructions in **Figure 5** would have only reset the pump run-timers after both pumps have been running the same period of time.

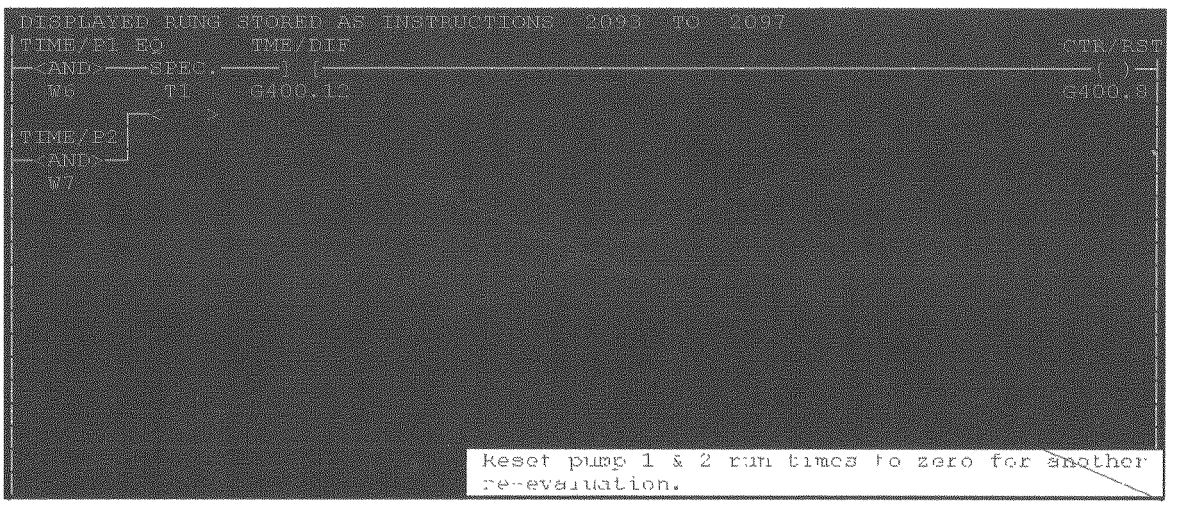

Figure 5

1.5 Pump Run Logic

Figure 6 (below): Existing rung modified.

NC G466.1 was inserted to inhibit chop-over from Pump 2 to Pump 1 when G466.1 = TRUE.

NO (normally opened) G466.0 and OR function inserted to inhibit chop-over from Pump 1 to Pump 2 when G466.0=TRUE.

The LE (less than or equal to) comparators were originally LT (less than). They were changed due to timing problems with implementing the modification carried-out on the rung described below in **Figure 7**.

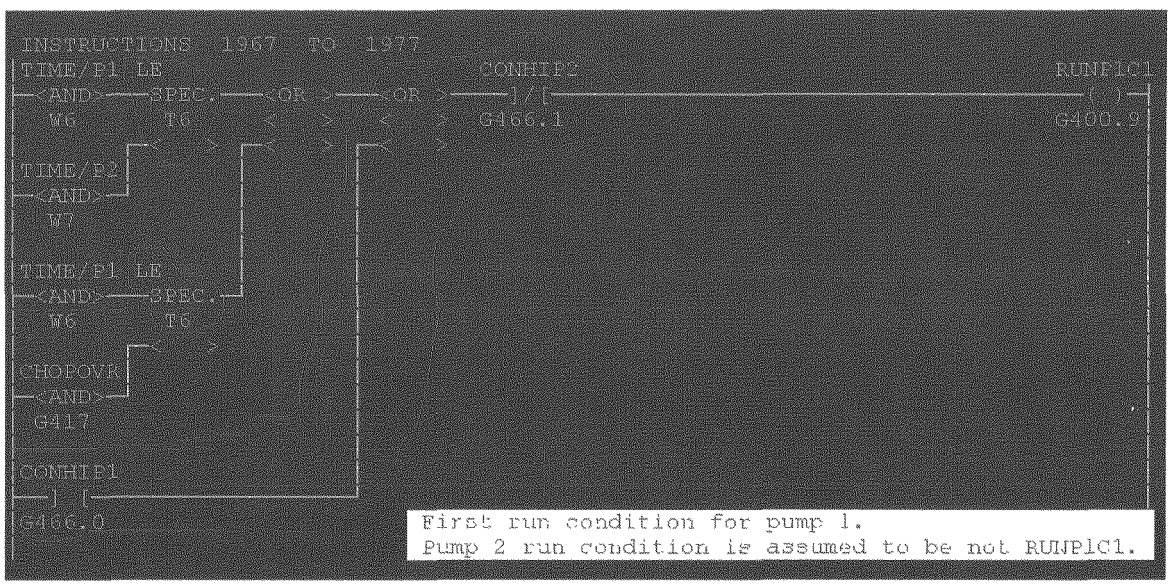

Figure 6

1.6 Pump 1 Run-Time Counter

Figure 7 (below): Existing rung modified.

If Pump 1 were faulted and Pump 2 ran a long time, upon becoming healthy Pump 1 will continue to run until it has run as long as Pump 2 in order to equalize the pumps' run-time. Without the modification outlined in red below, the pump run-timers would be reset to zero after Pump 1's run-time reached Pump 2's run-time, therefore starting the cycle over again, running Pump 1 again.

The mod below will reset Pump 1's run timer to the chop-over time when the pumps have run longer than the chop-time, Pump 1 is running, and the pumps' run timers are equal. This will cause Pump 2 to run next.

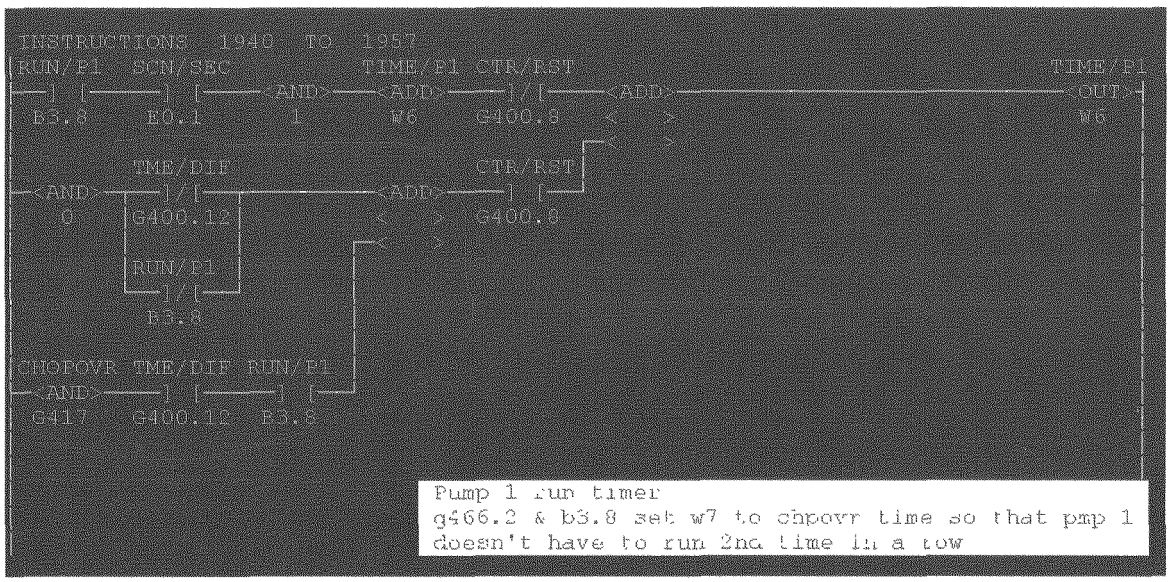

Figure 7

1.7 Conductivity Alarm Levels

Figure 8 (below): Existing rung modified.

Replaced C16 with G461. G461 is in units of uS/cm, C16 is in raw counts. The software is much easier to understand and modify when using Engineering Units.

The presets G430 & G431 values were changed to Engineering Units as well.

Upon recommendation from the Converteam Project Engineer, Sid Pant, G430 was changed from 0.6 uS/cm to 0.5 uS/cm in the Links program.

Also upon recommendation from the Converteam Project Engineer, G431 was changed from 0.4 uS/cm to 0.3 uS/cm in the Links program.

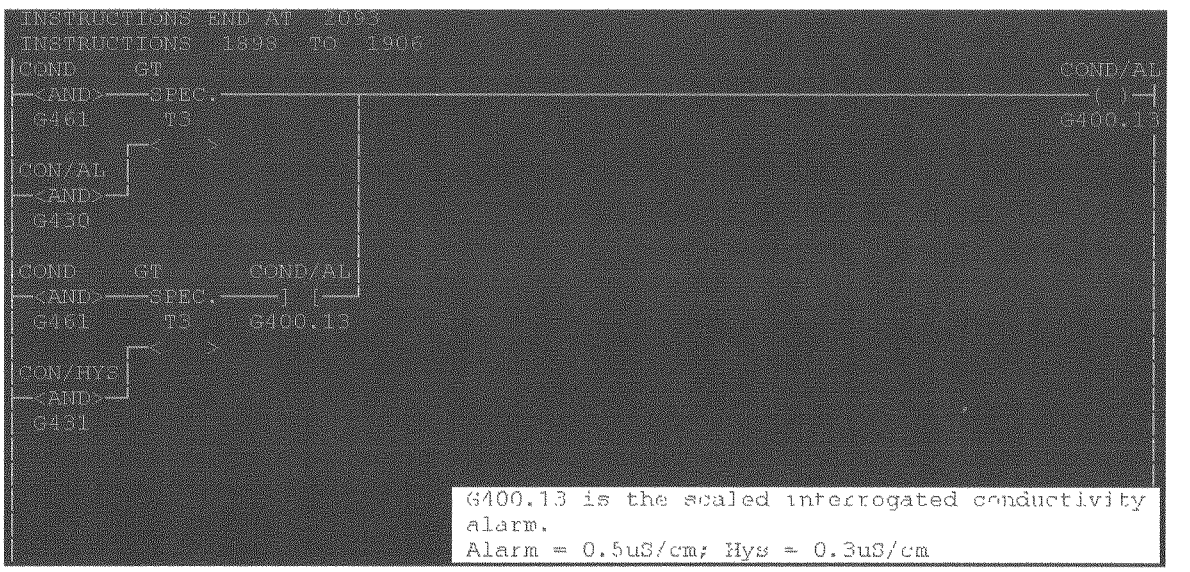

Figure 8

1.8 Chop-over has recently taken place

Figure 9 (below): New Rung Added.

After pump Chop-over, G466.3 will be set TRUE for the period of time specified in G423 (presently 90000 ms).

This bit is used to inhibit Conductivity Trips after Water Cooling Pump Chop-over's, as described in 1.9 below.

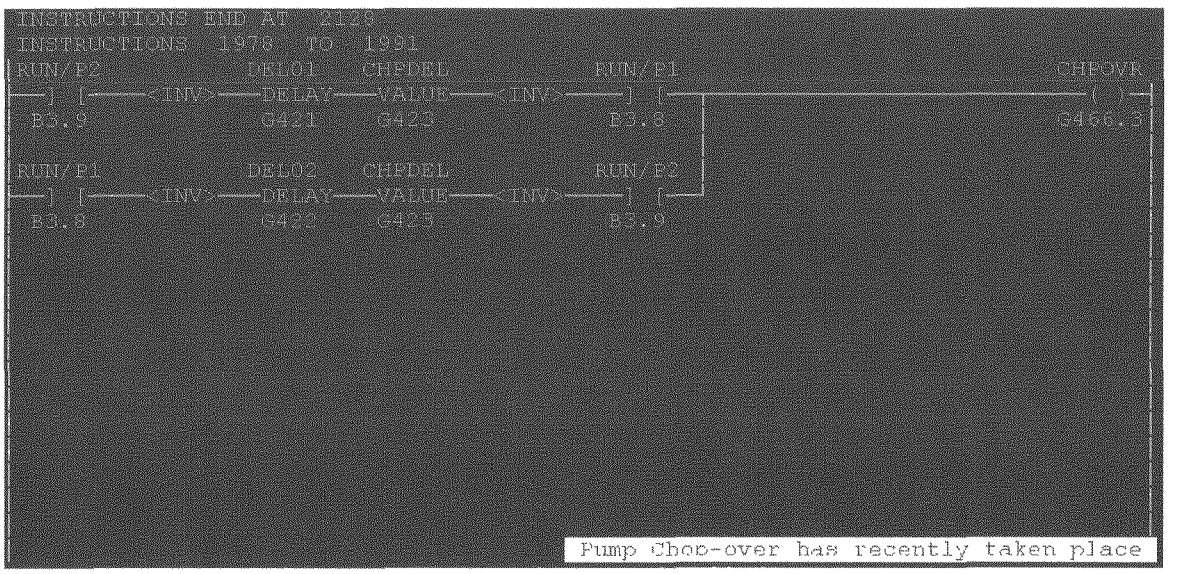

Figure 9

1.9 Inhibit Conductivity Trip after Pump Chop-Over

Figure 10 (below): Existing Rung Modified.

Inhibit Conductivity Trip while G466.3 (pump change-over has recently taken place).

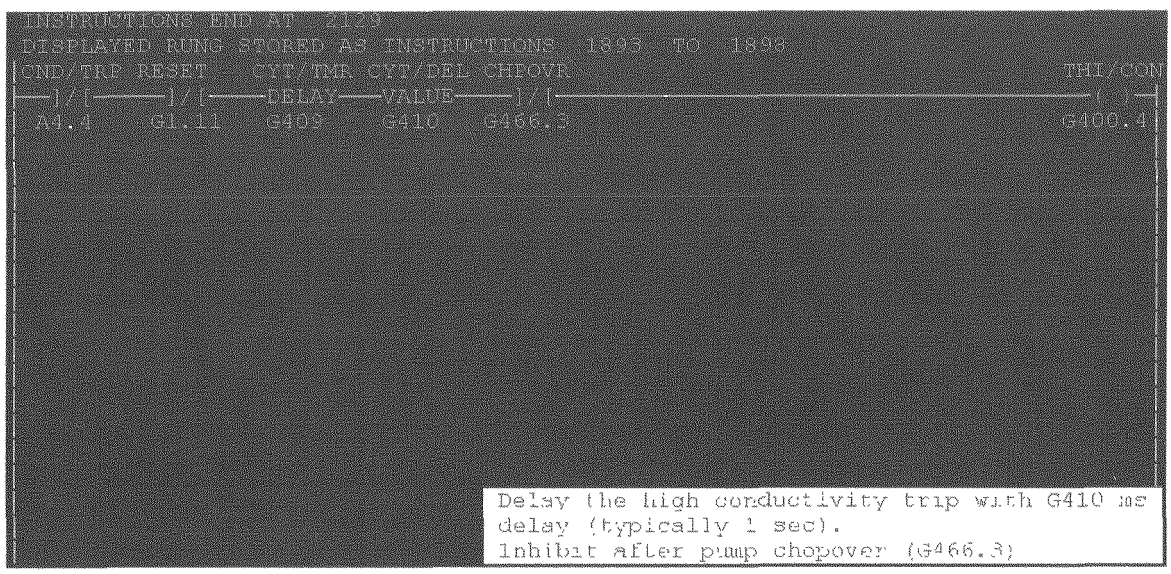

Figure 10

2. Software Testing

2.1 Pump 1 Failure – no inhibits.

- Insure that system is running normally.
- Insure that no chop-over inhibits due to conductivity will occur:
  - Poke 5000 into G464
  - Poke 1000 into G465
  - Observe G466.0 = 0
  - Observe G466.1 = 0
- Insure Pump 1 is running:
  - Poke 0 into W6
  - Poke 864000 into W7
- Pump 1 runs 9 days and Fails.
  - Poke 777600 into table W6 to simulate Pump 1 running for 9 days.
  - Switch-off Pump 1 overload relay MSP1.
  - System will switch-over to Pump 2
- Pump 2 runs 30 days, then Pump 1 is fixed
  - Poke 2592000 into table W7 to simulate Pump 2 running for 30 days.
  - Make Pump 1 healthy by switching MSP1 back on and pressing reset.
  - System will switch-over to Pump 1
- Pump 1 runs 30 days, then timer's will reset.
  - Poke 2591990 in table W6 to simulate Pump 1 running for nearly 30 days.
  - After W6 increments to 2592000, W6 will reset to 864000 (chop-over time of 10 days).
  - System will switch-over to Pump 2.
- Back on normal 10 day cycles.
  - Poke 863900 into W7 to simulate Pump 2 running almost 10 days.
  - Watch W7 increment to 864000.
    - System will switch-over to Pump 1.
    - W6 and W7 will reset to 0.
  - Poke 863900 into W6 to simulate Pump 1 running almost 10 days.
  - Watch W6 increment to 864000.
    - System will switch-over to Pump 2.
    - W6 and W7 will not reset to 0.

2.2 Pump 1 Failure – Chop-over to Pump 2, Pump 2 runs 30 days, Chop-over back to Pump 1 inhibited

- Insure that system is running normally.
- Insure that no chop-over inhibits due to conductivity will occur for now:
  - Poke 5000 into G464
  - Poke 1000 into G465
  - Observe G466.0 = 0
  - Observe G466.1 = 0
- Insure Pump 1 is running:

  - Poke 0 into W6
  - Poke 864000 into W7
- Pump 1 runs 9 days and Fails.
  - Poke 777600 into table W6 to simulate Pump 1 running for 9 days.
  - Switch-off Pump 1 overload relay MSP1.
  - System will switch-over to Pump 2
- Insure that Pump 2 to Pump 1 chop-over inhibit is on:
  - Poke 0 into G464
  - Poke 0 into G465
  - Observe that G466.1 = 1
- Pump 2 runs 30 days, then Pump 1 is fixed
  - Poke 2592000 into table W7 to simulate Pump 2 running for 30 days.
  - Make Pump 1 healthy by switching MSP1 back on and pressing reset.
  - System will not switch back to Pump 1
- Insure that Pump 2 to Pump 1 chop-over inhibit is healthy:
  - Poke 5000 into G464
  - Poke 1000 into G465
  - Observe that G466.1 = 0
  - System will switch-over to Pump 1
- Pump 1 runs 30 days, then timer's will reset.
  - Poke 2591990 in table W6 to simulate Pump 1 running for nearly 30 days.
  - After W6 increments to value in W7 (2592000+), W6 will reset to 864000 (chop-over time of 10 days).
  - System will switch-over to Pump 2.
- Back on normal 10 day cycles.
  - Poke 863900 into W7 to simulate Pump 2 running almost 10 days.
  - Watch W7 increment to 864000.
    - System will switch-over to Pump 1.
    - W6 and W7 will reset to 0.
  - Poke 863900 into W6 to simulate Pump 1 running almost 10 days.
  - Watch W6 increment to 864000.
    - System will switch-over to Pump 2.
    - W6 and W7 will not reset to 0.

2.3 Pump 1 Failure – Chop-over to Pump 2, Pump 2 runs 30 days, Pump 1 fixed, Pump 1 runs 30 days, Chop-over back to Pump 2 inhibited

- Insure that system is running normally.
- Insure that no chop-over inhibits due to conductivity will occur for now:
  - Poke 5000 into G464
  - Poke 1000 into G465
  - Observe G466.0 = 0
  - Observe G466.1 = 0
- Insure Pump 1 is running:
  - Poke 0 into W6
  - Poke 864000 into W7

- Pump 1 runs 9 days and Fails.
    - Poke 777600 into table W6 to simulate Pump 1 running for 9 days.
    - Switch-off Pump 1 overload relay MSP1.
    - System will switch-over to Pump 2
- Pump 2 runs 30 days, then Pump 1 is fixed
    - Poke 2592000 into table W7 to simulate Pump 2 running for 30 days.
    - Make Pump 1 healthy by switching MSP1 back on and pressing reset.
    - System will switch back to Pump 1
- Insure that Pump 1 to Pump 2 chop-over inhibit is on:
    - Poke 0 into G464
    - Poke 0 into G465
    - Observe that G466.0 = 1
- Pump 1 runs 30 days.
    - Poke 2591990 in table W6 to simulate Pump 1 running for nearly 30 days.
    - Watch W6 increment until W6 = W7
    - Observe G400.12 = 1
    - Observe G466.2 = 1
    - System will not switch-over to Pump 2.
- Insure that Pump 1 to Pump 2 chop-over inhibit is healthy:
    - Poke 5000 into G464
    - Poke 1000 into G465
    - Observe that G466.0 = 0
    - System will switch-over to Pump 2
- Back on normal 10 day cycles.
    - Poke 863900 into W7 to simulate Pump 2 running almost 10 days.
    - Watch W7 increment to 864000.
        - System will switch-over to Pump 1.
        - W6 and W7 will reset to 0.
    - Poke 863900 into W6 to simulate Pump 1 running almost 10 days.
    - Watch W6 increment to 864000.
        - System will switch-over to Pump 2.
        - W6 and W7 will not reset to 0.

2.4 Pump 2 Failure – no inhibits

- Insure that system is running normally.
- Insure that no chop-over inhibits due to conductivity will occur:
    - Poke 5000 into G464
    - Poke 1000 into G465
    - Observe G466.0 = 0
    - Observe G466.1 = 0
- Insure Pump 2 is running:
    - Poke 0 into W7
    - Poke 864000 into W6
- Pump 2 runs 9 days and Fails.
    - Poke 777600 into table W7 to simulate Pump 2 running for 9 days.
    - Switch-off Pump 2 overload relay MSP2.

    - System will switch-over to Pump 1
- Pump 1 runs 30 days, then Pump 2 is fixed
    - Poke 2592000 into table W6 to simulate Pump 1 running for 30 days.
    - Make Pump 2 healthy by switching MSP2 back on and pressing reset.
    - System will switch-over to Pump 2
- Pump 2 runs 30 days, then timer's will reset.
    - Poke 2591990 in table W7 to simulate Pump 2 running for nearly 30 days.
    - After W7 increments to 2592000, W7 will reset to 864000 (chop-over time of 10 days).
    - System will switch-over to Pump 1.
- Back on normal 10 day cycles.
    - Poke 863900 into W6 to simulate Pump 1 running almost 10 days.
    - Watch W6 increment to 864000.
        - System will switch-over to Pump 2.
        - W6 and W7 will not reset to 0.
    - Poke 863900 into W7 to simulate Pump 2 running almost 10 days.
    - Watch W7 increment to 864000.
        - System will switch-over to Pump 1.
        - W6 and W7 will reset to 0.

2.5 Pump 2 Failure – Chop-over to Pump 1, Pump 1 runs 30 days, Chop-over back to Pump 2 inhibited

- Insure that system is running normally.
- Insure that no chop-over inhibits due to conductivity will occur for now:
    - Poke 5000 into G464
    - Poke 1000 into G465
    - Observe G466.0 = 0
    - Observe G466.1 = 0
- Insure Pump 2 is running:
    - Poke 0 into W7
    - Poke 864000 into W6
- Pump 2 runs 9 days and Fails.
    - Poke 777600 into table W7 to simulate Pump 2 running for 9 days.
    - Switch-off Pump 2 overload relay MSP2.
    - System will switch-over to Pump 1
- Insure that Pump 1 to Pump 2 chop-over inhibit is on:
    - Poke 0 into G464
    - Poke 0 into G465
    - Observe that G466.1 = 1
- Pump 1 runs 30 days, then Pump 2 is fixed
    - Poke 2592000 into table W6 to simulate Pump 1 running for 30 days.
    - Make Pump 2 healthy by switching MSP2 back on and pressing reset.
    - System will not switch back to Pump 2
- Insure that Pump 1 to Pump 2 chop-over inhibit is healthy:
    - Poke 5000 into G464
    - Poke 1000 into G465

  - Observe that G466.0 = 0
  - System will switch-over to Pump 2
- Pump 2 runs 30 days, then timer's will reset.
  - Poke 2591990 in table W7 to simulate Pump 2 running for nearly 30 days.
  - After W7 increments to value in W6 (2592000+), W7 will reset to 864000 (chop-over time of 10 days).
  - System will switch-over to Pump 1.
- Back on normal 10 day cycles.
  - Poke 863900 into W6 to simulate Pump 1 running almost 10 days.
  - Watch W6 increment to 864000.
    - System will switch-over to Pump 2.
    - W6 and W7 will not reset to 0.
  - Poke 863900 into W7 to simulate Pump 2 running almost 10 days.
  - Watch W7 increment to 864000.
    - System will switch-over to Pump 1.
    - W6 and W7 will reset to 0.

2.6 Pump 2 Failure – Chop-over to Pump 1, Pump 1 runs 30 days, Pump 2 fixed, Pump 2 runs 30 days, Chop-over back to Pump 1 inhibited

- Insure that system is running normally.
- Insure that no chop-over inhibits due to conductivity will occur for now:
  - Poke 5000 into G464
  - Poke 1000 into G465
  - Observe G466.0 = 0
  - Observe G466.1 = 0
- Insure Pump 2 is running:
  - Poke 0 into W7
  - Poke 864000 into W6
- Pump 2 runs 9 days and Fails.
  - Poke 777600 into table W7 to simulate Pump 2 running for 9 days.
  - Switch-off Pump 2 overload relay MSP2.
  - System will switch-over to Pump 1.
- Pump 1 runs 30 days, then Pump 2 is fixed
  - Poke 2592000 into table W6 to simulate Pump 1 running for 30 days.
  - Make Pump 2 healthy by switching MSP2 back on and pressing reset.
  - System will switch back to Pump 2
- Insure that Pump 2 to Pump 1 chop-over inhibit is on:
  - Poke 0 into G464
  - Poke 0 into G465
  - Observe that G466.1 = 1
- Pump 2 runs 30 days.
  - Poke 2591990 in table W7 to simulate Pump 2 running for nearly 30 days.
  - Watch W7 increment until W7 = W6
  - Observe G400.12 = 1
  - Observe G466.2 = 1

    - System will not switch-over to Pump 1.
- Insure that Pump 2 to Pump 1 chop-over inhibit is healthy:
    - Poke 5000 into G464
    - Poke 1000 into G465
    - Observe that G466.1 = 0
    - System will switch-over to Pump 1
- Back on normal 10 day cycles.
    - Poke 863900 into W6 to simulate Pump 1 running almost 10 days.
    - Watch W6 increment to 864000.
        - System will switch-over to Pump 2.
        - W6 and W7 will not reset to 0.
    - Poke 863900 into W7 to simulate Pump 2 running almost 10 days.
    - Watch W7 increment to 864000.
        - System will switch-over to Pump 1.
        - W6 and W7 will reset to 0.

2.7 Pump 1 No Fault – Chop-over inhibited

- Insure that system is running normally.
- Insure that no chop-over inhibits due to conductivity will occur for now:
    - Poke 5000 into G464
    - Poke 1000 into G465
    - Observe G466.0 = 0
    - Observe G466.1 = 0
- Insure Pump 1 is running:
    - Poke 0 into W6
    - Poke 864000 into W7
- Insure that Pump 1 to Pump 2 chop-over inhibit is on:
    - Poke 0 into G464
    - Poke 0 into G465
    - Observe that G466.0 = 1
- Simulate Pump 1 running nearly 10 days:
    - Poke 863990 into W6
    - Observe W6 increment to 864000
    - System will not switch over to Pump 2
- Insure that chop-over inhibits becomes healthy:
    - Poke 5000 into G464
    - Poke 1000 into G465
    - Observe G466.0 = 0
    - System should switch-over to Pump 2
- Insure pump run-time is equalized
    - Poke 863990 into W7 to simulate Pump 2 running nearly 10 days
    - Observe system will not switch over to Pump 1 until W7 increments to value in W6

2.8 Pump 2 No Fault – Chop-over inhibited

- Insure that system is running normally.
- Insure that no chop-over inhibits due to conductivity will occur for now:
    - Poke 5000 into G464
    - Poke 1000 into G465
    - Observe G466.0 = 0
    - Observe G466.1 = 0
- Insure Pump 2 is running:
    - Poke 0 into W7
    - Poke 864000 into W6
- Insure that Pump 2 to Pump 1 chop-over inhibit is on:
    - Poke 0 into G464
    - Poke 0 into G465
    - Observe that G466.1 = 1
- Simulate Pump 2 running nearly 10 days:
    - Poke 863990 into W7
    - Observe W7 increment to 864000
    - System will not switch over to Pump 1
- Insure that chop-over inhibits becomes healthy:
    - Poke 5000 into G464
    - Poke 1000 into G465
    - Observe G466.1 = 0
    - System should switch-over to Pump 1
- Insure pump run-time is equalized
    - Poke 863990 into W6 to simulate Pump 1 running nearly 10 days
    - Observe system will not switch over to Pump 2 until W6 increments to value in W7

2.9 Pump 1 No Fault, No Inhibit, Normal Chop-over to Pump 2

- Insure that system is running normally.
- Insure that no chop-over inhibits due to conductivity will occur:
    - Poke 5000 into G464
    - Poke 1000 into G465
    - Observe G466.0 = 0
    - Observe G466.1 = 0
- Insure Pump 1 is running:
    - Poke 0 into W6
    - Poke 864000 into W7
- Simulate Pump 1 running nearly 10 days:
    - Poke 863990 into W6
    - Observe W6 increment to 864000
    - System will switch over to Pump 2
    - W6 and W7 will not reset to zero

2.10 Pump 2 No Fault, No Inhibit, Normal Chop-over to Pump 1

- Insure that system is running normally.
- Insure that no chop-over inhibits due to conductivity will occur:
  - Poke 5000 into G464
  - Poke 1000 into G465
  - Observe G466.0 = 0
  - Observe G466.1 = 0
- Insure Pump 2 is running, if not:
  - Poke 0 into W7
  - Poke 864000 into W6
- Simulate Pump 2 running nearly 10 days:
  - Poke 863990 into W7
  - Observe W7 increment to 864000
  - System will switch over to Pump 1
  - W6 and W7 will reset to zero

2.11 Conductivity Trip Inhibit after Pump 1 to Pump 2 Chop-Over

- Insure that system is running normally.
- Insure that no chop-over inhibits due to conductivity will occur:
  - Poke 5000 into G464
  - Poke 1000 into G465
  - Observe G466.0 = 0
  - Observe G466.1 = 0
- Insure Pump 1 is running, if not:
  - Poke 0 into W6
  - Poke 864000 into W7
- Simulate Pump 1 running nearly 10 days:
  - Poke 863990 into W6
  - Observe W6 increment to 864000
  - System will switch over to Pump 2
  - W6 and W7 will not reset to zero
  - Monitor G466.3 and verify that it stays on for 90 seconds.

2.12 Conductivity Trip Inhibit after Pump 2 to Pump 1 Chop-Over

- Insure that system is running normally.
- Insure that no chop-over inhibits due to conductivity will occur:
  - Poke 5000 into G464
  - Poke 1000 into G465
  - Observe G466.0 = 0
  - Observe G466.1 = 0
- Insure Pump 2 is running, if not:
  - Poke 0 into W7
  - Poke 864000 into W6

- Simulate Pump 2 running nearly 10 days:
    - Poke 863990 into W7
    - Observe W7 increment to 864000
    - System will switch over to Pump 1
    - W6 and W7 will reset to zero
    - Monitor G466.3 and verify that it stays on for 90 seconds.